II HAZARD IDENTIFICATION RISK ASSESSMENT

Introduction

The Hazard Identification Risk Assessment (HIRA) is a comprehensive assessment of the natural hazards that could potentially affect Pasco County and its widely dispersed communities. The communities include the six municipalities (New Port Richey, Port Richey, San Antonio, Saint Leo, Dade City and Zephyrhills), and unincorporated Pasco County. To the degree possible, the working group tried to identify specific communities affected by a hazard. In some instances, data is only available on a countywide basis, which allows the hazard to be discussed as affecting the entire county. The hazard analysis and vulnerability assessment process includes, among other facets, identifying the hazards with the highest probability of affecting the county; and which populations or communities are most vulnerable to each hazard. This information forms the basis on how the mitigation strategy is developed.

During the spring of 2009, Pasco County's Natural Hazards Analysis was updated to comply with the contemporary Federal Emergency Management Agency (FEMA) standards for the Local Mitigation Strategy (LMS) five-year updates, with this current document serving as a second update. For certain hazards an analysis provided by the Florida Division of Emergency Management (FDEM), and through a partnership with the University of Central Florida formed at the time of the 2009 update, allowed Pasco County to develop a higher level of detail related to hazard vulnerability. This document, included here as Appendix H, represents a foundation for this plan despite the fact that it is now more than five years old, includes hazards not included in the LMS, and does not include other hazards that are included in the LMS.

As part of the 2018 revision, the Local Mitigation Strategy Working Group reconsidered the overall hazards with a focus on keeping consistency with The Enhanced State of Florida Hazard Mitigation Plan 2018 and how specific hazards impacted Pasco County. Since the previous Pasco County LMS update in 2014, Pasco County's Emergency Operations Center has activated for multiple natural hazards, which in turn, allowed the committee to focus on the recent events to implement the review of the hazards both from the previously adopted LMS of 2014 and the recently updated state hazard mitigation plan. The data sources used to determine which hazards possess the greatest threat to Pasco County:

- Locally documented historical data for major events;
- FEMA declarations in which Pasco County was included;
- Conversations with subject matter experts, such as the Florida Forest Service;
- The National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) data compilations;
- Local strategic planning, emergency operations, comprehensive plans, transportation and stormwater management documents; conversations with agency or departments plan "owners;"
- Conversations and discussions with local emergency managers;
- Geographic Information Systems GIS information and data collection;
- The Enhanced State of Florida Hazard Mitigation Plan 2018;
- Internet research that included using the Hazard Analysis Toolbox provided by the Mitigation Bureau of FDEM; and

- Hazard Impact and Loss Estimation (University of Central Florida/Florida Division of Emergency Management), produced with the software called The Arbiter of Storms (TAOS).

A significant number of natural, man-made and technological hazards have been identified by FEMA Region IV for analysis and possible inclusion in our LMS. Due to the low probability associated with a number of these, Pasco County's LMS Working Group elected to discuss these minimally in this section. For hazards which posed a credible risk to Pasco County and/or any of its six municipalities, discussion includes history/background, location, vulnerability, extent (impacts) and probability.

Natural Hazard Analysis: Low Probability Hazards

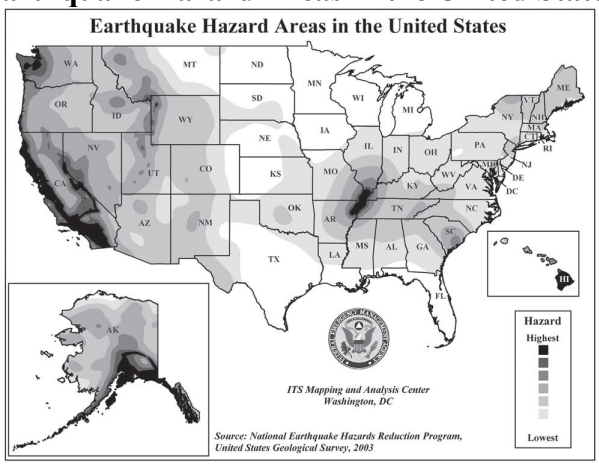
The following hazards are considered to have an extremely low probability of occurrence based on Pasco County's climate, geography, and hazard historical occurrence. For these reasons, the following "low probability hazards" should be considered omitted from the LMS plan but will still have a short explanation as they still pertain statewide and are mentioned in The Enhanced State of Florida Hazard Mitigation Plan 2018:

- Earthquakes
- Dam/Levees
- Landslides
- Tsunamis

Earthquakes

The U.S. Geological Survey, National Seismic Mapping Project (see Figure 2.1), locates Pasco County in the 1% (peak acceleration) area. Because of this very low rating and rare occurrence of earthquakes, the Pasco County Local Mitigation Strategy does not have any proposed project to mitigate against this hazard.

Figure 2.1
Earthquake Hazard Areas in the United States



***Source: Are You Ready? A Citizen's Guide to Community Preparedness*[1].**

Dam/Levee Failure

Dams are a created to retain or store liquids for various reasons that assist with energy generation, livestock, irrigation, or pollution control. Most dams are owned privately, with less than 30% of dams nationwide owned by the local, state, or federal government[2]. For the purposes of the Pasco County LMS, dams and levees exist throughout the State; however, there are no significant dams or levees in or near Pasco that warrant any proposed mitigation projects.

Landslides

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[1] https://www.fema.gov/media-library-data/20130726-1549-20490-4633/areyouready_full.pdf
[2] https://www.fema.gov/media-library-data/20130726-1845-25045-7939/fema_p_956_living_with_dams.pdf

The United States Geological Survey (USGS) defines a landslide as a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. In addition, the USGS identifies the most likely areas in the Appalachian Mountains, Rocky Mountains, the Pacific Coastal Ranges, Hawaii, and Alaska. [3] The 2018 State Hazard Mitigation Plan completed by Florida Division of Emergency Management explains that the occurrence of a landslide is extremely rare due to the State's flat terrain. Pasco County has no historical evidence of a landslide incident and does not have any active mitigation efforts devoted to landslide events.

Tsunamis

The National Oceanic Atmospheric Administration (NOAA) defines tsunamis as giant waves caused by earthquakes or volcanic eruptions under the sea[4]. The likelihood that a tsunami will impact the Gulf coast is extremely unlikely despite seismic activity in the Caribbean. The Enhance State Hazard Mitigation Plan of 2018 explains that the occurrence of a tsunami affecting the Gulf coast is minimal due to seismic stability. Pasco County has no historical evidence of a tsunami incident and does not have any active mitigation efforts devoted to tsunami mitigation.

[3] https://landslides.usgs.gov/learn/ls101.php
[4] https://oceanservice.noaa.gov/facts/tsunami.html

Natural Hazard Analysis: Moderate-to High Probability Hazards

The following hazards were identified as having previously affected Pasco County or as having the potential to do so in the future, and therefore, further analysis has been conducted. For each hazard, the most significant information related to vulnerability and impact is encapsulated at the end of this section in a summary table. As aforementioned, more detailed information from the previously mentioned TAOS study at UCF, is shown in the study results included as **Appendix H**.

Discussion of each hazard's historical occurrence and reference material is covered not only in the text within this section, but in the following appendices:

Appendix D:	Repetitive Loss Properties and Development of Repetitive Loss Areas
Appendix F:	National Climatic Data Center **(**NCDC)/NCEI Weather Data 1974-2014
Appendix G:	Documentation of HazMat Inspection Program
Appendix H:	Hazard Impact Estimated Losses
Appendix I:	*Tampa Bay Times* Article about "Sinkhole Alley"
Appendix J:	Mitigation Innovation
Appendix L:	Community Wildfire Protection Plan (CWPP)
Appendix M:	2014 Flood Information Study
Appendix O:	Commonly Used Acronyms

The reader is hereby directed to include a review of each appendix listed above in connection with its associated hazard.

Tropical Cyclones and Hurricanes

Source: NASA

Description

In accordance with the National Hurricane Center (NHC), a tropical cyclone is a rotating, organized system of clouds and thunderstorms that originates over tropical or subtropical waters and has a closed low-level circulation[5]. Tropical cyclones mainly develop over tropical waters around the world and are typically seasonal dependent which provides better lead time preparation. For Florida however, tropical cyclones typically form over the Atlantic Ocean, Caribbean Sea, or the Gulf of Mexico and move towards the State.

Tropical storms will continue to develop and intensify by moving through warm water, areas of favorable wind conditions, and areas of decreasing pressure. If one or more of these elementary components are not present, the tropical cyclone may lose intensity, or not develop at all. Tropical cyclones are more commonly referred to by their wind strength evolution, such as tropical depressions, tropical storms, hurricanes, and major hurricanes. The following define when the appropriate classification/category is used:

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[5] https://www.nhc.noaa.gov/aboutgloss.shtml#t

- Tropical Depression forms when a system meets the criteria for a tropical cyclone and has winds sustained of 38 mph or less.
- Tropical Storms are tropical cyclones with winds speeds between 39 mph -73 mph.
- Hurricanes form once the tropical cyclone reaches a wind strength of 74 mph or more and will then be categorized based on the Saffir-Simpson Hurricane Wind Scale located in Figure 2.1

Figure 2.1
Saffir-Simpson Hurricane Wind Scale:

Category	Wind Speed (mph)	Damage
1	**74 – 95**	**Very dangerous winds will produce some damage**
2	**96 – 110**	**Extremely dangerous winds will cause extensive damage**
3	**111 – 129**	**Devastating damage will occur**
4	**130 – 156**	**Catastrophic Damage will occur**
5	**156 +**	

Source: National Hurricane Center Glossary

The advances of meteorological science in identifying and tracking tropical cyclones is the primary reason for the decline in death tolls related to these systems, despite the continuous increase of coastal populations. Over the past 15 years, the NHC has been able reduce the average forecast track by half. This ultimately leads to increased success rates of official NHC advisories that include watches, warnings, and details of the tropical cyclone movement and intensity. The advisories allow local officials to make proper decisions before weather conditions become too dangerous for workers and residents of Pasco County. Figure 2.2 explains the most common advisories that may be issued for a tropical storm or hurricane[6]. Figure 2.2 only describes advisories that can be issued once the system is formed. In 2017, the NHC added an additional advisory known as the Potential Tropical Cyclone Warning to resolve this issue. This Potential Tropical Cyclone Warning will be issued when areas of tropical disturbance are expected to develop into a tropical storm or hurricane and impact land within 48 hours.

[6] https://www.nhc.noaa.gov/watchwarn_changes.shtml

Figure 2.2
National Hurricane Center Advisories

	Watch	Warning
Tropical Storm	Issued when sustained winds, as a result of a tropical cyclone, are possible between 39 – 73 mph for a specified area. Tropical Storm Watches are issued 48 hours in advance of the forecasted onset of winds.	Issued when sustained winds, as a result of a tropical cyclone, are possible 39 to 73 mph for a specified area. Tropical Storm Warnings are issued 36 hours in advance of the forecast onset of winds.
Hurricane	Issued when sustained winds, as a result of a tropical cyclone, are possible to reach 74 mph or higher for a specified area. Hurricane Watches are issued 48 hours in advance of the forecasted onset of winds.	Issued when sustained winds, as a result of a tropical cyclone, are possible to reach 74 mph or higher for a specified area. Hurricane Warnings are issued 36 hours in advance of the forecasted onset of winds.

Source: National Hurricane Center Issuance Criteria

Despite the efforts to reduce the loss of life and property, tropical cyclones remain unstable and can be unpredictable at times. As an example, in 2017, Tropical Storm Emily developed overnight leaving little to no warning for local officials to take proper preparedness actions. Luckily, this storm caused minimal damages and produced little effects. However, if Tropical Storm Emily was able to intensify to hurricane strength, if could have caused devastation for Tampa Bay shorelines and inland Counties. Tropical cyclones are one of the top significant threats to Florida and Pasco County.

As winds increase, pressure against objects is added at a disproportionate rate. Tall structures, like radio towers, can be destroyed by gusty hurricane force winds and some structures, such as mobile homes are particularly at risk. Pasco County has approximately 29,349 mobile homes registered in the County and all mobile home residents are required to evacuate in the event of a hurricane, irrespective of their location in the County.

Some severe weather hazards should be considered when dealing with tropical cyclones. Tornadoes, which are explained later in the Risk Assessment, may also be possible during a tropical cyclone. The Central Pacific Hurricane Center explains that tornadoes are strongly favored in the right-front quadrant (northeast side) of a tropical cyclone and occur mainly in the outer rain bands between 50-200 miles from the tropical cyclone center. However, some instances documents tornadic activity in the inner core or eyewall of the tropical cyclone[7]. Other severe storm hazards such as flooding, lightning, and heavy rains should be expected as a result of a tropical cyclone and they will be discussed later in the Risk Assessment.

[7] http://www.prh.noaa.gov/cphc/pages/FAQ/Hurricanes_vs_tornadoes.php

Hurricanes can bring six to twelve inches of rainfall to the area it crosses, and some have brought much more. Rainfall, in itself, will not normally require the emergency evacuation of large numbers of residents during the passage of a tropical cyclone as does storm surge and flooding. The ensuing rain, however, has the potential to slow traffic, overtax the stormwater drainage system, and hamper evacuation routes that could severely reduce the number of hours available for the overall evacuation. Flooding is a major threat to areas well inland of a tropical cyclone that may require the evacuation of coastal residents and mobile home residents. The potential wind and flood damage from a Category 5 hurricane could result in over $30 billion in damage to homes, businesses, employers and public service providers and displace almost half of the residents in Pasco County. The structures within evacuation levels A-E totals 113,862 which make up over 50% of the structures in the County.

One of the major issues that tropical storms pose other than severe weather is storm surge. Storm surge is the abnormal rise in sea level as a result of a tropical cyclone or severe storm pushing winds onshore. Storm surge is mainly located along tidal shorelines and tidal rivers in Pasco County. Storm surge can be even more destructive as it combines with high tides and high breaking waves. Generally, the more intense and closer a perpendicular track is to the coastline, the higher storm surge will be.

Storm surge intensity is not directly related to tropical cyclone intensity. Storm surge intensifies or abates based on the width and slop of the continental shelf[8]. For most cases, with a rare few exceptions, shallow continental shelf slopes produce more intense surges compared to a steeper shelf. Pasco County has a high shoaling factor (shallow water and gradual slope of the Gulf bottom) off the Central West Coast of Florida, and therefore modeling data indicated higher surges compared to other coastal counties in Florida.

In a recent study, conducted by the NHC, it was determined that 49% of deaths reported over a 50 year period were the direct result of storm surge. Six out of ten of the deadliest hurricanes reviewed in this study were Category 1 strength at landfall. The storm surge percentage supersedes all other lethal hazards associated with tropical cyclones or severe storms.[9] As previously explained in the Planning Section of this LMS, the area along the coast is heavily populated which leaves segments of Pasco County vulnerable to a passing tropical cyclone.

The National Hurricane Center utilizes Seal, Lake, and Overland Surges from Hurricanes (SLOSH) modeling to understand how vulnerable a coastline is during a storm surge event.[10]. The model incorporates physics of the storm, (track, intensity, size, forward speed, and landfall location) and continental shelf geography to determine surge inundation. Because tropical cyclones undergo constant change in physics and landfall, the SLOSH model has been further refined. The SLOSH model was refined by being run several thousand times with hypothetical hurricanes of different landfalls and intensities to provide what is called the Maximum Envelopes of Water (MEOWs)[11] and Maximum of MEOWs (MOMs)[12]. The MEOWs determine the worst case scenario for the Tampa Bay Basin for specific storm intensities, forward speeds, trajectories, and tide level with uncertainty with forecasted

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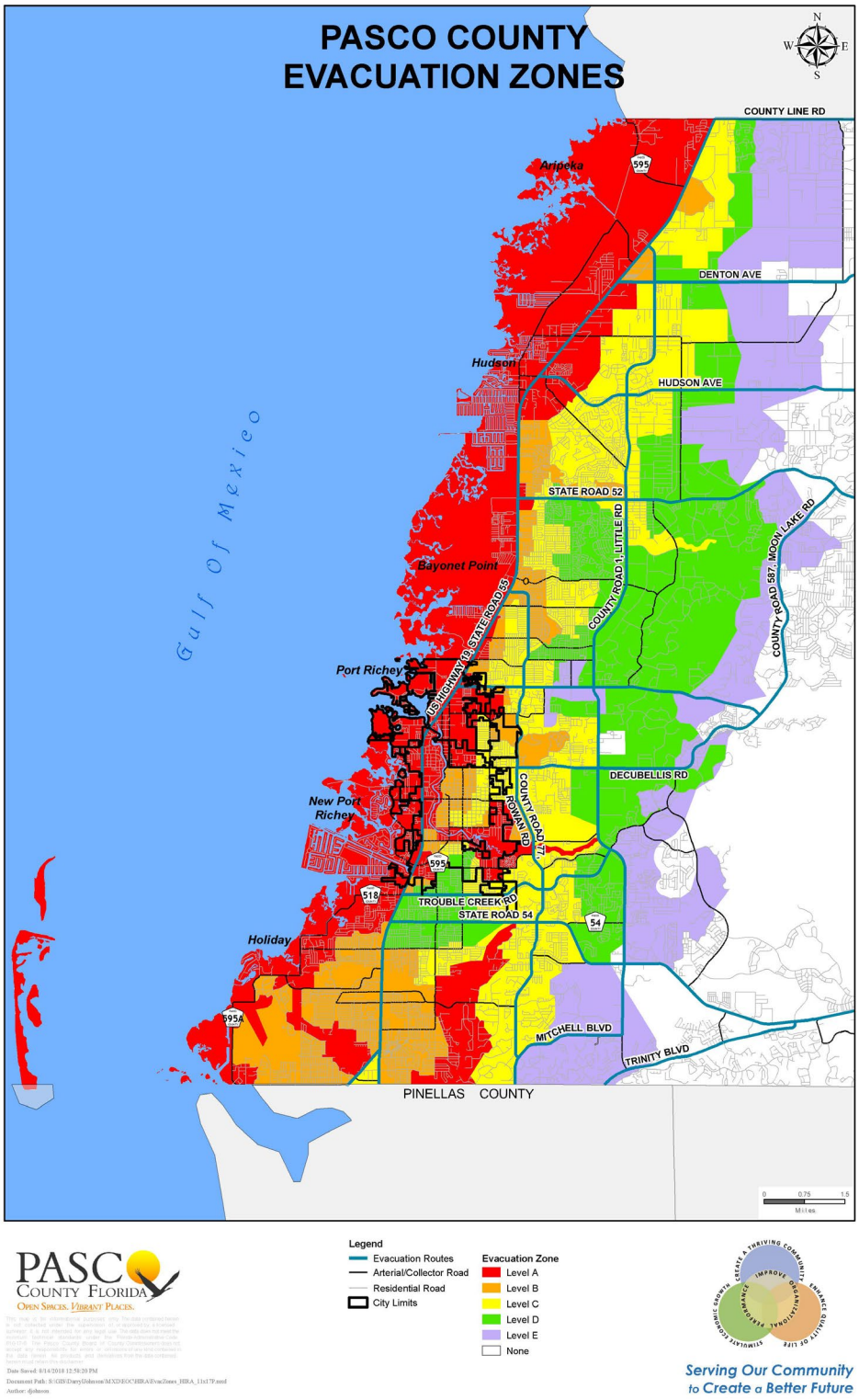
[8] https://www.nhc.noaa.gov/surge/
[9] https://journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-12-00074.1
[10] https://www.nhc.noaa.gov/surge/slosh.php
[11] https://www.nhc.noaa.gov/surge/meowOverview.php
[12] https://www.nhc.noaa.gov/surge/momOverview.php

landfall location. The MOMs determine the worst case scenario for the Tampa Bay Basin for particular intensity, forward speed, trajectory, and tide for the ***"****perfect****"*** forecast. The combination with the MEOWs and MOMs of the SLOSH model account for forecast uncertainty. This refined version of SLOSH and other appropriate modeling data from the Tampa Bay Regional Planning Council are part of the development for Pasco County evacuation zones. Figure 2.3 shows the current evacuation zones for Pasco County and will be used as a planning tool for public officials during tropical cyclone events, or severe weather that causes possible surge inundation.

Figure 2.3
Pasco County Evacuation Zones of 2018



Source: Pasco County GIS and Pasco County Disaster Planning Guide 2018

Historical Occurrence

According to the NOAA coastal services center website, 31 tropical cyclones of different strengths have crossed through Pasco County since 1872 with 15 tropical cyclones reported since 1950. Of these, in 1980 Tropical Depression 14 is argued to be the only tropical cyclone that made landfall in Pasco County[13]. There is a bit of controversy regarding Tropical Depression 14 as there are no official landfall reports from NHC for this system. Unofficial reports explain that the remnants of Tropical Depression 14 moved through central and north Florida. However, the official track reported by National Oceanic and Atmospheric Administration (NOAA) does show Tropical Depression 14 passing through Pinellas County waters and making landfall somewhere in New Port Richey as a Tropical Depression.

Most recently, tropical cyclones that traveled within 50 miles of Pasco County or required a Pasco County Emergency Operation Center activation to at least a Level 2 can be seen in Figure 2.4. Tropical cyclone activity increased over the past five years. Since 2012, the following seven tropical storms impacted Pasco County: Tropical Storm Debby, Tropical Storm Colin, Hurricane Hermine, Tropical Storm Julia, Hurricane Matthew, Tropical Storm Emily, and Hurricane Irma. The impacts of these storms mainly affected the coastal portions of Pasco County but this is not always the case. During Hurricane Irma, the eye of the storm traveled south to north directly between US 301 and I-75. The impacts countywide were mainly wind damages on homes, trees, weak utility infrastructure, and flooding in Special Flood Hazard Areas and surge inundation zones. Despite the increase in tropical cyclones over the last five years causing the County to prepare, respond, and recover, effects have been moderate compared to the predicted estimates based on Hurricane Hermine and Hurricane Irma's forecasted track. Tropical Storm Debby, Hurricane Hermine, and Hurricane Irma impacted Pasco County enough to meet the financial threshold for a Presidential Declaration for each storm.

Other notable storms that impacted Pasco and still remain a part of conversation when preparing for Hurricane Seasons are the No Name Storm of 1993, which was part of a strong cold front that brought dangerous storm surge and winds to Pasco County, and Hurricanes Charley, Frances, and Jeanne in 2004; all three of these back to back hurricanes skirted Pasco County. While each event was classified as a hurricane, Pasco County's impact was limited to tropical storm force winds. Nevertheless, the County documented approximately $5 million in damages, of which $3.5 million was directly related to debris collection and disposal.

Due to the increasing threat of tropical cyclone development and hurricane season, the threat of a hurricane impacting Pasco County occurs annually. The economic impacts associated with tropical cyclones (both emergency response costs associated with warnings and damage from impact) have totaled millions of dollars.

[13] https://coast.noaa.gov/hurricanes/

Figure 2.4
Pasco County Tropical Cyclones Since 1950

Storm Start Date			Storm Name	Storm Peak Wind Speed (knots)	Storm Peak Category	Pasco Impacted Wind Speed	Pasco Impacted Category
Year	Month	Day					
1950	10	14	King	115		65	H1
1950	9	1	Easy	105	H3	100	H3
1959	6	18	Not Named	75	H1	30	TD
1960	8	31	Donna	125	H4	105	H3
1960	7	28	Brenda	60	TS	30	TD
1960	9	23	Florence	50	TS	25	TD
1964	6	2	Not Named	50	TS	30	TD
1968	10	15	Gladys	75	H1	70	H1
1969	10	2	Jenny	40	TS	25	TD
1970	5	20	Alma	70	H1	25	TD
1974	6	25	Subtrop 1	55	SS	45	SS
1976	9	13	Subtrop 3	40	TS	15	SD
1982	6	18	Subtrop 1	60	TS	30	SD
1984	9	26	Isidore	50	TS	45	TS
1988	11	20	Keith	60	TS	55	TS
1990	10	10	Marco	55	TS	40	TS
1991	7	1	Ana	45	TS	20	L
1995	8	2	Erin	85	H2	50	TS
1995	8	23	Jerry	35	TS	35	TS
2000	9	16	Gordon	70	H1	65	H1
2001	9	15	Gabrielle	70	H1	45	TS
2002	9	2	Edouard	55	TS	20	TD
2003	9	6	Henri	50	TS	30	TD
2004	8	10	Charley	130	H4	75	H1
2004	8	25	Frances	125	H4	55	TS
2004	9	14	Jeanne	105	H3	55	TS
2005	10	24	Dennis	130	H4	34	TS
2006	6	11	Alberto	60	TS	37	TS
2007	6	1	Barry	50	TS	40	TS
2008	8	15	Fay	60	TS	36	TS
2012	6	23	Debby	55	TS	35	TS
2016	6	6	Colin	50	TS	44	TS
2016	8	31	Hermine	46	TS	70	H1
2016	9	13	Julia	45	TS	-	-
2016	9	28	Matthew	145	H5	34	TS
2017	7	31	Emily	50	TS	Less than 34	-
2017	8	30	Irma	155	H5	65	H1

Source: NOAA Office for Coastal Management

Vulnerability

Pasco County is considered highly vulnerable to tropical cyclones given the climatology for tropical storm development, coastal population, the population age, and the history of events. The number of people affected by tropical cyclones is significant, the economic costs are high, the likelihood of tropical cyclones is moderate, and the vulnerability is high. The majority of buildings and infrastructure in the County are vulnerable to major hurricanes. .

A large portion of Pasco County's non-mobile home housing stock consists of older and less substantially constructed homes built before the Florida Building Code enacted in 1994. These structures would be vulnerable to wind events and are more likely to suffer damage in the case of a major disaster. Countywide, approximately 56% of all recorded structures were built before the Florida Building Code was enacted. A majority (56.2%) of these structures are residential units, while approximately 41,000 are mobile homes and recreational vehicles. The criteria used for identifying the least, moderate and most vulnerable to wind to represent vulnerability percentages on structure year in Figure 2.5.

Figure 2.5
Wind Vulnerability Categories for Structures Built by Year

Category	Structure Effective Year Built Range
Least Vulnerable	Built from 2002 to present
Moderately	Built from 1994 to 2001
Most	Built prior to 1994

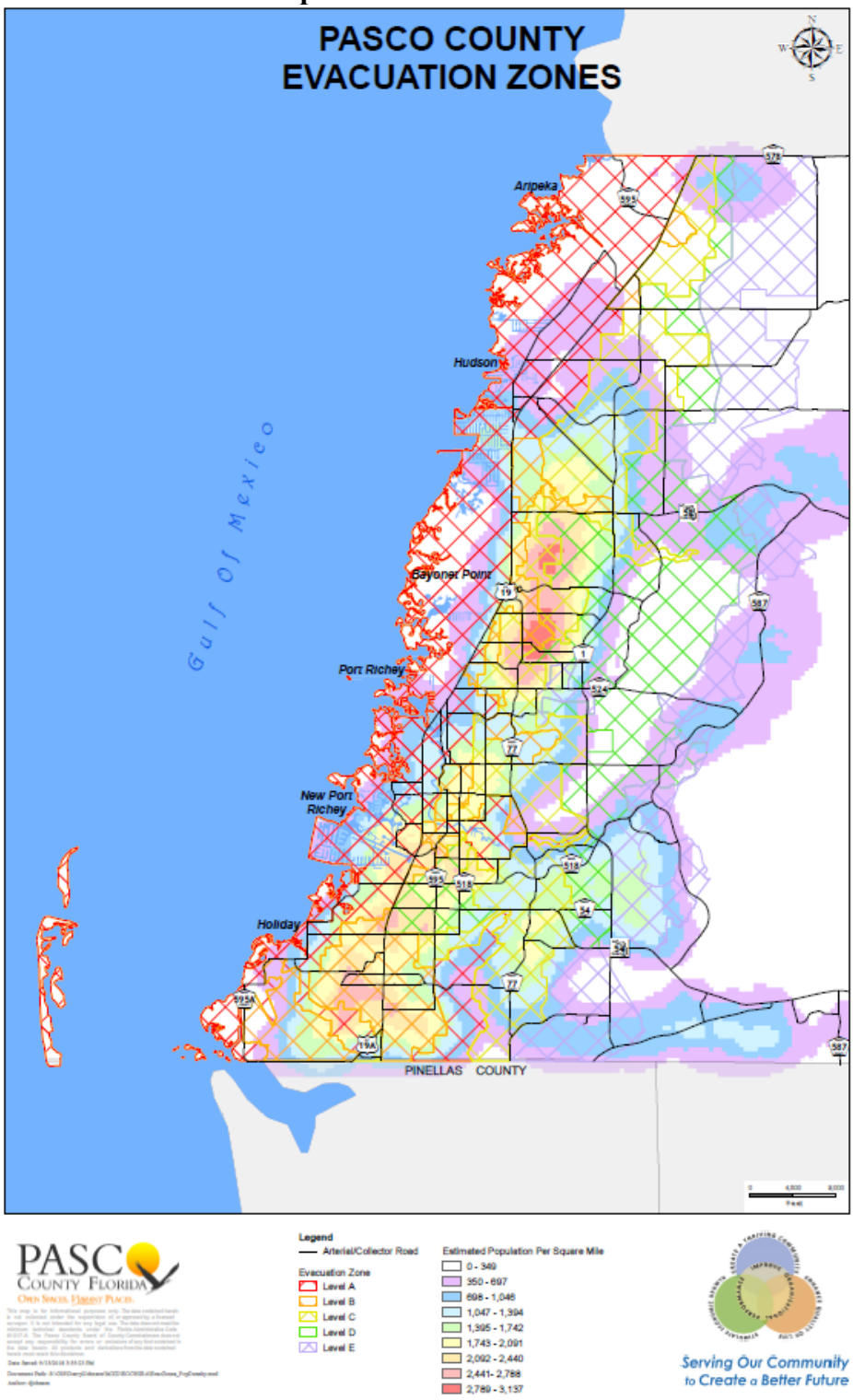
Year Built	Residential Buildings (Single Family or Multi Use)	Non-Residential Buildings (Non-Single Family or Multi Use)	Total by Year Built
Built Prior to 1994	98,578 (95.3%)	4,856 (4.7%)	103,434 (100%)
Built from 1994 to 2001	21,336 (97.0%)	665 (3.0%)	22,001 (100%)
Built 2002 and later	55,504 (96.9%)	1,773 (3.1%)	57,277 (100%)
Non-Mobile Home Total	175,418 (96.0%)	7,294 (4.0%)	182,712 (100%)
Countywide Mobile Homes (including rentals)	41,548	-	41,548

Source: Pasco County Property Appraiser's Data and GIS Data

New construction is required to be built to withstand the impact of wind-borne debris and to include appropriate window protection (shutters or shatter-resistant glass). Both as a result of changes in Florida are building code and the County's participation in the NFIP and Community Rating System, Pasco County strictly and consistently applies higher standards required by the construction codes. It is generally anticipated that, with strict application of building codes, future development will have less susceptibility to damages from the effects of tropical cyclones.

Focusing on Pasco County, Figure 2.6 shows the estimated population vulnerability for storm surge inundation for categories 1-5.

Figure 2.6
Estimated Population within Evacuation Zones



Source: Pasco County Property Appraiser and GIS Data

Figure 2.6 shows that the highest population concentrations estimate around 3,000 people per square mile located primarily in Regency Park, Jasmine Lakes, and Timber Oaks areas. They would most likely be impacted during a Category 2 or 3 storm due to surrounding waters, elevation, and distance from the coastline. The area east of US 19 shows an average population of 1,000 people or less per

square mile which is enough to cause major issues during a Category 1 storm. For Hurricane Irma, the storm surge threat forced local officials to evacuate the areas east of US 19. Furthermore, Hurricane Hermine brought Category 1 storm surge onshore for the coastal communities in Holiday, New Port Richey, Port Richey, and Hudson.

History and map overlays show a high vulnerability for a large portion of Pasco County's population for storm surge In addition, Pasco County still has many older homes that were not required to meet the new Florida Building Code standards, which represents a high vulnerability of homes inland.

Pasco County not only has older homes, but it has a high number of mobile home parks. Mobile Home Parks are the most vulnerable to both wind and surge hazards associated with tropical cyclones. Property records of the Pasco County Property Appraiser's Office indicate that there are 245 mobile home and recreational vehicle parks in Pasco County. Of these, 46 are located in Dade City, 107 are located in Zephyrhills, and 13 are in Wesley Chapel. On the west side of Pasco County, 7 are located in Holiday, 37 are in Hudson, 36 are in New Port Richey, and 13 are in Port Richey. In the central part of Pasco County, there are also a considerable number of parks With 16 in Land O' Lakes, and another seven located in Spring Hill.

Approximately 22,980 parcels throughout Pasco County are occupied by mobile homes or recreational vehicles. This constitutes a high percentage of the county's affordable housing stock. Figure 2.7 shows the large number of mobile homes located within high hazard zones. Approximately 6,399 of these properties in the high hazard zones are likely to be uninhabitable after a major storm.

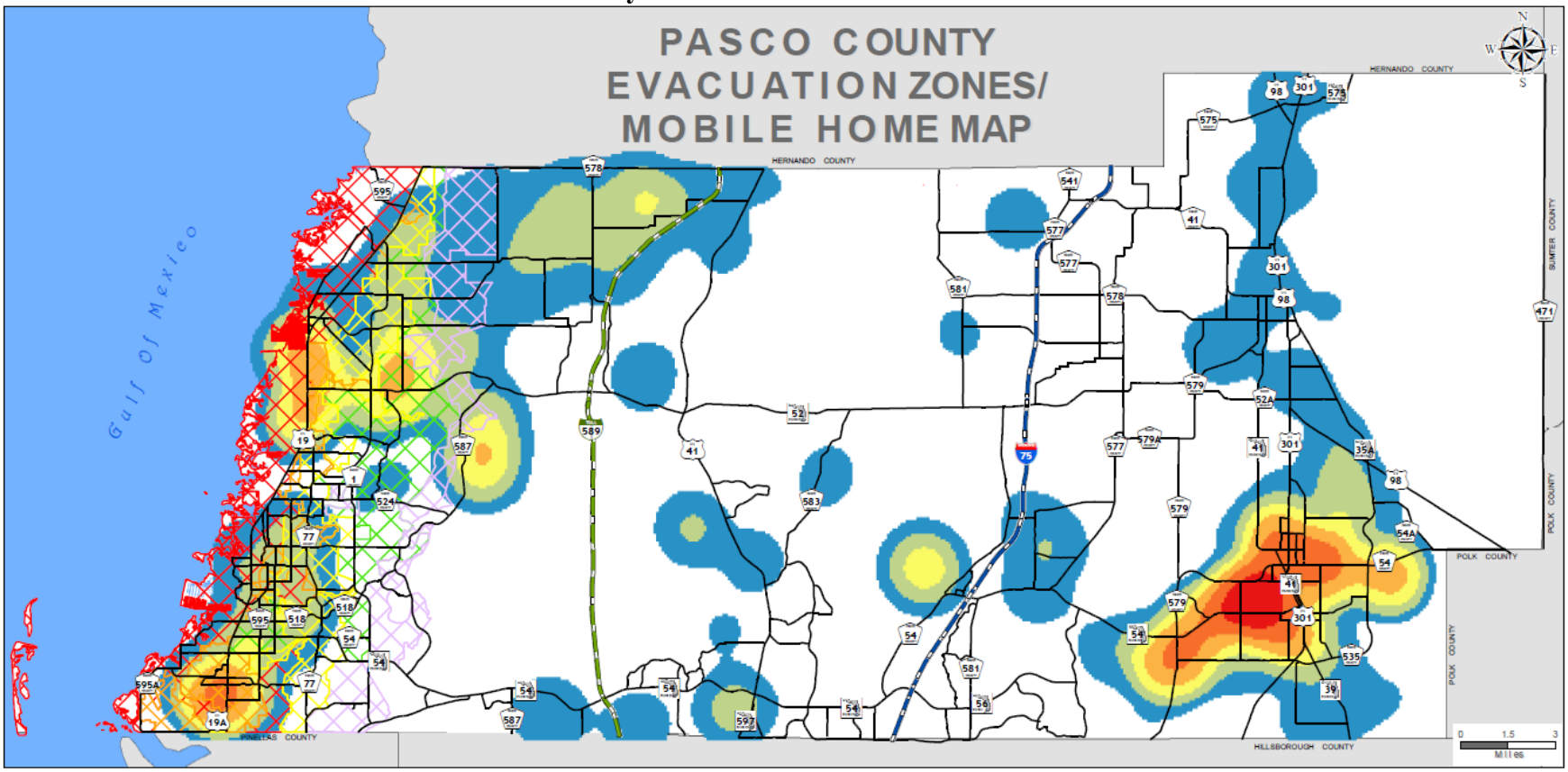
Figure 2.7
Mobile Home Units within Evacuation Zones and Flood Zones

Storm Surge/Flood Zone	Mobile Homes Within Mobile Home Parks	Mobile Homes Outside Mobile Home Parks
Flood Zone A	963	105
Flood Zone AE	3,864	269
Flood Zone VE	72	2
Flood Zone X (0.2%)	1,240	13
Evacuation Zone A	2,249	48
Evacuation Zone B	2,807	2
Evacuation Zone C	1618	5
Evacuation Zone D	1,592	28
Evacuation Zone E	562	29

Source: Pasco County Property Appraiser's Office and GIS Data

Figure 2.8 shows the mobile home density countywide overlaid with the Evacuation Zones, represented by the hatched boxes. A large portion of the mobile homes in Pasco County reside within an Evacuation Zone. This shows how vulnerable the mobile home community is during a tropical cyclone event. Furthermore, the last few tropical cyclones that approached Pasco County forced local officials to recommend evacuations for mobile homes countywide because of their extreme vulnerability to high wind.

Figure 2.8
Pasco County Mobile Homes in Evacuation Zones



PASCO COUNTY FLORIDA
OPEN SPACES. VIBRANT PLACES.

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Document Path: S:\GIS\DarryJohnson\MXD\EOC\HIRA\EvacZones_MobileHome_HEAT_Map.mxd
Author: djohnson

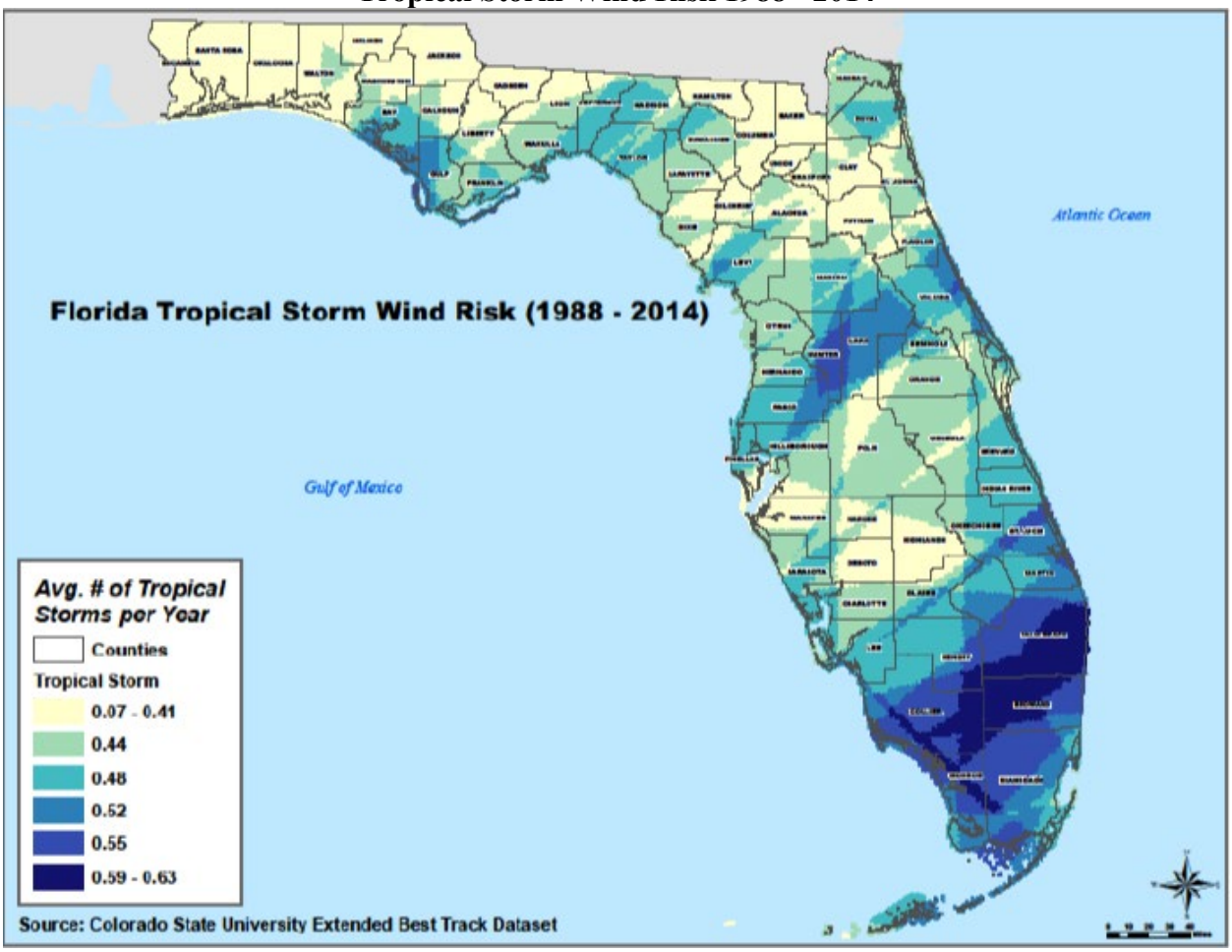
Serving Our Community to Create a Better Future

Source: Pasco County Property Appraiser and GIS

Probability

The renowned researchers at the Department of Atmospheric Science of Colorado State University, as obtained from the 2018 State Hazard Mitigation Plan[14], created the probabilities for both tropical storms and hurricanes impacting the State of Florida. This information was taken from 26 years' worth of data and the outputs are located in Figure 2.9 and Figure 2.10. Pasco County is likely to experience 0.48 tropical storms per year west of Interstate 75 and 0.52 tropical storms per year east of Interstate 75. Pasco County is also likely to experience 0.07 hurricanes each year west of US 19 and 0.04 hurricanes each year east of US 19. The 2018 State Hazard Mitigation Plan explains the probabilities of tropical cyclones further and is described in Figure 2.11.

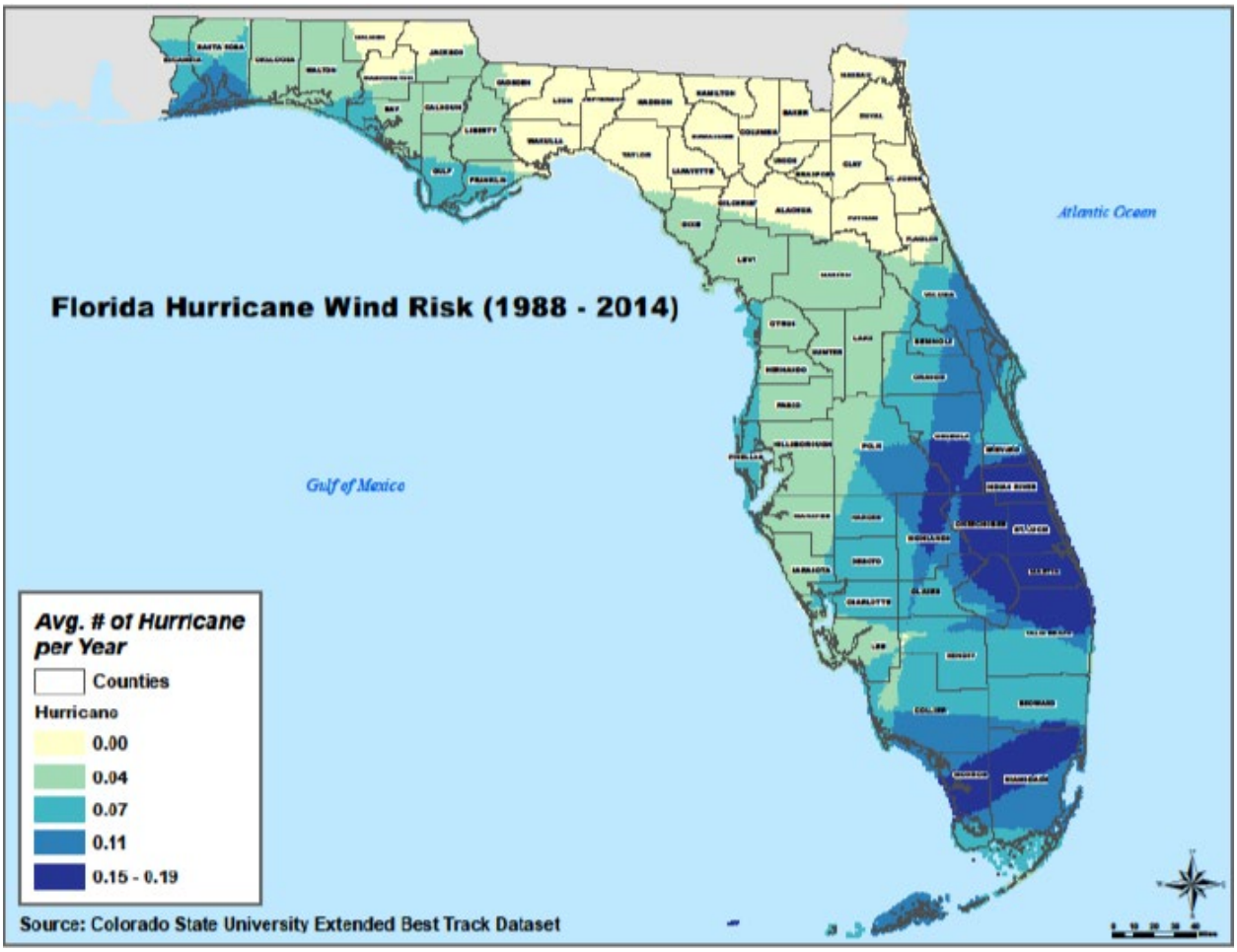
Figure 2.9
Tropical Storm Wind Risk 1988 - 2014



Source: 2018 State Hazard Mitigation Plan

[14] https://www.floridadisaster.org/globalassets/dem/mitigation/mitigate-fl--shmp/shmp-2018-full_final_approved.6.11.2018.pdf

Figure 2.10
Hurricane Wind Risk 1988-2014



Source: 2018 State Hazard Mitigation Plan

Figure 2.11
Expected Tropical Cyclone Wind Strengths by Specific Intervals

Recurrence Interval	Highest Likelihood of Wind Strength
Every 10 Years	Tropical Storm Winds
Every 20 Years	Category 1 Hurricane Winds
Every 50 Years	Category 2 Hurricane Winds
Every 100 Years	Category 3 Hurricane Winds – West of US 41
	Category 2 Hurricane Winds – East of US 41

Source: 2018 State Hazard Mitigation Plan

Pasco County's 50-year probabilities for tropical cyclone activity are as follows: 61.5% chance of at least one named storm making landfall in the county, 28.0% chance of at least one hurricane making landfall, and 16.6% chance of one or more intense hurricanes making landfall.

Based upon the high probability for tropical cyclones and the recent activity in the past five years, Pasco County can expect tropical cyclone activity to activate the County Emergency Operations Center at least once a year. Recent history indicates that we can expect a storm to affect our county every two to three years, and the most likely event will be a Category 3 or

lesser storm. However, the threat of a hurricane impacting Pasco County occurs annually. The United States land falling hurricane web project has been co-developed by William Gray's Tropical Meteorology Research Project at Colorado State University and the GeoGraphics Laboratory at Bridgewater State College[15].

Climatology data and probability assessments generated by the National Weather Service, with a regional office located 60 miles away in neighboring Hillsborough County, are shown in Figure 2.12, Figure 2.13, Figure 2.14, Figure 2.15, and Figure 2.16.

Figure 2.12
Current State Data (Climatology in Parentheses)

State	Probability of Hurricane Impact	Probability of Major Hurricane Impact
Florida	38.0% (51.0%)	14.6% (21.0%)

Source: Colorado State University and Bridgewater State University

Figure 2.13
Current Regional Data (Climatology in Parentheses), Including Pasco County

Region Number	Probability of 1 or More Named Storms Making Landfall in the Region	Probability of 1 or More Hurricanes Making Landfall in the Region	Probability of 1 or More Intense Hurricanes Making Landfall in the Region
5	15.0% (21.6%)	5.5% (8.1%)	3.1% (4.6%)

Source: Colorado State University and Bridgewater State University

Figure 2.14
Current County Data (Climatology in Parentheses):

County	Probability of 1+ Named Storms Making Landfall	Probability of 1+ Hurricanes Making Landfall	Probability of 1+ Hurricanes Making Landfall	Probability of Tropical Storm-Force (>= 40 mph) Wind Gusts	Probability of Hurricane-Force (75+ mph) Wind Gusts	Probability of Intense Hurricane-Force (>= 115 mph) Wind Gusts
Pasco	1.3% (1.9%)	0.4% (0.7%)	0.2% (0.4%)	11.8% (17.1%)	3.4% (5.0%)	1.1% (1.6%)

Source: Colorado State University and Bridgewater State University

Figure 2.15
50-Year Regional Data Probabilities

Region Number	50 Year Probability of 1 or More Named Storms Making Landfall	50 Year Probability of 1 or More Hurricanes Making Landfall	50 Year Probability of 1 or More Intense Hurricanes Making Landfall
5	>99.9%	98.8%	90.9%

Source: Colorado State University and Bridgewater State University

[15] http://landfalldisplay.geolabvirtualmaps.com/

Figure 2.16
50-Year County Data Probabilities

County	50-Year Probability of 1+Named Storms Making Landfall	50-Year Probability of 1 or More Hurricanes Making Landfall	50-Year Probability of 1 or More Intense Hurricanes Making Landfall	50-Year Probability of Tropical Storm-Force (40+ mph) Wind Gusts	50 Year Probability of Hurricane-Force (75+ mph) Wind Gusts	50-Year Probability of Intense Hurricane-Force (115+ mph) Wind Gusts
Pasco	61.5%	28.0%	16.6%	>99.9%	92.7%	55.4%

Source: Colorado State University and Bridgewater State University

Extent

Following the direct impact of a hurricane many residents will be unable to return to their homes. Many mobile/manufactured homes will be destroyed and repairs to other homes that are uninhabitable may take weeks or months to complete. Some may choose to never return to their homes as seen in Hurricane Andrew and Hurricane Katrina. The economic impact will vary greatly. Many small businesses will close forever while others will prosper. Home repair, carpet and appliance businesses will experience short-term increases in business. Other businesses, particularly those associated with tourism or real estate sales, will see significant declines, potentially for the long term.

Based on the previously shown evacuation zones in Figure 2.8, the information goes into effect based on the anticipated extent of the event. Wind velocity during a mild storm can be relatively light, with 0-40 miles per hour (mph) considered average winds for a normal storm. Evacuation Levels A through E correspond as a guide that incorporates evacuation times, potential surge heights, and tide heights that correspond to the intensity of the tropical cyclone. A larger version of this evacuation map is located on the Emergency Management page on the Pasco County website[16].

[16] www.pascocountyfl.net

Severe Storms

Source: USA Today

Description

Thunderstorms

Thunderstorms are likely to occur daily during the summer months in Pasco County and infrequently during the fall and winter months. A thunderstorm is defined as a rain shower that produces thunder and is not always considered "severe." An annual estimate of 16 million thunderstorms occurs worldwide, with approximately 100,000 occurring in the United States. Ten percent of the annual rate meets severe storm criteria defined by The National Weather Service. The National Weather Service defines a severe thunderstorm as one which produces winds of 58 mph or greater, ¾ inch hail or larger and/or tornadoes[17]. Severe storms disrupt daily lives more than any other form of weather or natural hazard described in this Risk Assessment Section.

Three conditions need to be present to create a thunderstorm which will become more intense as each condition present is more abundant[18]:

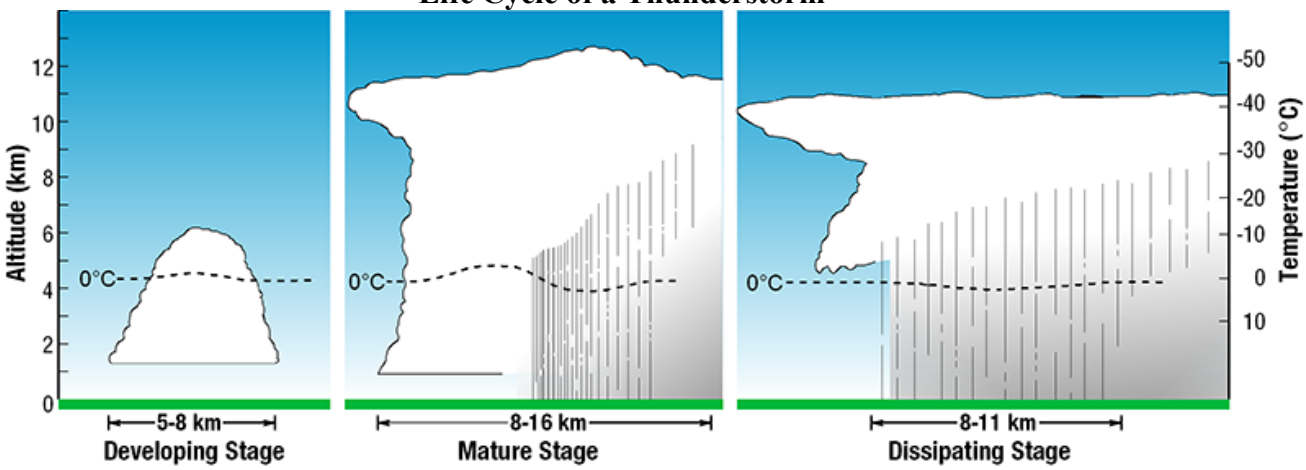
1. Moisture;
2. Rising unstable air; and
3. A mechanism to lift and initiate the rising of unstable air

Thunderstorms have a three stage life cycle: the developing stage, mature stage, and dissipating stage, see Figure 2.17. The developing stage consists of the three conditions present and clouds

[17] https://www.noaa.gov/explainers/severe-storms
[18] https://www.nssl.noaa.gov/education/svrwx101/thunderstorms/

forming due to the warm air moving vertically from the earth's surface (also known as an updraft). As the air moved higher in the atmosphere, the air surrounding the updraft cools and the moisture condenses into water droplets and ice particles suspended around the updraft resulting in a cloud. Once the thunderstorm moves into the mature stage rain begins to fall outside the updraft resulting in a downdraft, while moisture continues to feed the updraft. The mature stage of the thunderstorm produces high wind gusts, hail, and possible tornadoes making it the most dangerous portion of the thunderstorm cycle. Eventually, the rainfall will increase greatly and as a result widen the downdraft. This initiates the dissipating stage where the thunderstorm no longer receives fuel and becomes less intense and the thunderstorm begins subsiding.

Figure 2.17
Life Cycle of a Thunderstorm



Source: National Oceanic Atmospheric Association

Thunderstorms have different types and can be classified based on the development in its life cycle and the three conditions. Understanding the different types can further the understanding of what severe criteria are possible and how they may affect Pasco County. There are many types of thunderstorms, but this plan will focus on the four main types that affect the County.

The first and most common type for Pasco County are called "single-cell thunderstorms" and are also referred to as popcorn convective storms. These are generally small, weak, and last less than an hour. These storms are driven by summertime heat across the inland portions of the County.

A multi-cell storm is also common and contains multiple single-celled storms that combine allowing the mature stage of the thunderstorms to extend as updrafts remain ahead of the rainfall. Multi-cell thunderstorms may last a few hours and have the potential to produce strong winds, brief tornadoes, and flooding.

Squall lines thunderstorms are possible, especially along frontal boundaries. This type of thunderstorm produces storms that arrange in a line and moves quickly through areas. Because of its forward speed, they are less likely to produce tornadoes, but may cause damage due to strong winds. Squall lines can be as large as hundreds of miles to as small as ten miles wide.

The final thunderstorm type that will be discussed is the supercell. Supercells are one of the most organized thunderstorms and occur mostly in the late afternoon and evening and can live through the overnight hours. This type of thunderstorm is one of the most dangerous types due to the timing of impact and intensity. Supercells often produce large hail, heavy rainfall, and strong gusty winds. In

addition, supercells have produced the strongest tornadoes because of the tilting of the updraft and storm rotation.

When it comes to severe weather, the majority of the hazards stem from thunderstorms of various types and sizes. Impacts from severe storms will be defined for each hazard that are a result, which include lighning, hail, tornadoes/waterspouts, and straight-lined wind.

Lightning

Severe storms are determined based on hail, strong winds, and tornadoes. However, lightning is a deadly element that occurs even in the weakest thunderstorms. Lightning strikes the United States approximately 25 million times a year. It is also deadly because lightning is a giant spark of electricity in the atmosphere between clouds, the air, or the ground[19]. It is visible result of electrical buildup and discharge of energy, and it produces an audible result of thunder. Thunder is the rapid heating of the air that creates a shockwave. The energy produced in lightning can be detrimental to property, humans, and livestock. Lightning does not necessarily need to strike someone to cause injury or death; it may strike trees, poles, homes, or other mediums which can cause secondary impacts. Some of the secondary impacts lead to sparking wildfires, poweroutrages, damages to homes, and damage to trees lead to downed branches making roads impassible.

Lightning can also strike directly within a storm, but can still strike areas miles from the center of a storm. Scientists do not understand yet exactly how it works or how it interacts with the upper atmosphere or the Earth's electromagnetic field. Lightning is one of the oldest observed natural phenomena on Earth, seen in volcanic eruptions, intense forest fires, surface nuclear detonations, heavy snowstorms, in hurricanes, and in thunderstorms. NOAA's partner in forecasting, the National Weather Service, reminds people of its danger because "each spark of lightning can reach over five miles in length, soar to temperatures of approximately 50,000 degrees Fahrenheit, and contain 100 million electrical volts."

Hail

The presence of hail indicates that a strong multi-celled or super celled system is moving through the area because hail is a result of a strong updraft in a mature thunderstorm. As the rain becomes heavy and falls to the ground, the updraft overtakes its falling speed and lifts it back into the air where cold air freezes the rain drop and/or adds an additional layer of ice to the droplet. The ice pellet will continue to fall and rise within the cloud until it is heavy enough to fall to the ground. Larger hail has the ability to cause property damage and cause injury to humans and other livestock[20]. It essentially becomes a projectile missile falling from the sky at high rates of speed. Some examples of impacts to Pasco County are damaged windshields to vehicles and damaged solar panels for residents and businesses. Pasco County has a plethora of outdoor activities from golf, parks, and outdoor water parks. Residents partaking would be extremely vulnerable to injury and potential death from large hail. The National Weather Service utilizes the 1" diameter, or the size of a quarter to determine severity and potential damage.

[19] https://www.nssl.noaa.gov/education/svrwx101/lightning/faq/
[20] https://www.nssl.noaa.gov/education/svrwx101/hail/

Tornadoes

Tornadoes are one of the most dangerous hazards associated with strong thunderstorms. Tornadoes are violently rotating column of air that extend from the base of thunderstorms to the ground[21]. Tornadoes can form from non-supercell thunderstorms and supercell thunderstorms[22]. Non-supercell tornadoes are a result of warm and cold air mixing along a boundary which causes vertical rotation that can be bumped upright and form a tornado. The supercell tornado forms when the updraft in a supercell rotates and is more common and dangerous than a non-supercell tornado.

Tornadoes occur worldwide, but the majority of tornadoes occur in the United States when the cooler air from the Rocky Mountains to the west, meets the warmer air from the Gulf of Mexico to the south, in the downward slope across the Great Plains from west to east. This is the best combination of a warm humid climate and cool dry climate collision that provides enough near ground rotation to fuel tornadoes. As conditions are mainly produced in the Great Plains, some atmospheric dynamics can push this setup towards the Southeast United States causing threats to Florida and Pasco County specifically. The most likely time for the states along the Gulf of Mexico is during early spring, although they can occur all year long[23].

Unlike the Great Plains violent summertime tornado outbreaks, waterspouts and tornadoes are more likely to form in Pasco County during the winter months. Even though Pasco County's tornadic activity rarely makes national headlines, the historical and potential damage remains high from a local perspective. Weak tornadoes can produce winds speeds up to 110 mph which can potentially damage the older homes that do not meet current building codes. Furthermore, damage is not limited to the center of a tornado's path, it can extent outward and create secondary effects.

Tornadoes are categorized by the Enhanced Fujita (EF) scale, which is an upgrade to the original Fujita (F) scale in 2007. The older F scale relied solely on damages to report severity of a tornado. With advancements in technology and research, the F scale was revised to the EF scale to allow for damaged structures based on types and revised wind speeds. See Figure 2.8 for the relation of the EF scale, the F scale, and potential damages. The EF Scale has been created to support and maintain the original tornado F scale database[24].

[21] https://www.nssl.noaa.gov/education/svrwx101/tornadoes/
[22] https://www.nssl.noaa.gov/education/svrwx101/tornadoes/types/
[23] https://www.nationalgeographic.com/environment/natural-disasters/tornadoes/
[24] https://www.spc.noaa.gov/efscale/

Figure 2.18
Fujita and Enhanced Fujita Scale Comparison

F Scale	Wind Speed (mph)	EF Scale	Wind Speed (mph)	Anticipated Damage
F0	65-73	**EF0**	65-85	**Light Damage**
F1	73-112	**EF1**	86-110	**Moderate Damage**
F2	113-157	**EF2**	111-135	**Considerable Damage**
F3	158-206	**EF3**	136-165	**Severe Damage**
F4	207-260	**EF4**	166-200	**Devastating Damage**
F5	261-318	**EF5**	200+	**Incredible Damage**

Source: Storm Prediction Center

The National Weather Service produces official weather watches and warnings for both tornadoes and severe thunderstorms in the United States. Please note that there is difference between a watch and a warning for these severe weather phenomena as identified in Figure 2.19. A watch indicates that there is a potential for severe thunderstorms or tornadoes to develop and is simply a tool for the public and local officials to *be prepared* to seek shelter at a moment's notice. A warning indicates that a severe thunderstorm or tornado imminent to the defined area or is already occurring in the defined area through trained weather spotters or Doppler radar. The public and local officials must be ready to *take action* when issued.

Figure 2.19
Watch vs Warning for Severe Thunderstorms and Tornadoes

	Watch	Warning
Severe Thunderstorm	Issued in coordination with the National Weather Service and the Storm Prediction Center and can be issued up to 6 to 7 hours prior to possible occurrence: Conditions are favorable for the development of severe thunderstorms and would meet the criteria of a Severe Thunderstorm Warning	Issued by the National Weather Service based on the imminent threat or actual occurrence of 1 inch or greater diameter hail; 58 mph or greater wind gusts, or damage from winds 58 mph or greater
Tornado	Issued in coordination with the National Weather Service and the Storm Prediction Center and can be issued up to 6 to 7 hours prior to possible occurrence: Atmospheric conditions are favorable for the development of severe thunderstorms capable of producing tornadoes	Issued by the National Weather Service based on the imminent threat of a tornado, based on sound radar data or trusted ground truth reports.

Source: The National Weather Service

Tornado warning and watches are a subset of a severe thunderstorm because a tornado does not occur without a thunderstorm. There are times where reported damages are misinterpreted as tornado damage because severe thunderstorms can produce damaging wind gusts of 58 mph or higher. In order to lessen confusion, strong winds not associated with tornadoes are called "straight-line" winds. See straight-line wind after waterspouts.

Waterspout

The states surrounding the Gulf of Mexico experience unique weather phenomena of tornadoes over water which are also known as waterspouts[25]. These are just as dangerous as tornadoes on land as waterspouts can produce similar damages to boats, marinas, and increase wave action. Waterspouts are most common in Florida. The Florida Keys are the number one location with annual reports of up to 500[26]. Closer to home, the Tampa Bay Region has the greatest number of damaging waterspouts. This may be attributed to the high number of boaters and marinas located throughout the Bay. The weakest waterspouts have the ability to capsize small boats, move smaller boats into other boats within a marina, and potentially damage weaker and older docks.

Straight-Line Winds and Strong Wind Gusts

Straight-line winds account for about half of all severe weather reports in the Continental United States[27]. Straight line winds would be the most common result from a severe thunderstorm as this is often the trigger for the thunderstorm warning. In Pasco County, winds that meet 58 mph or greater can cuase great impact to property damage. Often, straight-line wind events are easily confused with tornadic damage because of similar impacts. Straight-line winds can cause minor damage of uprooting of trees and downed tree branches that may cascade to secondary impacts. Some of the secondary impacts could be loss of power or vehicle travel in localized areas. As the winds increases, damage potential increases. Previous straight-line wind events in Pasco have shown a loss in roofing, siding, shingles, lanais, and more.

Combining straight-line winds along the coastline of Pasco County may intensify a severe thunderstorm even further by producing additional effects of a coastal storm. Larger waves and potential storm surge may result from this combination. Storm surge is mainly driven by wind but is mostly associated with tropical cyclones. In a tropical cyclone, many of the rain bands can form different severe storms which can explain tornado warnings issued during the passing of a tropical cyclone.

The area west of US 19 is designated as a wind-borne debris region and is subject to wind gusts between 140 to 150 mph from severe weather. The remainder of the western half of the county is a 120 mph basic wind speed zone. The eastern half of the county is in the 110 mph basic wind speed zone. Figure 2.20 shows the degree to which damage from wind-borne debris may accompany tropical cyclones or severe storms affecting the county[28]. Note that the portion of county identified as being potentially exposed to severe winds was expanded in the 2010 forecast, shown by the green striped region.

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[25] http://glossary.ametsoc.org/wiki/Waterspout
[26] https://www.usatoday.com/story/weather/2015/05/26/waterspouts-florida/27954007/
[27] https://www.nssl.noaa.gov/education/svrwx101/wind/faq/
[28] https://www.floridabuilding.org/fbc/wind_2010/flyer_wind_january2012.pdf

Figure 2.20
Wind Borne Debris Region

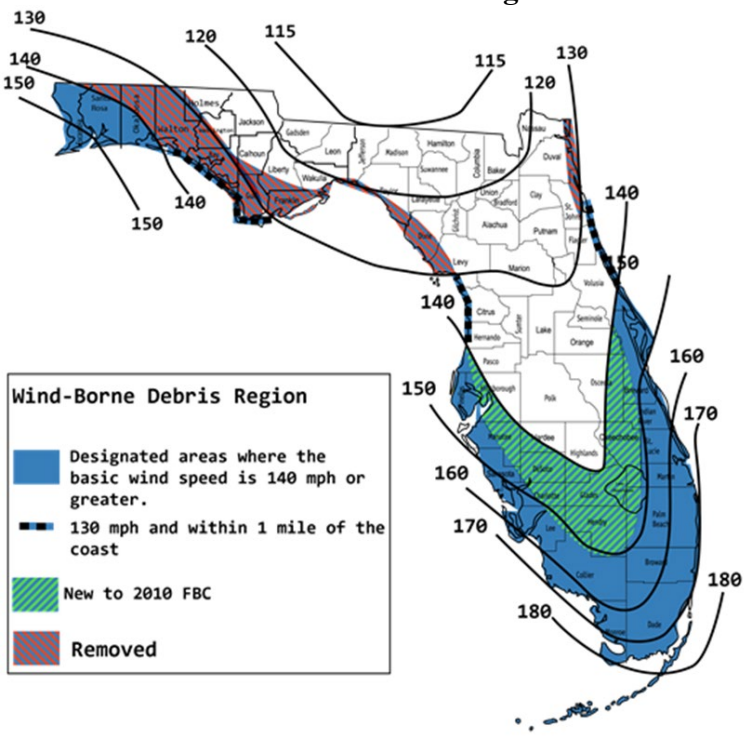


Figure 1609A Wind-Borne Debris Region, Category II and III
Buildings and Structures except health care facilities

Source: Florida Building Code 2010

Historical Occurrence

Thunderstorms

Pasco County experiences thunderstorms daily during the summer and fall months due to rapid heating and moisture. During the winter and spring months, thunderstorms become more sparse and occur during a frontal or more organized event as moisture and heating is not as constant. Figure 2.21 shows the detail for Pasco County thunderstorms that met Severe Thunderstorm Warning criteria for straight-line wind gusts of 50 knots (58 mph) or higher. According to the detailed report from the National Centers for Environmental Information (NCEI), half of the Severe Thunderstorms Warning recorded since 2014 formed as a result of frontal boundaries during the winter months whereas the other warnings were issued based on summertime heating.

A recent straight-line wind event is identified in Figure 2.21; it occurred in January 2017. The Emergency Operations Center was at a Level 1 Activation in order to respond and recover from various home damages, fallen trees, and downed powerlines. There were approximately 508 Duke Energy customers and 2,078 Withlacoochee River Electric Company customers without power in Pasco; ultimately, there was about $55,000 in property damage from this event.

Figure 2.21
Severe Thunderstorms of 58 mph or Greater Wind Gusts

Location	Date	Type	Mag	Deaths	Injuries	Property Damage	Crop Damage
LAND O LAKES	03/27/2003	Thunderstorm Wind	50 kts. EG	0	0	0.00K	0.00K
ST LEO	05/14/2003	Thunderstorm Wind	50 kts. EG	0	0	3.00K	0.00K
NEW PORT RICHEY	06/23/2003	Thunderstorm Wind	50 kts. EG	0	0	0.00K	0.00K
ZEPHYRHILLS	07/08/2003	Thunderstorm Wind	58 kts. EG	0	0	40.00K	0.00K
ZEPHYRHILLS	06/08/2004	Thunderstorm Wind	50 kts. EG	0	0	50.00K	0.00K
LAND O LAKES	08/03/2006	Thunderstorm Wind	50 kts. EG	0	0	0.00K	0.00K
SAN ANTONIO	12/25/2006	Thunderstorm Wind	60 kts. EG	0	0	30.00K	0.00K
DADE CITY	04/11/2007	Thunderstorm Wind	55 kts. EG	0	1	25.00K	0.00K
DADE CITY	04/15/2007	Thunderstorm Wind	52 kts. EG	0	0	0.00K	0.00K
LAND O LAKES	06/08/2007	Thunderstorm Wind	56 kts. EG	0	0	0.00K	0.00K
DADE CITY	06/09/2007	Thunderstorm Wind	50 kts. EG	0	0	0.00K	0.00K
ARIPEKA	08/14/2007	Thunderstorm Wind	52 kts. MG	0	0	0.00K	0.00K
ODESSA	09/20/2007	Thunderstorm Wind	54 kts. EG	0	0	0.00K	0.00K
NEW PORT RICHEY	12/16/2007	Thunderstorm Wind	52 kts. EG	0	0	0.00K	0.00K
PORT RICHEY	01/19/2008	Thunderstorm Wind	54 kts. EG	0	0	0.00K	0.00K
PORT RICHEY	01/19/2008	Thunderstorm Wind	63 kts. EG	0	0	5.00K	0.00K
ELFERS	01/19/2008	Thunderstorm Wind	60 kts. EG	0	0	5.00K	0.00K
PORT RICHEY	01/19/2008	Thunderstorm Wind	52 kts. EG	0	0	3.00K	0.00K
ARIPEKA	02/26/2008	Thunderstorm Wind	52 kts. EG	0	0	0.00K	0.00K

ZEPHYRHILLS	06/30/2008	Thunderstorm Wind	52 kts. EG	0	0	0.00K	0.00K
ZEPHYRHILLS	04/14/2009	Thunderstorm Wind	52 kts. EG	0	0	0.00K	0.00K
ZEPHYRHILLS	05/28/2009	Thunderstorm Wind	43 kts. EG	0	0	7.00K	0.00K
HUDSON	12/02/2009	Thunderstorm Wind	52 kts. EG	0	0	0.00K	0.00K
GULF HARBORS	03/02/2010	Thunderstorm Wind	43 kts. EG	0	0	5.00K	0.00K
JASMINE ESTATES	03/02/2010	Thunderstorm Wind	43 kts. EG	0	0	5.00K	0.00K
ZEPHYRHILLS	03/11/2010	Thunderstorm Wind	52 kts. EG	0	0	80.00K	0.00K
ARIPEKA COMPS SITE	04/25/2010	Thunderstorm Wind	52 kts. EG	0	0	20.00K	0.00K
PORT RICHEY COMPS SITE	04/25/2010	Thunderstorm Wind	54 kts. MG	0	0	0.00K	0.00K
WORTHINGTON GARDENS	05/16/2010	Thunderstorm Wind	48 kts. EG	0	0	10.00K	0.00K
CRYSTAL SPGS	06/03/2010	Thunderstorm Wind	52 kts. EG	0	0	18.00K	0.00K
RICHLAND	07/14/2010	Thunderstorm Wind	43 kts. EG	0	0	7.00K	0.00K
HUDSON	03/30/2011	Thunderstorm Wind	56 kts. EG	0	0	25.00K	0.00K
MOON LAKE ESTATES	03/30/2011	Thunderstorm Wind	50 kts. EG	0	0	5.00K	0.00K
DADE CITY	03/30/2011	Thunderstorm Wind	56 kts. EG	0	0	15.00K	0.00K
ANCLOTE GULF PARKS COMP SITE	03/31/2011	Thunderstorm Wind	53 kts. MG	0	0	0.00K	0.00K
MOON LAKE ESTATES	03/31/2011	Thunderstorm Wind	52 kts. EG	0	0	0.00K	0.00K
LAND O LAKES	03/31/2011	Thunderstorm Wind	52 kts. EG	0	0	0.00K	0.00K
ARIPEKA	06/01/2011	Thunderstorm Wind	48 kts. EG	0	0	5.00K	0.00K
JESSAMINE	06/06/2011	Thunderstorm Wind	52 kts. EG	0	0	10.00K	0.00K
ARIPEKA COMPS SITE	06/06/2012	Thunderstorm Wind	39 kts. EG	0	0	10.00K	0.00K
NEW PORT RICHEY	06/24/2012	Thunderstorm Wind	45 kts. EG	0	0	5.00K	0.00K
WESLEY CHAPEL	07/10/2012	Thunderstorm Wind	50 kts. EG	0	0	0.00K	0.00K
WESLEY CHAPEL	08/06/2012	Thunderstorm Wind	45 kts. EG	0	0	5.00K	0.00K
ZEPHYRHILLS	08/08/2012	Thunderstorm Wind	45 kts. EG	0	0	2.00K	0.00K
DADE CITY	03/24/2013	Thunderstorm Wind	50 kts. EG	0	0	0.00K	0.00K
ZEPHYRHILLS	04/14/2013	Thunderstorm Wind	39 kts. EG	0	0	3.00K	0.00K
CRYSTAL SPGS	05/20/2013	Thunderstorm Wind	50 kts. EG	0	0	0.00K	0.00K
PASCO CO.	07/03/2013	Thunderstorm Wind	50 kts. EG	0	0	5.00K	0.00K
PASCO CO.	07/04/2013	Thunderstorm Wind	50 kts. EG	0	0	2.00K	0.00K
PASCO CO.	08/21/2013	Thunderstorm Wind	50 kts. EG	0	0	30.00K	0.00K
DENHAM	05/26/2014	Thunderstorm Wind	52 kts.EG	0	0	0.00K	0.00K
DREXEL	05/29/2014	Thunderstorm Wind	50 kts. EG	0	0	5.00K	0.00K

HOLIDAY	06/16/2014	Thunderstorm Wind	50 kts. EG	0	0	1.00K	0.00K
SAINT LEO	07/05/2015	Thunderstorm Wind	53 kts. EG	0	0	0.00K	0.00K
DADE CITY	03/24/2016	Thunderstorm Wind	60 kts. EG	0	0	145.00K	0.00K
NEW PORT RICHEY	01/22/2017	Thunderstorm Wind	55 kts. EG	0	0	50.00K	0.00K
HOLIDAY	01/22/2017	Thunderstorm Wind	50 kts. EG	0	0	5.00K	0.00K
WORTHINGTON GARDENS	07/10/2017	Thunderstorm Wind	50 kts. EG	0	0	4.00K	0.00K
Totals:				0	1	601.00K	0.00K

Source: National Centers for Environmental Information[29]

29 https://www.ncdc.noaa.gov/stormevents/listevents.jsp?windfilter=050&sort=DT&statefips=12%2CFLORIDA&county=PASCO%3A101&eventType=%28C%29+Thunderstorm+Wind&beginDate_yyyy=1999&beginDate_mm=12&beginDate_dd=31&endDate_yyyy=2018&endDate_mm=08&endDate_dd=31

Lightning

The area between Tampa, Florida and Orlando, Florida has the most cloud to ground lightning strikes in the country. This is due to the daily summertime heating and persistent moisture in the atmosphere at the lowest levels in the United States. For Pasco County, lightning strikes occur just about daily during the summer months and due to the high frequency of lightning strikes in Pasco County, Figure 2.21 shows lightning strikes that led to a shed fire, structure fires, other critical facility fires, or a response of some sort.

In addition, on average 49 citizens are killed and hundreds are injured each year in the United States by primary and secondary lightning impacts, with primary impacts being a direct strike[30]. There are only a few documented lightning deaths in Pasco County.

Figure 2.21
Lightning Strike Events

Location	Date	Type	Mag	Deaths	Injuries	Property Damage	Crop Damage
SAN ANTONIO	07/26/2001	Lightning		1	3	0.00K	0.00K
ZEPHYRHILLS	05/31/2002	Lightning		0	0	0.00K	10.00K
NEW PORT RICHEY	06/19/2003	Lightning		0	0	25.00K	0.00K
ODESSA	06/29/2004	Lightning		0	0	8.00K	0.00K
DARBY	07/06/2004	Lightning		0	1	0.00K	0.00K
HUDSON	05/04/2005	Lightning		0	1	0.00K	0.00K
WESLEY CHAPEL	08/17/2006	Lightning		1	0	0.00K	0.00K
WESLEY CHAPEL	08/24/2006	Lightning		0	4	0.00K	0.00K
ZEPHYR HILLS MUNI AR	08/31/2009	Lightning		0	1	0.00K	0.00K
GULF HARBORS	04/25/2010	Lightning		0	0	12.00K	0.00K
CRYSTAL SPGS	08/01/2010	Lightning		0	1	0.00K	0.00K
LAND O LAKES	12/10/2012	Lightning		0	0	1.00K	0.00K
HOLIDAY	07/16/2014	Lightning		0	0	100.00K	0.00K
ELFERS	06/15/2015	Lightning		0	0	1.00K	0.00K
LAND O LAKES	08/16/2015	Lightning		0	0	350.00K	0.00K
DENHAM	05/04/2016	Lightning		0	0	50.00K	0.00K
HUDSON	08/31/2016	Lightning		0	0	0.00K	0.00K
ST. JOSEPH	07/06/2018	Lightning		0	0	45.00K	0.00
LOYCE	07/22/2018	Lightning		0	0	5.00K	0.00K
PORT RICHEY COMPS SITE	08/25/2018	Lightning		0	0	100.00K	0.00K
Totals:				**2**	**11**	**697.00K**	**10.00K**

Source: National Centers for Environmental Information[31]

[30] https://www.weather.gov/safety/lightning-victims

[31] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Lightning&beginDate_mm=12&beginDate_dd=31&beginDate_yyyy=1999&endDate_mm=08&endDate_dd=31&endDate_yyyy=2018&county=PASCO%3A101&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

Hail

Pasco County has experienced over 43 separate hail events of a 0.50 inch or greater since 2000. Of those, 17 events were issued for 1 inch or greater hail size which met severe storm criteria as seen in Figure 2.23. Pasco County has not had a recorded occurrence since 2015. Pasco County does however receive a threat of hail at least once a year through strong squalls typically during the springtime.

Figure 2.23
Severe Thunderstorm Warnings Issued Based on 1 inch or greater Hail Size

Location	Date	Type	Mag	Deaths	Injuries	Property Damage	Crop Damage
DADE CITY	05/09/2000	Hail	1.00 in.	0	0	0.00K	0.00K
NEW PORT RICHEY	03/29/2001	Hail	1.75 in.	0	0	50.00K	0.00K
ZEPHYRHILLS	03/29/2001	Hail	1.00 in.	0	0	0.00K	0.00K
ZEPHYRHILLS	06/15/2001	Hail	1.00 in.	0	0	0.00K	0.00K
ZEPHYRHILLS	05/31/2002	Hail	1.00 in.	0	0	0.00K	0.00K
NEW PORT RICHEY	07/29/2002	Hail	1.00 in.	0	0	0.00K	0.00K
WESLEY CHAPEL	03/27/2003	Hail	1.75 in.	0	0	50.00K	0.00K
LAND O LAKES	03/27/2003	Hail	1.00 in.	0	0	0.00K	0.00K
ZEPHYRHILLS	06/13/2004	Hail	1.00 in.	0	0	0.00K	0.00K
HOLIDAY	05/04/2005	Hail	1.00 in.	0	0	0.00K	0.00K
ZEPHYRHILLS	08/04/2006	Hail	1.00 in.	0	0	0.00K	0.00K
WESLEY CHAPEL	05/05/2007	Hail	1.00 in.	0	0	0.00K	0.00K
ELFERS	05/14/2009	Hail	1.00 in.	0	0	0.00K	0.00K
PORT RICHEY	06/17/2009	Hail	1.00 in.	0	0	0.00K	0.00K
LAND O LAKES	06/28/2010	Hail	1.00 in.	0	0	0.00K	0.00K
HUDSON	03/24/2013	Hail	1.00 in.	0	0	0.00K	0.00K
FIVAY JCT	03/24/2013	Hail	1.00 in.	0	0	0.00K	0.00K
ARIPEKA	03/24/2013	Hail	1.00 in.	0	0	0.00K	0.00K
WESLEY CHAPEL	05/20/2013	Hail	1.00 in.	0	0	0.00K	0.00K
DREXEL	09/06/2013	Hail	1.00 in.	0	0	0.00K	0.00K
LOYCE	05/25/2014	Hail	1.25 in.	0	0	0.00K	0.00K
Totals:				0	0	100.00K	0.00K

Source: National Centers for Environmental Information[32]

32 https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Hail&beginDate_mm=12&beginDate_dd=31&beginDate_yyyy=1999&endDate_mm=08&endDate_dd=31&endDate_yyyy=2018&county=PASCO%3A101&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=12%2CFLORIDA

Tornadoes

Pasco County has experienced 18 tornadoes since the year 2000 as seen in Figure 2.24. Seventy-eight percent of the reported tornadoes occurred during the month of May. Historically, tornado threats for Pasco County mainly occur during spring. Tornadoes are the second costliest hazards associated with Severe Thunderstorms, with flooding as the top costliest hazard. Pasco County has recorded over six million dollars of property damage from tornadoes.

Figure 2.24
Pasco County Tornado Events Since 2000

Location	Date	Type	Mag	Deaths	Injuries	Property Damage	Crop Damage
JASMINE ESTATES	07/15/2000	Tornado	F0	0	0	0.00K	0.00K
HUDSON	07/15/2000	Tornado	F0	0	0	0.00K	0.00K
JESSAMINE	07/28/2000	Tornado	F0	0	0	0.00K	0.00K
HUDSON	03/04/2001	Tornado	F0	0	0	250.00K	0.00K
DADE CITY	03/29/2001	Tornado	F0	0	0	150.00K	0.00K
WESLEY CHAPEL	06/21/2001	Tornado	F0	0	0	100.00K	0.00K
DADE CITY	06/29/2003	Tornado	F0	0	0	40.00K	0.00K
NEW PORT RICHEY	08/14/2004	Tornado	F0	0	0	0.00K	0.00K
ARIPEKA	09/06/2004	Tornado	F0	0	0	0.00K	0.00K
LAND O LAKES	05/31/2005	Tornado	F1	0	0	80.00K	0.00K
LAND O LAKES	07/20/2006	Tornado	F0	0	0	0.00K	0.00K
PASCO	12/25/2006	Tornado	F2	0	2	3.500M	0.00K
LAND O LAKES	12/16/2007	Tornado	EF1	0	0	1.000M	0.00K
HOLIDAY	04/14/2009	Tornado	EF1	0	0	240.00K	0.00K
WESLEY CHAPEL	04/14/2009	Tornado	EF0	0	0	30.00K	0.00K
ZEPHYR HILLS MUNI AR	07/07/2011	Tornado	EF0	0	0	20.00K	0.00K
NEW PORT RICHEY	06/24/2012	Tornado	EF1	0	0	650.00K	0.00K
JASMINE ESTATES	04/07/2016	Tornado	EF0	0	0	100.00K	0.00K
Totals:				0	2	6.162M	0.00K

Source: National Centers for Environmental Information[33]

Since 1950, the strongest tornadoes that impacted Pasco County were no higher than F2 intensity. The strongest tornadoes move through Pasco County during the late winter and spring season. This makes sense as the weather pattern is shifted towards the Gulf as described earlier in the section. It is during this time, weather dynamics support a higher chance of multi-celled thunderstorms or supercells. Summertime tornadoes cannot be ruled out but they tend to weaker in intensity and often spawned by tropical cyclones.

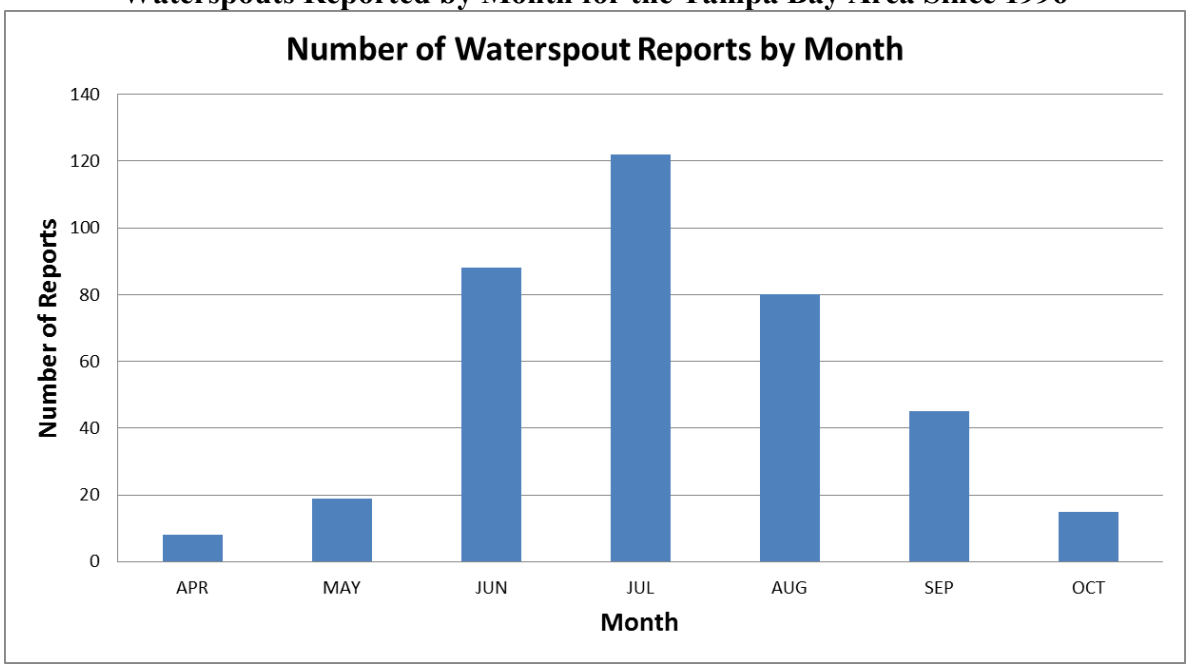
33 https://www.ncdc.noaa.gov/stormevents/listevents.jsp?tornfilter=0&sort=DT&statefips=12%2CFLORIDA&county=PASCO%3A101&eventType=%28C%29+Tornado&beginDate_yyyy=1950&beginDate_mm=01&beginDate_dd=01&endDate_yyyy=2018&endDate_mm=08&endDate_dd=31

Waterspouts

Over the past five years, there have been reports of waterspouts in the Tampa Bay Region. The last recorded waterspout through National Centers for Environmental Information's (NCEI) software dates back to 2001 for Pasco County specifically. Recent communication with NCEI explained that during October 2001, the locations were reclassified to bodies of water, rather than the specific County because it is a water phenomenon.

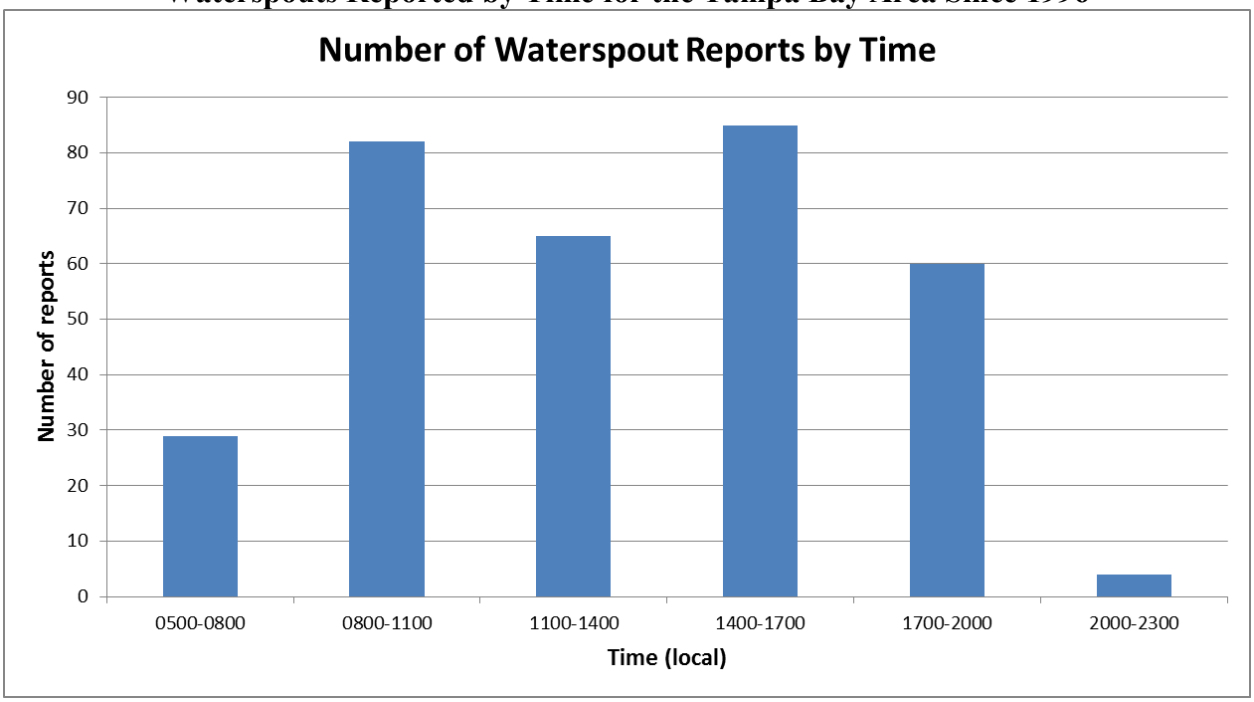
The local NWS office provided additional information as there are multiple reports each year of an observed waterspout in the Tampa Bay Area. Figure 2.25 shows that the most likely month for a reported waterspout occurs in July and Figure 2.26 details that the majority of waterspouts occur during daylight hours. Figure 2.27 shows the historical frequency of the reported waterspouts with the Coast of Pasco County ranking medium to high. Note, the figure shows where the waterspout formed, direction is unaccounted for.

Figure 2.25
Waterspouts Reported by Month for the Tampa Bay Area Since 1996



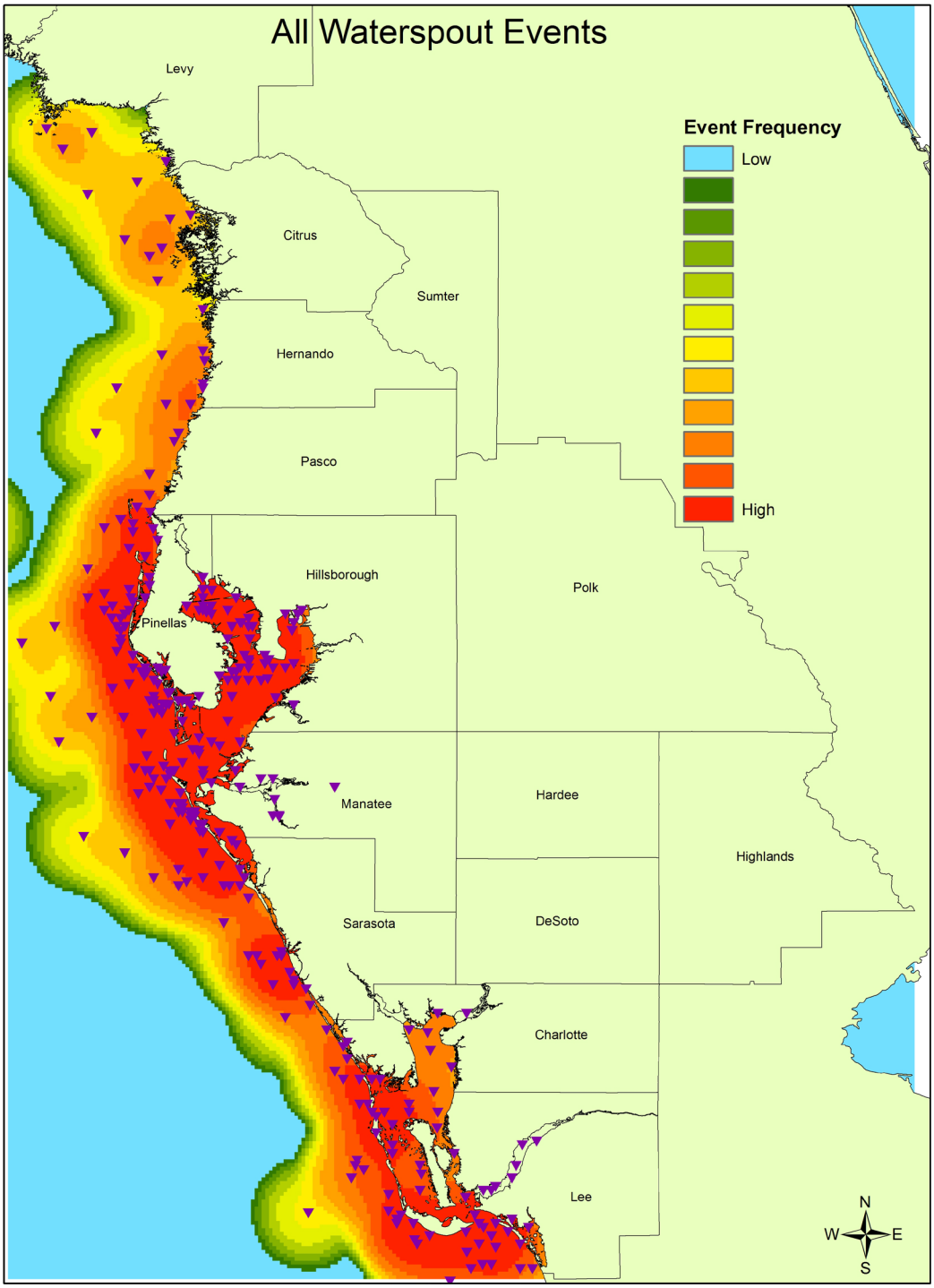
Source: National Weather Service

Figure 2.26
Waterspouts Reported by Time for the Tampa Bay Area Since 1996



Source: National Weather Service

Figure 2.27
Historical Frequency of Reported Waterspouts Since 1996



Source: National Weather Service

Vulnerability

The frequency, unpredictability, and widespread nature of thunderstorms in the Tampa Bay Area pose an overall risk for Pasco County. All unincorporated and incorporated areas of the County are subject to thunderstorms and potential damages or impacts.

Approximately 68% of the residential structures countywide were built prior to the year 2000. These homes were built prior to the required enhanced Florida Building Code at the turn of the century. In addition to the residential structures, approximately 41,548 mobile homes are recorded in Pasco[34]. Both mobile homes and the residential structures built prior to the year 2000 are susceptible to severe winds, tornadoes, hail, and other flying debris that result from severe weather.

As such, approximately half of the recorded mobile home units are considered as a primary residence and are defined by location in Figure 2.28. The majority of the units are located along the eastern side of Pasco County, of which the majority is in Zephyrhills where most daily daytime heating thunderstorms initiate. Regardless, this figure shows that primary residence mobile homes are throughout each geographic area of Pasco County.

Figure 2.28
Mobile Homes Subject to Gusty Winds/Tornadoes by Location

Local Area	County Location	# Mobile Homes	Location Total
Dade City	East	1,640	
Crystal Springs	East	92	
Ridge Manor	East	570	
Richland	East	849	
Lacoochee	East	57	
Zephyrhills	East	6,459	
Wesley Chapel	East	1,541	
Saint Leo	East	10	
San Antonio	East	100	
Trilby	East	42	11,360
Shady Hills	Central	1793	
Land O' Lakes	Central	281	2,074
New Port Richey	West	2,618	
Trinity	West	104	
Hudson	West	3,136	
Port Richey	West	621	
Aripeka	West	19	
Holiday	West	1,072	
Elfers	West	50	7,620

Source: Pasco County Property Appraiser and GIS;
Note: Includes only mobile homes that have a physical address in Pasco County

[34] Pasco County Property Appraiser, also referenced earlier in the HIRA Section under Tropical Cyclones.

Probability

Based on the historical trend over the past five years, Pasco County can expect to experience thunderstorms daily and 1.6 chance of receiving a Severe Thunderstorm Warning based on wind gusts of 58mph or greater. The most likely timeframe of the thunderstorms meeting severe weather criteria based on climatology is between March and August[35]. Furthermore, Pasco County should expect at least one tornado or waterspout touchdown within the marine and land based boundaries each year.

Extent

Severe storms are measurable and the National Weather Service (NWS) uses specific measurement criteria to classify a storm as severe. The specific measurement units for severe storms are defined in Figure 2.29. As seen in the historical occurrence section, each severe storm was classed with property and crop damage to show the damage potential of a given storm's magnitude. Sixty-eight percent of our residential community was built prior to the enhanced Florida Building Code and therefore may not be able to withstand weak tornadoes and strong gusty winds.

This percentage, countywide, should heed the Severe Thunderstorm Warnings has 58 mph gusts or higher, or an EF0 tornado may cause destructive damage to property such as roof, siding, doors, and window damage. The other 30% of Pasco County homes have been built under the enhanced Florida Building Code and should be able to withstand the majority of weaker severe storms. Regardless, severe storms can occur daily and all warnings should be taken seriously despite the construction date.

Figure 2.29
Units Required to Measure Storm Severity

Severe Weather Element	Unit of Measurement
Straight-Line Wind	Mph
Tornadoes	EF-Scale
Hail	Diameter/Size
Lightning **(does not determine storm severity, but can lead to injury or death during any storm)**	Density/Rate (strikes per second by area)

Source: National Weather Service

[35] https://www.spc.noaa.gov/new/SVRclimo/climo.php?parm=anySvr

Flooding

Source: Pasco County Sheriff's Office

Description

Floods are the most common and widespread of all natural disasters, with the exception of wildfire. A flood, as defined by the National Flood Insurance Program is "A general and temporary condition of partial or complete inundation of 2 or more acres of normally dry land area or of 2 or more properties from: overflow of inland or tidal waters, unusual and rapid accumulation or runoff of surface waters from land source, or a mudflow[36]." Floods can be slow or fast rising, but generally develop over a period of days.

Flooding typically involves the overflowing of the normal flood channels, rivers or streams as a result of prolonged rainfall. The lateral spread of floodwater is largely a function of the terrain, becoming greater in wide, flat areas, which generally affects narrower areas in steep terrain. Variations in circumstances affect the duration of the inundation of the floodplain with rapid water movement draining floodplains faster. The duration of storm patterns also affects the length of the period of inundation. Many storms unleash considerable amounts of rain within just hours, producing very short-term, but damaging floods in localized areas. The key contributing factors in identifying the scope of the local flood hazard are: the size of the watershed; development within the watershed affecting stormwater runoff; soil characteristics; topographic characteristics affecting the direction and flow of flood waters; and regional climate. Increasing impervious surface, building obstructions to the flow of water along the riverbank, or allowing sedimentation through stream bank erosion all exacerbate the probability of flooding, and thus, may change a100- year floodplain into 80-year or 50-year floodplains.

[36] https://www.fema.gov/national-flood-insurance-program

Historical Occurrence

The National Weather Service differentiates flood events based on the cause. Riverine and closed basin flooding occur due to rainfall events and are fresh water floods. Coastal flooding is a salt water flood that occurs as a result of storm surge (wind driven water) or heavy rain, which is exacerbated by an astronomical high tide. Pasco County is subject to riverine flooding, closed basin flooding, and coastal flooding. Sometimes these floods occur as flash floods if rainfall falls at a moderate or intense rate[37].

The Withlacoochee River lies within the northeast quadrant of the County and the Anclote River lies within the southwestern section of the County. The Pithlachascotee River enters the mid-section of the County from the Gulf of Mexico. The areas surrounding the Withlacoochee and Anclote Rivers are subject to flood damage because they are high-density population areas. The "no name" storm of 1993 and Tropical Storm Josephine in 1998 caused flood surges from the Gulf of Mexico to travel up the Pithlachascotee River. There is potential for repeat occurrences of flood surges along this heavily populated river during future tropical storms and hurricanes. FloodIQ shows a public representation of what a Category 1 storm surge can potentially do along the Pithlachascotee River and the Anclote River[38]. Rainfall over several days causes these rivers to exceed their banks and tend to overflow. Many of the residents along these rivers are in a floodplain that may flood at least once per year. Many residents are aware of this hazard and mitigate or plan accordingly.

Flood damage probability is high in Pasco County because a large number of the existing homes were built pre-Flood Insurance Rate Map (pre-FIRM), there are insufficient stormwater systems to handle rainfall accumulation, and people tend to settle in areas previously impacted by a flooding event. Pasco County is a Category C Repetitive Loss Community because it has fifty (50) or more repetitive loss properties[39]. Pasco County's repetitive loss properties are located in areas developed prior to the County joining the National Flood Insurance Program (NFIP). These areas have streets and drainage systems which were developed prior to the delineation of the floodplain. Structures in these areas were almost always placed on the existing grade and very few were elevated to the base flood elevations designated by the NFIP. Local drainage problems, freshwater rainfall, tropical storms, hurricanes and rivers overflowing their banks have caused flooding within Pasco County.

The most recent significant flooding event in the County occurred in August 2015 when weak area of low pressure developed along a stationary frontal boundary and produced 6 to 8 inches of rain across Pasco on already saturated soils. The second recent flooding event occurred June 2012 during Tropical Storm Debbie. The third recent flooding in the County occurred from May through September of 2003, nine years earlier. While many areas were affected, areas in the Northwest portion of the County experienced sustained levels of flooding over a period of several weeks as rains continued on almost a daily basis. Several areas not previously designated as floodplain areas experienced flooding for the first time. Additional historical data is included in Figure 2.30.

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[37] http://glossary.ametsoc.org/wiki/Flash_flood
[38] https://www.floodiq.com/

[39] https://www.fema.gov/media-library/assets/documents/8768

Table 2.30
Flood Event History

Location	Date	Incident Details
Coastal Flood Incidents		
Hudson	1/22/2017	• A line of strong and fast moving thunderstorms developed ahead of a cold front • Water was reported over US 19 in Hudson, peaking at about 2 feet above the high tide • Gradient winds were compounded by stronger thunderstorm wind gusts • Persistent gradient winds caused minor coastal flooding
Heavy Rain Incidents		
San Antonio	8/22/2013	• Slow moving thunderstorms produced very heavy rainfall causing numerous flood impacts in Pasco • Pasco County Emergency Management reported five cars stranded on a flood prone road in an estimated 4 inches of rain that had fallen
Dade City	8/22/2013	• Slow moving thunderstorms produced very heavy rainfall causing numerous flood impacts in Pasco • Pasco County Emergency Management reported heavy rainfall causing flooding on the roads near the Dade City Hospital of an estimated up to 3 inches of rain had fallen
Hudson	9/27/2014	• A stalled frontal boundary produced localized areas of heavy rain which caused minor flooding in low-lying areas as well as along some area rivers. • A CoCoRaHS observer near Hudson measured 5.67 inches of rain during the 4 day period
Hudson	8/3/2015	• A weak area of low pressure developed along a stationary frontal boundary • A trained spotter reported receiving 6.5 inches of rain in six hours • The heaviest rain fall in some portions of Pasco produced 6 to 8 inches of rain • This event was exacerbated from recent flooding and already saturated soils
Flood Incidents		
Aripeka	7/24/2015	• An area of low pressure developed along a weak frontal boundary over the eastern Gulf of • Pasco County Emergency Management and broadcast media reported widespread flooding across western Pasco County due to very heavy rainfall, with at least one site reporting over 11 inches of rain • In Hudson street flooding was reported to have caused several stranded cars • In New Port Richey, Jarvis Street was closed due to heavy rain
New Port Richey	7/26/2015	• An area of low pressure developed along a weak frontal boundary over the eastern Gulf of Mexico • Heavy rain fell over the Anclote River basin causing the river to rise into moderate flood stage (22 feet) and cresting at a level of 23.62 feet • The Pasco County Office of Emergency Management reported that 321 homes were evacuated near Elfers along the Anclote River, and multiple swift water rescues were conducted by Pasco County Fire Rescue. • This resulted in some areas receiving as over 11 inches of rain with both areal flooding and riverine flooding reported.
Hudson	8/3/2015	• A weak area of low pressure developed along a stationary frontal boundary across north Florida • The Anclote River near Elfers, was just below flood stage at the onset of the heavy rain due to 6-10 inches of rain across the basin at the end of July • The river crest at 25.4 feet • The heaviest rain fall in some portions of Pasco Counties produced 6 to 8 inches of rain • The heavy rain and subsequent river flooding produced millions in dollars of damage across Pasco County. • 36 mobile homes were destroyed while 6 others sustained damage from flooding, 46 single family dwellings were destroyed, 32 received major damage and 258 homes sustained minor damage from the flooding
Elfers	9/3/2016	• Hurricane Hermine formed in the Florida Straits south of Key West on August 28th. • Heavy rains from Hurricane Hermine brought the Anclote River at Elfers into major flood stage, cresting at 25.08 feet • Storm surge generally ranged from 2 to 7 feet above normal high tide, with the highest storm surge value recorded of 7.5 feet at Cedar Key. • Hurricane Hermine resulted in just over $219M in property damage across West-Central and Southwest Florida. This damage included $124.15 million in surge and coastal flood damage, $91.9 million in inland flooding
Elfers	9/11/2017	• Heavy rains from Hurricane Irma caused the Anclote River at Elfers to rise above flood stage • The water level crested at 24.87 feet • The flood waters entered several homes in the Anclote River Estates and Anclote River Acres neighborhoods. Flood damage to homes was estimated at $460,000 • Coastal Pasco rainfall was generally around 4 inches or greater, with the highest rain total 6.83 inches near Port Richey • Inland Pasco County rainfall was generally around 6 inches or greater, with the highest rain total being 9.64 inches in Richland
Flash Flood Incidents		
		None recoreded/reported since the last update
Source: Data is from: https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=12%2CFLORIDA# National Centers for Environmental Information: NOAA		

Source: National Centers for Environmental Information[40]

[40] *https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=12%2CFLORIDA# National Centers for Environmental Information: NOAA*

Vulnerability

Due to the low elevation along the western coast, adjacent to the Gulf of Mexico, the area west of US 19 is particularly vulnerable during high tides, coastal storms (surge) and heavy rain events. Occasionally, moderate rain events also cause flooding due to ground saturation or poor drainage.

There are 318 critical facilities located in the 100-year flood plain and several sections of road that are normally affected and 508 repetitive loss parcels have been identified . Of the 508, according to NFIP records, 31 have been mitigated. The 477 properties remaining on the list are the object of targeted outreach programs and HMPG grant writing efforts.

Approximately 42.6% of Pasco County is located in 100 Year Flood Plain (208,125 acres). Pasco County also contains significant wetland area. Approximately 2.3% (11,055 acres) is located in the coastal high hazard area. Moreover, a good number of the existing structures would be moderately or highly vulnerable to floods based on the year they were built (see upcoming figures). The criteria used for identifying least, less, moderate and most vulnerable to floods are as follows shown in Figure 2.31.

Figure 2.31
Flood Vulnerability Categories

Category	Structure Effective Year Built Range	Reason
Least Vulnerable	2018 - Present	Pasco County Flood Damage Prevention Ordinance adopts Florida Building Code (FBC) updates, ASCE – 24, ASCE – 7
	2004 to 2017	Pasco County Flood Damage Prevention Ordinance modified to adopt 1-foot freeboard in 12/2003
Less	1986 to 2003	Hydrostatic vents were placed into Federal standards in 1985 and local enforcement of these standards followed
Moderate	1982 to 1985	Original Flood Ordinance adopted November 18, 1981
Most	1981 and prior	No flood mitigation required

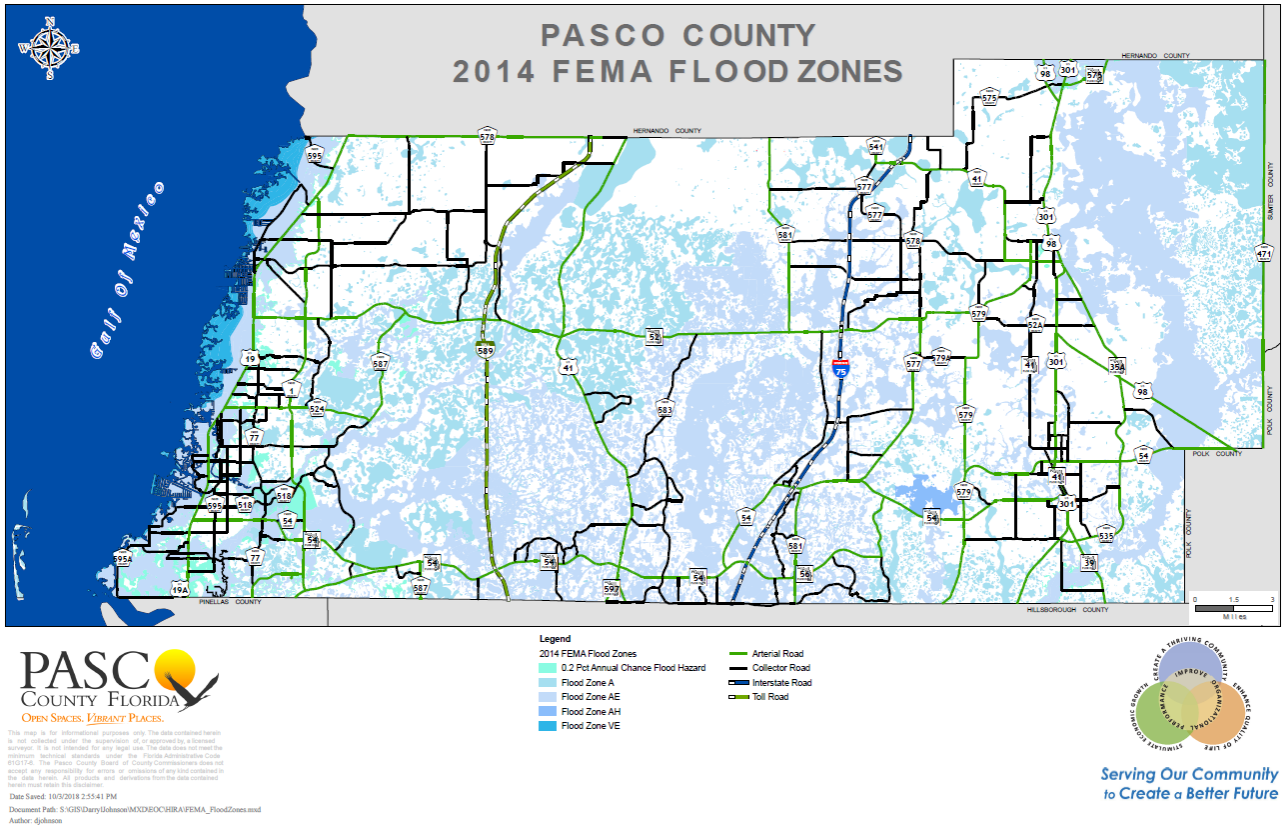
Source: Pasco County Building Construction Services

Flood Vulnerability – Count and Percentages by Year Built

Year Built	Residential	Non-Residential	Total by Year Built
1981 - 1985	20,466	1,037	21,503
1986 - 2003	62,483	2,263	64,746
2004 - 2012	34,806	1,497	36,303
2013 - Present	11,676	303	11,979
Total by use	129,431	5,100	134,531

Source: *Pasco County Property Appraiser's Office.*
Note: *Parcel data used for the wind and flood vulnerability analysis was obtained from the Pasco County Property Appraiser's Office. The analysis pertains to structures only and not total housing units (i.e. 1 multifamily structure may contain 16 units). If the data did not indicate that there was a structure built on it (i.e. Year Built = zero), the property was removed from analysis.*

Figure 2.32
2014 FEMA Flood Zones In Pasco County



Source: Pasco County 2014 FIRM Flood Zones

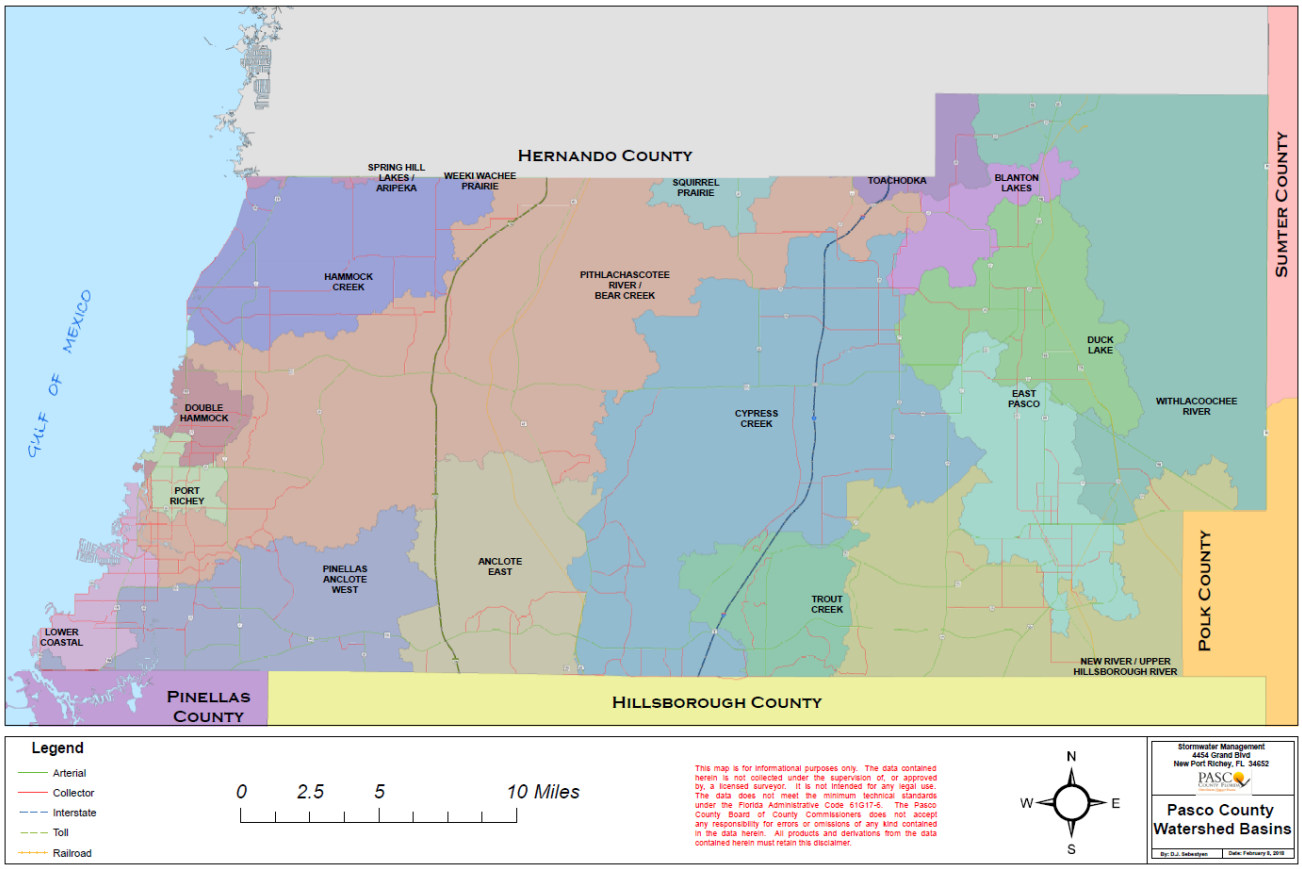
Extent

A flood event can cause minor inconvenience or major devastation. Appendix F shows that between 1997 and 2012 property damage from flooding totaled $6,410,000 and crop damage totaled $600,000. The financial losses ranged from zero to significant losses reported by FEMA in 2012 from Tropical Storm Debbie, losses that are still mounting and being paid for either Individual Assistance or Public Assistance. To date, 6,758 households have received $27,800,267 for housing and Other Needs assistance. Public Assistance funding current stands at $5,806,147, divided between Emergency Work (Categories A + B) and Permanent Work (Categories C through G). With numbers that are still in flux, $33,606,414 has been obligated as of July 9, 2014.

Flooding may result from Thunderstorm, Tropical Storm and Tropical Cyclone activity. The problem becomes more severe when heavy rainfall occurs during high tide. This combination of factors prevents rainfall from flowing through the drainage system into the Gulf of Mexico, thereby causing coastal flooding. While Pasco County imposes structural elevation requirements and has an extensive storm water runoff system, flooding still occurs. Figure 2.32 shows most of Pasco County as being highly vulnerable to flooding, with most of the land being in areas with a 1% annual chance of flooding. The slate blue-shaded areas show this level of probability. The map clearly reflects statements in the Executive Summary about the county's geography including high ridges separated by valleys. The beige areas (outside the 1% probability range) show small areas in the northwest corner and far eastern segments of the county. Given that flooding does occur countywide in some instances, the beige sections have a probability of 0.25 to 0.50 % annual chance of flooding.

A new Flood Insurance Study (FIS) and FIRM update became effective in September 2014, and are located on the Map Service Center (MSC) web site. The FIS is included as Appendix M. There are seven major FIRMs comprised of 159 maps covering smaller county segments. A new FIS and FIRM update for Coastal map panels is currently in progress. There are 31 map panels included in this study. A community open house was held on August 30, 2018 to present the preliminary map updates and a comment and appeal process will follow. The anticipated effective date for the updated Coastal FIS and FIRM maps is 2019.

Figure 2.33
Pasco County Watersheds



Source: Pasco County GIS and Pasco County Stormwater

These tables and the watershed map, in Figure 2.33 provide information about water depth throughout the county, depth with additional rainfall and depth when the waters are still. A more complete list of all points in communities across the county can be found in the FIS (Appendix M).

Communities located in the flood zones described above are the most vulnerable. Challenges in mitigating existing drainage problems result from a lack of funding and the location of the pre-FIRM housing stock in SFHAs which increases the level of vulnerability. Most pre-FIRM housing is located west of US 41 in New Port Richey, Port Richey, and unincorporated coastal areas. Appendix D contains the CRS report on Repetitive Loss Areas and provides more information about flooding, including information about Repetitive Loss (RL) and Severe Repetitive Loss (SRL) properties. In addition to mitigating these properties, home owners may obtain flood insurance through the National Flood Insurance Program (NFIP). Figure 2.34, Figure 2.35 below captures recent statistics from the NFIP reporting center showing participation broken down by community.

Table 2.34
Record of Loss Statistics

Loss Statistics through 7/31/2018

Community Name	Total Losses	Closed Losses	Open Losses	Total County Payments
City of Dade City	39	28	0	$430,721.51
City of New Port Richey	658	527.00	0	$9,334,392.97
City of Port Richey	779	686.00	0	$15,907,777.94
City of Zephyrhills	9	8.00	0	$191,974.49
Pasco County Unincorporated	7,202	5,495	3	$108,987,416.85
Totals	**8,687**	**6,744**	**3**	**$134,852,283.76**

Source: Southeast office, NFIP iService, 7/31/2018

Table 2.35
Record of Policy Statistics

Policy Statistics through 7/31/2018

Community Name	Policies In force	Insurance In Force Whole $	Written Premium In-force
City of Dade City	45	$10,370,400	$42,962
City of New Port Richey	1,192	$243,779,200	$1,345,257
City of Port Richey	719	$151,346,000	$922,437
City of Zephyrhills	148	$35,807,800	$93,246
City of San Antonio	6	$1,691,000	$3,460
Town of St. Leo	3	$950,000	$3,155
Pasco County Unincorporated	22,670	$5,292,286,000	$17,645,914
Totals	**24,783**	**$5,736,230,400**	**$20,056,431**

Source: Southeast office, NFIP iService, 7/31/2018

The 2018 figures for flood insurance policies in-force and policy amounts show a decrease in participation since the 2014 LMS submission. At that time, there were 30,327 policies in force, which represents a decrease of 5,544 policies in a county that experienced a steady population increases in recent years, as Figure 2.36.

Figure 2.36
US Census Annual Estimate of Population Increases

2010 Census Population	2013 Population Estimate	2017 Population Estimate
465,547	**475,502**	**525,643**

Source: US Census Bureau

The current dollar value for policies in force is $5,736,230,400 which represents a dollar value decrease of $687,818,400 of the 2014 policy values total of 6,424,048,800. Through a CRS credited Program for Public Information plan (PPI), an analysis is being conducted to identify target areas for outreach to increase awareness of and need for flood insurance. It should be noted that the City of San Antonio was admitted to the NFIP on an emergency basis in 2009 and became a Permanent member of the NFIP in August of 2014. The Town of St. Leo is also in the middle of applying for membership. Extensive rainfall that caused flooding in both communities over the years has propelled the municipalities to give residents access to flood insurance through the program.

Probability

Although flooding does result from hurricanes, it can also occur during winter storms, as well as during prolonged summer thunderstorm activity. Prolonged periods of rainfall have shown increased potential for causing damage to property and the need for evacuation of residents due to flooding. The problem becomes more severe should the heavy rainfall occur at the same time as the astronomical high tide, thus preventing much of the rainfall from flowing through the drainage system into the Gulf of Mexico. Heavy rains and fresh water flooding occur in cycles that many now attribute to the "El Nino". There is a long history of flooding in Pasco County and most of central Florida. This trend is expected to continue and the probability of flooding is high for Pasco County, especially in the low lying areas.

Pasco County provides a more thorough review of the flooding probabilities in Pasco County in the areas of coastal zone flooding, closed basin flooding, and riverine flood areas. Each of these areas has locations that are mapped on the existing effective FEMA flood maps, which were produced in September 2014. The 1992 FIRM was replaced by the Map Modernization Program and New Coastal FIRM maps are expected to be presented to the county in 2019. The updated maps show that there are significant areas of the County which have a 1% chance of flooding but were not identified in the original FIS. This is to be expected given the tremendous damage caused by hurricanes and major storms during the 22-year period in which the older maps were in use.

Coastal and Riverine Erosion

Description

Erosion changes the shape and structure of the coastal areas and river banks. Pasco County's western boundary is adjacent to the Gulf of Mexico resulting in the region being subject to coastal erosion resulting from tropical storms, hurricanes, strong waves, and high winds. Coastal erosion is the process of the gradual wearing away of land masse and can occur along coasts, rivers, and streams[41].

Inland, the course of any given river is fluid, constantly alter course, changing shape and depth trying to find a balance between the sediment transport capacity of the water and the sediment supply. This process, called riverine erosion, is usually seen as the wearing of riverbanks and riverbeds over a long period of time. Riverine erosion is often initiated by failure of a riverbank causing high sediment loads or heavy rainfall. This generates high volume and velocity run-off which will concentrate in the lower drainages within the river's catchment area. When the stress applied by these river flows exceeds the resistance of the riverbank material, erosion will occur. As the sediment load increases, fast-flowing rivers will erode their banks downstream. Eventually, the river becomes overloaded or velocity is reduced, leading to the deposition of sediment further downstream or in dams and reservoirs. The deposition may eventually lead to the river developing a new channel. Riverine erosion has many consequences including the loss of land and any development on that land. It can cause increased sedimentation of harbors and river deltas. It can hinder channel navigation and affect marine transportation sources.

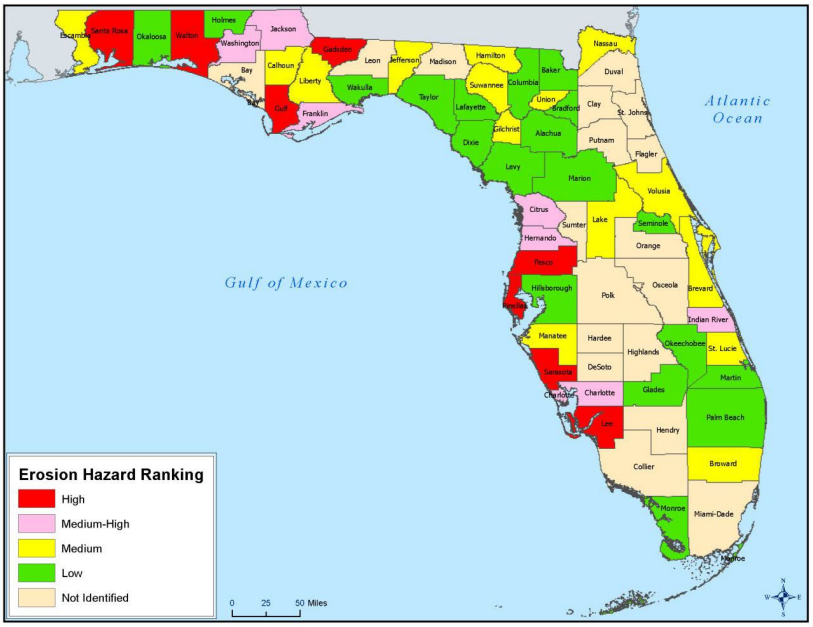
Historical Occurrence

Some erosion changes are slow, inevitable, and usually gradual. The changes on a beach in contrast, can happen overnight, especially during a storm. Even without storms, sand may be lost to longshore drift (the currents that parallel coastlines) or sand may be pulled to deeper water and then lost to the coastal system. The Withlacoochee, Hillsborough, Pithlachascotee and Anclote Rivers are major permanent streams and surface drainage systems in the County; therefore, these rivers make Pasco County susceptible to riverine erosion. While historical data has not been identified, the next two maps were created based a resource that enabled designers to generate comparative studies.

Figure 2.37 compares the level of erosion in Pasco County to that of other counties in Florida. Of the 67 Florida counties – 36 of which border the Atlantic Ocean or the Gulf of Mexico – only eight rank high for the erosion hazard, and all but one of these are located on the Gulf of Mexico.

[41] https://www.fema.gov/erosion

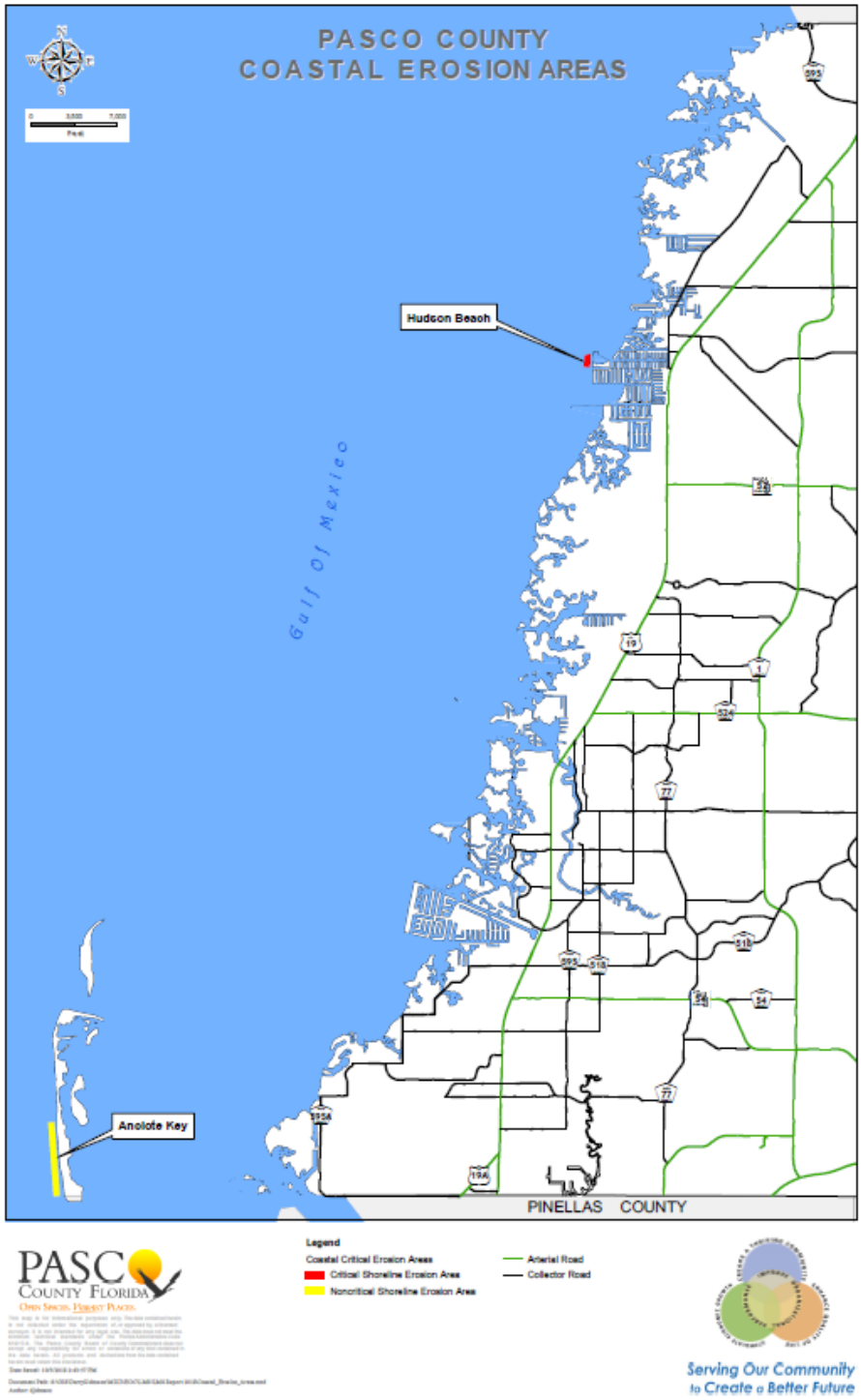
Figure 2.37
Florida Counties Erosion Hazard Ranking



Source: The Enhanced State of Florida Hazard Mitigation Plan 2018

The Figure 2.38 shows critical shoreline erosion for Pasco County. In the northwestern corner of the county, the red dot shows the segment of the county experiencing critical erosion. This is due to the counterclockwise rotation of Gulf currents, and areas jutting more prominently into the Gulf appear to erode more than those slightly further eastward along the state's irregular western coastline. In contrast, the east coast of the state runs more or less in a straight line and experiences almost total critical erosion.

Figure 2.38
Critical and Non-Critical Shoreline Erosion



Source: Pasco County GIS, 2018

This information dovetails with what was revealed in the Florida Department of Environmental Protection Strategic Beach Management Plan done for the Bureau of Beaches and Coastal Systems. One of the three sub-regions studied for the plan is the Sun Coast, defined here as the coastal segment that extends from the Withlacoochee River in Citrus County (two counties north of Pasco) to the Anclote River, immediately north of the Pinellas-Pasco County line. Erosion is

attributed to tropical storms, hurricanes, and the natural geomorphic changes caused by the pattern of littoral transport of sediments in this area. The most erosive storms in recent years were Hurricane Agnes (1972), Hurricanes Elena and Kate (1985), a severe extratropical storm in March 1993, Tropical Storm Josephine (1996), Hurricane Gordon (2000), Tropical Storm Frances (2004), and Hurricane Irma (2017), The same northwest segment of coastal area is identified in both of the above maps as being critical erosion areas.

Vulnerability

A significant number of people living along the coast would be affected by coastal erosion. Relative to the number of people living along the coast, the number of people living along the rivers, and potentially impacted by riverine erosion, is significantly less. The economic costs are high, the likelihood of coastal erosion is extremely high, and therefore the vulnerability of coastal erosion resulting from tropical storms and hurricanes is moderate because the county is at highly vulnerable to storms and hurricanes. As such, the coastal cities of New Port Richey and Port Richey and coastal unincorporated areas, are vulnerable to coastal erosion. It is difficult to define areas of the County that are vulnerable to riverine erosion because the county holds four rivers within its boundaries and each has many tributaries. In 1998 and 2003 the County had significant periods of rainfall which caused the rivers and tributaries to swell, resulting in widespread flooding which affected all areas of the county and its municipalities.

The degree to which erosion could be considered widespread and moderate is shown in the following map, produced by the County GIS department to show flood plains through the county. It was mentioned in that context that the geography of the county is comprised primarily of low level valleys with ridges in the northwest corner of the county and in a line in the eastern section of the county.

Probability

The probability of coastal and riverine erosion is moderate based on what little data can be gleaned from the above identified resources. Coastal and riverine erosion occurs in small amounts and has not occurred significantly enough to generate overall statistics. If and when significant erosion occurs, Pasco County will experience a change in the shape of the coastline and riverbanks, as well as loss of structures business and residences located in vulnerable areas especially combined with tropical cyclone activity.

Extent

The impact of erosion is cumulative. Water encroaching homes located along the coast or a river may not see the level of coastal ground diminish until a significant "wash" (for a river) or major storm carries away sediment that has been loosened over time. Endangered homes may need to be raised, moved elsewhere, or demolished. The same goes for businesses located in these areas, which are more likely to be small businesses rather than large industry.

The report addresses the fact that erosion is lower in west Florida than might be expected given its Gulf location. A report segment shown below discusses extent of erosion in both geographic and economic terms.

> "Compared to shoreline erosion in some other Gulf Coast states, the average long-term erosion rate of -0.8 ± 0.9 m/yr for west Florida (Table 7a) is low, primarily because wave energy is low. Even though erosion rates are generally low, more than 50% of the shoreline is experiencing both long-term and short-term erosion. The highest rates of erosion in west Florida are typically located near tidal inlets. Long-term and short-term trends and rates of shoreline change are similar where there has been little or no alteration of the sediment supply or littoral system (see Dog Island, St. George Island, and St. Joseph Peninsula). Conversely, trends and rates of change have shifted from long-term erosion to short-term stability or accretion where beach nourishment is common (see Longboat Key, Anna Maria Island, Sand Key, and Clearwater, Panama City Beach, and Perdido Key). A shift from long-term relative stability to short-term erosion occurred on Santa Rosa Island, probably as a result of beach erosion and overwash deposition associated with Hurricane Opal in October 1995. Slow but chronic erosion along the west coast of Florida eventually results in narrowing of the State's valuable recreational beaches (Figs. 14-16), and many highly developed beaches retain no dunes to protect buildings from large storm waves and flooding. Lighthouse Point, south of Tallahassee, presents a good example. Situated in the low energy sector of the coast, past storms have still destroyed park facilities and some roads (Fig. 15) that are now protected by rock revetments. In places where beach erosion is chronic, these structures have replaced the beaches (Fig. 16) except where artificially nourished (Fig. 17)[42]."

Given the historically low rate of erosion in the county, it is safe to say that the rate of coastal erosion cited above for west Florida overall -- 0.8 ± 0.9 m/yr – is a figure comparable to rate of loss in Pasco County. The author found no resources documenting the rate of riverine erosion.

[42] Extent is discussed in a 2004 report of the U.S. Geological Services and the U.S. Department of Interior titled *USGS National Assessment of Shoreline Change Part 1 Historical Shoreline Changes and Associated Coastal Land Loss Along the U.S. Gulf of Mexico (Open-File Report 2004-1043)*.

Geological Hazards (Sinkholes/Depressions)

Source: Pasco County Libraries

Description

Sinkholes and geological depressions are a common, naturally occurring geologic phenomenon and one of the predominant landforms in Florida. Many of the lakes in Florida were molded by sinkholes. Sinkholes are depressions or holes in the land surface that occur throughout west central Florida. They can be shallow, deep, small, or large, but all are a result of the underlying limestone dissolving when mixed with acidic water.[43] Contrasting conditions can cause sinkholes, including lack of rainfall, lowered water levels, or excessive rainfall in a short period of time. Water inundation causes the soil "roof" over a cavity in the limestone to collapse resulting in a sinkhole.

Sinkholes are also caused by droughts that lower groundwater levels. The lower groundwater levels reduce the buoyant support of a cavity roof which can prompt a collapse. Sinkholes are classified as geologic hazards, sometimes causing extensive damage to structures and roads which result in costly repairs. Sinkholes also threaten water supplies by leaking contaminated

[43] https://www.swfwmd.state.fl.us/resources/weather-hydrology/sinkholes

water from streams, lakes, wetlands and runoff from urban development directly into waterway systems, as seen in a recent Pasco County sinkhole response.[44]

Historical Occurrence

According to the Pasco County Development Services Department, 4,799 permits were pulled for incidents of sinkhole subsidence repairs between January 2009 and September 2018. There were 7,600 reported incidents from January 2009 through September 2018, for an average of 844 sinkholes reported annually over this time period. It is important to note the numbers reported are based on property ownership and therefore are not indicative of ground settlement activity occurring outside of urban developmental areas.

Furthermore, as these numbers represent permits, which are required for a property owner or contractor to begin sinkhole repairs, incidents where private insurance companies or other entities are called to investigate ground settlement anomalies, as well as condemned or demolished buildings would not be captured by these calculations.

Pasco County Emergency Management receives notifications from the Pasco County 9-1-1 Communications Center when suspected sinkhole activity is reported through the County Warning Point. Pasco County Fire Rescue and Emergency Management responds to determine if there are life-safety concerns, document the occurrence, and provide referrals for property owners, however, the depression or anomaly is not classified as a sinkhole unless a geologist makes this determination. Where there is concern a structure is unsafe due to ground settlement, a County building official is notified to respond for further investigation and a determination on the habitability of the building.

Dividing the total number of investigation requests (7,600) by the number of work week days in a nine-year period results in an average of three sinkhole investigations per day. These calculations demonstrate the number of investigations and sinkhole remediation for Pasco County as a consistently pervasive issue. Figure 2.39 shows the geographic breakdown by community of sinkhole investigations and remediation permitting which exhibits the sinkhole hazard as a countywide threat.

[44] https://www.wtsp.com/article/news/local/pascocounty/crews-continue-monitoring-massive-pasco-co-sinkhole/67-456657829

Figure 2.39
Pasco County Sinkhole Reports by Community

	Community	# of Investigations / Remediation Permits
*	Bayonet Point	907
*	Blanton	5
*	Crystal Springs	13
	Dade City	21
*	Darby	13
*	Holiday	758
*	Hudson	2,098
*	Lacoochee	3
*	Land O Lakes	657
*	Lumberton	2
*	Lutz	198
	New Port Richey	4,640
*	Odessa	151
	Port Richey	1,777
	San Antonio	25
*	Spring Hill	316
*	Trilby	5
*	Wesley Chapel	687
	Zephyrhills	86
	Out of County or Unknown Location	41
*	*Unicorporated Pasco County*	
January 2009 - September 2018		

Source: Pasco County Development Services Department

Vulnerability

Figure (2.40) created by the Florida Department of Environmental Protection and the Florida Geological Survey, is a map of Subsidence Incidents. While sinkholes are closed depressions in areas underlain by soluble rock, other subterranean events can cause holes, depressions, or subsidence of the land surface that may mimic sinkhole activity. For the purposes of Figure 2.40, a reported depression is not verified by a licensed professional geologist to be a true sinkhole, and the cause of subsidence is not known. While this data may include some true sinkholes, the majority of the incidents have not been field-checked and the cause of subsidence is not verified.

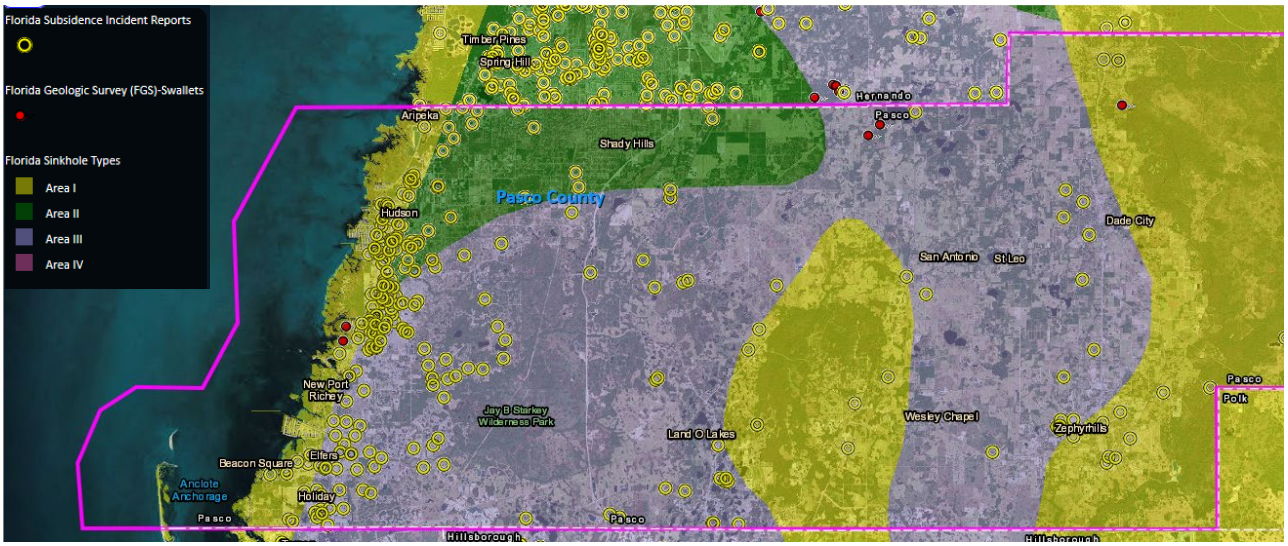
The Florida Geological Survey (FGS) has captured the subsidence data for over 100 years and the Figure 2.40 is for reports through September 2018. The FGS records however, have been largely collected on a voluntary basis through the State Watch Office (the clearing house for emergency response calls involving man-made and natural disasters), citizens who submit the information to the FGS, or via an emergency situation where a swarm of sinkholes occurs and the FGS is called in by emergency officials to help survey the sinkhole hazard.[45]

Through additional research, FGS also shows in Figure 2.40 that Pasco County is primarily comprised of soils prone to abruptly forming a collapse in the Starkey Park, Lacoochee, and Wesley Chapel areas (Area III Sinkhole Type). Area III Sinkhole Types consist of cohesive clayey sediments of low permeability that is generally 30 to 200 feet thick[46]. Shallower sinkhole formation is likely along the coastline and in between the Land O' Lakes and Wesley Chapel

[45] https://floridadep.gov/fgs/sinkholes/content/subsidence-incident-reports
[46] http://publicfiles.dep.state.fl.us/FGS/FGS_Publications/MS/MS110SinkholeType/sinkholetype2.pdf

areas (Area I Sinkhole Type). Area I Sinkhole Type consist of bare or thinly covered limestone. The area surrounding north central Pasco County near Shady Hills is considered sandy soil and would likely produce small sinkholes (Area II Sinkhole Type). Area II Sinkhole Type consist of incohesive and permeable sand that is generally 30 to 200 feet thick.

Figure 2.40
Voluntary Subsidence Incidents Reported to FGS



Source: Florida Department of Environmental Protection and Florida Geological Survey

Probability

A review of historical occurrences shows the probability of a sinkhole occurring in the county is extremely high. Twice as many sinkhole incidents are reported during the rainy season as in the dry season. The probability of occurrence increases in areas of man-made development due to heavy equipment removing and damaging protective layers of soil for parking lots, paved roads, and buildings.[47]

Reports state sinkholes have always occurred in "sinkhole alley," (Hillsborough, Pasco, and Hernando counties); however, due to the increased population growth it is now affecting highly populated communities more so than rural areas.[48] Figures 2.40 and 2.41 show communities countywide that are susceptible to sinkholes; however, the most vulnerable areas are located in western Pasco County. This includes: the municipalities of New Port Richey and Port Richey, and the unincorporated areas of Holiday, Hudson, and Bayonet Point.

If the Pasco County Special Flood Hazard Areas (SFHAs) have a 1% chance of experiencing a flood in any given year, the high-risk communities have a 25% chance of experiencing a sinkhole on any given day. This is based on an average of three reported incidents per day from the historical data, with each household representing one of the possible three incidents.

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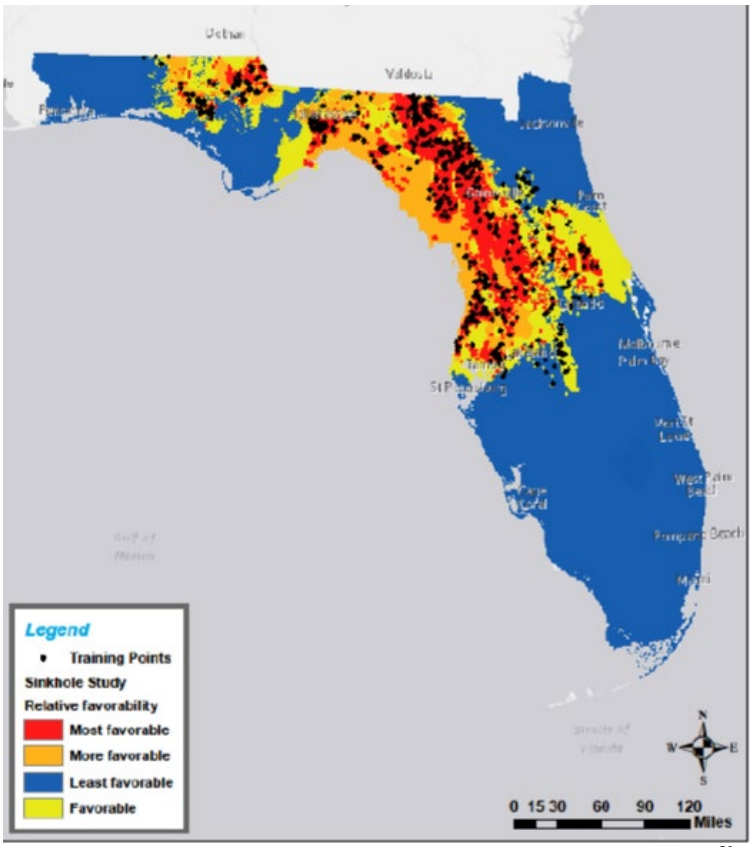
[47] https://www.smithsonianmag.com/science-nature/science-behind-floridas-sinkhole-epidemic-180969158/
[48] https://www.theguardian.com/world/2013/aug/14/sinkhole-alley-florida-fact-of-life

Furthermore, a study completed in 2011 showed Pasco County as the number one sinkhole prone county in Florida, with one possible reason relating back to SFHA zones.[49] Figure 2.41 below shows a predictive map of Florida for potential sinkhole development illustrating that while the county as a whole is prone to sinkholes, the majority of the coastline is most favorable for development.

Figure: 2.41
Favorable Sinkhole Formation for Florida



Source: The Enhanced State Hazard Mitigation Plan, State of Florida[50]

[49] https://www.insurancejournal.com/news/southeast/2011/03/30/192278.htm
[50] https://www.floridadisaster.org/dem/library/publications-and-guides/

Extent

Sinkhole incidents affect a small number of people or businesses per occurrence, however collectively the number of sinkhole incidents over time has significant economic and geographic impacts within communities by drastically changing the dynamics of an area. The earlier statistic of an average of three reports a day becomes cumulatively significant when a number of incidents happen in a particular neighborhood. This is indicative of ground instability and therefore those who are unaffected but reside in surrounding areas must begin to pay careful attention to whether their home or business is shifting.

Shifting can be detected, among other indicators, by observing the following: cracks in walls, ceilings, floors, and pavement, popped nails in roofing or wallboards, lose or sagging flooring, loss of water in pools or other bodies of water, recently leaning, sagging, un-level or un-plumb fence posts, decks, sidewalks, trees, or shrubbery.

The length of a sinkhole is often measured in miles as sinkholes can range from inches to over 100 feet and can extend well underground.[51] Pasco County is working with geologists from the University of South Florida to create aerial mapping of communities prone to sinkholes based on historical occurrence and the geographic location within the County. The geologists are utilizing the mapping tools to measure any shifting of buildings that occur over time to hopefully one day create a reliable forecasting tool for suspected sinkhole activity.

In July of 2017 a massive sinkhole opened in the Land O'Lakes area of Pasco County swallowing two homes, causing another seven to be condemned and meet the criteria for demolition, and closing the residential street to through traffic. During debris removal, crews dumped 758 dump trucks of uncrushed lime rock into the sinkhole.[52] The Land O'Lakes sinkhole was originally estimated to be 260 feet wide and 50 feet deep. Figure 2.42 shows an aerial image.

The Pasco County Commission approved installing two T-intersections to allow vehicles to get around the street without having to back onto private property to turn around, and to surround the sinkhole with a fence. Those repairs are estimated to cost $242,000 for a response the County had already spent over $900,000 to address. Other remediation options such as extending the nearby body of water, Lake Saxon, by connecting it to the sinkhole were abandoned. While the County is working to ensure the fencing is decorative, the long term impact on potential decline in property values in the surrounding area is still a huge concern for property owners and elected officials alike.

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[51] https://www.ardaman.com/civil-engineering/sinkhole-evaluation/
[52] https://www.wfla.com/news/pasco-county/total-of-8-homes-now-condemned-near-massive-land-o-lakes-sinkhole/994839991

Figure 2.42
July 2017 Land O'Lakes Sinkhole

Source: Associated Press[53]

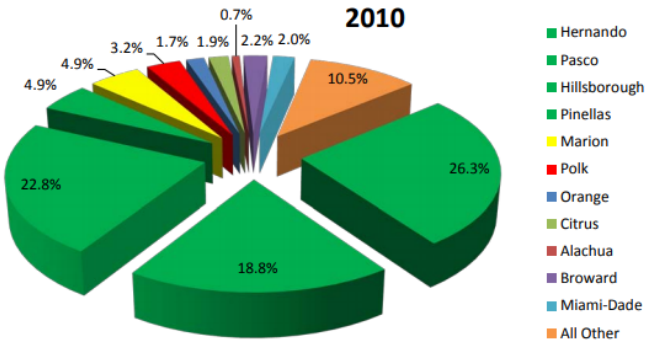
No two sinkholes are alike; Therefore, it is difficult to gauge the average cost for sinkhole repair. A small sinkhole with minimal damage to a structure may cost anywhere from $10,000 to $15,000. However, sinkholes that cause extensive damage and need a significant amount of work to repair or revive the structure may be much pricier, costing anywhere from $20,000 to $100,000, or more according to a local engineering and foundation repair firm.[54]

The Florida Office of Insurance Regulation's (FLOIR) most recent report on sinkhole data was prepared in 2010 to examine closed sinkhole claims in Florida. The results of the data call indicated the problem of sinkholes had increased in both frequency and total cost during the period examined (2006-2010). Specifically, the results showed an increase in the occurrence and cost of sinkhole claims.

Of the total sinkhole claims in the report, Pasco County has the highest percentage of claims accounting for 26.3% of the statewide study and is referenced in the report as part of a three county "sinkhole belt" located in the Tampa Bay region. In aggregate, the total of sinkhole claims in these three counties has increased by 67.9%.

[53] https://www.theledger.com/news/20170812/geologists-study-massive-land-olakes-sinkhole
[54] http://crosstownengineering.com/insight/the-cost-of-a-sinkhole-repair/

Figure 2.43
Florida Office of Insurance Regulation Regional Level Analysis



NOTE: Green counties represent "Sinkhole Belt"

Source: Report on Review of the 2010 Sinkhole Data Call

Total sinkhole costs over the sample period amounted to approximately $1.4 billion statewide and increased from $209 million in 2006 to $406 million in 2009, resulting in an increase of over 51% in a three year period of time. Adjusted for inflation, the costs today are easily closing in on $500 million dollars, with the most substantial costs in the claims accounting for structure loss.[55] The overall economic impacts from sinkholes are tremendous and the surrounding communities suffer the brunt of this in declining property values for many years to come.

[55] https://www.floir.com/siteDocuments/Sinkholes/2010_Sinkhole_Data_Call_Report.pdf

Wildfires

Source: Florida Forest Service; Silver Palm Wildfire of 2017

Description

With the exception of fires triggered by lightning strikes, which are usually mitigated in their impact by the precipitation of an accompanying thunderstorm, wildfires tend to be the culmination of hot, dry weather patterns that merely create the conditions for their occurrence. Once those conditions and the buildup of dry fuel to feed a fire are in place, the occurrence of a conflagration depends simply on the right spark in the right place and the disaster is set in motion. Wildfires often begin unnoticed. The three factors contributing directly to the behavior of wildfires are topography, fuel and weather. Wildfires spread quickly igniting brush, trees and homes. Every year, thousands of acres of wildland and many homes are destroyed by fires that can erupt at any time of the year from a variety of causes including arson, lightning and debris burning.

There are four types of forest fires:

1. **Surface:** A surface fire is the most common type and burns along the floor of the forest, moving slowly while killing or damaging trees.
2. **Ground:** Ground fires (muck fires) are usually started by carelessness. They burn on or below the forest floor. These fires are hard to detect, and even harder to extinguish.
3. **Crown:** Crown fires are spread rapidly by the wind and move fastest of all types of fires by jumping along the tops of trees.
4. **Wildland-Urban Interface:** WUI fires occur in a geographical area where structures and other human development meet or intermingle with wild lands or vegetative fuels.

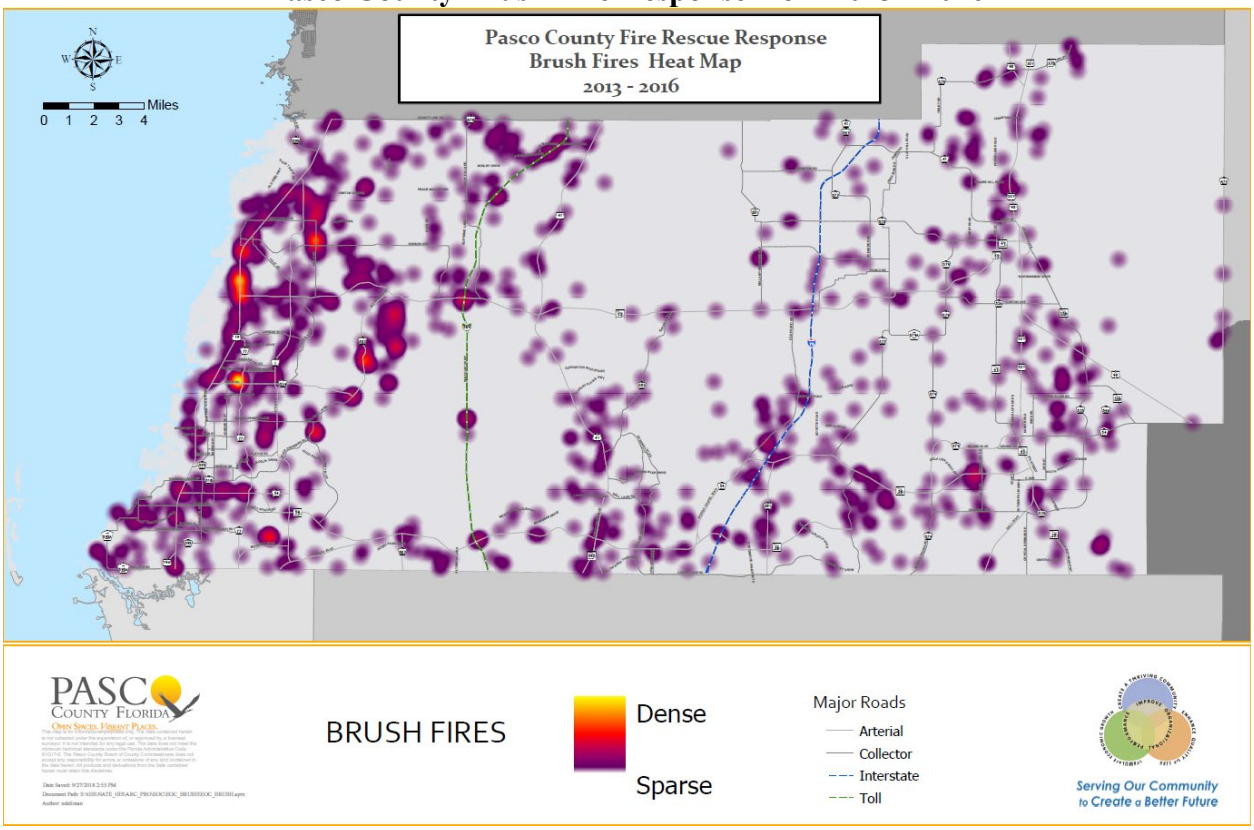
In the wildland, fires have historically performed an important role in the cycle of forest growth, clearing underbrush to allow the regeneration of certain plant species at the expense of others.

With or without the human presence, fire is a part of nature. Human efforts to eliminate wildfires from the natural environment, rather than helping matters, have served to make such fires more severe when they occur. Vegetative fuels accumulate in the forest understory, and when fires occur, they are more severe and disastrous than might otherwise have been the case. Thoughtful mitigation involves integrating the role of wildfires in ecosystems, and to incorporate this understanding in development planning for construction that occurs at the interface between growing urban areas and wildland. This interface is the focus of hazard identification efforts.

Historical Occurrence

Over the last five years, 2013 and 2017 were abnormally dry years which lead to very active calendar years for Wildfires in the State of Florida and specifically, Pasco County. Florida Forest Service reported 188 wildfires in Pasco County from 2013 to 2018 involving over 5,604 acres. The Pasco County Fire Rescue department responded to approximately 1,372 brush fires from 2013 to 2016. The average brush fire responses for the more normally dry years, 2014-2016, were just shy of227 calls. For 2013 alone, Pasco County Fire Rescue responded to over 350 calls and 380 events for 2017. Pasco County received 71,000 calls annually, which equates to an average of 194 calls per day. Figure 2.44 shows the brush fire response from 2013 – 2016.

Figure 2.44
Pasco County Brush Fire Response from 2013 - 2016



Source: Pasco County Fire Rescue, Pasco County 9-1-1, and Pasco County GIS

The following information is the 2017 Florida Wildfire Summary from Florida Forest Service for the State of Florida:

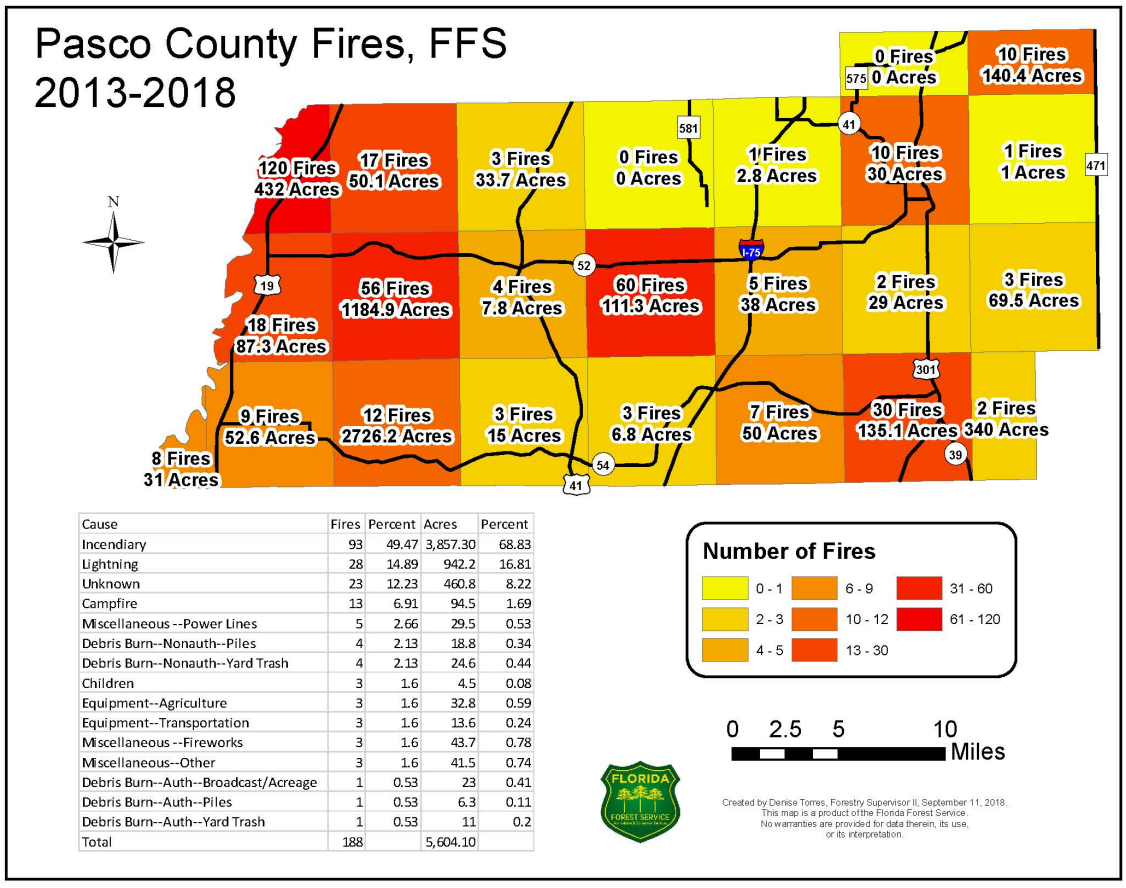
- Firefighters suppressed 3,271 Wildfires
- 298,760 acres were burned
- 6,730 homes, businesses and out buildings were threatened but saved by firefighters
- 66 homes, 1 business and 46 out buildings were damaged
- 52 homes. 6 businesses and 365 out buildings were destroyed.

The following information is the 2013 and 2017 Wildfire Summaries from Florida Forest Service for Pasco County:

- 2013 - 38 Wildfires for a total of 1,064 acres
- 2017 - 43 Wildfires for a total of 2,863 acres.

Over the course of the past 5 years, both Pasco County Fire Rescue and the Florida Forest Service (FFS) have responded to an abundance of wildfire calls. As seen in Figure 2.45, FFS responded to approximately 188 wildfires totaling in an estimated 5,604.10 acres burned within Pasco County. The majority of the fires started as a result of incendiary (human caused) or lightning (naturally caused). Figure 2.45 is defined by township and range to provide a better understanding of the hotspots for wildfire occurrence.

Figure 2.45
Florida Forest Service Wildfire Calls by Geography from 2013 - 2018



Cause	Fires	Percent	Acres	Percent
Incendiary	93	49.47	3,857.30	68.83
Lightning	28	14.89	942.2	16.81
Unknown	23	12.23	460.8	8.22
Campfire	13	6.91	94.5	1.69
Miscellaneous --Power Lines	5	2.66	29.5	0.53
Debris Burn--Nonauth--Piles	4	2.13	18.8	0.34
Debris Burn--Nonauth--Yard Trash	4	2.13	24.6	0.44
Children	3	1.6	4.5	0.08
Equipment--Agriculture	3	1.6	32.8	0.59
Equipment--Transportation	3	1.6	13.6	0.24
Miscellaneous --Fireworks	3	1.6	43.7	0.78
Miscellaneous--Other	3	1.6	41.5	0.74
Debris Burn--Auth--Broadcast/Acreage	1	0.53	23	0.41
Debris Burn--Auth--Piles	1	0.53	6.3	0.11
Debris Burn--Auth--Yard Trash	1	0.53	11	0.2
Total	188		5,604.10	

Source: Florida Fire Management System (FMIS)

Vulnerability

The ***Pasco County Community Wildfire Protection Plan*** (CWPP) discusses wildfire vulnerability, analyzes historical patterns, and identifies communities at risk. This document is included with the LMS as Appendix L. The CWPP was written using the Southern Wildfire Risk Assessment program[56].

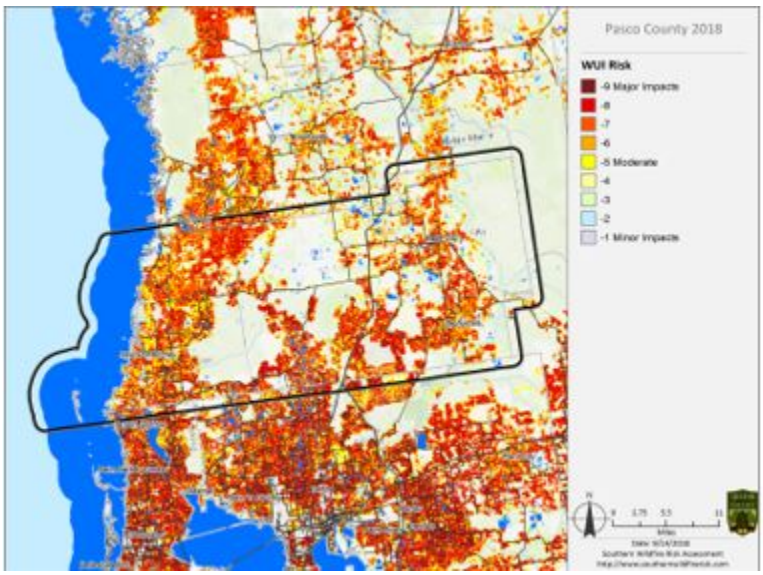
The goal of the Southern Wildfire Risk Assessment (SWRA) project was to provide a consistent, comparable set of scientific results to be used as a foundation for wildfire mitigation and prevention planning in the Southern states. Results of the SWRA can be used to help prioritize areas in the state where tactical analyses, community interaction and education, or mitigation treatments might be necessary to reduce risk from wildfires. In addition, the information provided in the assessment can be used to support the following key priorities:

- Identify areas that are most prone to wildfire
- Identify areas that may require additional tactical planning, specifically related to mitigation projects and Community Wildfire Protection Planning
- Provide the information necessary to justify resource, budget and funding requests
- Allow agencies to work together to better define priorities and improve emergency response, particularly across jurisdictional boundaries
- Define wildland communities and identify the risk to those communities
- Increase communication with local residents and the public to address community priorities and needs
- Plan for response and suppression resource needs
- Plan and prioritize hazardous fuel treatment programs

The SWRA information is then incorporated into the Wildland Urban Interface (WUI) Risk Index. This data layer is a rating of the potential impact of a wildfire on people and their homes. They key input, WUI, reflects housing density (houses per acre) consistent with Federal Register National standards. The location of people living in the WUI and rural areas is key information for defining potential wildfire impacts to people and homes. Figure 2.46 shows the WUI Risk Index Layer taken from the Pasco County Southwrap 2018 report.

[56] https://www.southernwildfirerisk.com/

Figure 2.46
Wildland Urban Interface Risk Index



Source: Pasco County Southwrap 2018 report.

The level of vulnerability is high due to the patterns and location of new development, probability of occurrence based on fuel types, and costs associated with these events. Several of the most vulnerable identified by the Florida Forest Service:

1) Old Dixie Highway in Hudson (Sections 11, 12, 14, 22, 27, 28, Township 24, Range 16),
2) Moon Lake (Sections 10, 11, 12, 13, 14, 15; Township 25, Range 18)
3) Starkey Area (Sections 10 thru 27, Township 25, Range 18)
4) River Ridge Subdivision in New Port Richey (Sections 29, 30, 31, 32, 33, Township 25, Range 17)
5) Trinity Communities in New Port Richey (Sections 34, 35, 36, Township 26, Range 16), and
6) Quail Hollow Subdivision in Wesley Chapel (Sections 1, 2, 3, Township 26, Range 19, and Sections 34, 35, 36, Township 25, Range 19).

Approximately one-third of Pasco County acreage is undeveloped, forested, or pastureland. As more development occurs adjacent to or intermixed within these areas, the vulnerability of wildfire impacts to people and improved property increases.

The Florida Forest Service works with the Pasco County LMS Working Group to identify mitigation projects. Mitigation Projects are completed by Pasco County Rangers, the Region 3 Mitigation Team and the Cooperative Outdoor Burning Resource Assistance (COBRA) Team, and the Pasco County Parks, Recreation, and Natural Resource Department. Figure 2.47 below represents projects completed in 2013-2018; the funding for the projects comes from grants within the Florida Forest Service.

Figure 2.47
FFS Pasco County Mitigation Projects Completed Since 2013

Project Name	Owner	County	Treatment Cost	Acres	Structures Protected	Structures Total Value
Safety Town	County	Pasco	$7,849.49	3.60	34	$7,120,000.00
Safety Town	Private	Pasco	$3,505.00	40.00	27	$4,320,000.00
Richlam Burn 14B	State	Pasco	$3,591.50	681.00	24	$3,600,000.00
Key Vista Park	County	Pasco	$2,487.00	110.00	22	$4,400,000.00
Troy Fonder Property	Private	Pasco	$304.00	10.00	19	$2,850,000.00
Hopewell Mow	Private	Pasco	$7,028.38	12.10	126	$24,450,000.00
Hopewell Plow	Private	Pasco	$10,500.98	0.00	0	$0.00
Hopewell Plow 2	Private	Pasco	$6,696.16	0.00	0	$0.00
Hopewell Burn	Private	Pasco	$4,000.79	200.00	0	$0.00
Hopewell Rx Two	Private	Pasco	$2,977.00	300.00	126	$24,450,000.00
Silver Palm	Private	Pasco	$3,907.05	17.60	33	$6,600,000.00
Werner-Boyce	State	Pasco	$3,628.74	0.00	400	$50,000,000.00

Source: Florida Forest Service Mitigation Team

While Figure 2.48 shows the Pasco County Communities most at risk for wildfire, the wildfire potential remains possible countywide. The community at risk are identified in the CWPP as those with the highest levels of wildfire user interface (WUI), where homes and businesses are located near heavily wooded lands.

Figure 2.48
Pasco County Communities at Risk, 2018

HIGH	Medium	Low
Old Dixie Highway	Bayoneet Point	Beacon Lakes
Quail Hollow	Clay sink	Beacon Square
River Ridge	Dade City	Blanton
Trinity	Ehren	Brown Acres West
Moon Lake	Hudson	Crystal Springs
Starkey Area	Jasmine Estates	Dade City
Forest Hills	Lacoochee	Darby
	Wesley Chapel	Senate Manor
	Ridge Manor	Gowers Corner
	Tanglewood	Timber Woods
	Verandahs	Holiday
	Silver Plam	Jessamine
		Lake Psadena Heights
		Land O' Lakes
		New Port Richey
		New Port Richey East
		Odessa
		Pasadena Shores
		Richland
		Saint Joseph
		San Antonio
		Bexley
		South Clinton Heights
		St Leo
		Tampa Bay Golf and Country Club
		Trilby
		Trilcoochee
		Zephyrhills

Source: Community Wildfire Protection Plan (CWPP), Florida Forest Service (FFS)

A ranking of low, medium or high risk was determined by using a Florida Wildfire Risk Assessment Checklist for three segments of the county: the western, central and eastern geographic areas. The checklist assigned points for elements such as (but not limited to) ingress and egress, road width, vegetation, and building construction. A maximum number of points was assigned for each element, based on vulnerability, although the highest number of possible points for each element ranged from 2 to 25. The hazard assessment breakdown that occurred in the Florida CWPP and an enhanced discussion of the observations in Table 2.49 can be found in Appendix L.

Figure 2.49
CWPP Hazard Assessment

HAZARD ASSESSMENT	POINT RANGE
Low Hazard	less than 50
Moderate Hazard	50-74
High Hazard	75-99
Very High Hazard	100-120
Extreme Hazard	more than 120

Source: Florida Forest Service CWPP

Enhanced discussion of these observations can be found on in Appendix L, the CWPP.

Probability

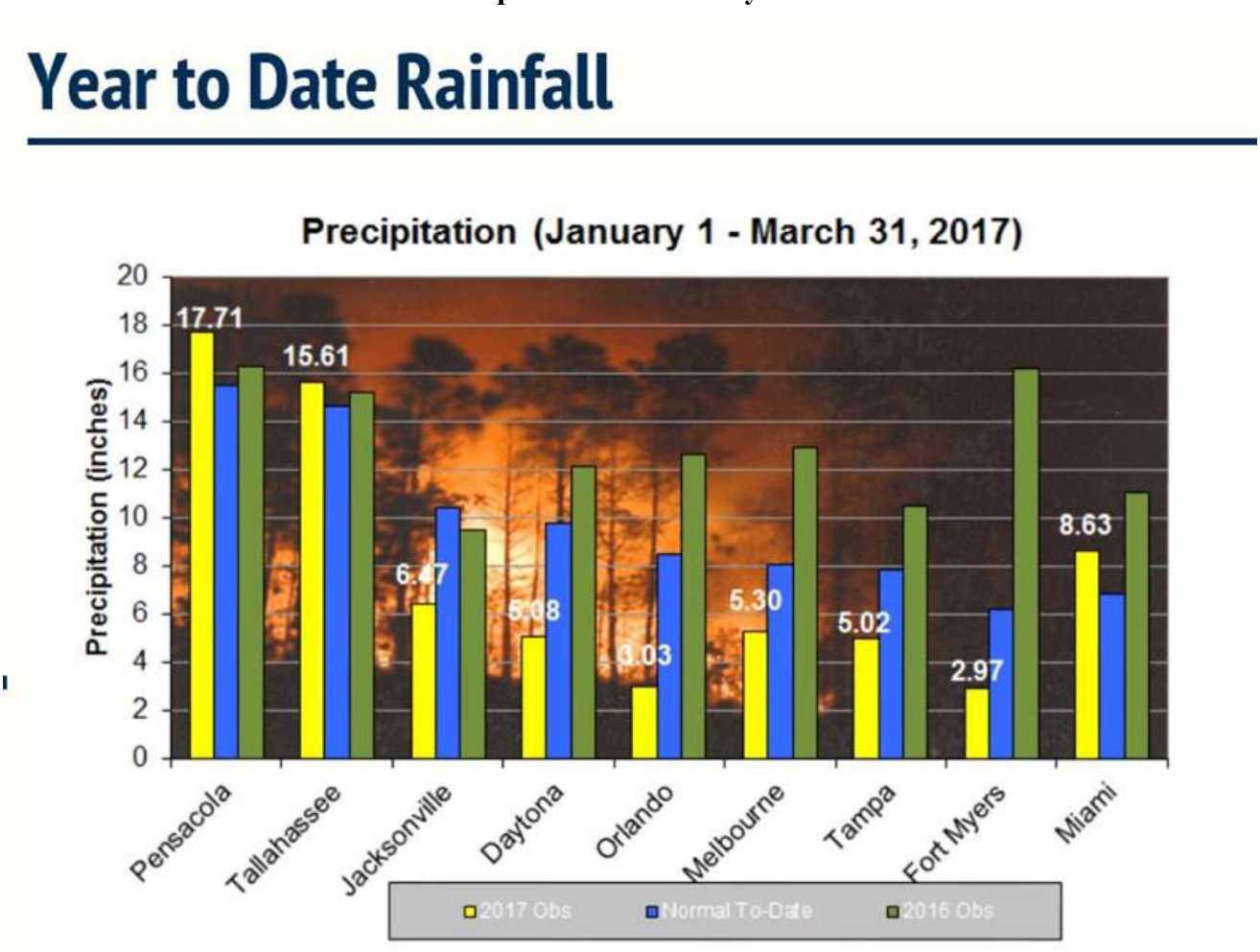
The predominance of forested acreage, current patterns of development and historical weather conditions indicate the probability of occurrence is high. The threat of fires cannot be eliminated, but public education and the use of prescribed burns can be used to better manage this hazard. The local Fire Rescue department suggests that the probability exists for at least five wildland fires in Pasco County per year. Florida's wildfire season normally runs from December to June, with the largest/greatest number of acres burned peaking in May. April and May are typically considered dry in Florida. This is because the frontal passages from the north and west are no longer moving through the State and the summer thunderstorm pattern has not yet begun. Wildfires can erupt at any time of the year from a variety of causes, including arson, lightning and debris burning. Forest fires from natural causes such as lightning account for only a very small percentage of Florida's wildfires, whereas man is by far the leading cause of wildfires. As an aside, the LMS Working Group this summer welcomed a new member, one from the state forestry service.

Extent

Wildfires in Florida occur at all times of the year. The size and magnitude of wildfires are determined by the acreage. The severity of the wildfires magnitude is determined by nearby exposures. In appendix L, the CWPP shows the extent of most wildfires in Pasco County run from 0.1 to 0.9 acres in size. The single-family homes are the most exposed type of residential structure in the areas most susceptible to wildfire. Single-family homes, commercial structures, and institutional/government structures located within the CWPP areas are collectively worth $435,210,00.00.

Wildfire activity can vary from year to year, but this is determined more by fuels, weather patterns, and lack of mitigation. Florida's weather patterns vary year to year with some years being extremely dry as seen in 2011, 2013, and 2017. Figure 2.50 shows that Tampa reported well above average rainfall for 2016 and well below average rainfall during 2017.

Figure 2.50
Rainfall Totals Comparison for January 1 – March 2017

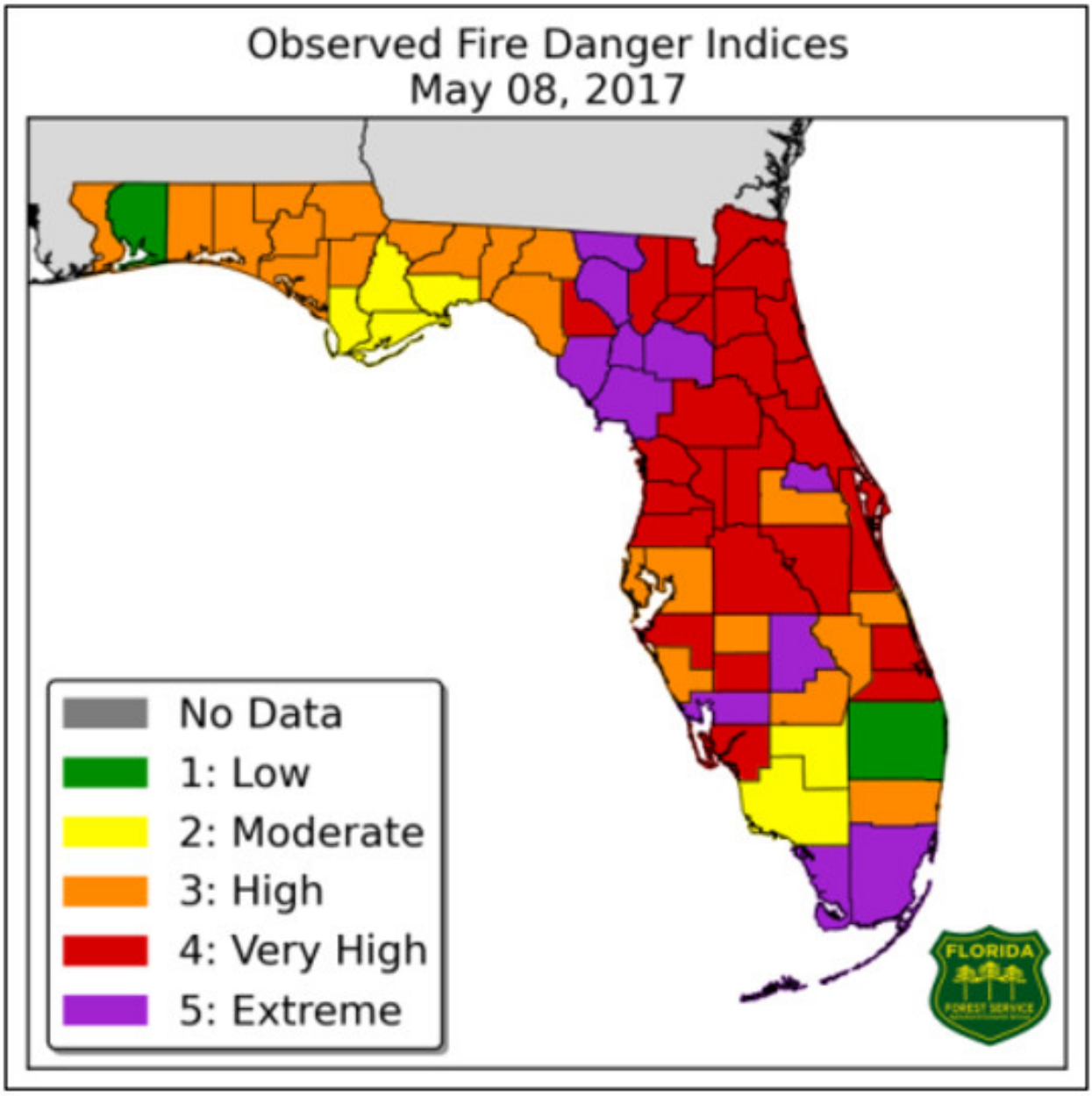


Source: Florida Forest Service

To account for precipitation changes, the Keetch-Byram drought index (KBDI) is a continuous reference scale for estimating the dryness of the soil and duff layers. The index increases for each day without rain (the amount of increase depends on the daily high temperature) and decreases when it rains. The scale ranges from 0 (no moisture deficit) to 800. The range of the index is determined by assuming that there is 8 inches of moisture in a saturated soil that is readily available to the vegetation.

In addition to the KBDI, the Florida Forest Service uses the Wildland Fire Danger Index (FDI) for estimating the potential for a fire to start and require suppression action on any given day. It does not consider how quickly any fires that do start will grow, or how difficult they will be to suppress. The FDI is updated every at 4:45 pm / 3:45 pm Central. Figure 2.51 provides an example of the FDI and its output on one of the most recently active wildfire days in Florida, May 8, 2017 as seen in Figure 2.52.

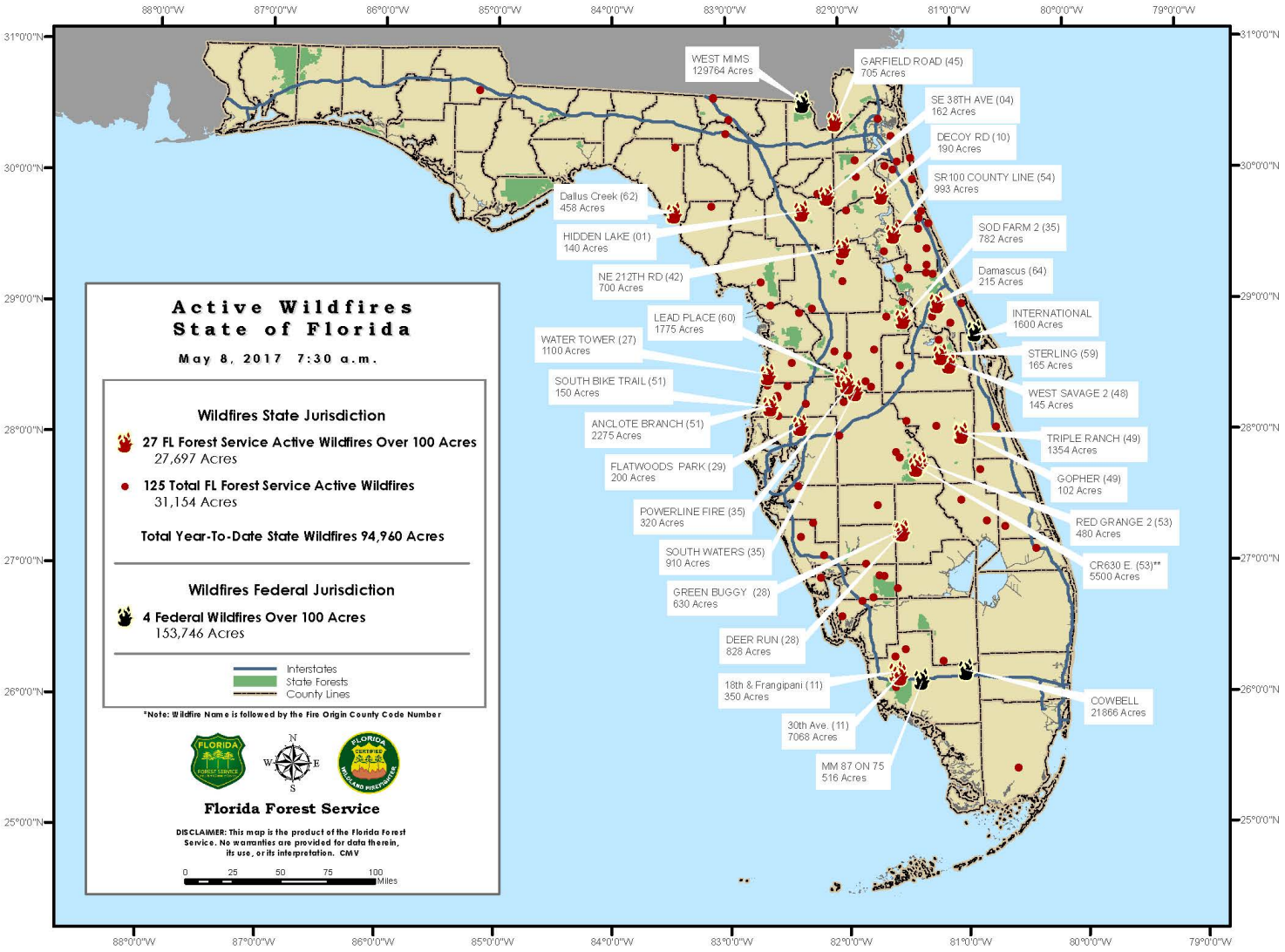
Figure 2.51
Fire Danger Index for May 8, 2017



Source: Florida Forest Service[57]

[57] https://www.freshfromflorida.com/Divisions-Offices/Florida-Forest-Service/Wildland-Fire/Current-Wildfire-Conditions2

Figure 2.52
Active Wildfire State of Florida May 8, 2017



Source: Florida Forest Service

DROUGHT/HEAT WAVE

Photo: Palm Beach Post;

Description

A drought is defined by NOAA as a deficiency of moisture that results in adverse impacts on people, animals, or vegetation over a sizeable area. The severity of the drought depends on the degree of moisture deficiency, the duration and the size of the affected area[58].

There are four ways to define drought:

1. Meteorological: A measure of the departure of precipitation from normal. Due to climatic differences, what may be considered a drought in one location may not be considered a drought in another location
2. Agricultural: This refers to a situation when the amount of moisture in the soil no longer meets the needs of a particular crop.
3. Hydrological: This occurs when surface and subsurface water supplies are below normal.
4. Socioeconomic: This refers to what occurs when physical water shortage begins to affect people.

Drought is often described as a rating on the Keetch-Byram Drought Index (KBDI), a continuous reference scale for estimating the dryness of the soil and duff layers. The index increases for each day without rain, and the amount of increase depends on the daily high temperature. The index decreases during and after precipitation occurs. The index ranges from 0 (no moisture deficit) to 800. The range of the index is determined by assuming that there is 8 inches of moisture in a saturated soil that is readily available to the vegetation. The Florida Forest Service monitors drought by water drainage basins associated with the state's major rivers. In addition, they provide the output in the referenced KBDI Index for the community Countywide. Pasco

[58] https://www.ncdc.noaa.gov/monitoring-references/dyk/drought-definition

County falls into the Withlacoochee River District, which also includes Citrus County, Hernando County, Lake County, and Sumter County[59].

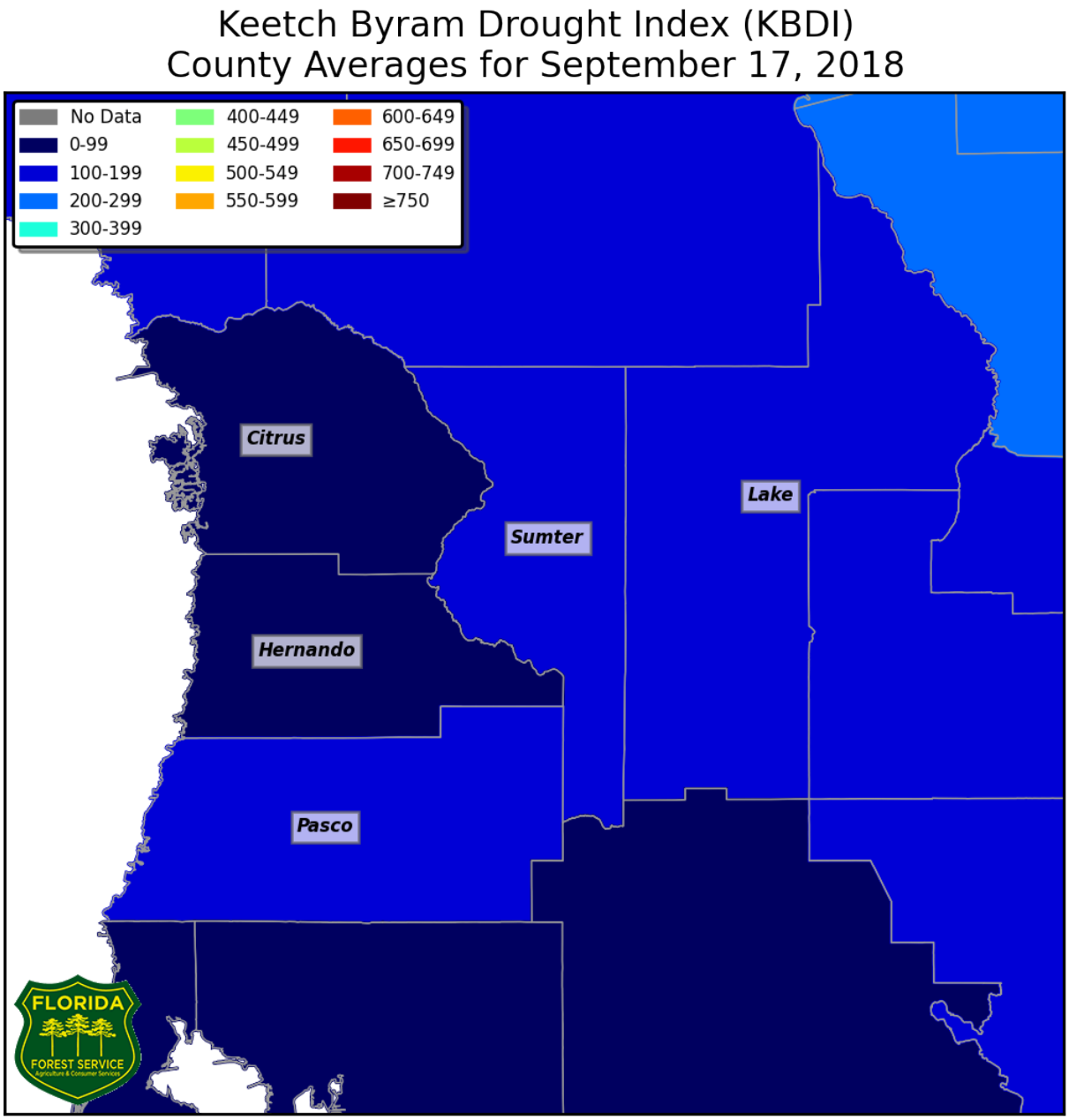
A heat wave, which can often lead to a drought, is an extended time interval of abnormally and uncomfortably hot and unusually humid weather. To be defined as a "heat wave," such a period should typically last at least two or more days[60]. During the summer season, in warm climates, a heat wave can occur when an area of high pressure containing little or no rain or clouds, heats the air and ground to excess. When the high pressure area remains static, it results in a persistent heat wave. Heat waves are referred to as the "silent killer," leading to many national fatalities for heat victims. Heat waves have physical, psychological and environmental impact. Each National Weather Service office throughout the County can issue Excessive Heat Warnings, Excessive Heat Watches, Heat Advisory, and Excessive Heat Outlooks to help prevent heat related illness and death[61].

Historical Occurrence

On September 17, 2018, Pasco County Emergency Management produced current snapshots of the KBDI summary for the local area as it relates to a short term forecast for dryness. Figure 2.53 shows the visual representation of the KBDI data and Figure 2.54 shows the numerical data of the KBDI data. The reports shows Pasco County is not currently in drought conditions. The summer of 2018 has seen temperatures in the low to mid 90° range and those conditions have persisted through the month of September. Fortunately, the weather pattern has been seasonably wet reducing the drought threat. Pasco County residents welcome the rain to maintain crops, gardens, roadways, retention ponds, lakes, rivers and other water bodies.

[59] https://www.freshfromflorida.com/Divisions-Offices/Florida-Forest-Service/Our-Forests/State-Forests/Withlacoochee-State-Forest
[60] https://forecast.weather.gov/glossary.php?word=heat%20wave
[61] https://www.weather.gov/safety/heat-ww

Figure 2.53
Map of KBDI Report



Source: Florida Forest Service[62]

[62] https://www.freshfromflorida.com/Divisions-Offices/Florida-Forest-Service/Wildland-Fire/Keetch-Byram-Drought-Index-KBDI

Figure 2.54
Numerical KBDI Report

Florida Forest Service
KBDI Summary for September 17, 2018

Average	Detailed	Rainfall	Report	Archive

				Percent of Area in KBDI Range							
	Mean	Change	Min/Max	0-100	101-200	201-300	301-400	401-500	501-600	601-700	701-800
Statewide	**177**	+16	1 / 591	26	37	24	12	2	0	0	0

KBDI Values by District

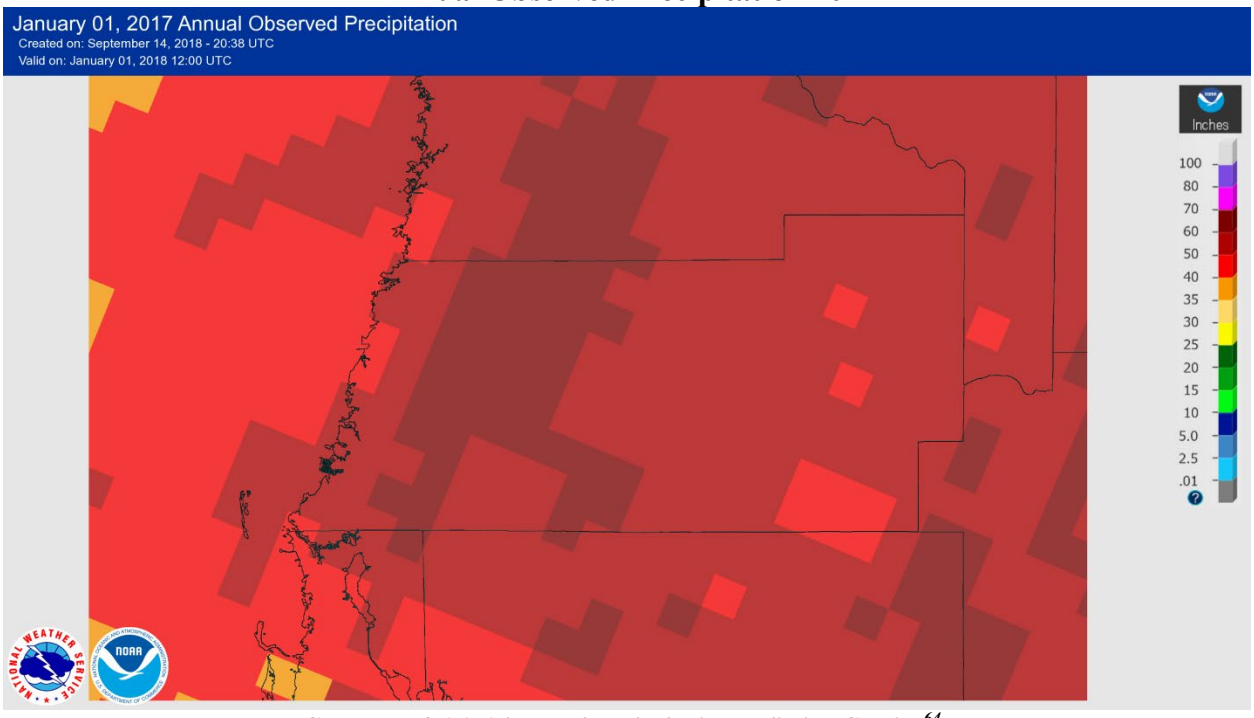
				Percent of Area in KBDI Range							
	Mean	Change	Min/Max	0-100	101-200	201-300	301-400	401-500	501-600	601-700	701-800
Blackwater F.C.	**149**	+23	54 / 298	17	68	15	0	0	0	0	0
Chipola F.C.	**182**	+18	67 / 417	13	51	27	9	0	0	0	0
Tallahassee F.C.	**279**	+20	60 / 427	4	16	30	46	3	0	0	0
Perry	**222**	+21	107 / 432	0	46	37	15	1	0	0	0
Suwannee F.C.	**245**	+18	108 / 400	0	25	54	20	0	0	0	0
Jacksonville	**312**	+16	133 / 465	0	7	34	49	10	0	0	0
Waccasassa F.C.	**173**	+21	34 / 346	15	49	34	1	0	0	0	0
Bunnell	**281**	+15	121 / 388	0	6	56	38	0	0	0	0
Withlacoochee F.C.	**138**	+4	1 / 377	39	38	22	2	0	0	0	0
Orlando	**221**	+12	1 / 591	16	36	23	14	9	2	0	0
Lakeland	**91**	+11	1 / 227	63	34	3	0	0	0	0	0
Myakka River	**87**	+13	1 / 241	72	26	2	0	0	0	0	0
Okeechobee	**194**	+14	1 / 554	18	38	29	11	4	1	0	0
Caloosahatchee F.C.	**74**	+15	1 / 267	75	26	2	0	0	0	0	0
Everglades	**126**	+19	1 / 441	39	50	10	1	0	0	0	0

Source: Florida Forest Service[63]

The National Weather Service Figure 2.55, created on September 14, 2018 illustrates the greater Tampa Bay area level of precipitation for the year 2017.

63 https://www.freshfromflorida.com/Divisions-Offices/Florida-Forest-Service/Wildland-Fire/Keetch-Byram-Drought-Index-KBDI

Figure 2.55
Annual Observed Precipitation 2017



Source: NOAA Advanced Hydrologic Prediction Service[64]:

Pasco County is identified with the county boundary at the center of the map. While the area's average of 50 inches of rain seems high in comparison to areas of the state experiencing drier climates, this amount does not go far in serving the county over 365 days, some of which include days with scorched land that is unable to readily absorb the falling water.

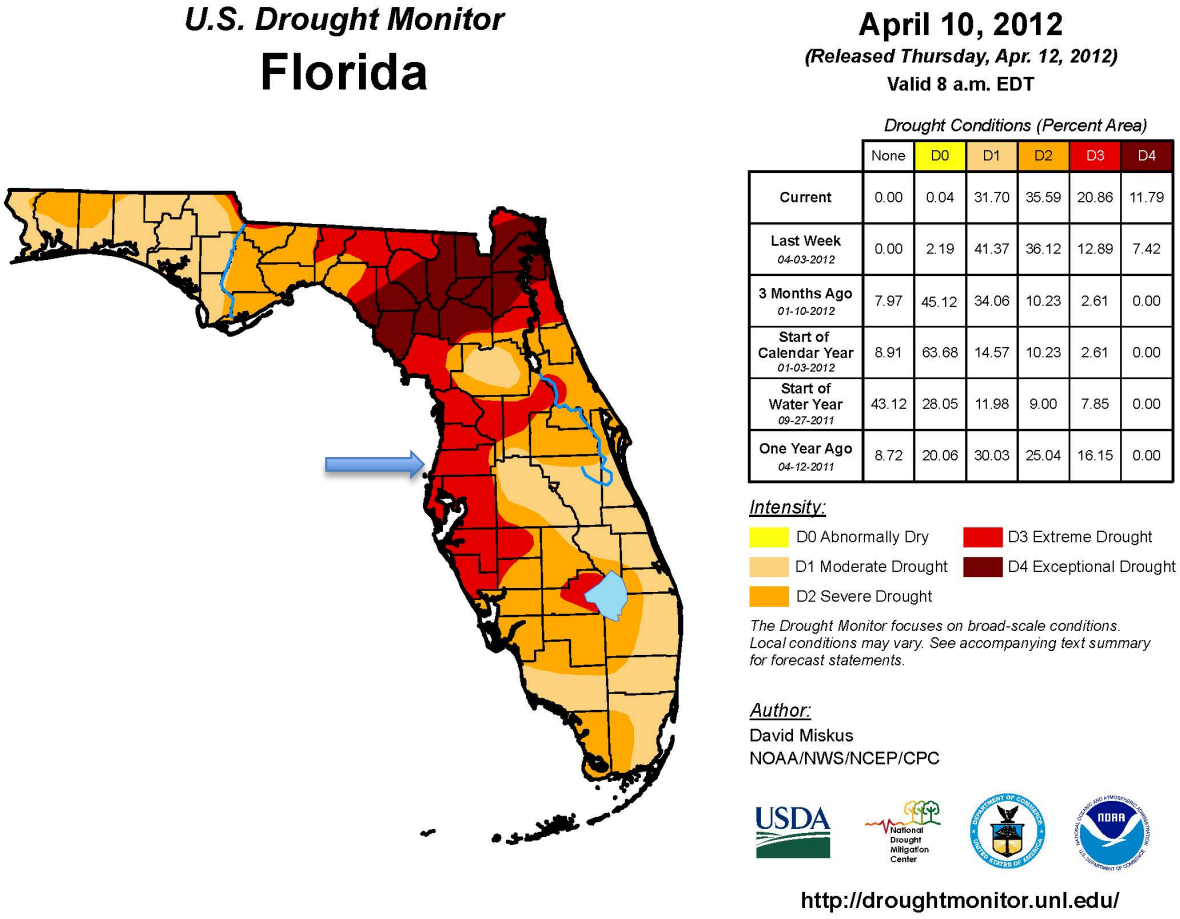
The Tampa Bay area, along with the State of Florida and much of the Southeast, felt the impacts of a severe dry spell in 2001/2002. The below normal rains caused $100 million in crop damages. Florida's citrus crop was 6% less than normal because of a two-year drought. Lawns and landscape that could only be watered one day a week for four hours to comply with regional watering restrictions were also affected by drought. According to the Southwest Florida Water Management District website, Pasco County is one of many Florida counties that have been experiencing drought conditions since 2007. In February of 2009, the county was put on alert for severe water shortage conditions. During the previous three years (2006-2008), the rainfall deficit was 27 inches and our water resources continue to be impacted. There was insufficient rainfall during the 2008 summer rainy season and all of our water resources, such as rivers and lakes, declined rapidly during the dry season. The 2013 State of Florida Hazard Mitigation Plan documents nine historical drought cycles (typically of two-year periods) have occurred in Florida since 1900. Most often, the area of impact was regional rather than the state as a whole. From 1891 to 2007, there were 58 recorded instances of drought in Florida. Four major hydrologic droughts have affected Florida. Areas of the state most severely affected by these droughts were the panhandle and south-central peninsula from 1932-1935; the entire state from 1949-1957 and again from 1980-1982; and the peninsula from 1970-1977.

[64] https://water.weather.gov/precip/

More recently there have been periods of extreme drought such as April and May of 2012 or times of severe drought such as April and June of 2017. The US Drought Monitor reports, shown in Figure 2.56, Figure 2.57, Figure 2.58, and Figure 2.59 provide more details on each period. Please note, the blue arrow in each report is pointing to Pasco County.

The Drought Monitor utilizes the Palmer Drought Severity Index (PSDI) to indicate areas of poor water supply. The PSDI compares precipitation and temperature data to determine long term drought conditions as it contains monthly comparisons[65]. This data is a planning tool to assist in water conservation measures for local areas.The PSDI shows rates drought severity from D0, which represents normal conditions, through D4, which represents extreme drought.

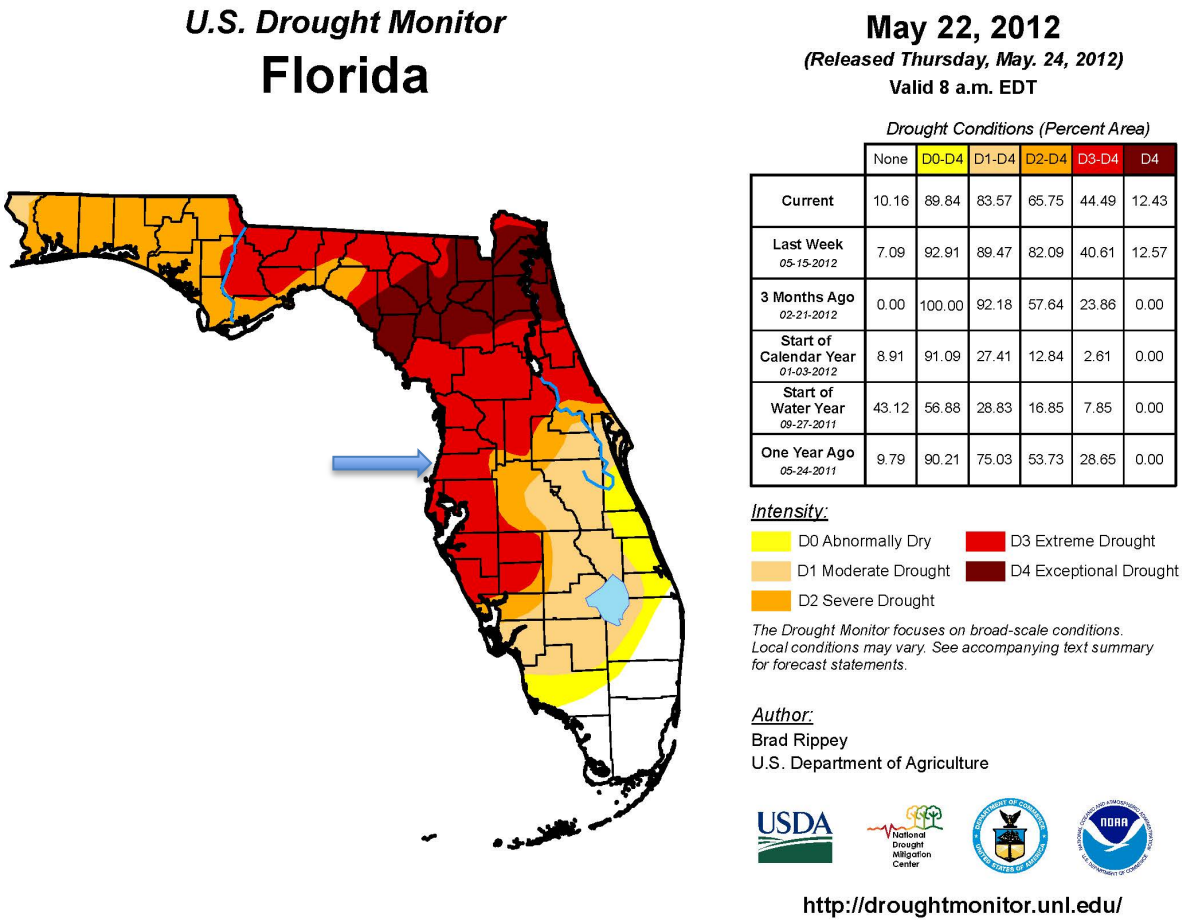
Figure 2.56
Drought Monitor April 10, 2012



Source: US Drought Monitor[66]

[65] https://climatedataguide.ucar.edu/climate-data/palmer-drought-severity-index-pdsi
[66] https://droughtmonitor.unl.edu/Maps/MapArchive.aspx

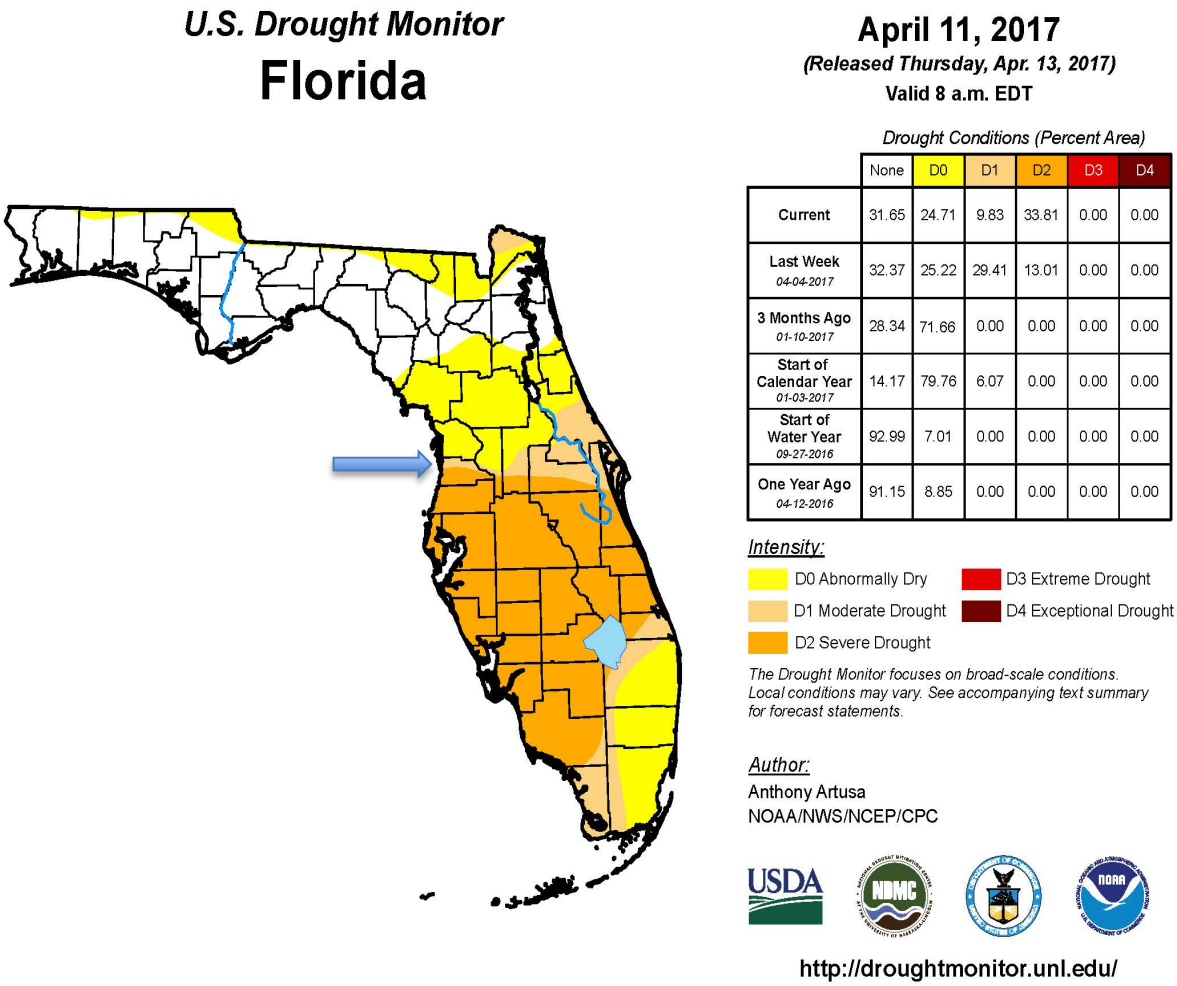
Figure 2.57
Drought Monitor May 22, 2012



Source: US Drought Monitor[67]

[67] https://droughtmonitor.unl.edu/Maps/MapArchive.aspx

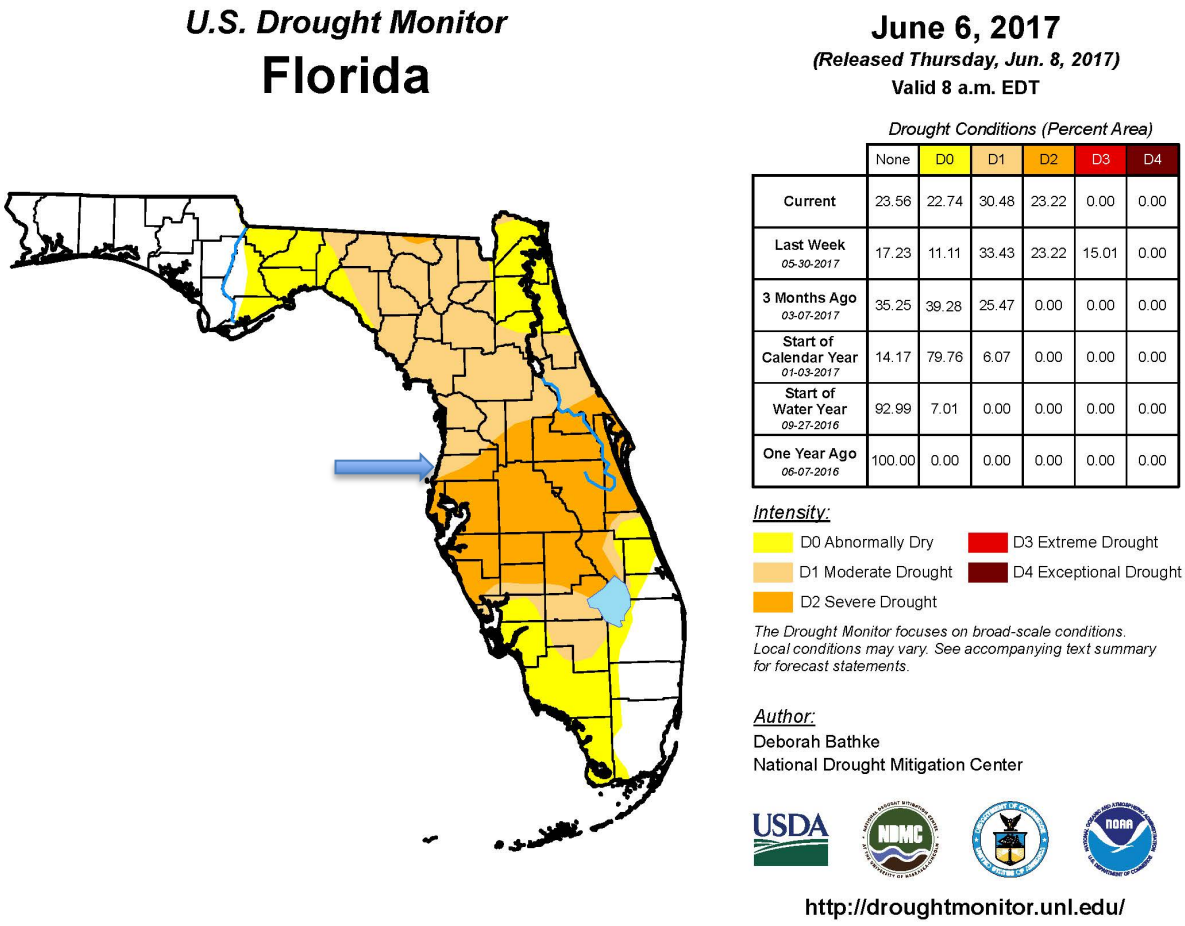
Figure 2.58
Drought Monitor April 11, 2017



Source: US Drought Monitor[68]

[68] https://droughtmonitor.unl.edu/Maps/MapArchive.aspx

Figure 2.59
Drought Monitor June 6, 2017



***Source: US Drought Monitor*[69]**

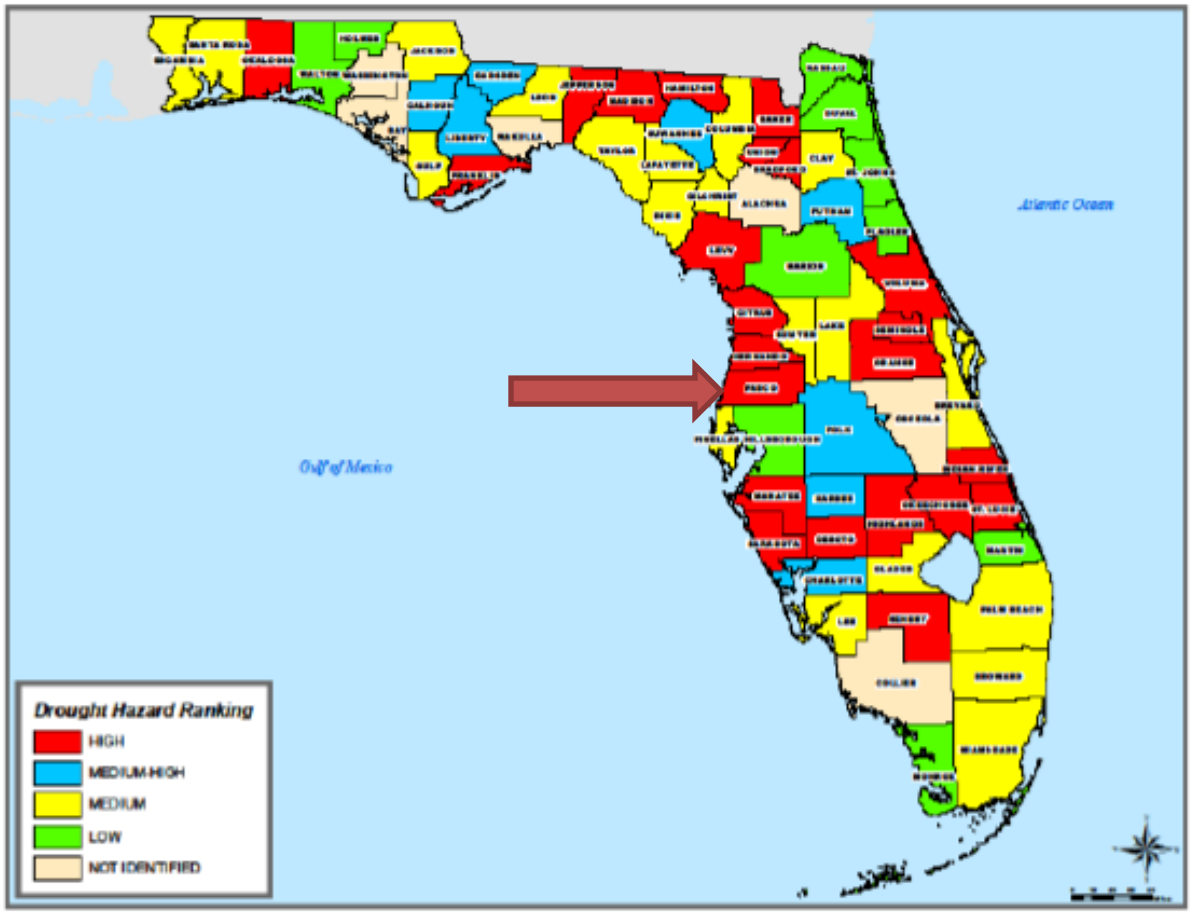
[69] https://droughtmonitor.unl.edu/Maps/MapArchive.aspx

Given Florida's geographic location and historical weather patterns, the probability of hot temperatures is high across much of the state, with Pasco County included. However, according to the National Weather Service, there has not been a heat wave in Pasco County during the last seven to fifteen years. To clarify this point, while there have been extremely hot temperatures at times, the accepted definition of a "heat wave" event has not been met. Based on historical information provided by the NWS, the probability of a classical heat wave is low.

Vulnerability

There is a significant amount of acreage in Pasco County designated for conservation, public lands and agricultural land use. When this acreage becomes parched during a drought, the area becomes vulnerable to wildfires. The economic impact from these events has not been high, as other reasons have been cited for the decrease in agricultural land uses. Therefore, the vulnerability is considered low due to the number of people impacted by a drought being not overly significant and compared to other events the economic costs are low. Pasco County's agricultural areas are most vulnerable to drought conditions as a result of the economic impact.

Figure 2.60
Drought Hazard Ranking



Source: The Enhanced State Hazard Mitigation Plan: State of Florida 2018[70]; Note: Red arrow shows location of Pasco County

[70] https://www.floridadisaster.org/dem/mitigation/mitigatefl/

Probability

The probability of the occurrence of a drought is high because of Pasco County's variable water trends over the long haul. Figure 2.61 is the annual rainfall from 2013 to Present for Pasco County. The rainfall data was received from The Southwest Florida Water Management District, which is colloquially known as SWFWMD[71]. SWFWMD partners closely with Pasco County. Representatives frequently attend Stormwater Management's Flood Task Force meetings, and are involved with updates of FEMA Special Flood Hazard Area maps and all other major water-related initiatives.

[71] https://www.swfwmd.state.fl.us/

Figure 2.61
Monthly Rainfall Data

2013	Monthly Rainfall	2014	Monthly Rainfall
January	0.70	January	3.43
February	1.61	February	1.85
March	1.37	March	6.67
April	2.71	April	1.81
May	2.36	May	5.70
June	12.25	June	5.28
July	10.13	July	9.74
August	7.44	August	6.49
September	8.81	September	7.75
October	1.03	October	2.39
November	2.43	November	7.10
December	0.55	December	2.58
2013 TOTAL:	**51.39**	**2014 TOTAL:**	**60.79**

2015	**Monthly Rainfall**	**2016**	**Monthly Rainfall**
January	2.15	January	5.89
February	4.64	February	2.01
March	2.01	March	2.53
April	3.54	April	2.34
May	3.57	May	3.89
June	5.16	June	7.69
July	13.62	July	6.02
August	13.29	August	9.08
September	5.05	September	10.85
October	1.39	October	2.33
November	2.65	November	0.04
December	0.59	December	0.43
2015 TOTAL:	**57.66**	**2016 TOTAL:**	**53.10**

2017	**Monthly Rainfall**	**2018**	**Monthly Rainfall**
January	2.07	January	4.28
February	1.72	February	1.12
March	0.67	March	1.15
April	0.28	April	4.11
May	4.03	May	9.52
June	10.27	June	6.79
July	7.81	July	10.83
August	10.77	August	8.67
September	10.86	**2018 Year to Date:**	**46.47**
October	1.78		
November	0.93		
December	0.92		
2017 TOTAL:	**52.11**		

Source: Southwest Florida Water Management District[72]

72

During years in which temperatures are high and rainfall low, the region can expect to experience drought conditions.

The probability of a heat wave, on the other hand, is low, since one has not been measured here during the history in which records have been maintained. Neither drought nor heat wave appears on the list of NCEI-documented events appearing in Appendix E.

Extent

The direct physical effects of drought typically include poor crops and foliage, increased fire danger, less water in the soil, streams and reservoirs, and less water available for livestock and wildlife. This leads to indirect effects such as less farm income, foreclosures, and reduced revenues for vendors and retailers who serve agricultural producers. Current drought conditions have caused some trees to become unstable. Should Pasco County experience a wind or rain event, structures will be in danger from falling trees. The extent of danger from falling trees is unknown. The extent of social effects of extreme drought and heat waves includes brown outs, potential loss of life in the elderly and other at risk populations, and possible water restrictions. In Pasco County many owners of smaller properties use agricultural exemptions to raise cattle, harvest hay, plant citrus groves and cultivate tree farms. However, there has been a recent decline in the total amount of agricultural acreage in Pasco County. This decline can be attributed to the purchase of acreage by public entities as public lands and also the shift of this acreage from agriculture to residential use. Pasco County has experienced a number of prolonged dry periods in the past twenty years. Prolonged drought conditions experienced between 1998 and 2008 resulted in many failed wells and ecological impacts to businesses in the spring of 2000.

To date there have been no measurable human or significant economic impacts from droughts in Pasco County. If a major long term hydrological drought were to cause a loss of an entire year's citrus crop in Pasco County the financial damage would be severe. Figure 2.62 shows the number of boxes of oranges for crop year 2016-2017 was 244,000. There were 5,000 boxes of grapefruit for crop year 2016-2017. Using the price per box[73] for citrus fruit for the crop years 2016-2017, $9.70 for a box of oranges & $11.30 for a box of grapefruit, the total amount of lost income would be $2,423,380.

Figure 2.62
Potential Crop Damage Yield 2016-17

	Crop Year 2016 - 2017				
	Oranges (1,000 Boxes)	**Grapefruit (1,000 Boxes)**	**Specialty Fruit (1,000 Boxes)**	**Total Citrus (1,000 Boxes)**	
Pasco County	244	5	6	255	

Source: USDA, NASS Southern Region Florida County Estimates[74]

[73] *Citrus prices per box for crop years 2016-2017 comes from the United States Department of Agriculture & National Agricultural Statistics Service 2016 – 2017 Citrus Summary Production, Price, and Value Production by County & by Tree Report. August 31, 2017 (Page 1)* https://www.nass.usda.gov/Statistics_by_State/Florida/Publications/Citrus/Citrus_Summary/Citrus_Summary_Prelim/cit83117.pdf

[74] https://www.nass.usda.gov/Statistics_by_State/Florida/Publications/County_Estimates/2017/FLCitrus16-17CE.pdf

As population growth continues to increase in Pasco County, the demand on the water supply will increase. Increased development in the western half of the county and in the entire region may soon cause hydrological drought to become a hazard of much greater significance.

In addition to the loss of water during drought, it may be caused or may combine with a potential heat wave. The effects of a prolonged heat wave on the human population include physical reactions such as: hyperthermia, heat edema, heat rash, heat cramps and heat syncope (dehydration). In addition, there are psychological and sociological effects resulting from stress that manifest in degraded performance and overall increase in violent crime. Often, heat waves lead to a greater consumption of power. The spike in demand typically results in power outages which increase the problem. When heat waves are coupled with drought, there is also a higher degree of risk for wildfire (dry vegetation on lands that do not have irrigation systems). Finally, heat may result in physical damage by causing roads to buckle, water pipes to burst, and power transformers to explode.

In a worst case scenario, Pasco County would be subjected to a prolonged heat wave, where temperatures consistently exceed the average range for several days or weeks, during a seasonal drought. The expected response would be high power consumption rates resulting in sporadic brown outs or complete black outs. The increasingly higher temperatures within structures would lead to physical responses and ultimately death. In addition, brush and wild fires would consume thousands of acres of vegetation with little water or resources available to respond.

Winter Storms/Freezes

Source: WUSF News[75]

Description

Severe winter weather that includes extreme cold, snowfall, ice storms, winter storms, and/or strong winds, affects every state in the continental United States. Areas where such weather is uncommon, such as Florida, are typically disrupted more severely by severe winter weather than regions that experience this weather more frequently. This is due to the fact that state, county and local governments do not keep sanders, blowers and other equipment needed to plow highways, or keep a large quantity of salt to maintain the roads in the event of freezing rain or an ice storm. This is simply not practical in a part of the country where such equipment might only be used every two or three years. When winter hazards do occur, the storms may also spawn other hazards such as flooding, tornadoes, and extreme winds that may interfere with recovery efforts.

[75] http://wusfnews.wusf.usf.edu/post/protect-your-plants-during-cold-snap

Historical Occurrence

Pasco County has experienced moderate to severe freezes in the past. Unlike a drought, a freeze does not continue for an extended period of time in Pasco County, and precautions are taken by the residential and agricultural community to minimize the impacts. Both winter storms and freezes impact business conducted by farmers. Figure 2.63 is taken from Appendix E, which is the list of all Pasco County FEMA declarations. While declarations for freezing weather may occur frequently in Florida, the media widely disseminates at least one or two stories each year about farmers preparing their crops for a night of freezing temperatures.

Figure 2.63
Severe/Freezing Temperature Disaster Events

Date of Declaration	Title of Declaration	Disaster Number
1/31/1977	Florida Severe Winter Weather	DR - 526
3/18/1985	Florida Severe Freeze	DR - 732
1/15/1990	Florida Severe Freeze	DR - 851
2/5/2001	Florida Severe Freeze	DR - 1359

Source: Federal Emergency Management Agency[76]

The last winter weather FEMA declaration that included Pasco County was on February 5, 2001. FEMA declaration number 1359 provided unemployment compensation (Disaster Unemployment Assistance) benefits to individuals who lost jobs or businesses in designated counties as a direct result of freezing weather that struck much of Florida over the period of December 1 through January 25, 2001.

The most recent occurrence of a frost/freeze event according to the National Centers for Environmental Information (Formerly the National Climate Data Center) was January 18, 2018[77]. According to the narrative provided by the NCEI: "A strong cold front moved southeast through the Florida peninsula on January 17th bringing with it strong cold air advection causing a hard freeze over large portions of the Nature Coast and west central Florida during the morning of January 18th. A second hard freeze occurred on the morning of the 19th as light winds and clear skies allowed for strong radiational cooling." The NCEI narrative for this event stated: "Temperatures fell into the mid 20's across inland portions of Pasco County for several hours on the morning of the 18th, causing damage to citrus crops and landscaping." The coldest temperature in Pasco County was reported by a FAWN (Florida Automated Weather Network) site in Dade City which was 24°[78].

Figure 2.64 shows the frost, freeze, and hard freeze advisories & warnings for both coastal and inland Pasco County issueded by the Tampa Bay National Weather Service office over the past 5 years. According to the National Weather Service, a frost advisory is issued when minimum temperatures are forecast to be 33° to 36° on nights with good radiational cooling conditions (clear skies & light winds). Freeze warnings are issued when the temperature is forecast to be between 27° and 32° over a widespread area for 2 hours or longer. A hard freeze warning is issued when temperatures are expected to be below 27° for 2 or more hours.

[76] https://www.fema.gov/disasters/year
[77] www.ncdc.noaa.gov
[78] https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=12%2CFLORIDA#

Figure 2.64
Freeze Warnings for Pasco County

Phenomena	Type	Valid For	Zone
Freeze	Warning	12/22/2012	Pasco County
Freeze	Warning	12/23/2012	Pasco County
Freeze	Warning	2/17/2013	Pasco County
Hard Freeze	Warning	2/18/2013	Pasco County
Frost	Advisory	3/15/2013	Pasco County
Freeze	Warning	3/27/2013	Pasco County
Frost	Advisory	3/28/2013	Pasco County
Freeze	Warning	1/7/2014	*Coastal Pasco County
Freeze	Warning	1/8/2014	Coastal Pasco County
Freeze	Warning	1/7/2014	Inland Pasco County
Freeze	Warning	1/8/2014	Inland Pasco County
Freeze	Warning	1/17/2014	Coastal Pasco County
Freeze	Warning	1/17/2014	Inland Pasco County
Freeze	Warning	1/19/2014	Inland Pasco County
Freeze	Warning	1/23/2014	Coastal Pasco County
Freeze	Warning	1/23/2014	Inland Pasco County
Frost	Advisory	2/14/2014	Inland Pasco County
Frost	Advisory	11/20/2014	Inland Pasco County
Frost	Advisory	12/11/2014	Inland Pasco County
Frost	Advisory	12/13/2014	Coastal Pasco County
Frost	Advisory	12/13/2014	Inland Pasco County
Frost	Advisory	12/14/2014	Inland Pasco County
Freeze	Warning	2/14/2015	Inland Pasco County
Hard Freeze	Warning	2/20/2015	Coastal Pasco County
Hard Freeze	Warning	2/20/2015	Inland Pasco County
Freeze	Warning	1/20/2016	Inland Pasco County
Freeze	Warning	1/24/2016	Inland Pasco County
Frost	Advisory	1/25/2016	Coastal Pasco County
Frost	Advisory	1/25/2016	Inland Pasco County
Frost	Advisory	2/11/2016	Coastal Pasco County
Frost	Advisory	2/11/2016	Inland Pasco County
Frost	Advisory	1/31/2017	Inland Pasco County
Freeze	Warning	12/11/2017	Inland Pasco County
Freeze	Warning	1/4/2018	Inland Pasco County
Freeze	Warning	1/5/2018	Coastal Pasco County
Hard Freeze	Warning	1/5/2018	Inland Pasco County
Freeze	Warning	1/18/2018	Coastal Pasco County
Hard Freeze	Warning	1/18/2018	Inland Pasco County
Freeze	Warning	1/19/2018	Coastal Pasco County
Hard Freeze	Warning	1/19/2018	Inland Pasco County

*** Zone grouping changed on Dec 3, 2013 from only one for Pasco County (FLZ049) to Coastal Pasco (FLZ149) and Inland Pasco (FLZ249).**

Source: NWS Ruskin, Iowa State University[79]

Vulnerability

The citrus industry is the most vulnerable to freezes. As was mentioned in the Drought/Heat Wave section, the loss of an entire year's citrus crop would cost Pasco County millions of dollars. (Please see Figure 2.62 in the Drought/Heat section for more information.) The risk of crop loss is a real danger during the winter months in Florida. In December of 1894, temperatures fell into the teens and frost and ice covered plants and trees for three days. A second freeze hit growers six weeks later. During the winter of 1926-27, many trees were killed

[79] https://mesonet.agron.iastate.edu/vtec/search.php

by frost. The next winter was a repeat and all citrus trees were destroyed. Another freeze in 1934 wiped out more than 2,000 acres of citrus and caused many growers to go into the poultry business. In 1962, a hard freeze with a low temperature of eight degrees all but put the citrus industry out of business. Income fell from $3.5 million to $229,000. Two freezes in 1983 and another in 1985 brought economic havoc on Pasco County. In 1983, eight thousand acres were lost and the tax rolls lost over $7 million. The 1985 freeze caused 6,471 acres to be lost and the remainder severely damaged. In the years 2000 to 2003, eleven freezes occurred each year and from 2004 through 2008 a total of 17 incidents of freezing weather occurred.

Probability

History indicates that it is extremely likely that several short-term freezes will occur each year in Pasco County, including one or more hard freezes that could damage crops. Over the last five years, at least one frost or freeze warning was issued and at least one cold weather shelter for the public was opened and is further detailed under the extent of this hazard. The probability of the occurrence of a freeze is high, given the historical weather patterns.

As for winter weather, Pasco County has not received snow in over 40 years, dating back to January 19, 1977[80]. More recently in January of this year, Florida prepared for winter conditions to press south as northern Florida received snowfall. The fear and preparation for Pasco County related to icy roads as temperatures were cold enough to freeze any residual standing water from rainfall a few days prior[81]. This was more of an abnormal event for Pasco County and the threat of snowfall or ice storms does not occur often in Pasco County.

Do not let the low probability of winter storms mask the annual risk of extremely cold temperatures. This annual threat leads to protection of crops, protection of structures, and opening of cold weather shelters for those without adequate heat.

Extent

While freezing temperatures are expected annually by residents and agricultural communities, residents generally take precautions to limit loss of life and crop or property damage. History indicates that the entire county can experience moderate to severe freezes. The extent of damage is greatest in the eastern half of the county where farms/groves are located. The economic impact from these events has not been high because less Pasco County land is used for agricultural purposes as parcels are sold in tracts for new development. The number of people impacted by a freeze event is not overly significant compared to other events and the economic costs are low.

When it comes to colder temperatures, not all Florida homes have access to heat sources and residents may require relocation. While cold weather doesn't have a similar financial impact on people to the extent of other hazards, the County still takes precautions. The Cold Weather Shelter Program for Pasco County is a community effort that includes area churches; non-profit agencies like the United Way, the Salvation Army, and the American Red Cross; the Homeless Coalition; social service organizations; Pasco County Emergency Management; the Pasco County Sheriff's Office, and Pasco County Public Transportation. For this county, cold weather

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[80] https://www.tampabay.com/news/weather/the-day-it-snowed-in-tampa-bay-40-years-ago-today/2310127

[81] https://www.tampabay.com/weather/Ice-closes-I-10-snow-arrives-in-Florida-as-winter-hurricane-hampers-Southeast_164170333

shelters open if there is a risk of temperatures dropping below 36°F with or without wind chill for a period of four hours or more. Normally, cold weather shelters open by 6:00 p.m. for when the sun is setting and temperatures begin to fall for the day. Figure 2.65 shows the number of shelters that were open and the number of days a shelter was open in Pasco County from 2013 through January 2018.

Figure 2.65
Shelter Openings for Pasco County

Year	Date of Flash Report	Shelters That Opened	Days Opened	Total Days Per Event	Total Days Opened, Each Year
2013	January 31, 2013	2 (Port Richey, Hudson)	2 (Thurs - Fri)	4	
2013	February 15, 2013	3 (Zephyrhills, New Port Richey, Hudson)	2 (Sat - Sun)	6	**21**
2013	March 25, 2013	3 (Zephyrhills, New Port Richey, Hudson)	3 (Mon - Wed)	9	
2013	November 26, 2013	2 (Zephyrhills, New Port Richey)	1 (Wed)	2	
2014	January 6, 2014	2 (New Port Richey, Hudson)	2 (Mon - Tues)	4	
2014	January 14, 2014	4 (Zephyrhills, Holiday, New Port Richey, Hudson)	1 (Tues)	4	
2014	January 15, 2014	4 (Zephyrhills, Holiday, New Port Richey, Hudson)	1 (Wed)	4	
2014	January 17, 2014	4 (Zephyrhills, Holiday, New Port Richey, Hudson)	2 (Fri - Sat)	8	**42**
2014	January 22, 2014	5 (Zephyrhills, Dade City, Holiday, New Port Richey, Hudson)	2 (Wed - Thurs)	10	
2014	January 23, 2014	5 (Zephyrhills, Dade City, Holiday, New Port Richey, Hudson)	1 (Fri)	5	
2014	January 29, 2014	5 (Zephyrhills, Dade City, Holiday, New Port Richey, Hudson)	1 (Wed)	5	
2014	November 18, 2014	2 (Port Richey, Hudson)	1 (Tues)	2	
2015	January 7, 2015	3 (Zephyrhills, Port Richey, Hudson)	1 (Wed)	3	
2015	January 9, 2015	3 (Zephyrhills, Port Richey, Hudson)	1 (Fri)	2	
2015	January 24, 2015	3 (Zephyrhills, Port Richey, Hudson)	1 (Fri)	3	
2015	January 28, 2015	3 (Zephyrhills, Port Richey, Hudson)	1 (Wed)	3	**24**
2015	February 2, 2015	2 (Dade City, Port Richey)	1 (Fri)	2	
2015	February 12, 2015	3 (Zephyrhills, Dade City, Port Richey)	2 (Thurs - Fri)	6	
2015	February 18, 2015	2 (Dade City, Port Richey)	2 (Wed - Thurs)	4	
2015	February 20, 2015	1 (Port Richey)	1 (Fri)	1	
2016	January 11, 2016	4 (Zephyrhills, Dade City, Holiday, Port Richey)	1 (Mon)	4	
2016	January 18, 2016	5 (Zephyrhills, Dade City, Holiday, Port Richey, West Pasco)	1 (Mon)	5	
2016	January 22, 2016	5 (Zephyrhills, Dade City, Holiday, Port Richey, West Pasco)	2 (Sat - Sun)	10	
2016	February 5, 2016	3 (Zephyrhills, Holiday, West Pasco)	2 (Fri - Sat)	6	
2016	February 7, 2016	1 (Zephyrhills)	1 (Sun)	1	**50**
2016	February 9, 2016	4 (Dade City, Holiday, Port Richey, West Pasco)	2 (Tues - Wed)	8	
2016	February 12, 2016	4 (Dade City, Holiday, Port Richey, West Pasco)	1 (Sat)	4	
2016	February 26, 2016	5 (Zephyrhills, Dade City, Holiday, Port Richey, West Pasco)	2 (Fri - Sat)	10	
2016	December 30, 2016	2 (Holiday, United Way)	1 (Fri)	2	
2017	January 6, 2017	2 (Holiday, United Way)	2 (Sat - Sun)	4	
2017	March 15, 2017	4 (Zephyrhills, Dade City, Holiday, United Way)	1 (Wed)	4	**12**
2017	December 8, 2017	4 (Zephyrhills, Dade City, Holiday, United Way)	1 (Sun)	4	
2018	January 2, 2018	4 (Zephyrhills, Dade City, Holiday, United Way)	3 (Tues - Thurs)	12	
2018	January 12, 2018	4 (Zephyrhills, Dade City, Holiday, United Way)	1 (Sat)	4	**24**
2018	January 17, 2018	4 (Zephyrhills, Dade City, Holiday, United Way)	2 (Wed - Thurs)	8	

Source: Pasco County Emergency Management and GIS

Technological Hazard Analysis: ***Moderate probability hazard***

Cyber Incident

Source: Florida International University News

Description

An incident is the act of violating an explicit or implied security policy. Of course, this definition relies on the existence of a security policy that, while generally understood, varies among organizations.

These include but are not limited to:

- attempts (either failed or successful) to gain unauthorized access to a system or its data
- unwanted disruption or denial of service
- the unauthorized use of a system for the processing or storage of data
- changes to system hardware, firmware, or software characteristics without the owner's knowledge, instruction

Cyber incidents are becoming more common and more costly in our society. Because of this, Cyber Incidents will be profiled as a hazard to the state of Florida. The word Cyber refers to anything that contains, is connected to, or controlled by computers and computer networks. A computer is a machine that can take instructions and perform computations based on those instructions. Cyber technology refers to the computers and computer networks and the information and services we rely upon. For example, critical infrastructure relies on such computers and the Internet. Critical infrastructure includes sectors such as communications, energy, financial services, and health care, transportation, and water and wastewater systems, among others. A Cyber Incident then refers to an incident involving computers, networks, and information or services that affect daily operations of critical infrastructure.

A Cyber Incident differs from traditional hazards such as a flood, which makes it difficult to plan for, respond to, recover from, and mitigate against. For example, there is often a lack of physical presence

or evidence of a cyber-incident, making it difficult to understand the scope of the incident. Furthermore, the scope will likely cross municipal jurisdictions because of the nature of cyber technology. There are also fewer resources for cyber incidents due to a lack of awareness and knowledge of the cyber threat.

There are many causes of a data breach or a cyber-incident. A cyber incident could be a malicious attack or it could stem from a system glitch or human error. In 2014, the average cost of a data breach to an organization in the United States was $6.53 million.

Pasco County has identified and has started to work towards being prepared for a cyber-incident. Cyber Preparedness is defined as the process of ensuring that an agency has developed, tested, and validated its capability to protect against, prevent, mitigate, respond to and recover from a significant cyber incident.

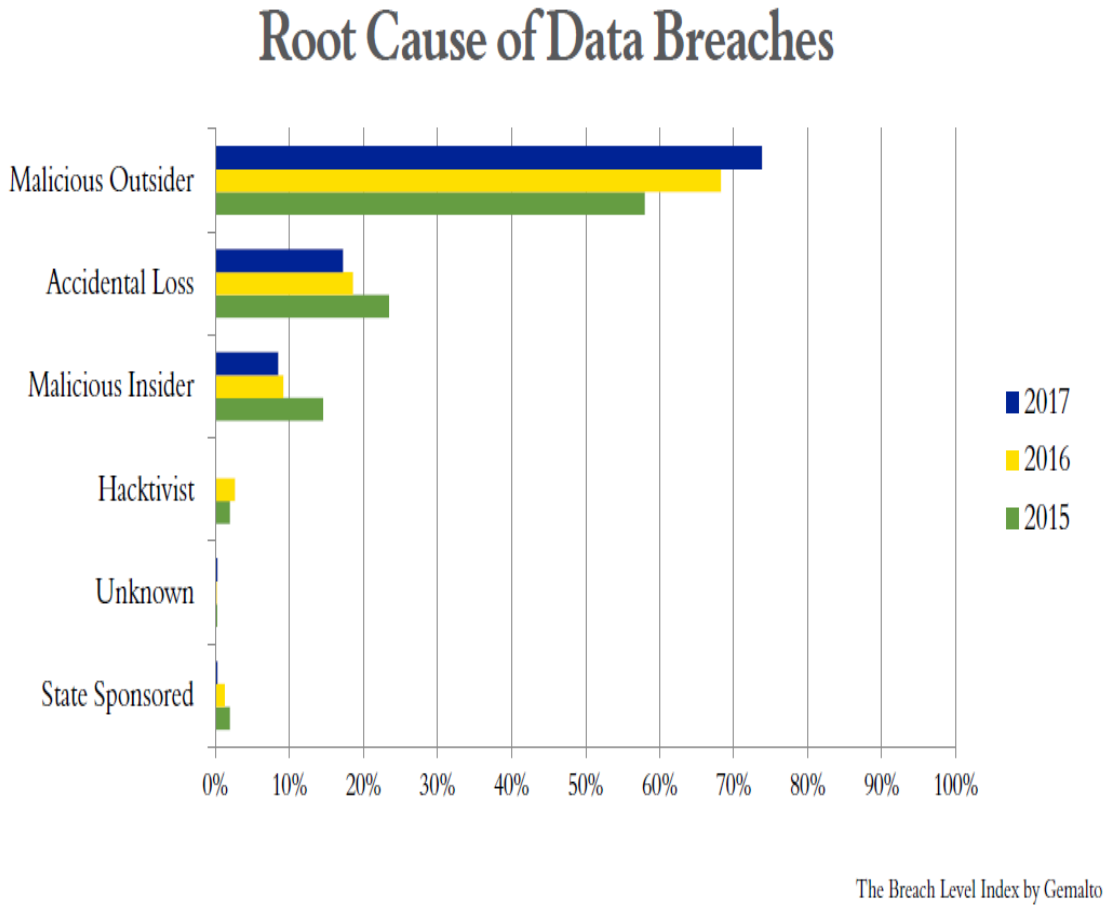
Though a cyber-incident is different than traditional hazards, all phases of emergency management are still applicable. For instance, Mitigation, Prevention, and Preparedness occur before a cyber-incident happens, by implementing policies and increasing awareness. Response is attempting to stop the cyber incident or a data breach. Recovery, and sometimes Mitigation, are after the cyber incident and involve restoring networks, replacing damaged equipment, and eliminating vulnerabilities that allowed the breach. Pasco County is currently exploring grant opportunities to enhance training and technology to prepare and mitigate instances of cyber incidents.

Historical Occurrence

Because cyber incidents occur in "cyber space," there are not always geographic areas affected by cyber incidents. However, cyber incidents may cause physical disruptions in critical infrastructure, which could affect a jurisdiction, region or a power grid. It is important to note that power grids are vast, sometimes crossing county and state lines, meaning that a cyber incident at one facility at one location could cause disruptions at other locations hundreds of miles away or further.

Recent studies has shown that Governmental entities are the most targeted regarding the threat of lost/stolen records by industry. Governmental entities are the most vulnerable to malicious outsiders/insiders or accidental loss with the goal of identity theft and/or fiscal gain. The primary motivation behind these attacks is through Malware and other hostile methods of cyber intrusion. For further detail, please see Figure 2.66, Figure 2.67, Figure 2.68, Figure 2.69. Pasco County currently does not have a credible database to represent the frequency of cyber attacks. However, Pasco County IT has communicated numerous attempts through phishing emails and malware attempts Countywide over the past few years to all government employees. The awareness communication has has justified a recent shift in security changes from the IT Department and general cybersecurity awareness in the LMSWG and overall LMS Plan .

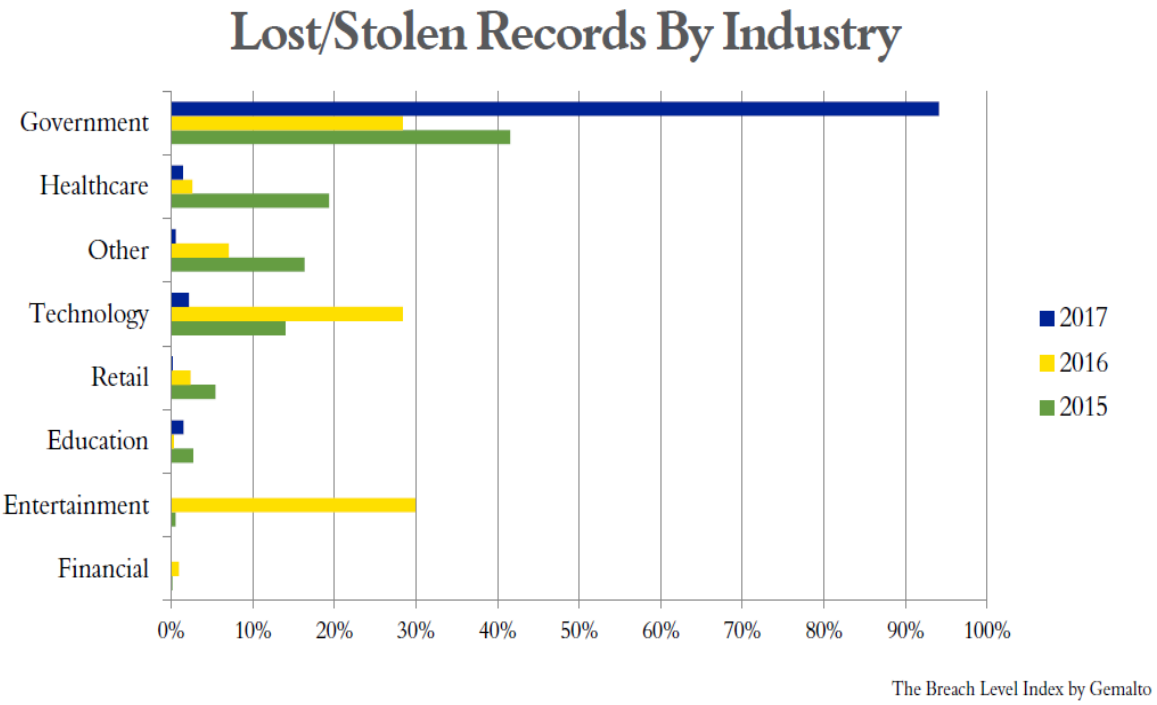
Figure 2.66



Source: Breach Level Index[82]

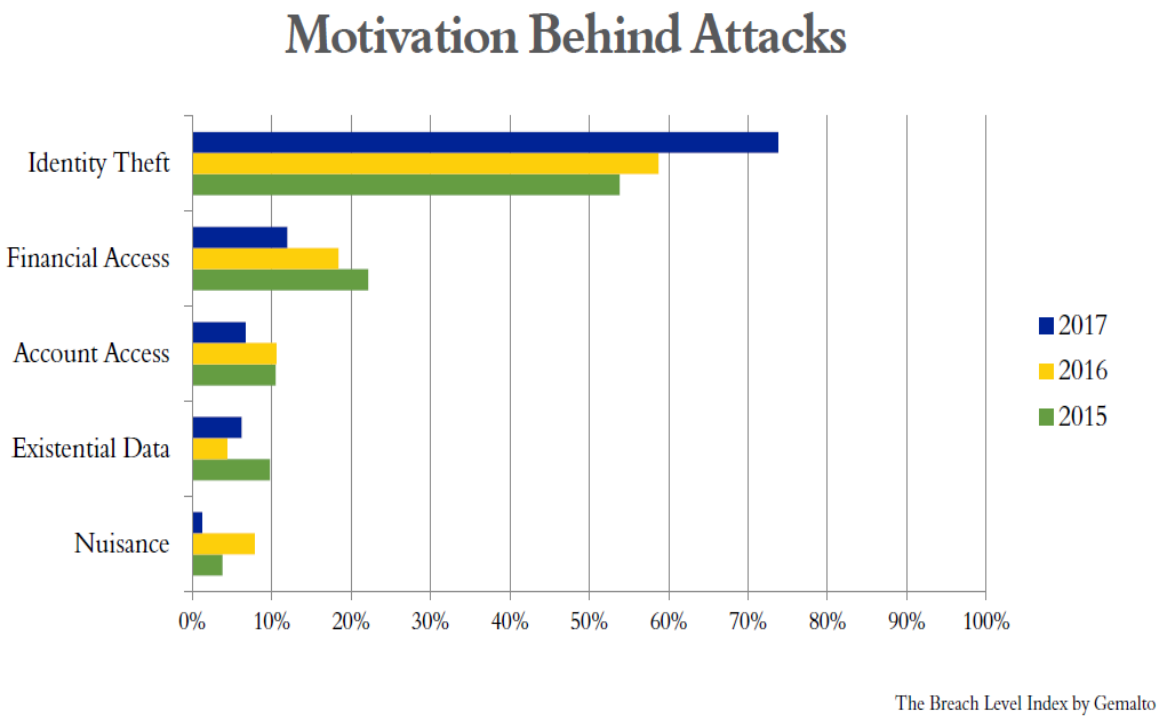
[82] https://breachlevelindex.com/

Figure 2.67



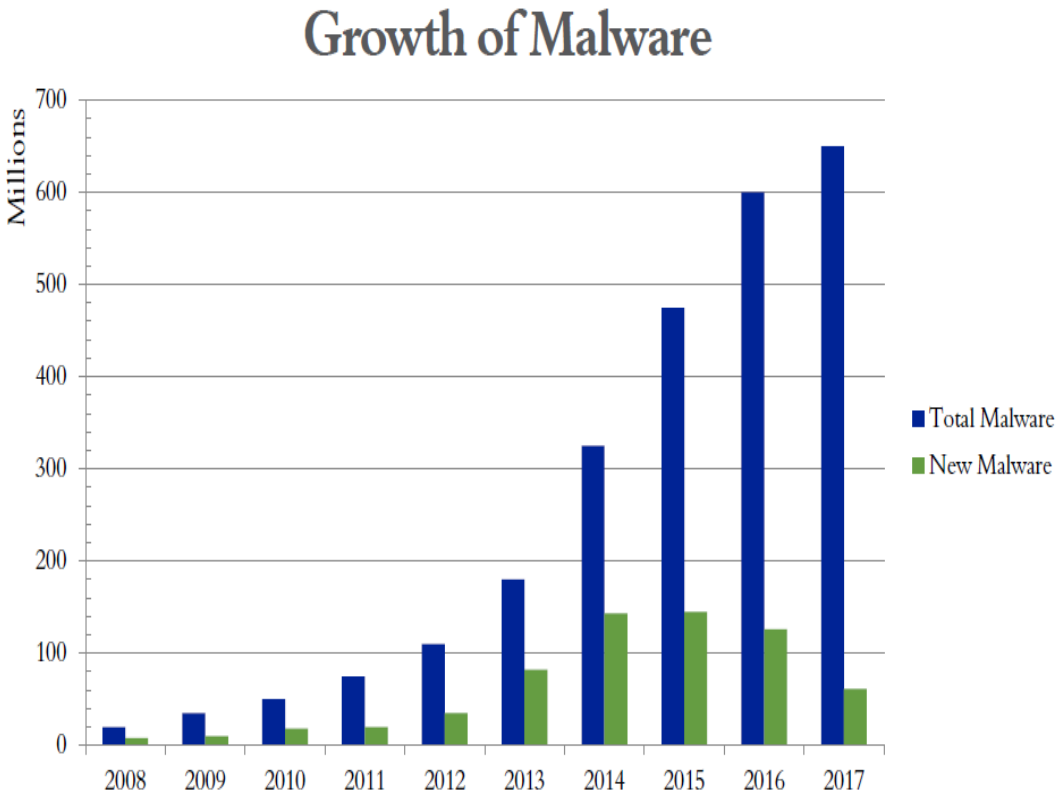
Source: Breach Level Index

Figure 2.68



Source: Breach Level Index

Figure 2.69



Source: Breach Level Index

Vulnerability

Because our society is increasingly reliant upon cyber technology and the Internet, new vulnerabilities are presenting themselves. There are vulnerabilities at the personal, local and national scale. For example, an individual person may have their identity stolen. Additionally, hackers may take a local 911 system offline for an extended period of time. Finally, there could be a multi-state power outage or a hack of a large company that affects many across the nation, such as the Yahoo or Target breaches.

More specifically, critical infrastructure often relies upon cyber technology and the Internet, making critical infrastructure vulnerable to cyber incidents. Additionally, many critical infrastructure systems are interconnected, so even if a particular critical sector is not reliant upon cyber technology, it may be reliant upon a critical sector that is reliant upon cyber technology. These possible cascading impacts are very important to consider when planning for hazard mitigation. This can be complicated though, as not all critical infrastructure sectors are controlled by the government, some include privately owned companies, like a private energy company, financial institution, or hospital. Sometimes the priorities of privately owned organizations differ from those of the government. For example, while the government is concerned with protecting all critical infrastructures from cyber-attacks, these privately owned organizations may be more concerned with profits or public reputation.

Furthermore, the interconnectivity of sectors expands the scope from one geographical area to large regional areas that likely cross political jurisdictions, making planning more complicated.

There are multiple identified threats within Pasco County that could leverage human and/or machine interaction to create vulnerabilities including:

1. Social Engineering (Human vulnerability attacks) – Phishing, Vishing, Pretexting, Shoulder Surfing, Dumpster Diving, Tailgating
2. Malware – Viruses, Worms, Trojans, Ransomware, Rootkits, Botkits
3. Data Leakage
4. Medical Devices
5. Inside Threats

Cyber incidents are unpredictable and can strike within a non-locality, thus making it hard to identify specific areas of threat as it could strike anywhere including local governmental entities, businesses or the healthcare providers creating the potential for incidents to strike at any time in both within and outside Pasco County affecting critical infrastructure elements.

Probability

This hazard was determined to occur annually, giving it a Frequency ranking of Very Likely.

The probability of cyber incidents occurring is increasing every day. Hospitals are highly likely, but so are local jurisdictions and federal and state agencies. Many healthcare providers have moved to isolated networks for critical care systems to mitigate risk to services provided to patients that could lead to life threatening situations. It is estimated that every 40 seconds, a business falls victim to a ransomware attack and it is predicted that attacks will rise to every 14 seconds by 2019. In 2015, government was among the top five most cyber-attacked industries and that is expected to remain accurate in the future.

Extent

This hazards injuries and deaths magnitude was determined to be low. This hazards infrastructure magnitude was determined to be medium, meaning significant damage to property or fiscal damages may occur during a data breach. This hazards environment magnitude was determined to be low, environmental damage is not likely to occur.

This hazard is measured by breach attempts and successful breaches. Pasco County's mitigation measures should be concerned with its people (citizens and employees), through personal financial loss and risk of personal information. Cyber-attacks are very costly and it is expected that from 2017 until 2021, $6 trillion will be spent on cybercrime damages and remediation[83]. Some of the costs relate back to response efforts, repairing and replacing new equipment and critical resources, implementation of continuity of operations plans, and loss of government confidence.

[83] The Enhanced State of Florida Hazard Mitigation Plan 2018

Pasco County 9-1-1 center received multiple reports daily regarding identity theft through computers, credit cards, and social media platforms. Residents may experience impacts to their credit scores and financial stability. These attacks can often be prevented with proper outreach and awareness strategies. Potential impacts to a business may include stolen shareholder information, financial loss (that may include consumer identity theft, or company profit theft). Breaches in critical infrastructure such as power companies, traffic controls, and communication towers can disrupt daily routines amd cause a cascade of events such as fires, vehicle crashes, injuries, and even death.

Since 2015, the top five cyber attacked industries were healthcare, manufacturing, financial services, government, and transportation with no indicator that this trend will continue. Pasco County implemented new goals to provide awareness and show vulnerabilities within the public and private entities. As such, the County is working towards constant review of internal and external mitigation of threat management with the ever increasing demand on technology within local government.

Hazardous Materials Incidents

Source: Pasco County; joint PCFR and FBI training at the PCFR Training Center

Definition

The Institute of Hazardous Materials Management (IHMM) defines a hazardous material as *any item or agent (biological, chemical, physical) which has the potential to cause harm to humans, animals, or the environment, either by itself or through interaction with other factors*. IHMM defines hazardous materials[84] professionals as persons who are r*esponsible for and properly qualified to manage such materials.* Such professions manage and/or advising other managers on materials handling at any point in their product life-cycle: during process planning; new product development; manufacturing; distribution; end product usage; disposal; cleanup; and remediation. Such materials are identified and regulated in the U.S. by laws and regulations administered by the U.S. Environmental Protection Agency (EPA), the U.S. Occupational Safety and Health Administration (OSHA), the U.S. Department of Transportation (DOT), and the U.S. Nuclear Regulatory Commission (NRC). Each has its own definition of a "hazardous material."

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[84] http://www.ihmm.org/about-ihmm/what-are-hazardous-materials

In facilities where the material is handled at a fixed site, hazards are pre-identified, and the facility is required by law to prepare a risk management plan and provide a copy of this plan to the local emergency planning commission (LEPC)[85] and local fire departments. While leaks and other accidents are possible, most hazardous incidents occur during transportation of materials from one place to another.

Historical Occurrence

As of July 2018, 58 facilities in Pasco County were listed in the OEM CAMEO (Computer-Aided Management of Emergency Operations) program, a software system used to plan for and respond to chemical emergencies. These facilities reported quantities of extremely hazardous substances under Title III of the 1983 Superfund Amendments and Reauthorization Act (SARA). The annual Hazards Analysis required under Emergency Planning and Community Right-to-Know Act (EPCRA). Sara Title III identifies all types of fixed facilities that are vulnerable to hazardous materials incidents. Appendix G includes documentation of the County's HazMat inspection program.

The volume of truck traffic moving through county in populated areas increases the vulnerability to transportation accidents involving hazardous materials. In addition, two railroad lines pass through the County transporting unknown amounts of hazardous materials. The roads are featured on the top map of page 87; their route through populated is shown on the second map, which offers a satellite view of the county. The most frequent incidents occur along the county's two east-west routes, S.R. 52 and S.R. 54, and the seven north-south routes: U.S. Hwy 41, U.S. Hwy 301, U.S. Hwy 98, U.S. Hwy 19, the Suncoast Expressway, Little Road, and Interstate 75. Two railroad lines also pass through the county transporting hazardous materials. Most incidents involve petroleum-based products. The Pasco 9-1-1 Emergency Communications Computer aided reports an average of 158 hazardous material spills or releases in any given year. Chlorine is the most abundant and extremely hazardous substance stored nearby.

Vulnerability

Most releases to which Pasco County Emergency Management or the Pasco County Fire Rescue Department respond are manageable, affecting only the building of origin and a relatively small number of people and economic costs are usually low. Vulnerability to the release or spill of a hazardous material is moderate, and depends upon the amount and type of material spilled or released, and the location of the incident. Emergency Management duty staff and the Hazardous Incident Team (HIT) are trained and capable of minimizing the effects of spills and/or releases of most hazardous materials. The hazardous materials response component has transitioned to primarily the Fire Rescue Department with Emergency Management personnel available for coordination and follow-up with regulatory agencies to ensure compliance.

[85] See appendix G

Probability

Spills or releases of hazardous materials during transport are common, occurring almost every day. The probability of a hazardous materials transportation incident is high. The event will most likely occur during a vehicle accident along one of Pasco County's major transportation routes carrying unknown quantities of hazardous materials. Fortunately, long periods of time lapse between train derailments with the most recently recorded incident having occurred in 2009.

Extent

Smaller incidents include five-gallon mishaps that can be contained by the staff working at the location where the accident occurred; many of the reported incidents are of this type. Large incidents include a train derailment or overturned truck and require additional personnel to handle the material. In addition to the human and environmental hazards, this plan previously discussed the limited number of roadways on which haulers can travel, so traffic is likely to be tied up for a short or long distance, depending on the alternate roadways available to personal (non-industrial) vehicles.

HAZARD ANALYSIS SUMMARY

The table at right is featured on the following seven pages, each depicting a hazard analysis summary for the seven jurisdictions included in this LMS: Unincorporated Pasco County and its six municipalities. The tables include the twelve hazards to which residents are considered to be most at risk. These tables provide a basis for conversation between and among the seven communities and they – individually and collectively – determine how best to mitigate against one or all hazards.

The goal of this summary is to address each of the required LMS elements for each hazard in each location.

The chart at right shows how the risk level of low, medium, and high were calculated.

Probability of occurrence is based on historical occurrences and predicted likelihood:

High	= Multiple occurrences and/or predictions of likelihood
Moderate	= Single occurrence and/or predictions of likelihood
Low	= No occurrences and/or predictions of likelihood

Economic impacts

High	if > 30% of exposure is lost
Moderate	if 15-30 of exposure is lost
Low	if 15% or less of exposure is lost

Significant number of people/structures affected/at risk

Yes	= greater than 25% are impacted

Level of Vulnerability is calculated by assigning a value to probability and economic impacts

Low	=1
Moderate	=2
High	=3

Significant # of people and structures are impacted

Yes	= 1

Final value is established based on cumulative scores

High	=6-8
Moderate	=3-5
Low	=1-2

UNINCORPORATED PASCO COUNTY						
Type of Hazard	**Probability of Occurrence**	**Economic Impacts**	**Significant # People Impacted**	**Significant # of Structures Impacted**	**Level of Vulnerability** (Previous Update: 2014)	**Level of Vulnerability** (Current Update: 2019)
Tropical Cyclones	High	High	Yes	Yes	Moderate	High
Floods	High	High	Yes	Yes	High	High
Coastal/River Erosion	High	Moderate	No	Yes	Moderate	High
Geological	High	Moderate	Yes	Yes	High	High
Wildfires	High	Moderate	Yes	Yes	High	High
Severe Storm	High	High	Yes	Yes	High	High
Drought/Heat wave	High	Moderate	Yes	No	High	High
Winter Storm/Freezes	High	Moderate	Yes	No	Low	High
Hazardous Materials	High	Low	Yes	No	Moderate	Moderate
Cyber Incident	High	High	Yes	No	N/A	High

Probability of occurrence is based on historical occurrences and predicted likelihood where high=multiple occurrences and/or predictions of likelihood; moderate=single occurrence and/or predictions of likelihood; low=no occurrences and/or predictions of likelihood

Economic impacts = High if > 30% of exposure is lost; moderate if 15-30 of exposure is lost; low if 15% or less of exposure is lost

Significant number of people/structures affected/at risk = Yes if greater than 25% are impacted

Level of Vulnerability is calculated by assigning a value to probability and economic impacts where low =1, moderate =2, high = 3 and where Yes = 1 for Significant # of people and structures are impacted. Final value is established as high if cumulative score =6-8; moderate if cumulative shore =3-5; low if cumulative score =1-2

CITY OF DADE CITY						
Type of Hazard	**Probability of Occurrence**	**Economic Impacts**	**Significant # People Impacted**	**Significant # of Structures Impacted**	**Level of Vulnerability** (Previous Update: 2014)	**Level of Vulnerability** (Current Update: 2019)
Tropical Cyclones	High	Moderate	Yes	No	Moderate	High
Floods	High	High	Yes	Yes	High	High
Coastal/River Erosion	Moderate	Moderate	No	No	Moderate	Moderate
Geological	High	Moderate	Yes	Yes	High	High
Wildfires	High	Moderate	Yes	Yes	High	High
Severe Storm	High	High	Yes	Yes	High	High
Drought/Heat Wave	High	Moderate	Yes	No	High	High
Winter Storm/Freezes	High	Moderate	Yes	No	Low	High
Hazardous Materials	High	High	Yes	No	High	High
Cyber Incident	High	High	Yes	Yes	N/A	High

Probability of occurrence is based on historical occurrences and predicted likelihood where high=multiple occurrences and/or predictions of likelihood; moderate=single occurrence and/or predictions of likelihood; low=no occurrences and/or predictions of likelihood

Economic impacts = High if > 30% of exposure is lost; moderate if 15-30 of exposure is lost; low if 15% or less of exposure is lost

Significant number of people/structures affected/at risk = Yes if greater than 25% are impacted

Level of Vulnerability is calculated by assigning a value to probability and economic impacts where low =1, moderate =2, high = 3 and where Yes = 1 for Significant # of people and structures are impacted. Final value is established as high if cumulative score =6-8; moderate if cumulative shore =3-5; low if cumulative score =1-2

CITY OF NEW PORT RICHEY						
Type of Hazard	**Probability of Occurrence**	**Economic Impacts**	**Significant # People Impacted**	**Significant # of Structures Impacted**	**Level of Vulnerability** (Previous Update: 2014)	**Level of Vulnerability** (Current Update: 2019)
Tropical Cyclones	High	High	Yes	Yes	Moderate	High
Floods	High	High	Yes	Yes	High	High
Coastal/River Erosion	High	Moderate	No	Yes	Moderate	High
Geological	High	High	Yes	Yes	High	High
Wildfires	High	Moderate	Yes	Yes	High	High
Severe Storm	High	High	Yes	Yes	High	High
Drought/Heat Wave	High	Moderate	Yes	No	High	High
Winter Storm/Freezes	Moderate	Moderate	Yes	No	Low	Moderate
Hazardous Materials	Moderate	Low	No	No	Low	Low
Cyber Incident	High	High	Yes	Yes	N/A	High

Probability of occurrence is based on historical occurrences and predicted likelihood where high=multiple occurrences and/or predictions of likelihood; moderate=single occurrence and/or predictions of likelihood; low=no occurrences and/or predictions of likelihood

Economic impacts = High if > 30% of exposure is lost; moderate if 15-30 of exposure is lost; low if 15% or less of exposure is lost

Significant number of people/structures affected/at risk = Yes if greater than 25% are impacted

Level of Vulnerability is calculated by assigning a value to probability and economic impacts where low =1, moderate =2, high = 3 and where Yes = 1 for Significant # of people and structures are impacted. Final value is established as high if cumulative score =6-8; moderate if cumulative shore =3-5; low if cumulative score =1-2

CITY OF PORT RICHEY						
Type of Hazard	**Probability of Occurrence**	**Economic Impacts**	**Significant # People Impacted**	**Significant # of Structures Impacted**	**Level of Vulnerability** (Previous Update: 2014)	**Level of Vulnerability** (Current Update: 2019)
Tropical Cyclones	High	High	Yes	Yes	Moderate	High
Floods	High	High	Yes	Yes	High	High
Coastal/River Erosion	High	Moderate	No	Yes	Moderate	High
Geological	High	Moderate	Yes	Yes	High	High
Wildfires	High	Moderate	Yes	Yes	High	High
Severe Storm	High	High	Yes	Yes	High	High
Drought/Heat Wave	High	Moderate	Yes	No	High	High
Winter Storm/Freezes	Moderate	Moderate	Yes	No	Low	Moderate
Hazardous Materials	Low	Low	Yes	No	Low	Low
Cyber Incident	High	High	Yes	Yes	N/A	High

Probability of occurrence is based on historical occurrences and predicted likelihood where high=multiple occurrences and/or predictions of likelihood; moderate=single occurrence and/or predictions of likelihood; low=no occurrences and/or predictions of likelihood

Economic impacts = High if > 30% of exposure is lost; moderate if 15-30 of exposure is lost; low if 15% or less of exposure is lost

Significant number of people/structures affected/at risk = Yes if greater than 25% are impacted

Level of Vulnerability is calculated by assigning a value to probability and economic impacts where low =1, moderate =2, high = 3 and where Yes = 1 for Significant # of people and structures are impacted. Final value is established as high if cumulative score =6-8; moderate if cumulative shore =3-5; low if cumulative score =1-2

CITY OF SAN ANTONIO						
Type of Hazard	**Probability of Occurrence**	**Economic Impacts**	**Significant # People Impacted**	**Significant # of Structures Impacted**	**Level of Vulnerability** (Previous Update: 2014)	**Level of Vulnerability** (Current Update: 2019)
Tropical Cyclones	High	High	Yes	No	Moderate	High
Floods	Moderate	Moderate	Yes	Yes	High	High
Coastal/River Erosion	Low	Moderate	No	No	Moderate	Low
Geological	High	Moderate	Yes	Yes	High	High
Wildfires	High	Moderate	Yes	Yes	High	High
Severe Storm	High	High	Yes	Yes	High	High
Drought/Heat Wave	High	Moderate	Yes	No	High	High
Winter Storm/Freezes	High	Moderate	Yes	No	Low	High
Hazardous Materials	Low	Low	Yes	No	Low	Low
Cyber Incident	High	High	Yes	Yes	N/A	High

Probability of occurrence is based on historical occurrences and predicted likelihood where high=multiple occurrences and/or predictions of likelihood; moderate=single occurrence and/or predictions of likelihood; low=no occurrences and/or predictions of likelihood

Economic impacts = High if > 30% of exposure is lost; moderate if 15-30 of exposure is lost; low if 15% or less of exposure is lost

Significant number of people/structures affected/at risk = Yes if greater than 25% are impacted

Level of Vulnerability is calculated by assigning a value to probability and economic impacts where low =1, moderate =2, high = 3 and where Yes = 1 for Significant # of people and structures are impacted. Final value is established as high if cumulative score =6-8; moderate if cumulative shore =3-5; low if cumulative score =1-2

TOWN OF ST. LEO						
Type of Hazard	**Probability of Occurrence**	**Economic Impacts**	**Significant # People Impacted**	**Significant # of Structures Impacted**	**Level of Vulnerability** (Previous Update: 2014)	**Level of Vulnerability** (Current Update: 2019)
Tropical Cyclones	High	High	Yes	No	Moderate	High
Floods	Moderate	Moderate	Yes	Yes	High	High
Coastal/River Erosion	Moderate	High	Yes	Yes	Moderate	High
Geological	Moderate	High	Yes	Yes	High	High
Wildfires	High	Moderate	Yes	Yes	High	High
Severe Storm	High	High	Yes	Yes	High	High
Drought/Heat Wave	High	Moderate	Yes	No	High	High
Winter Storm/Freezes	High	Moderate	Yes	No	Low	High
Hazardous Materials	Low	Low	Yes	No	Low	Low
Cyber Incident	High	High	Yes	Yes	N/A	High

Probability of occurrence is based on historical occurrences and predicted likelihood where high=multiple occurrences and/or predictions of likelihood; moderate=single occurrence and/or predictions of likelihood; low=no occurrences and/or predictions of likelihood

Economic impacts = High if > 30% of exposure is lost; moderate if 15-30 of exposure is lost; low if 15% or less of exposure is lost

Significant number of people/structures affected/at risk = Yes if greater than 25% are impacted

Level of Vulnerability is calculated by assigning a value to probability and economic impacts where low =1, moderate =2, high = 3 and where Yes = 1 for Significant # of people and structures are impacted. Final value is established as high if cumulative score =6-8; moderate if cumulative shore =3-5; low if cumulative score =1-2

CITY OF ZEPHYRHILLS						
Type of Hazard	**Probability of Occurrence**	**Economic Impacts**	**Significant # People Impacted**	**Significant # of Structures Impacted**	**Level of Vulnerability** (Previous Update: 2014)	**Level of Vulnerability** (Current Update: 2019)
Tropical Cyclones	High	Moderate	Yes	No	Moderate	High
Floods	High	High	Yes	Yes	High	High
Coastal/River Erosion	Moderate	High	No	Yes	Moderate	High
Geological	High	Moderate	Yes	Yes	High	High
Wildfires	High	Moderate	Yes	Yes	High	High
Severe Storm	High	High	Yes	Yes	High	High
Drought/Heat Wave	High	Moderate	Yes	No	High	High
Winter Storm/Freezes	High	Moderate	Yes	No	Low	High
Hazardous Materials	Moderate	Low	Yes	No	Moderate	Moderate
Cyber Incident	High	High	Yes	Yes	N/A	High

Probability of occurrence is based on historical occurrences and predicted likelihood where high=multiple occurrences and/or predictions of likelihood; moderate=single occurrence and/or predictions of likelihood; low=no occurrences and/or predictions of likelihood

Economic impacts = High if > 30% of exposure is lost; moderate if 15-30 of exposure is lost; low if 15% or less of exposure is lost

Significant number of people/structures affected/at risk = Yes if greater than 25% are impacted

Level of Vulnerability is calculated by assigning a value to probability and economic impacts where low =1, moderate =2, high = 3 and where Yes = 1 for Significant # of people and structures are impacted. Final value is established as high if cumulative score =6-8; moderate if cumulative shore =3-5; low if cumulative score =1-2