SECTION IV: ASSESSING VULNERABILITY AND RISK

Describing vulnerability in terms of potential dollar loss provides the local government, the State and the federal government with a common framework with which to quantitatively measure the effects of hazards on the community and more accurately determine the benefit-cost ratio of investments in mitigation activities. It is an essential component to risk assessment and the ability to implement a strategy to prevent or reduce future losses. In Florida, it is a vital tool for decision-makers who must make the sometimes difficult decisions regarding growth-management, land development regulations, and funding for infrastructure and mitigation projects.

A. TAOS RISK ANALYSIS

1. Hazard Modeling Using TAOS
   The Florida Department of Community Affairs funded an update of the comprehensive storm hazard modeling project using the TAOS model as part of the Local Mitigation Strategy. Hazard modeling using TAOS is part of an effort to produce a consistent state-wide assessment of risk from natural disasters. It is useful to have a calculation of risk that is consistent throughout the state.

   The new TAOS model data also includes components to assess vulnerability, risk and potential damage from not only storm surge, but inland flooding, severe winds, sinkholes, wildfires, earthquake, tsunami. When interfaced with the most current property appraiser files, local governments are able to more accurately determine the total number and type of structures at risk, property values and potential loss. This greatly enhances the information available to local governments and enhances the opportunity to implement a strategic mitigation program.

2. LMS Mapping Data Sets Methodology Quick Reference
   The following describes the methodology used for developing the TAOS model for the LMS mapping data sets.

   a. Hurricanes/Winter Storms
      Historical storms (past 153 years for tropical cyclones and past 50 years for winter storms) were simulated using the TAOS model, version 10.2. Winds, wave, rainfall, and storm surge perils were computed, and hazard zones created. Flood zones and wind layers were created, and tables were created based on percent damage expected. Additionally, FEMA

Flood Insurance Rate Map (FIRM) data was ingested, and the tabular data sets were run for comparison.

b. Tornadoes

Tornado track data since 1950 from the National Weather Service was analyzed to determine the annual probability that a tornado would cause damage to a structure in each 90m grid cell in Florida. The data was stratified into three annual probability classes: High risk (1 in 100 or greater), Medium risk (1 in 101 to 1 in 250), or low (1 in 250 to 1 in 500 chance).

c. Tsunami

Tsunami risk in Florida is difficult to assess, as there are minimal reliable historical records. Consequently, simulation techniques were used. Three classes of initiating events were simulated: Caribbean volcanic events, Caribbean and Central American earthquakes, and East Atlantic (Azores) volcanic events. In general, in north Florida, these events produced at worst a 4 meter wave, while in some parts of south Florida this value grew to nearly 6 meters. Expert opinion suggests that this would be approximately a 1 in 500 year event. Note that these tsunami zones are all smaller than those of a category 5 hurricane, which is probably an event of comparable frequency. However, a tsunami wave from the Azores would more than likely inundate virtually all of the Atlantic coastline, as opposed to only a few dozen miles of coastline in the case of a hurricane.

d. Wildfire Potential

The wildfire potential map was created by reclassifying the land cover data sets created for the hydrologic models. These data sets were reclassified to equate the Anderson Level II classification to fuel models used in the National Fire Danger Rating System (Burgan et al, 2000). These fuel models are an indication of the ability of a fire to start and spread in the given terrain type, and are used as the input to the Fire Potential Index as well as fire spreading models. The resulting map was compared with the NFDR Fuel Model Map created by the US Forest Service (USFS). The NFDR Fuel Model Map is used for the next generation fire danger rating system being developed by USFS, and is a nationwide map at a resolution of 1000 meters per grid cell based on data from 1997. The KAC developed map for Florida is at a resolution of 90 meters, and compares well the much more general national map while providing a great deal of additional detail, as well as being more up to date due to land cover changes.

Each of the fuel models was assigned to a risk code of “low”, “medium”, or “high”, based on fire spreading potential during a climatologically “dry” year, and processed with the statewide parcel data base to create the tables supplied with the LMS analysis. The mode of the fuel types within 500 meters of the parcel was used to determine risk category for the parcel.

e. Sinkhole Potential

Sinkhole potential was determined according to points assigned to each 90m grid cell in the state. Three classes of points were assigned, for distance to historic sinkholes, geology, and soils:

2 points if cell was within 2000m of an existing sinkhole;
1 point if cell between 2000m and 5000m of an existing sinkhole;
1 point if the cell was in the same USGS surface geologic unit as an existing sinkhole;
1 point if the cell was in the same NRCS soil unit as an existing sinkhole.

Thus, each cell as assigned a value from 0 to 4:

0: no significant risk
1: low risk
2: moderate risk
3: high risk
4: very high risk.

f. Earthquake Risk

The USGS 50 year 10% likelihood data set was used to assign earthquake risk. The peak ground acceleration (PGS) value was used to create four zones:

< 0.01g	Almost none
0.01g	Minimal (0.01, 0.02)
0.02g	Very low (0.02, 0.03)
0.03g	Low (0.03, and higher

Note that the earthquake risk, even in the “highest” risk zone in the state, is quite small.

g. Exposure Data Base

The 2000 Department of Revenue Tax Records and Census 2000 data sets were used to create the structure inventory data base. First, the DOR records were address matched against the TIGER Road files. This resulted in positions for approximately 70% of the records statewide. The remaining records were either partial matched (15%), matched to the zip code (5%), or to the nearest TRS point (10%).

3. TAOS Results: Economic Loss for Hillsborough County

According to the information obtained from the TAOS model, Hillsborough County has a total exposure to structural losses from hazardous events in excess of $28 billion. The model estimates that the average annual economic loss for wind to be nearly $24 million while that for water is nearly $310 million. The following is a summary of the results of the application of the TAOS model to Hillsborough County by hazardous event. The detailed TAOS report, by hazard event can be found at the conclusion of this section.

Hillsborough County will continue to work with the State of Florida to develop a model with a consistent methodology to address other specific hazards before the next update of the LMS and to better assess the potential impacts of future development.

Table 27
TAOS Flood Events

Number Buildings Damaged/Value	Flood Event			
	10 Year	25 Year	50 Year	100 Year
In Wave/Current	0	322	2,323	9,071
Value	0	$558,320,832	$817,680,512	$1,514,741,376
In Flood Zone	12,153	24,173	32,645	40,717
Value	$2,080,106,752	$2,970,936,320	$3,703,596,288	$4,063,406,592
Not in Flood Zone	320,190	307,848	297,375	282,555
Value	$26,075,158,528	$24,625,817,600	$23,633,659,904	$22,576,889,856

Table 28
TAOS Wind Zone

Number Buildings Damaged/Value	Wind Zone			
	10 Year	25 year	50 Year	100 Year
Moderate (10 - 30%)	0	0	0	1,657
Value	0	0	0	$202,760,448
Light (<10%)	96,693	332,314	332,343	330,686
Value	$9,782,092,800	$28,154,152,960	$28,154,984,448	$27,952,252,928
None	96,693	29	0	0
Value	$18,373,120,000	$836,259	0	0

Table 29 TAOS Flood Zone by Category					
Number Damaged Buildings/Value	Category				
	1	2	3	4	5
Wave/Current	2,027	8,258	16,825	29,962	32,633
Value ($000)	$787,061	$1,367,278	$2,305,081	$3,955,510	$4,123,971
In Flood	33,396	45,726	49,545	58,107	57,868
Value ($000)	$3,422,072	$4,407,325	$4,390,605	$5,256,722	$5,255,761
In None	296,920	278,359	265,973	244,274	241,842
Value ($000)	$23,945,816	$22,380,229	$21,458,969	$18,942,712	$18,775,243

Table 30 TAOS Wind Zone by Category					
Number Damaged Buildings/Value	Category				
	1	2	3	4	5
Light (<10%)	332,343	292,036	0	0	0
Value ($000)	$28,154,984	$22,860,214	0	0	0
Moderate (10 - 30%)	0	40,307	332,343	6,424	0
Value ($000)	0	$5,294,862	$28,154,984	$622,361	0
Heavy (30 - 50%)	0	0	0	279,645	968
Value ($000)	0	0	0	$21,292,014	$68,015
Severe (50 - 80%)	0	0	0	46,274	191,510
Value ($000)	0	0	0	$6,240,922	$14,924,099
Destroyed (80%>)	0	0	0	0	139,865
Value ($000)	0	0	0	0	$13,163,228

Table 31 Number of Properties and Building Value Identified on FEMA FIRM		
Flood Zone	# Buildings	Value
AE	51,046	$5,811,435,008
X500	14,907	$1,188,027,904
X	240,071	$18,571,292,672
A	23,423	$2,025,410,560
VE	2,582	$533,048,768
Undesignated	314	$25,841,240

Table 32 Number of Properties and Building Value identified by TAOS as Subject to Miscellaneous Flood Hazards		
Zone	# Buildings	Value
None (>100 year)	330,592	$27,785,664,512
Frequent (2 year)	1,751	$369,346,528

Table 33 Economic Loss identified by TAOS resulting from Tornado Risk, Sinkhole Potential, Wildlife Potential, 500+ Year Tsunami Zone, and USGS 50-year Ground Motion		
Event	# Buildings	Value
Tornado Risk		
1 in 200	279,727	$24,423,196,672
1 in 100	52,616	$3,731,791,360
Sinkhole Potential		
Very Low	1,476	$123,659,544
Low	38,657	$2,451,523,328
Medium	87,227	$7,277,893,120
High	78,212	$8,251,524,608
Very High	126,771	$10,050,866,176
Wildfire Potential		
Low	268,571	$21,309,517,824
Medium	20,620	$2,441,321,216
High	43,152	$4,403,897,856
500+ Yr Tsunami Zone		
Out of Zone	269,932	$21,459,357,696
1 in 500	62,411	$6,695,318,016
USGS 50-yr Ground Motion		
Minimal (0.01g)	318,626	$27,250,974,720
Very Low (0.02g)	13,717	$903,992,960

4. TAOS Results: Vulnerable Population for Hillsborough County

Using the County's 2000 population, the TAOS model was able to generate a listing of the population at risk to the hazards previously described. The following tables identify the vulnerable population by hazard event.

Table 34 Population in TAOS Flood Zone						
Event	Affected Population	Minority	Elderly (65+)	Disabled	Below Poverty	Single-parent
10 Year						
Wave/Current	0	0	0	0	0	0
Flood	33,966	3,932	4,873	10,169	2,302	820
None	964,982	244,113	114,800	343,448	120,570	39,395
25 Year						
Wave/Current	0	0	0	0	0	0
Flood	78,271	14,475	9,310	23,788	6,529	2,448
None	920,677	233,570	110,363	329,829	116,343	37,767
50 Year						
Wave/Current	5,406	515	521	1,505	415	142
Flood	106,148	21,674	12,179	32,715	9,425	3,527
None	887,394	225,856	106,973	319,397	113,032	36,546
100 Year						
Wave/Current	15,040	2,913	1,472	3,957	1,410	409
Flood	135,478	27,718	16,960	45,546	12,714	4,848
None	848,430	217,414	101,241	304,114	108,748	34,958

Table 35 Population in TAOS Wind Zone						
Event/Damage	Affected Population	Minority	Elderly (65+)	Disabled	Below Poverty	Single-parent
10 Year						
Moderate (10 - 30%)	0	0	0	0	0	0
Light (<10%)	287,817	62,972	39,687	95,744	31,458	10,021
None	711,131	185,073	79,986	257,873	91,414	30,194
25 Year						
Moderate (10 - 30%)	0	0	0	0	0	0
Light (<10%)	998,508	248,001	119,623	353,449	122,823	40,200
None	440	44	50	168	49	15
50 Year						
Moderate (10 - 30%)	0	0	0	0	0	0
Light (<10%)	998,948	248,045	119,673	353,617	122,872	40,215
None	0	0	0	0	0	0
100 Year						
Moderate (10 - 30%)	2,082	63	323	439	25	22
Light (<10%)	996,866	247,982	119,350	353,178	122,847	40,193
None	0	0	0	0	0	0

Table 36 Population in TAOS Flood Zone by Category						
Category	Affected Population	Minority	Elderly (65+)	Disabled	Below Poverty	Single-parent
1						
Wave/Current	4,163	382	377	1,159	315	99
Flood	104,817	22,487	11,745	33,579	9,977	3,680
None	889,968	225,176	107,551	318,879	112,580	36,436
2						
Wave/Current	15,918	2,256	2,118	4,827	1,506	444
Flood	148,823	29,703	18,002	48,226	13,443	5,271
None	834,207	216,086	99,553	300,564	107,923	34,500
3						
Wave/Current	40,494	6,553	4,687	11,747	3,527	1,116
Flood	152,437	33,956	19,669	52,886	16,739	6,045
None	806,017	207,536	95,317	288,984	102,606	33,054
4						
Wave/Current	67,324	10,443	9,281	20,875	5,691	1,922
Flood	178,077	44,067	22,067	62,086	20,639	7,232
None	753,547	193,535	88,325	270,656	96,542	31,061
5						
Wave/Current	80,129	14,340	11,243	26,046	7,911	2,662
Flood	173,179	42,179	21,194	60,736	19,743	6,831
None	745,640	191,526	87,236	266,835	95,218	30,722

Table 37 Population in TAOS Wind Zone by Category						
Category/Damage	Affected Population	Minority	Elderly (65+)	Disabled	Below Poverty	Single-Parent
1						
Light (<10%)	998,948	248,045	119,673	353,617	122,872	40,215
Moderate (10 - 30%)	0	0	0	0	0	0
Heavy (30 - 50%)	0	0	0	0	0	0
Severe (50 - 80%)	0	0	0	0	0	0
Destroyed (80%>)	0	0	0	0	0	0
2						
Light (<10%)	872,516	218,567	104,058	310,032	108,898	35,725
Moderate (10 - 30%)	126,432	29,478	15,615	43,585	13,974	4,490
Heavy (30 - 50%)	0	0	0	0	0	0
Severe (50 - 80%)	0	0	0	0	0	0
Destroyed (80%>)	0	0	0	0	0	0
3						
Light (<10%)	0	0	0	0	0	0
Moderate (10 - 30%)	998,948	248,045	119,673	353,617	122,872	40,215
Heavy (30 - 50%)	0	0	0	0	0	0
Severe (50 - 80%)	0	0	0	0	0	0
Destroyed (80%>)	0	0	0	0	0	0
4						
Light (<10%)	0	0	0	0	0	0
Moderate (10 - 30%)	28,709	4,370	3,248	8,236	2,038	771
Heavy (30 - 50%)	838,461	205,297	100,223	295,806	102,817	34,317
Severe (50 - 80%)	131,778	38,378	16,202	49,575	18,017	5,127
Destroyed (80%>)	0	0	0	0	0	0
5						
Light (<10%)	0	0	0	0	0	0
Moderate (10 - 30%)	0	0	0	0	0	0
Heavy (30 - 50%)	1,891	142	195	761	203	60
Severe (50 - 80%)	568,264	106,310	69,932	187,377	55,836	19,944
Destroyed (80%>)	428,793	141,593	49,546	165,479	66,833	20,211

Table 38 Population identified by TAOS on FEMA FIRM						
Flood Zone	Affected Population	Minority	Elderly (65+)	Disabled	Below Poverty	Single-Parent
AE	156,128	26,618	18,326	48,242	14,236	5,425
X500	45,331	10,379	4,917	14,924	4,114	1,673
X	682,025	184,527	84,403	253,083	92,375	28,585
A	99,312	24,956	9,187	32,424	11,062	4,211
VE	12,000	1,176	1,642	3,316	702	232
Undesignated	4,152	389	1,198	1,628	383	89

Table 39 Population identified by TAOS subject Miscellaneous Flood Hazards						
Zone	Affected Population	Minority	Elderly (65+)	Disabled	Below Poverty	Single-Parent
None (>100 year)	986,547	245,587	118,809	350,565	121,344	39,863
Frequent (2 year)	12,401	2,458	864	3,052	1,528	352

Table 40 Population identified by TAOS subject to Tornado Risk, Sinkhole Potential, Wildlife Potential, 500+ Year Tsunami Zone, and USGS 50-year Ground Motion						
Event	Affected Population	Minority	Elderly (65+)	Disabled	Below Poverty	Single-Parent
Tornado Risk						
1 in 200	844,778	222,147	101,839	302,519	107,061	35,659
1 in 100	154,170	25,898	17,834	51,098	15,811	4,556
Sinkhole Potential						
Very Low	3,582	326	1,418	1,732	436	64
Low	99,489	16,835	23,320	36,536	11,501	3,125
Medium	255,497	44,715	26,813	78,560	20,653	7,941
High	243,138	76,092	27,109	91,112	36,118	10,890
Very High	397,242	110,077	41,013	145,677	54,164	18,195
Wildfire Potential						
Low	763,111	204,370	91,591	278,976	101,198	33,237
Medium	59,217	11,545	6,924	21,533	6,388	1,846
High	176,620	32,130	21,158	53,108	15,286	5,132
500+ Yr Tsunami Zone						
Out of Zone	822,279	213,756	96,611	295,915	104,339	33,708
1 in 500	176,669	34,289	23,062	57,702	18,533	6,507
USGS 50-yr Ground Motion						
Minimal (0.01g)	958,213	237,876	113,895	337,223	117,018	38,699
Very Low (0.02g)	40,735	10,169	5,778	16,394	5,854	1,516

B. MULTI-HAZARD MAPPING SYSTEM

Once, the hazards affecting the communities within Hillsborough County were identified, this information was incorporated into the county-wide geographic information system (GIS). This geographic information is available to all jurisdictions for emergency management, land use planning and public outreach. The GIS mapping capability also allows users the flexibility to access this information in conjunction with demographic data to facilitate analyses of impacts of development and policy.

The local governments within Hillsborough County have jointly produced a map series that includes community profile information (see Section II, Community Maps) and Hazard Vulnerability maps (See the previous Section III).

The TAOS model allows the user to develop maps illustrating historic events (i.e. hurricane tracks, sinkhole events, tornado paths, etc.). It also generates maps indicating risk from various hazards including hurricanes, wind events (10-, 20-, 50-, 100 year wind cycles), flooding, sinkhole potential, etc.) These maps, where appropriate (In some cases, such as hurricane storm surge or flooding vulnerability, the county data is more precise), will be incorporated into the countywide GIS before the next update of the LMS. The detailed TAOS reports and corresponding maps are included in Appendix E.

Community Maps
(See Section II)

1. Railroads, Ports, Airports, and Roads including designated regional evacuation routes
2. Population Density
3. Rivers, Streams, and Wetlands
4. Significant Wildlife Habitat/ Greenways
5. Future Land Use
6. Jurisdictional Boundaries

Hazard Vulnerability Maps
(See Section III**)**

7. Hurricane Storm Surge Areas
8. Hurricane Evacuation Zones
9. NFIP Floodplain
10. Flooded Structure Occurrence by Section
11. Repetitive Flood Loss Structures
12. Sinkhole Distribution
13. Hazardous Material (Section 302) Storage Sites
14. Wildfire Vulnerability
15. Wind Vulnerability

TAOS Maps
(See Appendix E)

Critical Facilities
(See Attachment C for Map Series)

16. Hospital/Clinics, Federal Buildings & Emergency Ops/Communication Centers
17. Law Enforcement Facilities and State Buildings
18. Nursing Homes/ALF's & City Buildings
19. Fire/Rescue Stations, GTE Sites & SWFMD Sites
20. Water Treatment Facilities, County Buildings & Radio/Television/Weather Towers
21. Landfills, Large Parks & Hazardous Materials Sites
22. Schools (public/Private), Universities, Tampa Electric Facilities, & Ice Manufacturing Sites
23. Shelters, People's Gas Sites & Airports

C. CRITICAL FACILITIES AND REGIONAL LIFELINES

In addition, the County Emergency Management agency developed and maintains, in coordination with the County Hazard Mitigation Office, a detailed county-wide listing of critical facilities. The critical facilities inventory is a list of public and private facilities critical to emergency response and/or the recovery of a community. These facilities are identified and mitigation initiatives prioritized to ensure they are operational as soon as possible following a disaster. To help organize the many variables that are related to this process, the County developed a Critical Facilities Rating (CFR) System and Database. The CFR System assesses several hazard variables and classifies a facility's vulnerability and impact if it were damaged or destroyed. From this, a numerical rating (0-100) is assigned to the facility. The rating can help to identify those facilities, which should receive hazard mitigation attention.

The list currently includes 2,282 facilities and is anticipated to increase to approximately 3,500 within the next two years due to further facility identification. The critical facility inventory is maintained by the County Hazard Mitigation Division and provided on CD in this report. (This listing contains information that relates to the physical security of facilities used by the jurisdictions and to the security systems of those facilities. This list therefore comes within the exemption of Section 119.071(1), Florida Statutes, and is a confidential component of this document. As such, it is not subject to the general disclosure requirements of Section 119.07(1), F.S. or to any other requirements of disclosure.

Infrastructure and institutions that network and support the community are considered “lifelines.” Protecting these lifelines furthers public safety goals and enhances the ability of the community to respond and recover from a disaster. Lifelines include regional significant transportation and communications systems, major medical facilities, and other significant facilities such as: potable water, sanitary sewer, natural gas, and petroleum/chemical products. Regional lifelines also include but are not limited to, other resources and institutions within the community including:

- Neighborhood Associations/ CrimeWatch/ Citizen Corps/ CERT Teams
- American Red Cross, Salvation Army, Volunteer Organizations Active in Disasters (VOAD) and other Faith-based organizations
- U.S. National Weather Service, Ruskin Weather Office,
- Major Military Presence: U.S. Coast Guard, MacDill AFB, Army National Guard

D. REGIONAL HURRICANE ECONOMIC LOSS MODEL

In 1995, the University of South Florida (USF), Center for Economic and Management Research (College of Business Administration) developed an econometric model that illustrated various levels of damage costs associated with three hurricane categories. This study provides estimated social and economic cost. This information was considered with mapped and table output from the TAOS program provided by the Florida Department of Community Affairs.

The purpose of this summary is to provide an illustration of potential losses and not to repeat any study in its entirety. The information illustrated is based upon the "worst probable" scenario. The hurricane track simulates a hypothetical hurricane that makes landfall north of Saint Petersburg and travels northeast through the cities of Tampa and Orlando and exiting through Daytona Beach.

The fact that a natural disaster such as a major hurricane, poses a substantial threat to the physical safety of the residents in the affected region, necessitates the need to first focus on preparations for pre-disaster evacuation, efficient response and recovery operations. The purpose of the Local Mitigation Strategy is to identify strategies which will reduce this vulnerability as well as potential property and economic loss.

It is known that a major hurricane (Category 3 or higher) will exact a heavy toll on the entire region. These tolls include temporary and permanent losses of:

- housing,
- employment,
- income,
- personal belongings, and
- means of transportation.

Singly, any one of these losses is normally considered a major disruption to our community's social functions. When these disruptions occur simultaneously, the results can be devastating. This problem is even more burdensome when one aggregates economic disruption that may take place within the Tampa Bay region.

In order to adequately assess potential damage, it is necessary to formulate some expectations of the types and magnitudes of economic effects that will likely be experienced in the aftermath of a natural disaster (the most probable "worst-case" scenario). The USF Center for Economic and Management Research (CEMR) analysis was performed to determine and quantify the likely economic environment within the Tampa Bay region following a major hurricane. To determine estimates of damage, an econometric model of the Tampa Bay region (Hillsborough, Manatee, Pasco, and Pinellas counties) was performed to simulate the paths of disruption from three hurricane scenarios. This model looked at such factors as changes in division level employment, sectoral income, population dispersion, unemployment and regional tax base effects.

The purpose in seeking to determine the likely economic effects on the region as a result of a major hurricane is threefold. First, the model was developed to allow an accurate assessment of the total expected losses of real property, personal income and local government revenues. It is hoped that in doing so, regional policy makers will be better prepared to work more effectively with Federal and State disaster relief program coordinators and allow more accurate assessments of the total relief dollars needed to adequately fund the short-and long-run recovery efforts.

Secondly, information is needed with respect to the distribution of losses over the various sectors of the regional economy. The primary importance of this information is to provide policy makers with a means of prioritizing relief efforts based upon the most efficient use of the available funds. The efficiency in allocating available relief funds and directing relief efforts to those sectors of the economy that have sustained the highest damage or would produce the greatest gains in regards to fostering the overall recovery effort, and most effectively facilitate the community in returning to a normal economic environment. It should be noted by the reader that this report will not in any way provide rankings of sectors that should actually be given first priority in relief funding but will provide the information necessary for the appropriate policy makers to make those decisions.

The final use for this information is to provide an indication of potential business disruption and the likely resulting financial effects. The model focused on the potential damage to the economy. The following summarizes the report findings:

1. Estimates of Storm Damage

For the purpose of this study, three distinct magnitudes of hurricanes were viewed: A relatively low-level storm (Category I Hurricane); a mid-level storm (Category 3 Hurricane); and a major storm (Category 5 Hurricane). To determine the degree of damage to structural properties associated with each particular storm, information on the expected storm surge and windfields was mapped over the geographic region. This data was then merged cross-sectionally at the micro-level with local-government property assessment information on the improvement values of all residential and non-residential properties in the region. The resulting data set was mapped over the region according to square mile grids and then translated into aggregate loss estimates by type of property (Tables of output are located within the USF Report on file).

The initial use of this information was to gain insight into the potential level of structural damage and associated levels of homelessness and business interruption as measured by employment losses. Residential loss data was merged with zip code level demographic data by unit type from the U.S. Census 1990 STF4A files. This juncture added in the relevant data on the number of occupied housing units and average household size by zip code.

Using a benchmark of a <u>50% loss in structural value</u> as a lower bound for a housing unit being uninhabitable (similar to that used by FEMA), the number of persons displaced by each category storm was obtained. The following table illustrates displacement by hurricane category.

Table 41
Population and Housing Losses Based on Storm Category

Storm Category	Description – Population and Housing (Numbers obtained from USF Model)
1	Estimates did not show any average losses greater than 49% within any single zip-code .
3	The model illustrates substantial need for alternative housing arrangements for a approximately 132,208 persons – over 50,000 units.
5	Catastrophic level of damage to residential properties and it is estimated that approximately 760,000 persons within the entire Bay region would be temporarily displaced.

Just as residential property losses disrupt household activities so do losses in the stock of business properties disrupt aggregate employment activity. Using the same approach described previously, it was determined the average non-residential property loss by zip code for the entire region. Employment by zip code data (obtained through the Florida Department of Labor and Employment Security by USF). The total employment by division was calculated and the level of business property loss was obtained. Based on the business interruption results (measured in months) the level of quarterly employment disruptions was aggregated over the region and reported by storm category.

Table 42
Employment Losses Based on Storm Category

Storm Category	Description – Employment (Numbers obtained from USF Model)
1	Estimates did show relatively minor employment losses lasting for only one quarter.
3	This size of storm is expected to produce a one quarter decline in employment for the region by approximately 90,000 jobs.
5	Catastrophic level of damage and is expected (**for the region**) to create two quarters of property loss induced business interruption. During the first quarter there would be some 425,000 jobs lost followed by approximately 13,000 reduction during the second quarter.

It should be noted that ordinarily these job losses would be pushed out through the multiplier process resulting in even further losses once the indirect and induced effects were taken into account. This has not been done in this case as it is believed that the on-going recovery process would mitigate much of this response. It should be noted that the employment data used (QUI) does not capture 100 percent of the employment in the region. These data accounts for those employees for which unemployment insurance is paid thus the above estimates are probably somewhat conservative.

2. Economic Impacts

Regardless of whether they come in the form of large-scale fires, floods, hurricanes or terrorist attacks, disasters inflict varying degrees of mass destruction on the geographic area hit. Following a major disaster, the economic environment of the community affected is pushed instantly out of its normal orderly mode of operation into a state of virtual standstill. From this initial point, the dynamics of the short-and long-run paths to economic recovery are much the same, irrespective of the type of disaster.

a. Phases of Recovery:

For the purposes of this report three distinct phases have been defined that illustrate a set of encompassing the short-, intermediate- and long-range recovery process.

The first phase (Emergency Recovery) covers the immediate post-disaster period (0-3 months) in which the community (region) is concentrating the relief effort towards the re-establishment of public infrastructure (communications, power and transportation) and repair of housing stock necessary to secure the immediate health and welfare of the community. After stabilizing the emergency condition of the community, the second phase (Functional Recovery) moves the community towards the broad intermediate term (4-18 months) in which efforts by the public and private sectors are focused on providing recovery. The next phase (19-60 months) in recovery activity is the downward drift towards normal trend growth in aggregate economic activity. It should be noted that the actual length of each of the above assigned phases would likely be proportional to the actual level of damage sustained; the extremes of the time periods described above would be related to a large-scale storm. A broader description of each of these phases is provided within the actual study.

As a note, it can be expected that much effort will be required to restore public utilities and transportation operations; as well as, execute clean-up efforts and establish food and shelter resources, all critically vital to the community's public safety. Unfortunately, often the level of need is far in excess of that which can realistically be handled by purely local, along with other national relief agencies, leaving some areas of the community without needed resources for a period of days, weeks or even months. (Born from data provided by FEMA on hurricane disasters.)

Endemic to this early phase of recovery is a period of wide-scale workforce and income disruption, heavy losses of proprietor income, population dispersion, and reduced local revenue generation. At this time, both households and the private business sector are temporarily concerned primarily with securing shelter and food along with minimizing any further loss of property due to additional weather exposure or looting.

Although there may be considerable patch work done on damaged structures immediately following the disaster event, there is relatively little reconstruction begun in this period as there is neither the capital nor workforce available to undertake much large-scale private construction activity. This does not suggest that local government planning agencies will not be overwhelmed with carrying on the permitting process. Individuals and organizations will certainly begin applying for construction permits well in advance of having money in hand.

The bulk of actual reconstruction activity will not begin until insurance checks and federal/state loans are processed and disbursed, and the transportation network is restored to a minimum level of operations. While in the past this process took considerable time, the experience accrued during the recent rash of natural disasters in the U.S. has greatly improved the functioning of both the public relief and private insurance sectors.

b. <u>Functional Recovery</u>:

Once early-period emergency actions begin to subside and capital flows begin to reach the community, attention can be directed to long-term recovery. During this period permanent repair and reconstruction of damaged properties is pursued along with the purchase and repair of damaged or lost business/personal property. Initially the process of rebuilding the regional economy begins in earnest and then very quickly turns into an extended period of supernormal growth for the region. It can be expected that the level of aggregate economic activity in the region will reach a plateau within six months, and remain relatively stable for a year or more.

The rate of rebuilding progress will depend heavily upon the composition and level of capacity of the regional economy as measured by the remaining capital stock and existing labor force. Recovery funding from local and non-local sources play a major role in the ability of the community to quickly restore its economy to pre-disaster levels. Timely provision of both public (local, state and federal) and private (insurance industry) funding in adequate amounts can greatly increase the speed of recovery.

Aggregate economic conditions in the local economy improve dramatically during the period of functional recovery. Total employment and gross sales levels reach or exceed pre-disaster levels, bringing a rebound in both individual wage earnings and proprietor income. Unemployment levels recede to more normal levels and the community as a whole becomes more stable as many of those previously left homeless now have new or refurbished shelter. The composition of activity will certainly be diverted primarily to the construction, services and trade sectors of the economy. Due to the interdependence of the construction sector and most all other sectors of the economy there will be wide spread increases in output across the economic board.

Effects on local government revenues over the short and intermediate phases of recovery are a mixed bag. Sales and motor fuels tax collections most certainly will slide during the first couple of months following the disaster as expenditures and travel by local residents is disrupted and many retailers are temporarily out of service. However once the rebuilding effort accelerates local collections should be bolstered above previous long-term trend rates of growth. Of longer duration and larger magnitude are the effects on the local ad valorem tax base.

Due to the potential for very large declines in property values as a result of the devastation of the natural disaster, the total level of lost revenues from the ad valorem tax base could be crippling to long-term local government operations. Replacement of the pre-existing tax base will depend greatly upon the composition of property losses, the level of insurance coverage in the community, and the propensity of owners of damaged properties to rebuild in the community. All of these variables are to a large degree determined by the magnitude of losses incurred, the perceived expectation of the level of rebuilding of the community as a whole, and the demographics of the region. Losses in the advalorem tax base hurt not only the normal operating capacity of local government, but its ability to meet matching requirements for available Federal funds. Loss of tax base also decreases the bonding capacity as well.

c. Trend Recovery:

At some point, the pace of aggregate economic activity will begin to decline from the supernormal rates of growth experienced during the thrust of full-scale reconstruction of the local economic base. As with most econometric models, the Tampa Bay regional model is composed of a set of simultaneous equations taking account of various sectors of the economy. Because of the difficulties in modeling and the existence of state produced forecasts, regional population has not been modeled explicitly, but rather has been run out from information within the most recent Florida Consensus Estimating Conference (Florida Consensus Estimating Conference, Book 3 Population & Demographic Forecast, Vol. 10 1994).

It should be noted that values associated with structure destruction are available through real estate files from the Property Appraiser’s office. Additionally, the Florida Department of Community Affairs (Born from an Insurance session at the 1999 National Hurricane Conference) estimated total Bay area destruction could amount to greater than $100,000,000,000. This amount would be associated with a direct hit by a catastrophic storm event.

E. RISK ASSESSMENT

A host of Federal, State, and local laws and ordinances, as well as private sector standards, have been adopted over the past 20 years, including the Environmental Protection Act, the Clean Water Act, the Clean Air Act, SARA Title III, the National Flood Insurance Program, and others which, collectively, have mitigated the effects of natural and technological hazards. Accordingly, the Disaster Mitigation Act of 2000, incorporates an all-hazards strategy, and builds upon existing programs that mitigate both natural, technological and civil hazards, and focus on the critical importance of coordination among efforts to mitigate hazards, regardless of the source of the risk.

Inevitably, the occurrence of catastrophes raises public awareness of the hazards we face, the costs they exact, and actions we might take to reduce their impact. Just as inevitably, attention shifts rapidly to other concerns. The press of day-to-day issues dissipates time for and interest in dealing with strategic planning and actions to mitigate potential future threats. The magnitude of the deficit in natural hazard public awareness and information requires a nationally based awareness effort supplemented by State and local programs designed around the particular hazards faced by the affected individuals.

The table below quantifies, where applicable, a ratio of the total number of occurrences by the number of years in which data has been recorded. This ratio can also be expressed in terms of the number of years that are anticipated to pass between occurrences. Both of these probabilities are shown in the following Table.

Table 43

Probability of Occurrence for Selected Hazards (sorted by frequency of event)				
EVENT	**Number[1]**	**Yrs[2]**	**Ratio[3]**	**Expected Frequency[4]**
Hurricanes and Tropical Storms	28	112	0.25	4 years
Flooding	39	38	1.03	1 year
Tornadoes	105	38	2.76	4.25 months
Severe Storm/Weather Events				
Thunderstorm/Wind	70	38	1.84	6.5 months
Severe Rain Events	5	3	1.67	7 months
Lightning	21	38	0.55	22 months
Hail	40	38	1.05	1 year
Fog	17	38	0.45	2.25 years
Freeze	3	38	0.08	12.5 years
Sinkholes	29	23	1.26	9.5 months
Fires	42,231	3	14,077	40 minutes
Hazardous Materials Incidents	2,133	5	426.6	20 hours
Other	2	38	0.05	20 years

[1] Number of occurrences as identified in tables in this report.
[2] The number of years for which data has been recorded
[3] The frequency of historical occurrences by number of years (Number/Years)
[4] The ratio of hazard occurrences expressed in years or months (1/Ratio)

Source: City of Tampa, 1999.

To provide additional guidance to the identification of the severity of various hazards listed, the following process was used to produce a risk factor. The factor is used in the process of establishing a community social/cost benefit for non-funded mitigation projects listed in Appendix G. The risk factor is determined through correlating the “Probability” and the “Consequence” nominal ratings (within the table below) with a numeric value. Related values are as follows:

Probability rank of Low	= 1	Correlated rank of Low	= 1
Probability rank of Moderate	= 2	Correlated rank of Moderate	= 2
Probability rank of High	= 3	Correlated rank of High	= 3

The value (factor) is obtained by multiplying the “Probability” and the “Consequence” rating (converted as identified above). The following “Risk Factor” is obtained and placed within the space provided.

Low Probability of Occurrence with a Low Consequence	= 1
Low Probability of Occurrence with a Moderate Consequence	= 2
Low Probability of Occurrence with a High Consequence	= 3
Moderate Probability of Occurrence with a Low Consequence	= 2
Moderate Probability of Occurrence with a Moderate Consequence	= 4
Moderate Probability of Occurrence with a High Consequence	= 6

High Probability of Occurrence with a Low Consequence = 3
High Probability of Occurrence with a Moderate Consequence = 6
High Probability of Occurrence with a High Consequence = 9

Table 44
Probability of Occurrence, Consequence, Risk Factor, Mitigation Techniques, and Potential Loss by Disaster Type

DISASTER TYPE	PROBABILITY OF OCCURRENCE		CONSEQUENCE
Hurricane/ Tropical Storm	**Low**	**1 every 3 or 4 years**	**High**
Mitigation Techniques: Public awareness programs, severe weather warnings and evacuations, building construction regulations, structure retrofits, Special Flood Hazard Area setbacks and additional development standards, Comprehensive Plan growth management policies.			
Risk Factor: 3	**Financial Loss:** Historical losses: $70,000,000; Potential: Minimum of $2.5 billion in private structure loss.		**Social Loss:** Four injuries associated with event; Potential: 400,000 in labor and 50,000 structures in V-zones.
Severe Storm/Weather	**High**	**Not Calculated**	**Moderate to High**
Mitigation Techniques: Public awareness programs, severe weather warnings (NEXRAD), building construction regulations, structure retrofits, Special Flood Hazard Area setbacks and additional development standards.			
Risk Factor: 9	**Financial Loss:** Historical losses: $175,000,000; Potential is as great as a hurricane event.		**Social Loss:** Historical loss 126 injured.
Severe Wind	**High**	**2% Probability Annually (50 Year Storm)**	**Moderate**
Mitigation Techniques: Public awareness programs, severe weather warnings and evacuations, building construction regulations – minimum design loads for buildings and other structures, and structure retrofits.			
Risk Factor: 6	**Financial Loss:** Historical losses: $2,500,000		**Social Loss:** Some injured and killed.
Tornadoes	**High**	**Not calculated**	**Moderate to High**
Mitigation Techniques: Public awareness programs and evacuations for mobile home parks, building construction regulations – minimum design loads for buildings and other structures, structure retrofits, severe weather warnings system: improved radio and wire communications with the media, improved warning systems available to industry with audible alert warning system, continued awareness programs and preparation for schools and similar private sector.			
Risk Factor: 6	**Financial Loss:** Historical: $18,000,000; Potential is as great.		**Social Loss:** Historical: 57 injured/1 death.
Floods	**Moderate**	**26% Probability**	**Moderate to High**

DISASTER TYPE	PROBABILITY OF OCCURRENCE		CONSEQUENCE
		Annually (for structures within the 100-year flood zone)	
Mitigation Techniques: Public awareness programs, building construction regulations, structure retrofits, severe weather warnings system (including water-level/gauging systems for riverine areas), flood insurance provided through the NFIP, and Flood Mitigation Assistance programs.			
Risk Factor: 6	**Financial Loss:** Historical: $18,000,000; Potential is as great.		**Social Loss:** There are approx. 400 repetitive loss structures within the county.
Storm Surge	**Low**	**Equivalent to a Hurricane**	**Moderate to High**
Mitigation Techniques: Public awareness programs and evacuations plans, building construction regulations, structure retrofits, severe weather warning systems, preparation for schools, beach re-nourishment, erosion control devices, participation with the NFIP – V-Zone identification, and Comprehensive Plan policy implementation.			
Risk Factor: 3	**Financial Loss:** Potential is greater than $2.5 billion in damage.		**Social Loss:** An event can effect greater than 50,000 structures.
Erosion	**Low**	**Equivalent to a Hurricane**	**Low**
Mitigation Techniques: Public awareness programs and evacuations plans, building construction regulations, structure retrofits, severe weather warning systems, preparation for schools, beach re-nourishment, erosion control devices, participation with the NFIP – V-Zone identification, acquisition of sensitive coastal areas, Ship and Port channel dredging, infrastructure monitoring, and Comprehensive Plan policy implementation.			
Risk Factor: 1	**Financial Loss:** Unknown		**Social Loss:** Unknown
Winter Storm/Freezes	**Low**	**Equivalent to a Hurricane (1 every 3 or 4 years)**	**Low to Moderate**
Mitigation Techniques: Similar to severe storm with the addition of the County's "Power-Outage" Plan.			
Risk Factor: 2	**Financial Loss:** Greatest financial loss is associated with agriculture ($55 million historically)		**Social Loss:** Unknown
Droughts	**Currently within 20 year drought**	**Not calculated**	**Low to Moderate**
Mitigation Techniques: Mitigation techniques used depend on the severity of the drought and the amount of precipitation for a given year, implementation of Comprehensive Plan policies, and pre-planning/implementation of guidelines by the Southwest Florida Water Management District: water conservation techniques, implementation of Federal drought contingency plans.			
Risk Factor: 3	**Financial Loss:** Greatest financial loss is associated with agriculture.		**Social Loss:** Unknown.
Sinkholes	**Low**	**1 to 2 per Year**	**Low to Moderate**
Mitigation Techniques: Public awareness programs, building construction regulations (principally			

DISASTER TYPE	PROBABILITY OF OCCURRENCE		CONSEQUENCE
for commercial structures), and home owners insurance.			
Risk Factor: 2	**Financial Loss:** Unknown **--** Potential probability is associated with the loss of a residential structure during a given year.		**Social Loss:** Potentially effecting one and two parcels during an event.
Urban/Wildland Fires	**Low to Moderate**	**1% Probability Annually for Home Fires**	**Moderate**
Mitigation Techniques: Public awareness programs, building construction regulations, structure retrofits, severe weather warnings system (due to lightening issues), rapid response teams, prescribed burns, dilapidated building removal, internal training, resource sharing (mutual aid programs).			
Risk Factor: 4	**Financial Loss:** Historically $10,000,000 annually, statewide.		**Social Loss:** Principal loss is to structures.
Hazardous Materials	**Moderate – Hillsborough County contains 50% of the State's Hazardous Materials.**	**No such analysis available – transportation corridors identified as highest risk areas nationally.**	**Moderate to High**
Mitigation Techniques: Public awareness programs, building construction regulations, Hazardous Materials Rescue teams, dikes/berms, siren notification for Port area, automated notification systems (phone system at EOC), identification of structures and populace in potential fall-out areas, Comprehensive and Emergency Preparedness Plans.			
Risk Factor: 6	**Financial Loss:** Not calculated.		**Social Loss:** The potential effect from an individual site is greater than 50,000 persons.
Dam Failures	**Low**	**Not Calculated**	**Low**
Mitigation Techniques: Public awareness programs, building construction regulations, Hazardous Materials Rescue teams, dikes/berms, automated notification systems (phone system at EOC), identification of structures and populace in potential fall-out areas, Comprehensive land-use maps and respective policies and emergency preparedness plans.			
Risk Factor: 1	**Financial Loss:** Undetermined due to many dams on private property.		**Social Loss:** Downstream properties and structures – limited number.
Civil Unrest	**Low**	**Not Calculated**	**Low to Moderate**
Mitigation Techniques: Public involvement programs/plans and emergency preparedness plans.			
Risk Factor: 2	**Financial Loss:** Unknown.		**Social Loss:** Unknown.
Port Vessel Collision or On-water Materials Spill	**Low**	**Not Calculated**	**Moderate**
Mitigation Techniques: Responder awareness and operations training, Emergency Preparedness and Hazardous Materials Rescue teams, automated notification systems (phone system at EOC), identification of structures and populace in potential fall-out areas, emergency			

DISASTER TYPE	PROBABILITY OF OCCURRENCE		CONSEQUENCE
preparedness plans and public awareness/education.			
Risk Factor: 2	**Financial Loss:** Historically events have affected specific vessels and/or berth areas.		**Social Loss:** Not calculated – fallout area is dependent on where the event occurs.
Utility Failure	**Low**	**No such analysis available**	**High**
Mitigation Techniques: Public awareness programs, severe weather warnings, utility outage preparedness plan, utility company readiness plan and operations, identification of critical structures.			
Risk Factor: 3	**Financial Loss:** Unknown		**Social Loss:** Unknown – dependent on the period of the year.
Telecommunications and Technological Hazards	**Low**	**No such analysis available**	**Moderate**
Mitigation Techniques: Responder awareness and operations training, public awareness programs, standby/backup systems, emergency preparedness plans, automated notification systems (phone system at EOC) and critical facility and populace identification.			
Risk Factor: 3	**Financial Loss:** Unknown.		**Social Loss:** Unknown.

<table>
<tr><td>Domestic Security/Terrorism</td><td>Moderate</td><td>No such analysis available</td><td>High</td></tr>
<tr><td colspan="4">Mitigation Techniques: Responder awareness and operations training, public awareness programs, building construction regulations, Emergency Preparedness and Hazardous Materials Rescue teams, automated notification systems (phone system at EOC), identification of structures and populace in potential fall-out areas and emergency preparedness plans.</td></tr>
<tr><td>Risk Factor: 6</td><td colspan="2">Financial Loss: Event has a potential of effecting an area larger than an individual site – potential costs are unknown.</td><td>Social Loss: Potential for injuries and deaths is high.</td></tr>
</table>

ATTACHMENT C

CRITICAL FACILITIES MAP SERIES

Critical Facility Maps (Some may be exempted from public distribution, protected under Chapter 119.071(1), Florida Statutes as provided by the provisions of the Critical Infrastructure Information Act of 2002.)

16. Hospital/Clinics, Federal Buildings & Emergency Ops/Communication Centers
17. Law Enforcement Facilities and State Buildings
18. Nursing Homes/ALF's & City Buildings
19. Fire/Rescue Stations, GTE Sites & SWFMD Sites
20. Water Treatment Facilities, County Buildings & Radio/Television/Weather Towers
21. Landfills, Large Parks & Hazardous Materials Sites
22. Schools (public/Private), Universities, Tampa Electric Facilities, & Ice Manufacturing Sites
23. Shelters, People's Gas Sites & Airports