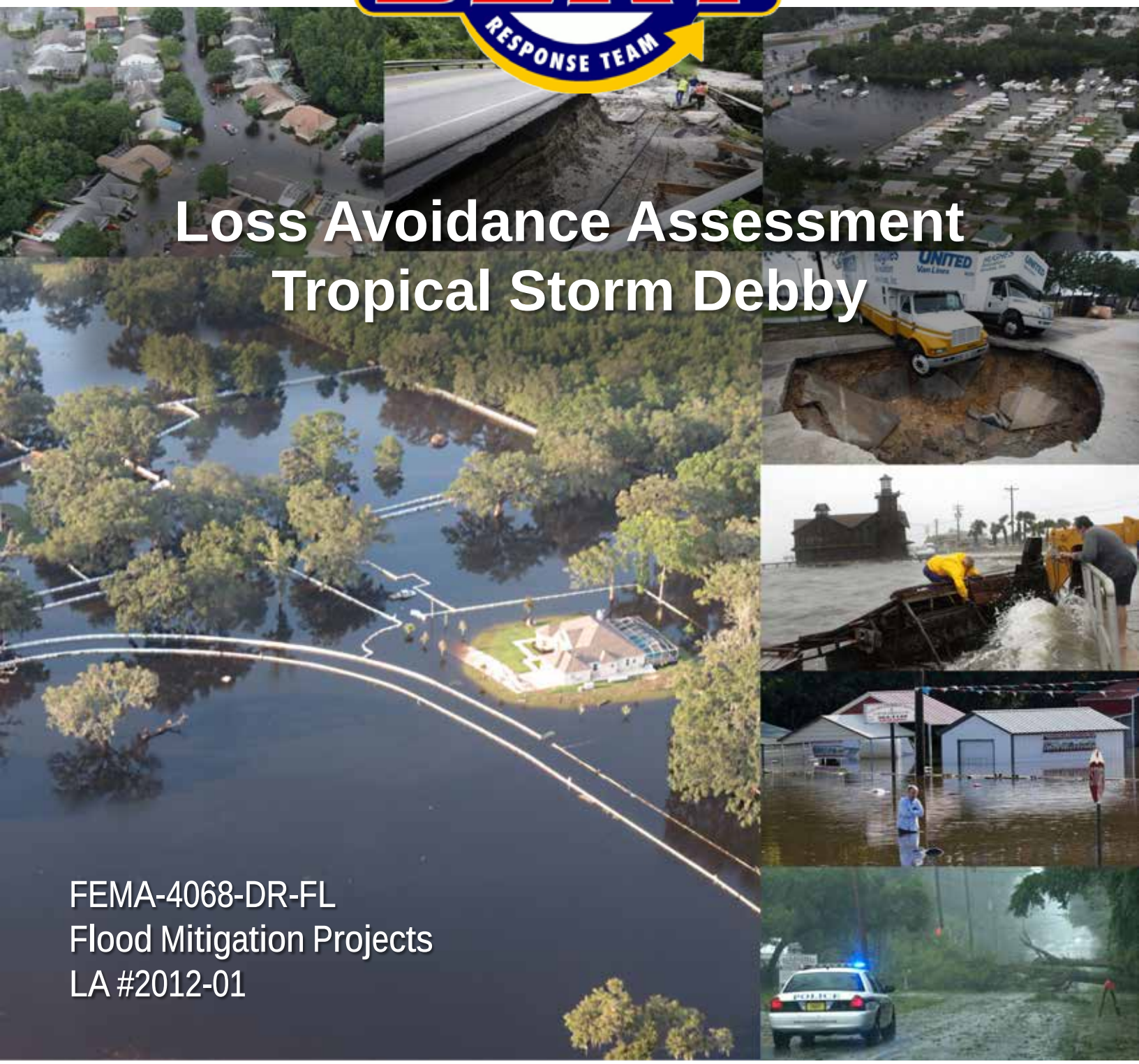
# APPENDIX N:

# Loss Avoidance Report

# Tropical Storm Debby



# Loss Avoidance Assessment
# Tropical Storm Debby

FEMA-4068-DR-FL
Flood Mitigation Projects
LA #2012-01

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## Part II



## Appendices

# Executive Summary

In the summer and fall of 2012, Florida conducted a loss avoidance assessment of flood mitigation projects funded through Federal Emergency Management Agency (FEMA) Hazard Mitigation Assistance grant programs. Analysts assessed projects completed by June 23, 2012.[1]

The state evaluated 146 projects for their effectiveness during four recent flood events: Tropical Storm Fay (2008), the North Florida Flood Event (spring 2009), the Unnamed June Flood Event (2012), and Tropical Storm Debby (2012). Analysts only assessed projects complete by the time of each event, as well as within the area of impact.

This assessment's results demonstrate that it is a sound investment to spend resources mitigating the risk of natural hazards in Florida.

Of the 146 projects analyzed, 82 contain sites eligible for evaluation of losses avoided during at least one of the four events. Six contain sites impacted by two events.

At the time of this report 75 of these 82 projects have been analyzed for losses avoided (flood data was not yet available for the other eight). Of these 75, 50 projects contained sites with impacts sufficient that the sites would have received damage without mitigation.

Together, these 50 projects cost $18.9 million (in 2012 dollars) to implement. This assessment's results show a 116% return on investment for these projects, the majority of which (64 percent) were completed in and after 2011. This is a high return for a short time-frame.

Without mitigation, damages to these projects sites from the events analyzed would have cost almost $22 million.

*Results show a 116% return on investment for the assessed projects, primarily after only one event (Tropical Storm Debby).*

[1] Due to the archival of earlier mitigation project files, only projects with open files after January 1, 2007 were available for review.

# Report Contents

This report consists of two primary sections:

Part I contains an Introduction to Loss Avoidance Assessments, Project Highlights, Results[2], and Lessons Learned.

Part II provides an outline of Florida's System and Strategy, an explanation of how it was implemented for this report, and a history of the four events included in this study.

Appendices include:

A. Results by Project by County
B. Project Event Data and Calculations
C. Other Event Documentation
D. Blank Project Performance Call Sheet

Definitions are provided beginning on the next page in order to briefly familiarize readers with terms and concepts.

Detailed methodologies and technical details are provided in Florida's System and Strategy, available at www.floridadisaster.org/mitigation.

A resident navigates flooding from Tropical Storm Debby June 2012 (photo courtesy of Duval County, Florida).

[2] Results are provided in 2012 dollars according to the Relative Share of GDP method of cost-normalization. See **Definitions**.

# Definitions

Certain terms are used in this report that the reader may not be familiar with, or may be familiar within a different context. The following provides clarification regarding the use and meaning of terms in this report. More detailed explanations of the terminology used, as well as methodology and calculations used to provide the results of this assessment, are provided within the State of Florida's respective Loss Avoidance Assessment System and Strategy.

An electronic version of both this report and the System and Strategy are available on the Florida Division of Emergency Management Mitigation Bureau's website, www.floridadisaster.org/mitigation.

Area of Impact: Also known as the damage swath. This is the area within which damage is expected to have occurred as the result of a hazard event. For the purposes of this report, the area of impact was determined to be those counties that received a presidential declaration for the event being assessed or those areas which received precipitation levels at the two year return interval or higher. The two year return interval was selected due to the fact that historical losses for some projects were shown at this level in the original benefit cost analysis. Such a low threshold for the area of impact resulted in many project sites assessed within this defined area not experiencing losses avoided (as explained later in this report).

Building Modification Project: The term "building modification" has been adopted for this report in order to avoid confusion with conflicting terms used by other state and federal agencies. For instance, the term "non-structural" is used by the Army Corps of Engineers to refer to projects which do not modify the environment. Use of this term may cause confusion as the same projects may also be referred to as "structural" depending on context. Building modification projects refer to acquisition, elevation, floodproofing, mitigation reconstruction, and second story conversion.[3]

Current Dollars: Also known as "nominal". Refers to dollars current to the year in which they were spent. As opposed to "real" dollars, the value of dollars normalized to the present.

Employment Impact Analysis: An analytical assessment to estimate the employment-related benefits that certain activities provide. The Florida Division of Emergency Management conducted an Employment Impact Analysis in the fall of 2011 to determine the jobs-related benefits that mitigation activities funded through Hazard Mitigation Assistance Programs from August 2004 and February 2011 have provided to the state.

Event: The incidence of a hazard that results in damaging impact to an area of the state.

Losses Avoided: Losses avoided, as reported in the results of this assessment, consist of those losses that would have occurred without the mitigation project, also known as the "mitigation absent" scenario.

*Calculating Losses Avoided for Building Modification Projects*: Losses avoided for building modification projects (for the purposes of this assessment) consist of the total of building, content, inventory, and displacement cost losses that would have occurred had the mitigation action never been implemented.

*Calculating Loss Avoided for Drainage / Special Projects*: Losses avoided for drainage / special projects (for the purposes of this assessment) consist of losses that have been recorded and documented in the project file for similar event

[3] Second story conversion is now a sub-category of mitigation reconstruction mitigation activities. As such, future reports will refer to second story conversion projects as mitigation reconstruction.

return intervals in the past, normalized to present dollar amounts (This is one of two ways losses avoided may be calculated for drainage and special projects. The other involves modeling and is described in Florida's Loss Avoidance Assessment System and Strategy).

Net Present Value: Net present value of a mitigation project is the sum of losses avoided during the events assessed minus dollars spent, in 2012 dollars.

Normalization: Often, the year of project completion will occur prior to the event year (some events occur in the same year the project was completed). This means that $1 at the time of project completion likely does not have the same value as $1 at the date of event impact. As a result, past and present benefits and costs must be normalized in order to measure their true value. Normalization refers to the process of converting figures of differing origins, in this case different dollar amounts from different years, into a value that can be recognized and interpreted consistently.

Occupancy Type: Occupancy type refers to the use of the structure. Occupancies used for the purposes of this report include Agricultural, Commercial, Educational, Government, Hospital, Industrial, Religious, and Residential.

Project: A project, for the purposes of this report, refers to an individual subgrant award. A single project may have multiple project sites. For example, one acquisition grant project may acquire multiple structures.

Project Cost: Project cost consists of the total investment in project implementation and includes both federal and non-federal share at project completion.

Project Site: The location in which a project is implemented. For building modification projects which mitigate multiple structures, project sites are analyzed individually for losses avoided. This is due to the fact that the same event may have a different impact on different structures.

Real Dollars: Dollars normalized to present day values. As opposed to "current" or "nominal" dollars, the value of dollars in the year they were spent.

Relative Share of GDP Method of Cost Normalization: This is the method of cost normalization used to report results for this assessment. It is an appropriate method for normalizing dollars spent on public expenditures. This method to normalize costs values public investment based on the size of economy at the time of the investment. It clarifies the value of the project at the time of the investment, in today's terms, as a share of the total amount of money available for investment in the country at the time. In other words, it answers the question, "What was the public investment's value?" with the question "How much of a share of GDP was spent on the public investment?"

Normalization through relative share of GDP can be calculated as follows:

$$(\text{Cost}_n / \text{Nominal GDP}_n)(\text{Nominal GDP}_x)$$

Where, n is the year of the cost incurred and x refers to the year prior to the present year.

Full descriptions of the other two normalization methods used by the calculator are provided in the Loss Avoidance Assessment System and Strategy.

Return Interval: Return interval can also be referred to as return period or recurrence interval. It is the inverse of the probability that a particular intensity event will be exceeded in any one year. In the case of this report, the event

type is flood. As an example, a 10 year flood has a 10% chance of its intensity being exceeded in any given year and a 50 year flood has a 0.02 or 2% chance of being exceeded in any one year. This does not mean that a 100 year flood will happen regularly every 100 years. In any given 100 year period, a 100 year event may occur once, not at all, or many times as each outcome has a probability of occurring in every year.

Return on Investment (ROI): ROI is a factor of the dollars saved (losses avoided) due to mitigation over the life of the investment. Losses avoided are considered a return because they represent money that is saved, as opposed to spent, due to the mitigation project.

These funds are thus available for investment in other endeavors, instead of disaster recovery.

ROI can help guide decision-making by identifying which investments have been cost-effective. The formula below was used in calculating the ROI.

**LA / PI = ROI**

Where

- **LA** = Losses Avoided ($) in terms of any of the above normalization methods;
- **PI** = Project Investment in terms of any of the above normalization methods (Mitigation Costs) ($); and
- **ROI** = Return on Investment (%).

Special Project: The term “special” project refers to all flood projects which are neither drainage nor building modification projects. These projects may be highly customized to the mitigation context and typically mitigate infrastructure. Examples might include armoring a coastal road or culvert opening.

# Part I

- Introduction to Hazard Mitigation and Loss Avoidance Assessment
- Detailed Results
- Project Highlights
- Conclusions
- Lessons Learned

# Introduction to Hazard Mitigation and Loss Avoidance Assessment

Loss avoidance assessments are conducted to substantiate the value of mitigation in real dollars.

Natural disasters are inevitable, but extensive damages are not (photo courtesy of Hernando County).

## n Hazard Mitigation reduces risk to natural disasters.

Hazard mitigation is any action taken to reduce or eliminate risk to natural hazards, such as flood, hurricane, wildfire, and more. Mitigation activities can be structural or non-structural and might include improved building codes, infrastructure and building hardening, outreach and education, land use planning, legislation, and more.

A significant difference between hazard mitigation and other stages of the emergency management cycle (preparedness, response, and recovery), is that mitigation should, in theory, reduce reaction-based activities in other stages of the cycle. Mitigation does this by hardening the community against, or removing the potential for, impacts in the first place.

Hazard mitigation is the most cost-effective stage of emergency management. For every dollar spent on mitigation, society likely saves four dollars in prevented loss over the life of the project.[4]

## n Mitigation is a public good.

Funds are provided to state, local, and non-profit organizations to facilitate the hardening of communities. Assistance for hazard mitigation activities is provided through both state and federal programs administered by the Florida Division of Emergency Management Mitigation Bureau (the Bureau). While the Federal Emergency Management Agency (FEMA) is the most prominent source of funding for projects the Bureau manages, the state also provides funding for wind mitigation projects through the Residential Construction Mitigation Program (RCMP). In addition, local governments and other eligible recipients provide funds for the required non-Federal cost share (typically 25%).[5]

## n Jurisdictions assess risk from natural hazards and identify mitigation projects to reduce that risk through planning.

The Disaster Mitigation Act of 2000, also known as DMA2k, requires mitigation planning to prioritize projects. This is so that funding may be appropriately allocated when it becomes available. Mitigation planning takes place in a repeating cycle of four steps: 1) assess risk and vulnerability, 2) identify methods to reduce that risk, 3) implement those methods, and 4) evaluate the effectiveness of the methods implemented (Loss Avoidance Assessment).

At the state-level, mitigation planning takes place through the Bureau and the State Hazard Mitigation Plan Advisory Team. Florida's Enhanced State Hazard Mitigation Plan is a coordinated stakeholder effort involving state agencies, private businesses and non-profits, other public groups, and local and federal governmental organizations. The goal of this plan is to coordinate hazard mitigation programs statewide.

Hazard mitigation planning in Florida also takes place at the local level; each of Florida's 67 counties has adopted a federally approved local mitigation strategy.

[4] Multihazard Mitigation Council. (2005). Natural Hazard Mitigation Saves. National Institute of Building Sciences. Washington, D.C.

[5] For more on these programs, please visit the Florida Division of Emergency Management Mitigation Bureau website at www.floridadisaster.org/mitigation.

*Between August 2004 and February 2011, over 12,000 jobs were created as a direct result of mitigation activities in the State of Florida. This equates to 1,525 jobs per year or 4 FTE jobs per day.*

These strategies are developed with the help of the public and Local Mitigation Strategy Working Groups and may be incorporated into local comprehensive and capital improvement planning mechanisms.

### n It is important to continually assess whether public funds have been spent wisely.

In these times when resources for public expenditure are scarce and costs for things such as infrastructure and community protection are ever increasing, it is important to determine whether public funds have been expended efficiently and cost-effectively. Such determination will help aid decision making to appropriately allocate resources into the future.

### n Loss avoidance assessment is one method to substantiate money spent on hazard mitigation.

An investment is sound if it can provide a positive return within a reasonable period of time. Many benefits of public expenditure cannot be quantified in a straightforward manner; they may be qualitative in nature, such as improving community health. Mitigation provides a litany of benefits to the citizens of Florida, both qualitative and quantitative.

Loss avoidance assessment is one method used to quantify the value of mitigation. It is performed by assessing, post-disaster, how much money was saved through mitigation.

### n Florida has also explored the value of mitigation in other ways.

Florida completed an employment impact analysis in the fall of 2011 to assess whether mitigation benefits the Florida economy, in addition to protecting it from impact. The results of this study revealed that hazard mitigation activities provide a positive economic benefit to Floridians, in terms of employment, in addition to economic stabilization following a disaster. Between August 2004 and February 2011, mitigation activities implemented in the State of Florida created 12,206 Full-Time Equivalent (FTE) jobs. This equates to 1,525 jobs per year or 4 FTE jobs per day.

### n These studies demonstrate that mitigation is a sound investment in Florida's future.

The incidence and impact of natural disasters are on the rise. For example, Hurricane Sandy's "superstorm" has just devastated the mid-Atlantic coast, with loss expectations nearing $100 billion.[6] The current jobless rate in Florida is at 8.7%.[7] In addition, engineers have assigned United States infrastructure a "D" grade and estimate that necessary upgrades will cost over $2 trillion.[8]

Mitigation projects address all three of these challenges by hardening our communities against disasters, adding jobs to the market, and improving our infrastructure.

### n The results of this loss avoidance assessment can help guide policy-makers in their decisions.

There is still some hesitation to invest in mitigation among policy makers. In fact, one study showed that citizens reward elected officials with higher rates of re-election for funds spent on disaster relief, but not for investment in preparedness and mitigation. "These inconsistencies distort the incentives of public officials, leading the government to underinvest in disaster preparedness (and mitigation), thereby causing substantial public welfare losses".[9]

The same study, however, stated that there is an apparent surge of support for mitigation when the potential costs of inaction are clear and post-disaster. There is "(s)ome… evidence that governments may be able to take action to make preparedness salient to voters in a more permanent fashion.[9]" As such, it is

[6] Geewax, Marilyn. "Hurricane Sandy's Economic Impact Likely To Be Immense." National Public Radio, 29 Oct. 2012, Web, 2012.

[7] U.S. Bureau of Labor Statistics, 30 Oct 2012, Web 2012,

[8] Environment News Service. "Engineers Give U.S. Infrastructure a 'D' Grade, $2.2 Trillion Price Tag." 28 Jan. 2009, Web 2012.

[9] Healy, Andrew and Neil Malhotra. *Citizen Competence and Government Accountability: Voter Responses to Natural Disaster*

necessary to ensure that the value of preventing hazard-induced losses is communicated loudly and clearly to the public and officials alike.

There is perhaps no simpler way to express the benefits of mitigation than to show losses that would have occurred without it.

Tools to substantiate public spending for mitigation, such as loss avoidance assessment:

1. Can improve public understanding of the benefits of investing in mitigation; and
2. Are a resource for decision makers and elected officials to better understand how mitigation benefits their communities.

This tool may be used to help guide future decision making with regard to the allocation of resources to safeguard Florida's tomorrow.

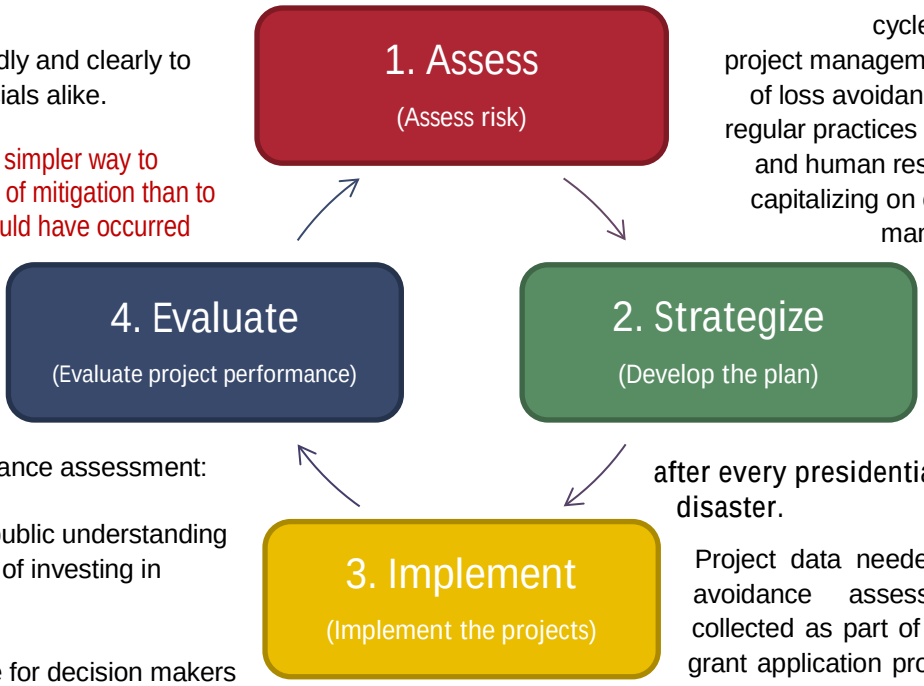
The results of this assessment demonstrate that, in a short period of time and within the current disaster context, mitigation can provide a positive return on investment for those areas which have historically experienced loss.

- Loss avoidance assessment should be integrated into regular emergency management practices.

The message of loss avoidance assessment can be communicated most efficiently and effectively if assessments are completed consistently and often.

This means using the same methodology at each event possible. To this end, loss avoidance assessment can

Loss Avoidance Assessment (Evaluate) is a natural part of the mitigation planning cycle and should be fully integrated into the process.




be integrated into the regular mitigation planning cycle, as well as normal project management. Full integration of loss avoidance assessment into regular practices will impact financial and human resources the least by capitalizing on existing emergency management activities.

- Florida has committed to conducting a loss avoidance assessment after every presidentially declared disaster.

Project data needed to conduct loss avoidance assessment must be collected as part of the regular project grant application process. The benefits of capturing and retaining this information for future use at the time of application vastly outweigh the minimal cost in staff time and data storage.

Event data required to conduct loss avoidance assessment may be gathered as a regular part of post-disaster preliminary damage assessments. This can be accomplished through the gathering of high water marks or photographic evidence of projects within the area of impact and / or through interviews with local officials.

Organizations that implement mitigation projects should do so with the intention of eventually conducting or participating in a loss avoidance assessment themselves. Simply retaining detailed project information in a spreadsheet may be all that is needed. Through such a small change in behavior, organizations may capture benefits of mitigation from all events and accurately depict a return on investment.

*There is an apparent surge of support for mitigation when the potential costs of inaction are clear.*

*Relief and Preparedness Spending.* Loyola Marymount University. 25 June 2009. Web, 2012.

# Detailed Results

This section of the report provides results of the assessment in terms of projects analyzed and losses avoided during the events covered by this report. Detailed methodologies are provided in Florida's Loss Avoidance Assessment System and Strategy posted to the Bureau's website (www.floridadisaster.org/mitigation). A description of how the methodology was implemented for this assessment is provided in Part II of this report.

## Projects Analyzed

Analysts gathered data from project files that fulfilled the following criteria:

- Projects which mitigate flood hazard
- Projects complete by 23 June 2012 (Tropical Storm Debby)
- Projects that had not yet been archived

Staff gathered data from 146 project files mitigating a total of 10,532 structures. Fifteen of these projects largely mitigated infrastructure, such as intersections and utilities.

Table 1 provides a snapshot of projects assessed for this report, by project type. It includes the total cost of the projects in current dollars[10], as well as the average cost per mitigated structure or, in the case of drainage or special projects, structures benefitting from the project.[11]

The total cost of the 146 flood mitigation projects evaluated for this report was almost $92 million in current (nominal) dollars. The average cost per structure benefitting from the mitigation initiatives was $8,231.82. Elevations and Second Story Conversion projects were the most expensive, at over $265,000 a structure. Drainage projects appear to have the lowest cost per benefitting structure at less than $6,000 a structure. Of the mitigation projects included in this report, drainage projects benefit far more structures, on average, than any other flood mitigation project type. Special projects were each unique in the assets they mitigated. Please see Appendix B for more information on any particular project.

Table 2 provides an overview of the occupancies of mitigated structures or, in the case of drainage or special projects, structures benefitting from the project.

Figure 1 is a visual representation of the information provided in Table 2.

Structure occupancy categories include Agricultural, Commercial, Educational, Government, Industrial, Religious, Residential, and Non-building Infrastructure.

The vast majority of structures mitigated by the flood projects assessed for this report are residential, at over 93 percent. Almost six percent are commercial and the rest are split between remaining occupancy types. Infrastructure is included as an "Occupancy Type" for illustrative purposes only.

The average cost per structure elevated was about $265,000 for projects included in this assessment (photo courtesy of Volusia County, Florida)

[10] Dollars current to the year in which they were spent.

[11] **Please note** that structures that benefit from drainage projects are not actually modified themselves; they are identified in the file as within the area the project is expected to mitigate (see Part II, Drainage Project Coordinates).

## Projects Reviewed by Event

While Tropical Storm Debby's impact to Florida triggered this assessment, Florida elected to also analyze losses avoided by mitigation projects from the following events which have occurred since 2007:

- 2012 June Unnamed Flood Event
- 2009 North Florida Flood Event (DR-1831)
- 2008 Tropical Storm Fay (DR-1785)

A description of the reason for this is included in System and Strategy Implementation of Part II of this report.

Staff identified 66 projects as existing within Tropical Storm Debby's area of impact and complete at the time of the event. These projects are identified in Map 1.

Structure flooded by Tropical Storm Fay and mitigation of the same structure in progress (photos courtesy of Volusia County)

Staff identified twelve projects as existing within the Unnamed June 2012 Flood Event's area of impact and complete at the time of the event. These projects are identified in Maps 2 and 3. Five of these same projects were also assessed for losses avoided during Tropical Storm Debby.

Staff identified four projects as existing within the North Florida Flood Event of spring 2009's area of impact and complete at the time of the event. These projects are identified in Map 4.

Staff identified six projects as existing within Tropical Storm Fay's area of impact and complete at the time of the event. These projects are identified in Map 5. One of these projects was also assessed for losses avoided during Tropical Storm Debby.

Eighty two (56%) of the 146 projects assessed had sites within the damage swath of, and were complete by, at least one event.

Staff members have successfully gathered event data for 75 of these 82 projects.[12] Phone calls have been made to counties requesting information regarding the remaining projects, but this information has yet to be received by the time of this report. Nevertheless, this information can easily be added to subsequent reports, due to the manner in which results are presented (Net Present Value, see Definitions).

Of the 75 projects assessed, analysts determined that 50 include sites that meet the impact threshold to have received damage without mitigation for the events. The return interval for the impact to such sites was almost always above the 2 year event.

Appendix A depicts the projects (by county) for which data was gathered, along with the events for which they were eligible for assessment.

[12] The event data collection process for this assessment is included in Part II of this report.

## Loss Avoidance Results

Results are reported as losses avoided, net present value, and return on investment in 2012 dollars using the Relative Share of GDP method of cost normalization (see Definitions).[13]

Aggregate values for the fifty projects for which analysts assessed losses avoided (in 2012 dollars) are as follows:

$18,990,019.62 in flood mitigation **project costs**.

$21,991,852.12 in **losses** that are **expected** to have occurred **without the mitigation projects** in place (losses avoided).

$3,001,832.50 in **actual costs avoided** (losses avoided minus project costs), also known as the net present value of these flood mitigation projects.

The overall **return on investment** for projects evaluated in the state of Florida is currently 116%.

This is especially impressive considering that 13 (26%) of the 50 projects assessed were completed in 2012 and 32 (64%) have only been completed since 2011.

In addition, most project sites were impacted by only one of the four events assessed to date.

Results vary based on the number of events evaluated for each project (provided in Appendix A), extent of expected impact (represented in the Project Calculations Sheets provided in Appendix B), and the resulting losses avoided.

- The results show that the projects assessed in this study have already demonstrated a positive return on investment.

Losses avoided have exceeded the project costs invested and provided additional benefit to the state valued at approximately $3 million dollars (net present value). As additional events impact these project sites, losses avoided, net present value, and the return on investment will increase substantially.

Table 3 provides a summary of losses avoided for the State of Florida. This table summarizes losses avoided for those analyzed projects with sites that received impacts sufficient that damage would have occurred without mitigation. Values are provided in 2012 dollars using the Relative Share of GDP Cost Normalization Method.

*Results show that the projects assessed in this study have demonstrated a positive return on investment, in the majority of cases, after one event.*

Table 4 identifies counties that contain project sites impacted by at least one of the four assessed events. This table summarizes losses avoided by county for those analyzed projects with sites that received impacts sufficient that damage would have occurred without mitigation. Values are provided in 2012 dollars using the Relative Share of GDP Cost Normalization Method. Return on investment in each county varies widely and is largely dependent upon the extent of impact to the project sites. For example, an acquisition site which received three feet of flooding would have avoided more loss than a site which received only one foot of flooding.

This table shows that the highest current return on investment for the projects and events evaluated is in Duval County at 220%. All but one of the projects in Duval has been completed since April 2011. This is a relatively high rate of return in terms of losses avoided in a short period of time. Tropical Storm Debby impacted the county with 50 and 100 precipitation return intervals and several projects received impacts from more than one event assessed.

The lowest rate of return county-wide, in terms of losses avoided, was 20%. Nevertheless, this project only received impact from one event and at a ten year return interval. The figure demonstrates that the project can be expected to yield a positive return within its life-span.

For detailed results of losses avoided by project, please refer to Appendices A and B.

[13] The Loss Avoidance Calculator provides results using three different methods of cost normalization. These methods are detailed in the Loss Avoidance System and Strategy.

Table 1 Summary of Projects Reviewed by Type (Current Dollars)

| Project type | # Projects | # Benefitting Structures | Total Cost | Per Structure Cost |
|---|---|---|---|---|
| **Acquisition** | 48 | 98 | $20,995,405.44 | $214,238.83 |
| **Drainage** | 60 | 10401[11] | $58,048,072.75 | $5,577.79 |
| **Elevation** | 20 | 22 | $5,841,037.81 | $265,501.72 |
| **Flood-proofing** | 3 | 3 | $243,365.00 | $81,121.67 |
| **Mit. Reconstruction** | 4 | 4 | $810,709.37 | $202,677.34 |
| **Second Story Conversion** | 3 | 3 | $798,331.62 | $266,110.54 |
| ***Special Projects*** | *9* | *1* | *$5,196,321.80* | - |
| ***Totals*** | ***146*** | ***10532*** | ***$91,933,243.79*** | ****$8,231.82*** |

* Figure does not include special projects

Table 2 Summary of Structures (by Occupancy) Benefitting from Flood Mitigation Projects Reviewed (Current Dollars)

| Occupancy | # Structures | Total Cost | Per Structure Cost |
|---|---|---|---|
| **Agricultural** | 8 | $61,877.49 | $7,734.69 |
| **Commercial** | 579 | $10,779,200.15 | $18,616.93 |
| **Educational** | 4 | $307,115.36 | $76,778.84 |
| **Government** | 34 | $2,274,806.58 | $66,906.08 |
| **Industrial** | 24 | $683,263.98 | $28,469.33 |
| **Religious** | 42 | $1,210,653.07 | $28,825.07 |
| **Residential** | 9841 | $64,963,652.19 | $6,601.33 |
| ***Non-Building Infrastructure*** | *15* | *$11,652,674.98* | *$832,333.93* |

Figure 1 Occupancy Types of Structures Benefitting from Flood Mitigation Projects in Florida

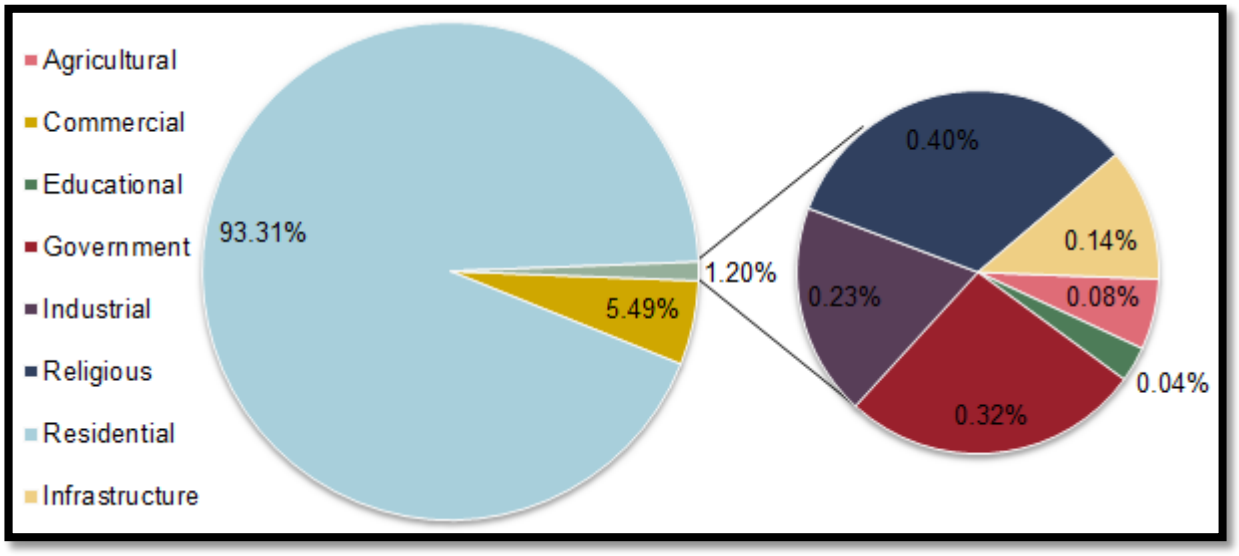
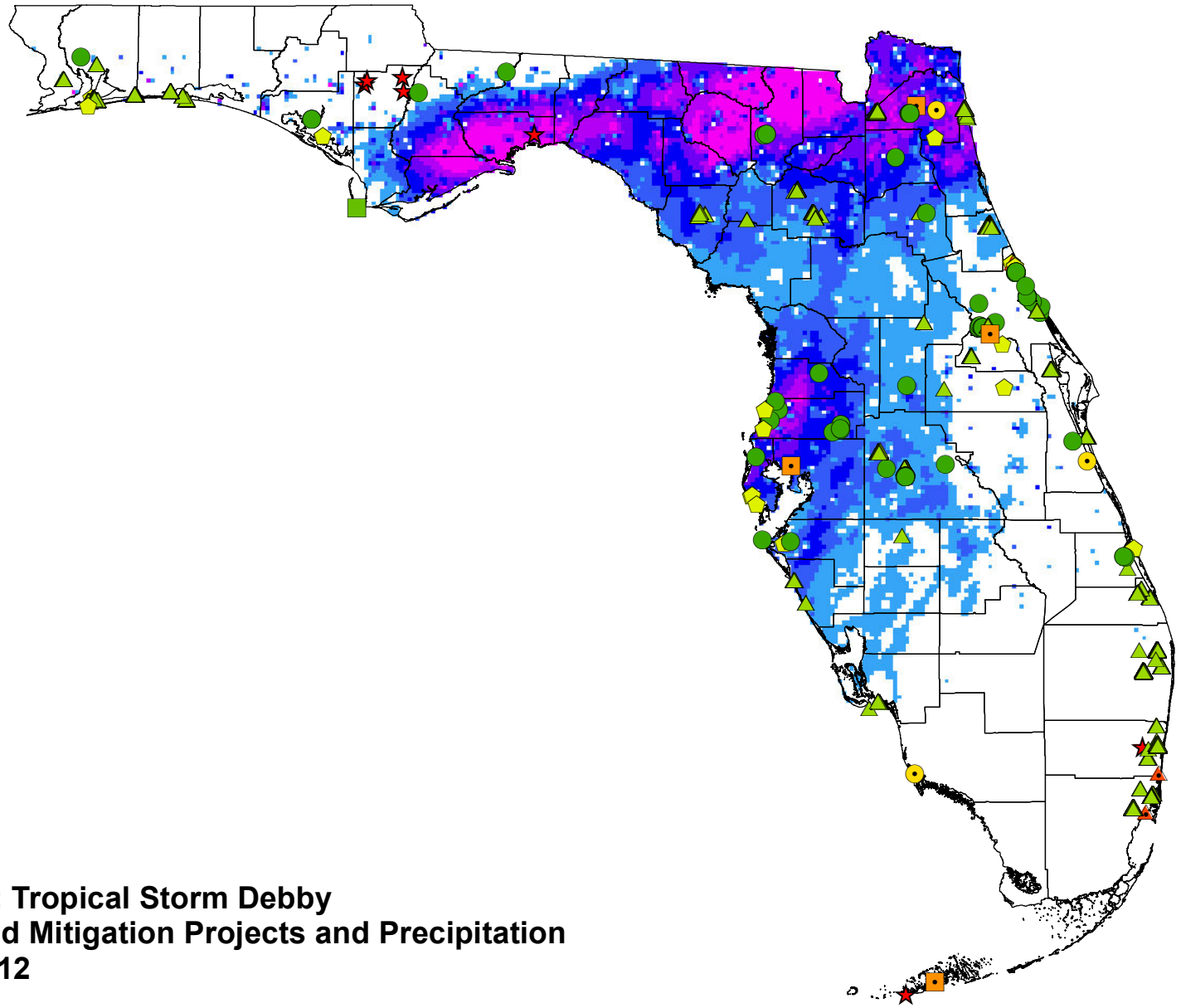


Table 3: Summary of Losses Avoided in 2012 Dollars, State of Florida, 2012

| Impacted Projects | Project Costs | Losses Avoided | Net Present Value | Return on Investment |
|---|---|---|---|---|
| **50** | $18,990,019.62 | $21,991,852.12 | $3,001,832.50 | 116% |

Table 4: Losses Avoided in 2012 Dollars, Results by County with Project Sites Impacted, 2012

| County | # Projects Impacted | Total Project Cost | Total Losses Avoided | Net Present Value | ROI |
|---|---|---|---|---|---|
| Alachua | 4 | $525,039.19 | $193,366.50 | -$331,672.69 | 37% |
| Bay | 3 | TBD | TBD | TBD | TBD |
| Broward | 1 | TBD | TBD | TBD | TBD |
| Clay | 1 | $269,024.09 | $57,519.17 | -$211,504.92 | 21% |
| Columbia | 1 (3 sites) | $220,474.69 | $148,544.76 | -$71,929.93 | 67% |
| Dixie | 1 | $1,145,241.53 | $232,791.30 | -$912,450.23 | 20% |
| Duval | 12 (14 sites) | $4,730,015.05 | $10,390,364.30 | $5,660,349.25 | 220% |
| Escambia | 2 (1 TBD) | $169,529.36 | $44,044.02 | -$125,485.34 | 26% |
| Flagler | 1 | $208,934.61 | $43,001.35 | -$165,933.26 | 21% |
| Gilchrist | 1 | $227,239.42 | $304,864.06 | $77,624.64 | 134% |
| Hillsborough | 1 | $175,585.00 | $74,937.55 | -$100,647.45 | 43% |
| Lake | 1 | $224,137.00 | $111,293.67 | -$112,843.33 | 50% |
| Lee | 1 | TBD | TBD | TBD | TBD |
| Okaloosa | 1 | TBD | TBD | TBD | TBD |
| Orange | 1 | TBD | TBD | TBD | TBD |
| Pasco | 1 | TBD | TBD | TBD | TBD |
| Pinellas | 6 | $1,762,893.61 | $417,526.12 | -$1,345,367.49 | 24% |
| Polk | 4 | $1,812,209.34 | $2,249,964.47 | $437,755.13 | 124% |
| Putnam | 2 | $392,114.36 | $643,778.65 | $251,664.29 | 164% |
| Santa Rosa | 7 | $4,411,043.25 | $4,846,572.36 | $435,529.11 | 110% |
| Sarasota | 2 | $1,666,183.00 | $686,012.57 | -$980,170.43 | 41% |
| Seminole | 1 | $616,367.56 | $1,186,846.04 | $570,478.48 | 193% |
| Volusia | 1 | $315,171.79 | $106,788.16 | -$208,383.63 | 34% |
| Wakulla | 1 | $118,816.77 | $253,637.07 | $134,820.30 | 213% |



# Map 1

## State of Florida: Tropical Storm Debby
## Completed Flood Mitigation Projects and Precipitation
## June 23 - 27, 2012

**Precipitation**

≤ 6" | 6.1" - 8" | 8.1" - 10" | 10.1" - 12" | 12.1" - 14" | 14.1" - 16" | ≥ 16.1"

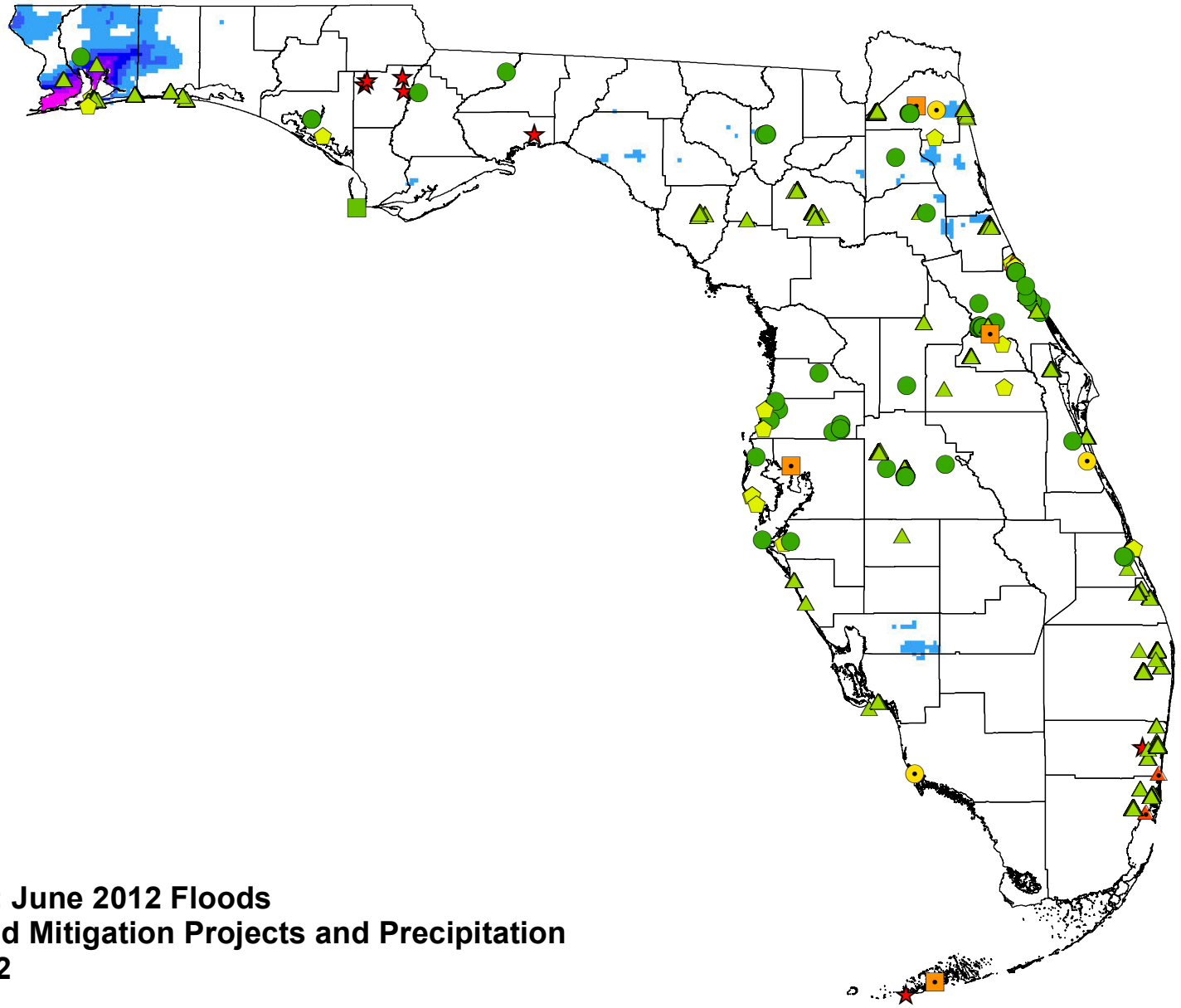
**Project Type**

- Acquisition
- Barrier Installation
- Drainage
- Elevation
- Flood-Proofing
- Miitgation Reconstruction
- Second Story Conversion
- Special/Unique

Note:
Map is for reference purposes only. Data obtained from the Florida Division of Emergency Management, the U.S. Census Bureau, and the National Weather Service.

0 50 100 200 Miles

N W E S



# Map 2

## State of Florida: June 2012 Floods
## Completed Flood Mitigation Projects and Precipitation
## June 8 - 11, 2012

**Precipitation**

≤ 6" | 6.1" - 8" | 8.1" - 10" | 10.1" - 12" | 12.1" - 14" | 14.1" - 16" | ≥ 16.1"

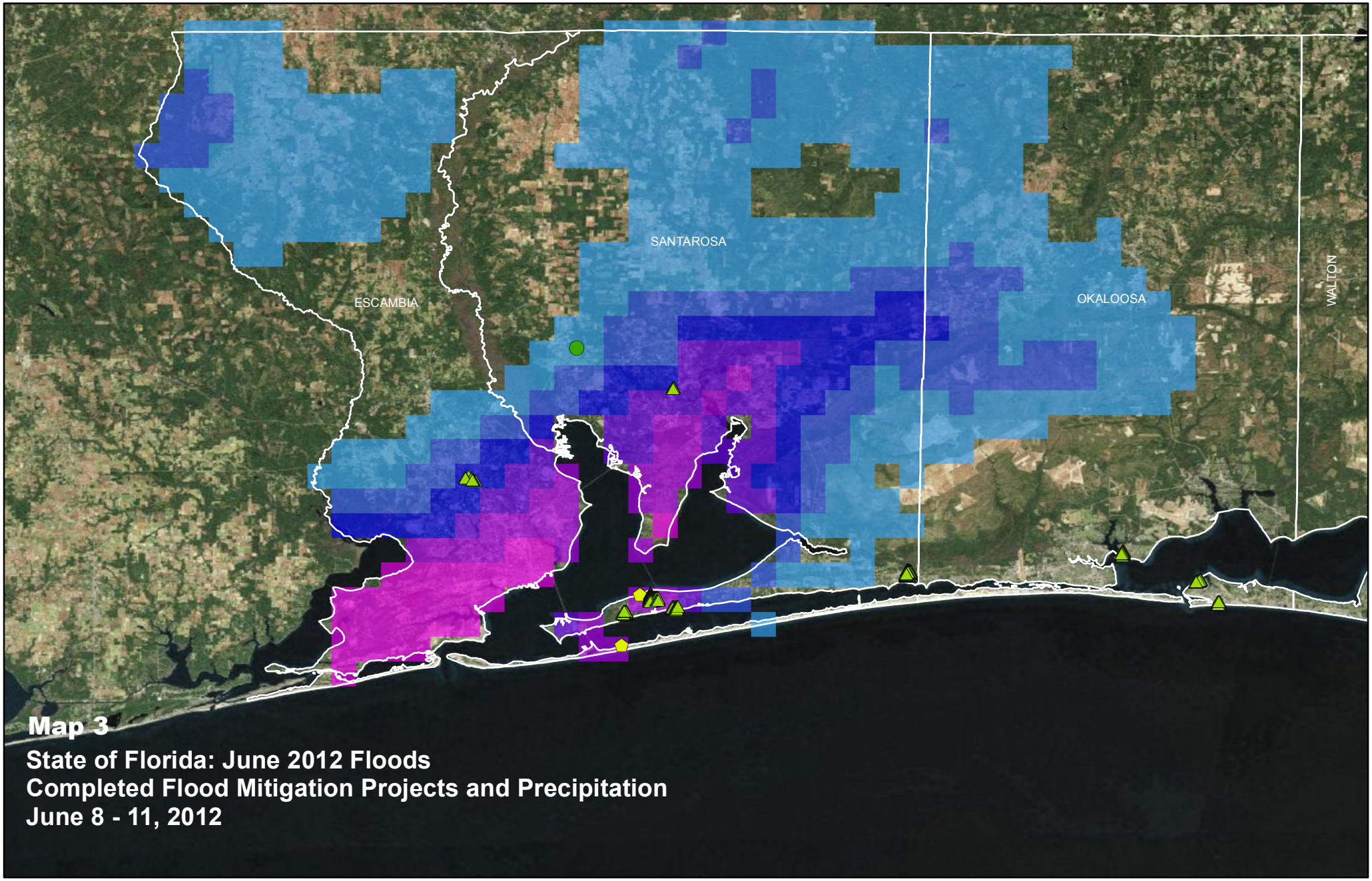
**Project Type**

- Acquisition
- Barrier Installation
- Drainage
- Elevation
- Flood-Proofing
- Miitgation Reconstruction
- Second Story Conversion
- Special/Unique

Note:
Map is for reference purposes only. Data obtained from the Florida Division of Emergency Management, the U.S. Census Bureau, and the National Weather Service.

0 50 100 200 Miles

N W E S




**Map 3**

**State of Florida: June 2012 Floods**
**Completed Flood Mitigation Projects and Precipitation**
**June 8 - 11, 2012**

## Precipitation

≤ 6"
6.1" - 8"
8.1" - 10"
10.1" - 12"
12.1" - 14"
14.1" - 16"
≥ 16.1"

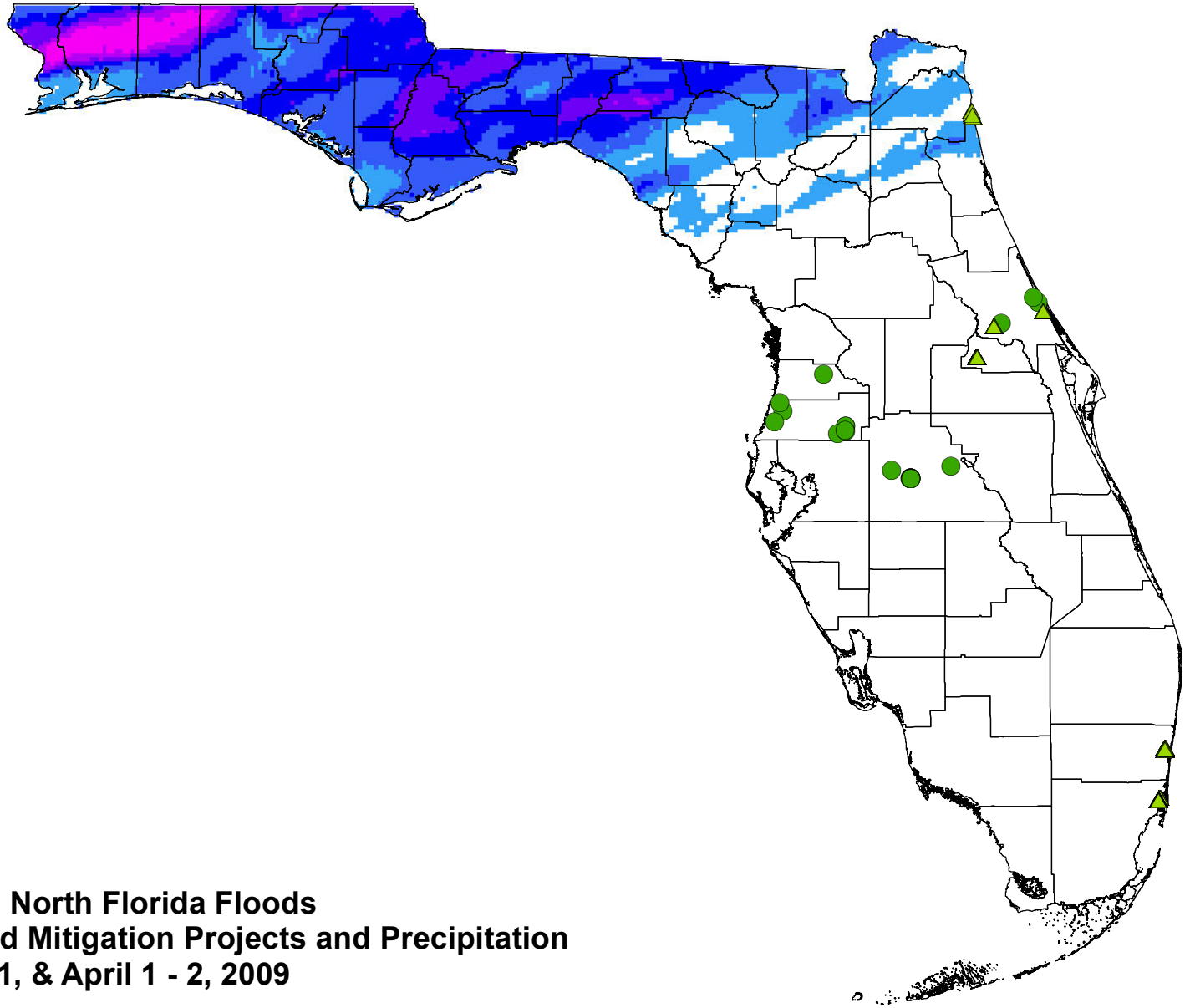
## Project Type

- Acquisition
- Barrier Installation
- Drainage
- Elevation
- Flood-Proofing
- Miitgation Reconstruction
- Second Story Conversion
- Special/Unique

Note:
Map is for reference purposes only. Data obtained from the Florida Division of Emergency Management, the U.S. Census Bureau, and the National Weather Service.

0 5 10 20 Miles

N
W E
S



## Map 4

**State of Florida: North Florida Floods**
**Completed Flood Mitigation Projects and Precipitation**
**March 26 - 28, 31, & April 1 - 2, 2009**

**Precipitation**

≤ 6" | 6.1" - 8" | 8.1" - 10" | 10.1" - 12" | 12.1" - 14" | 14.1" - 16" | ≥ 16.1"

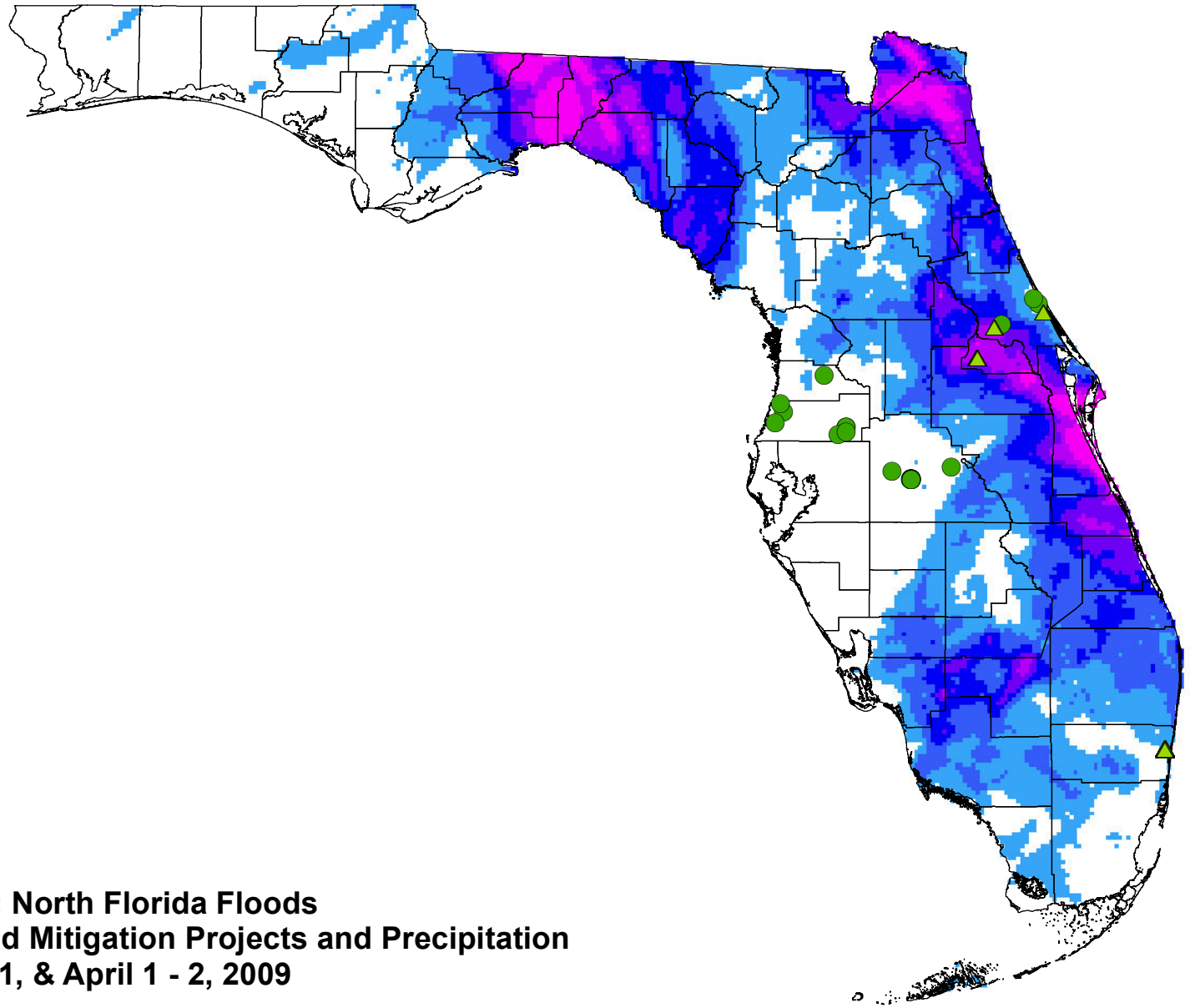
**Project Type**

- Acquisition
- Barrier Installation
- Drainage
- Elevation
- Flood-Proofing
- Miitgation Reconstruction
- Second Story Conversion
- Special/Unique

Note:
Map is for reference purposes only. Data obtained from the Florida Division of Emergency Management, the U.S. Census Bureau, and the National Weather Service.

0 50 100 200 Miles

N W E S



## Map 5

**State of Florida: North Florida Floods**
**Completed Flood Mitigation Projects and Precipitation**
**March 26 - 28, 31, & April 1 - 2, 2009**

**Precipitation**

≤ 6" | 6.1" - 8" | 8.1" - 10" | 10.1" - 12" | 12.1" - 14" | 14.1" - 16" | ≥ 16.1"

**Project Type**

- Acquisition
- Barrier Installation
- Drainage
- Elevation
- Flood-Proofing
- Miitgation Reconstruction
- Second Story Conversion
- Special/Unique

Note:
Map is for reference purposes only. Data obtained from the Florida Division of Emergency Management, the U.S. Census Bureau, and the National Weather Service.

0 50 100 200 Miles

N W E S

# Project Highlights

Throughout the loss avoidance assessment process, analysts identified mitigation actions which were exemplary. It is hoped that project highlights, provided within each loss avoidance assessment to be completed by the State of Florida, will help provide practical guidance to jurisdictions for hazard mitigation efforts.

## City of Lakeland, Polk County - Basin A, B, & C - Stormwater Collection System

- The City of Lakeland used mitigation funding to maximize benefits to many structures.

This mitigation action involved the use of multiple projects (HMGP 1539-076, 1539-088, 1539-127, and 1539-128) to benefit a greater area in the City of Lakeland in Polk County (Map 6). The area was experiencing localized flooding that caused damage to many structures. The scope of work for the projects was to install an improved stormwater collection system consisting of manholes, inlets and pipes, a stormwater detention pond, and rubble lined drainage ditch.

Rather than mitigating single structures, the City of Lakeland selected an approach that would be more cost effective. The same project cost for acquisition and elevations would have mitigated losses for only a few structures, and left many in the area still vulnerable to flooding. For much less of an investment, the City of Lakeland opted for an area-wide drainage project which would mitigate approximately 1,215 structures (Map 6).

No flooding or losses have occurred since project completion in the spring of 2011, including from Tropical Storm Debby.

The City of Lakeland is confident that work associated with these combined projects prevented flooding that might have occurred and is satisfied with the results.

Losses avoided are estimated at $2.1 million dollars as a result of Tropical Storm Debby for these four projects.

## Gulf Breeze, Santa Rosa County - Tiger Point Subdivision Drainage Projects

- The City of Gulf Breeze combined multiple projects for a “whole neighborhood” approach to mitigation.

Another instance of combining multiple mitigation projects to benefit a specific area is HMGP 1551-26 and 1551-28. These two projects consisted of improving the drainage within the Tiger Point Subdivision, which was experiencing flooding after significant precipitation events. Project 1551-26 improved the drainage along Sabertooth Circle, constructing additional piping, inlets, concrete curbs, outfalls and roadway resurfacing. Project 1551-28 added a littoral shelf to the ponds, improved interconnectivity of the ponds and constructed additional outfall structure. Both projects were designed to provide protection up to 100-year storm event.

These two projects took a “whole neighborhood” approach to mitigation by working in conjunction to mitigate a specific area and benefit 80 structures in total (Map 7).

Although not affected by Tropical Storm Debby, the unnamed June 2012 flood event was a true test of design for these two projects.

The project area received over thirteen inches of precipitation during this two day event and performed flawlessly.

County engineers confirmed that these projects preformed as designed and, as a result, no structural flooding occurred.

Losses avoided are estimated at $1.1 million dollars as a result of the unnamed June 2012 flood event for these two projects.

## City of Jacksonville (Duval) Hood Landing Elevation Project

- The City of Jacksonville preserves the character of a local cultural highlight and prevents further losses.

This project was funded through FEMA's Flood Mitigation Assistance Program (project FMA-PJ-04-FL-2007-016). According to the respondent, Clark's Fish Camp had experienced 10 loss claims prior to the mitigation project application. Claims were all pertaining to loss of contents, including food and beverage because the structure provided no alternative to storing perishables at a place other than ground level. The mitigation efforts afforded the owner a new elevated space to store perishables above the flood waters. The effort preserved the character of the structure and business, but prevented further content loss.

Due to the fact that this project was an elevation, access to the facility was not mitigated, as visible in the image below. Nevertheless, the project functioned as intended despite substantial flooding by Tropical Storm Debby and the facility experienced no further losses.

This project has experienced a 33% return on investment in less than one year since implementation.

Flooding came within one foot of Clark's Fish Camp, but no losses occurred (photo courtesy of City of Jacksonville).

Pre-mitigation image of project site for FMA-PJ-04-FL-2008-001 (photo courtesy of State of Florida).

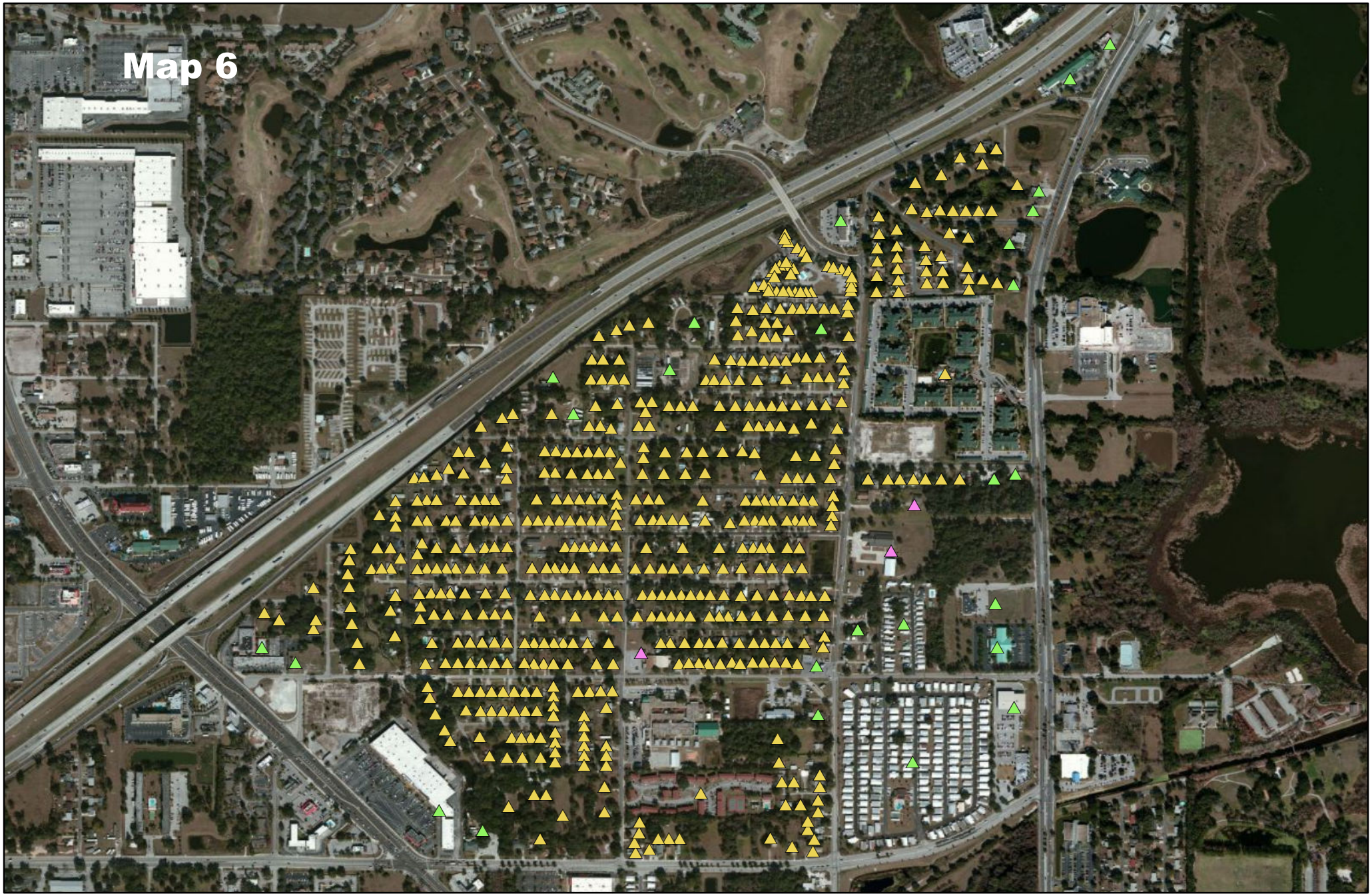
## City of Jacksonville Dongalla Court Flood Proofing Project

- City of Jacksonville prevents further flooding with floodwall.

This project demonstrates an alternative to the more "typical" projects for dealing with flooding, such as acquisitions and elevations.

This unusual project was successful in relieving flooding that would have occurred as a result of Tropical Storm Debby for a fraction of the cost of acquiring the benefitting structure. A pre-project analysis revealed no negative downstream impacts as a result of the project.

Post-mitigation image of project site for FMA-PJ-04-FL-2008-001 (photo courtesy of City of Jacksonville).




**Legend**

- Agricultural
- Commercial
- Educational
- Government
- Hospital
- Industrial
- Institutional
- Residential

**State of Florida**
**Tropical Storm Debby Loss Avoidance Analysis**
**Structures Benefitting from HMGP 1539-076, 1539-088, 1539-127, & 1539-128**
**Lakeland, Polk County**

N

Note: Data obtained from the Florida Division of Emergency Management, ESRI, and the U.S. Census Bureau. This map is for reference purposes only.

0 0.1 0.2 0.4 Miles


**Legend**

- Agricultural
- Commercial
- Educational
- Government
- Hospital
- Industrial
- Institutional
- Residential

**State of Florida**
**Tropical Storm Debby Loss Avoidance Analysis**
**Structures Benefitting from HMGP 1551-026 & 1551-028**
**City of Gulf Breeze, Santa Rosa County**

N

Note: Data obtained from the Florida Division of Emergency Management, ESRI, and the U.S. Census Bureau. This map is for reference purposes only.

0 0.025 0.05 0.1 Miles

# Conclusions

- **Every assessed project performed at or above the designed level of performance.**

No losses were incurred to any structures mitigated through building modification projects nor to any area mitigated through drainage or special projects. Furthermore, losses avoided by county show that mitigation projects are being implemented strategically at the county level, in locations which are proving to be a sound investment. Losses avoided by affected projects in Duval, Gilchrist, Putnam, and Wakulla Counties have exceeded initial project investments and show a positive net present value, in most cases just a year or two following project implementation.

In essence, these results show that the right type of mitigation is occurring in the right location at the local level.

- **Some project types provide more comprehensive mitigation than others.**

Eevations may mitigate flooding to structures, but do not mitigate access issues from flooding. During the events assessed, some elevated structures still encountered access issues, whereas structures mitigated through drainage or acquisition projects did not.

Improved drainage may be the most cost effective way to mitigate flooding in urban settings (aside from preventative actions, such as planning and codes and standards, which are not quantified in this report).

Projects which addressed entire neighborhoods provided greater benefit and per structure cost of mitigation was considerably lower. The average cost of drainage project mitigation per structure is a fraction of the cost for a building modification project (Table 1).

- **A whole neighborhood approach to mitigation is needed for larger areas that flood.**

In multiple cases, counties reported that projects were successful for mitigated structures, but that damages were sustained by many unmitigated structures in the area. This issue is discussed further in Project Highlights and is evidenced by the responses provided by counties documented in Appendix B. Such experiences evidence the benefits of a whole neighborhood approach to mitigation, instead of mitigating just a few structures in an area that regularly floods.

- **The results of this loss avoidance assessment support investment in hazard mitigation projects in Florida.**

The results of this assessment demonstrate cost effectiveness of assessed mitigation projects in the State of Florida for projects completed within a limited period of time (January 2007 through June 2012). The majority of projects (64 percent) were completed since 2011. That projects are providing a return on investment in such a short time period indicates the necessity for further mitigation in the state.

- **The loss avoidance calculator provides instant data to inform political will to further support mitigation across the country.**

States that are serious about mitigation will find ways to incorporate a loss avoidance assessment process into their daily efforts so that, when they experience a disaster (small or large, declared or not), they will be able to substantiate their mitigation efforts in a very short period of time. Florida hopes that the ease of using the calculator and its system and strategy will facilitate widespread and regular loss avoidance assessment.


This house in El Jobean, Florida avoided impact from Tropical Storm Debby (photo courtesy of State Floodplain Management Office). .

# Lessons Learned

The State of Florida identified several lessons learned that will facilitate future loss avoidance assessment. These involve lessons learned during project data collection and event data collection, as well as lessons learned concerning the use and storage of project location information, which affects both project and event data collection and retention.

## Lessons Learned During Project Data Collection

During project data collection, the state first reviewed data housed and collected in the Mitigation Bureau's project database, FloridaMitigation.org. This database had been almost exclusively used for the financial aspects of project management (processing payments, for instance), and less for data collection and retention of mitigation attributes. As a result, analysts determined that much of the information required to conduct a loss avoidance assessment had not been stored in the database. Analysts, therefore, found it necessary to find and review hard copy project files. Several changes have been implemented as a result of this experience.

*An added benefit to using a database is that project data may be easily used for purposes in addition to loss avoidance analyses.*

### n Database Modifications

Florida is implementing changes to ensure that its record-keeping database contains the information required to conduct future loss avoidance assessments.

To this end, data fields are being expanded to include the information identified in the state's Loss Avoidance Assessment System and Strategy and the Bureau is adding drop-down fields to ensure data consistency.

All project data gathered during the course of the Tropical Storm Debby loss avoidance assessment was combined into a single Microsoft Excel spreadsheet. The information in this spreadsheet is being imported into FloridaMitigation.org. As such, all data necessary for future loss avoidance assessment will be safely housed and can be easily accessed in the system. All changes to this system will affect data gathering for currently open and future project grants.

Note: While it's possible to house project data in loss avoidance calculators or in spreadsheets, the state is taking extra steps to ensure that project data is not lost and that data can be easily accessed for purposes in addition to loss avoidance assessment. Such uses may include economic impact analyses, reports to the Governor's Office, the publishing of statistics concerning mitigation projects, and any necessary cost analyses.

The online database, FloridaMitigation.org, will protect data from accidental deletion. Querying features will provide easy access to the information for many purposes.

### n Project Data Collection

Standard operating procedures ensure that data is collected and retained as part of regular project management.

In the future, all mitigation project file data necessary to conduct loss avoidance assessment in Florida will be gathered electronically by project completion. Such activity will add only minutes to project management and will significantly reduce time required for loss avoidance assessment. By completing the preparatory process up front, analysts can focus on event data collection and analysis. Not only is this likely to allow time to enrich the contents of the final report, but such preparation will also help minimize use of staff resources for loss avoidance assessment post-disaster, when demand for such resources are likely to be high for many reasons.

### n Housing Hard Copy Project Files

Prior to this loss avoidance assessment for Tropical Storm Debby, individual project managers housed files using their own system within their offices. The Bureau has since moved completed project files into a secure central location and established a process through which staff must "check-out" a project file.

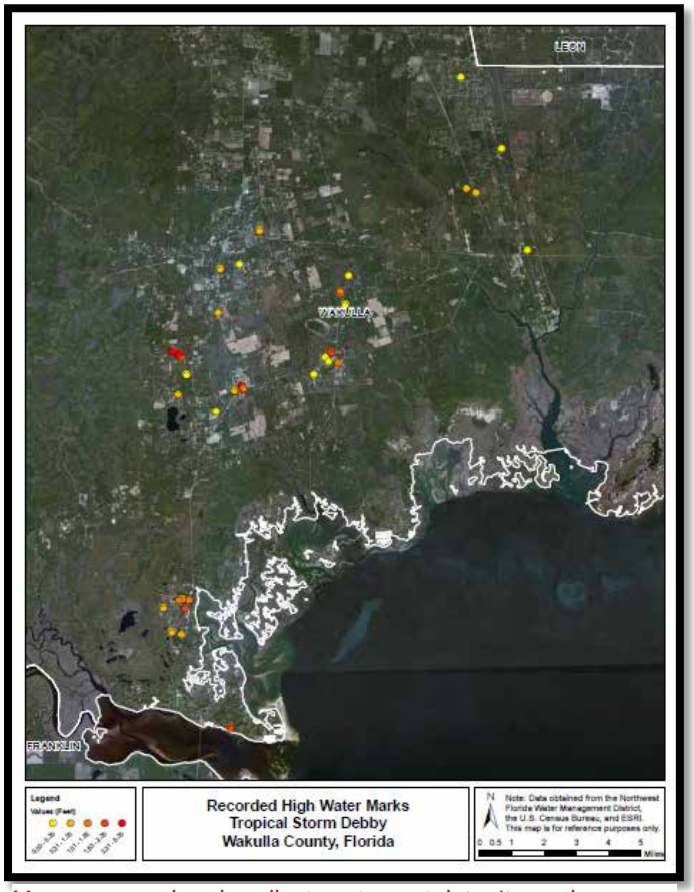
This ensures that the location of any hard-copy project file that may be needed for an assessment is known at all times and can be easily and quickly accessed.

### n Standardized Organization of Project Files

Hard copy project files are managed by project managers who may each have their own methodologies for retaining records. As a result, analysts identified recommendations for project file organization that would facilitate later data confirmation or additional data gathering, as needed. This has been incorporated into the Bureau's standard operating procedures.

## Lessons Learned During Event Data Gathering

Prior to Tropical Storm Debby, the State of Florida had not yet implemented a plan to gather event data necessary to conduct loss avoidance assessment. As a result, the state considered several different options for before settling on a method to gather event information that was both easy to implement and met Florida's purposes. System and Strategy Implementation in Part II of this report explains the decision-making process and practice of the method Florida selected for this loss avoidance assessment. The below identifies lessons learned from this experience.




Many groups already collect post-event data. It may be beneficial for organizations wishing to conduct loss avoidance analyses to integrate this data gathering with post-disaster preliminary damage assessments, high water mark expeditions, or other established activities.

### n Data Gathering Coordination

Many post-event data collection activities already take place in the state of Florida. As such, it makes sense to join loss avoidance data collection efforts to those already in existence.

In the future, Florida will be integrating event data gathering for loss avoidance assessment with other post-disaster activities. In addition, event data gathering will be coordinated with other partners in mitigation, where optimal. Coordination and consolidation may allow organizations to leverage resources and avoid duplicating effort.

Florida's System and Strategy Section C recommends integrating loss avoidance assessment event data gathering with the preliminary damage assessment process.

### n High Water Mark Strike Team

Flood elevations are the most important piece of event data for determining losses avoided to building modification projects; and high water marks are the most accurate way to determine flood elevations. Different groups may use different methods to collect this information. As such, a consistent method is needed in order to provide reliable results for an assessment.

In coordination with the Florida Chapter of the Silver Jackets, and in response to the experiences of gathering event data from Tropical Storm Debby, the Division formed a High Water Mark Strike Team.

This team held its first workshop in October 2012 and has been pursuing partnerships to leverage resources and consolidate data gathering for future flood events.

### n Project Point of Contacts

Project files assessed for this report were up to six years old. As a result, project contact information within the files was often out of date and unreliable. The state fared better by turning to project managers, planners, and floodplain managers who could point analysts to

local contacts with current knowledge of project locations. It is recommended that organizations maintain a regularly updated list of contacts within local jurisdictions. This can be accomplished through regular technical assistance to local jurisdictions.

Project point of contact information for completed projects has been updated as a result of the loss avoidance study.

## Geographic Information Systems (GIS) and Project Locations

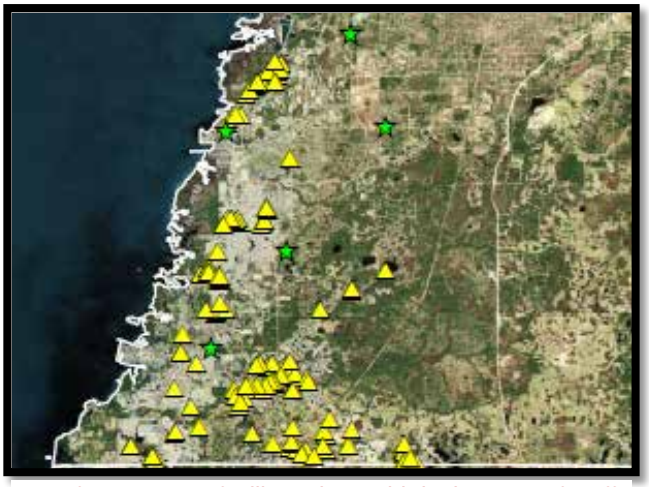
Electronic project data allows the state to make use of Geographic Information Systems (GIS) to aid event data gathering and future project planning.

### n Event Data Gathering

In order to accomplish efficient and effective event data gathering, potentially impacted project sites should be identified as soon as possible and the coordinates / addresses provided to the team gathering data. This is most easily accomplished with programs such as ArcGIS. GIS will allow the state to rapidly run a spatial query and determine which projects were most likely impacted during an event. In addition, ArcGIS allows the state to visually represent the area and structures benefitting from a project. This was useful in determining whether drainage projects were effective during the events reviewed for this assessment.

### n Planning Future Projects

Mapping existing projects in ArcGIS can be useful in planning for future projects. For example, the state can



Use of ArcGIS can facilitate the rapid deployment of staff to project sites to gather event information.

now visually depict what type and where mitigation is taking place throughout Florida. By comparing this information to the statewide Risk Assessment, Florida can easily identify opportunities for technical assistance to areas in need of additional mitigation. Comparing recent event impacts to project locations can also aid the state in identifying potential mitigation opportunities.

Furthermore, knowing where mitigation projects are in relation to known hazard areas coupled with an understanding of current project effectiveness (loss avoidance) will identify where mitigation may be most successfully implemented in the future

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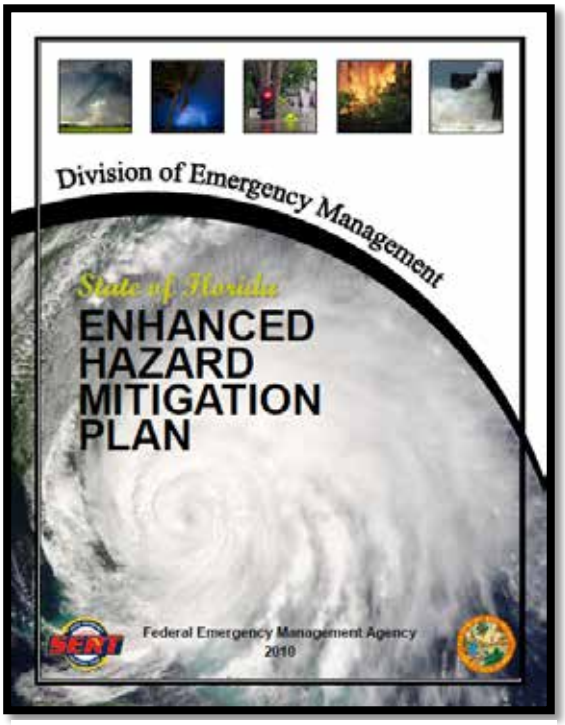
# Part II

- Florida's Loss Avoidance Assessment System and Strategy
- System and Strategy Implementation for Tropical Storm Debby
- Event History

# Florida's Loss Avoidance Assessment System and Strategy

In accordance with 44 CFR 201.5(b)(2)(iv), the State of Florida has developed a system and strategy by which it will conduct an assessment of completed mitigation actions and include a record of the effectiveness (actual cost avoidance) of each mitigation action. This system and strategy, called Loss Avoidance Assessment, is intended to contribute part of the requirements to maintain a FEMA approved Enhanced State Hazard Mitigation Plan (SHMP). States with Enhanced status at the time of a disaster declaration are eligible to receive five percent additional mitigation funding (44 CFR 201.5(a)). This has meant millions of dollars in additional funding for the State of Florida.




Enhanced status has meant millions of dollars in additional funding for the State of Florida.

- Loss avoidance analysis is incentivized by the Federal Government.

The Federal Government, as well as the State of Florida, contributes significant funds to reduce the potential impact of natural disasters. These funds are used to implement mitigation projects that must adhere to specific criteria identified by the programs that administer them, as well as OMB Circulars and Codes of Federal Regulation (CFR).[14] A key criterion involves cost-effectiveness.

Most mitigation proposals are subjected to a benefit-cost analysis (BCA), which is expected to determine the effectiveness of a project based on analysis of probabilistic hazard events. The BCA is completed prior to project funding and prior to project construction, but policy makers have taken interest in mitigation project performance during actual hazard events.

FEMA has developed a quantitative approach to assess the performance of mitigation projects based on actual post-construction hazard events. Policy now incentivizes states to do the same.

- Florida has developed a system and strategy to conduct loss avoidance analyses.

Florida seeks to better understand the fiscal benefits of implementing mitigation actions, as well as receive the additional five percent in Hazard Mitigation Grant Program (HMGP) funding that such analysis will help obtain post-disaster.

The state studied loss avoidance assessment methodologies, past FEMA loss avoidance studies, and other sources to determine methods for streamlining existing processes. This was done so as to identify ways to complete comprehensive analyses using existing staff and without adding significantly to the cost of mitigation. A further

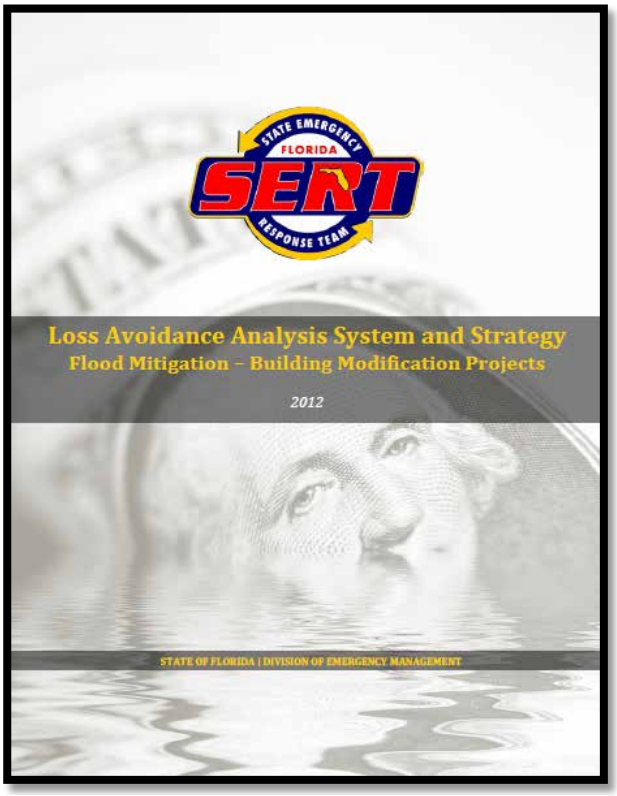

Florida has developed calculators to help conduct loss avoidance assessments.

[14] See the Division's website and Enhanced State Hazard Mitigation Plan for more on these programs at www.floridadisaster.org/mitigation.

*Florida developed a system that could be implemented in-house and shared with other organizations.*

goal was to provide a system that could be shared with other states and local organizations so that they might conduct their own analyses.

To this end, Florida has distilled mathematical calculations and methodologies and developed Loss Avoidance Calculators (LAC) for most project types that mitigate flood and wind hazards. The LAC can use limited or robust data. Losses avoided can be calculated for one event or multiple events and over the life of the project. Thus, in addition to calculating losses avoided by a single project for a single event, Florida may be able to provide the net present value of a mitigation project or the net present value, in investment terms, of all mitigation projects in the State of Florida available for analysis. Such analyses may help guide decision-making and identify best practices.




The System and Strategy is available on the Florida Division of Emergency Management website at www.floridadisaster.org.

Tropical Storm Debby is the first event for which the State of Florida conducted loss avoidance assessment using its new system and strategy for flood mitigation projects, completed in 2011. Guidance to use this system and strategy is provided by project type on the Florida Division of Emergency Management's website. This guidance consists of the following sections:

Section A System and Strategy Overview: Provides a basic outline of the process and an introduction to the guide.

Section B Project Record Keeping and Data Needs: This section provides recommendations for preparing for loss avoidance assessment and outlines project record-keeping and data needs.

Section C Event Data Collection and Processing: This section identifies event data needs and recommended methods for obtaining that data.

Section D Loss Avoidance Calculator User Guide: This section contains the user guide for the Loss Avoidance Calculator version 1.0 for the appropriate project type. The calculator is what provides losses avoided based on the analyst's inputs.

Section E Technical Details: This section includes technical details regarding computation of quantitative impacts, losses avoided, return on investment, and sources used to develop the system and strategy.

Loss Avoidance Calculator: The current LACs (Version 1.0) for flood mitigation projects operate within Microsoft Excel 2007 and 2010. This platform was chosen because it can be quickly and easily adapted, stored, and transferred to other users. The State of Florida is making the calculator available to other states, as well as local and regional entities, so that they may also substantiate the value of mitigation in their communities.

# System and Strategy Implementation for Tropical Storm Debby

This section will discuss how Florida's System and Strategy has been implemented for Tropical Storm Debby, lessons learned, and best practices. This section refers to the System and Strategy, which is posted on the Division's website, where more detailed explanations may be found.

There are two sets of data that must be collected in order to complete a loss avoidance assessment:

- Project data
- Event data

## Preparing for Loss Avoidance Assessment

Florida refers to project data collection as the loss avoidance preparatory process. This is due to the fact that once data is gathered and stored for a particular project; it need not be gathered again for any subsequent loss avoidance assessment.[15]

### The Importance of Project Data Record-Keeping

In order to conduct loss avoidance assessment quickly and efficiently, project data must be gathered and stored in an accessible format (preferably electronic). The preparatory process may be completed all at once or for each project as it is completed.[16] In any case, with electronic record-keeping, the preparatory process need only be completed once for each project. Furthermore, electronic project data is useful for cost analyses, employment impact analyses, as well as many other potential studies and uses that are simply not feasible otherwise.

*Project data collection should be completed before loss avoidance assessments are initiated.*

[15] Detailed guidance regarding the loss avoidance preparatory process is provided in Section B of Florida's System and Strategy. In addition, should organizations encounter situations in which project files are incomplete, Section B of Florida's System and Strategy provides some methods of working within a limited data context.

[16] Projects should only be included in a loss avoidance analysis if they were complete at the time of the event to be analyzed.

The State of Florida intended to begin the loss avoidance assessment preparatory process in the fall of 2012. Electronic project record-keeping was still in its early stages prior to Tropical Storm Debby; most project files were in hard copy format split between two offices. When Tropical Storm Debby struck, however, the State had to move forward with project and event data gathering simultaneously in order to complete a Loss Avoidance Assessment for the event.

Florida plans to collect project data needed for future loss avoidance analyses as or before projects are completed. It is, therefore, expected that such a scale of project data gathering will not be needed again. As such, this particular process will not be described in subsequent reports.

### Project Data Gathering for the Tropical Storm Debby Report

Analysts reviewed all available flood mitigation projects in the State of Florida for potential inclusion in this loss avoidance assessment. Flood mitigation projects include building modification projects, drainage projects, and special projects.

The steps below outline the process used to gather the required project data identified in Section B of Florida's loss avoidance guide and may be helpful for other organizations that intend to begin the data collection process for the first time.

1. Analysts obtained a spreadsheet from FEMA that contained projects in process or had been completed by the state. This list was cross-referenced with state documentation to ensure that all completed projects were properly identified. Only projects complete at the time of an event may be used in that event's loss avoidance analysis.
2. Analysts reviewed Florida's existing electronic record-keeping system and determined that hard copy project files would also need to be reviewed.

*146 projects were analyzed after Tropical Storm Debby.*

3. Analysts developed a simple spreadsheet with headings to represent file data necessary to conduct loss avoidance assessments (See Section B Project Record-Keeping and Data Needs from Florida's System and Strategy). This spreadsheet included drop down boxes and rules regarding the manner in which data could be entered in order to ensure data uniformity.
4. Hard copy project files were moved to a central location. Project files for projects still open in the year 2007 and onward were most likely available for data gathering. Analysts combed the files for data, entered the data into spreadsheets, and combined the spreadsheets into a master file.
5. Secondary analysts reviewed the material for completeness and accuracy.

Almost one hundred fifty flood mitigation projects, which together benefitted over 10,500 structures, were assessed for this report.

*Missing Project Data*

In some cases, project files were incomplete or certain pieces of necessary data were missing. In these cases, the methods suggested in Section B of Florida's guide were used to obtain the missing information.

*Confirming Coordinates*

The process for confirming project locations differed based on whether the project was of the building modification or drainage / special project types.

Coordinates for each mitigated structure were extracted from the final inspection report in the project file. Although coordinates are also provided in the project application, this document was selected as the primary source for location information because a consistent process gathered coordinates from the project site, thus improving data authority.

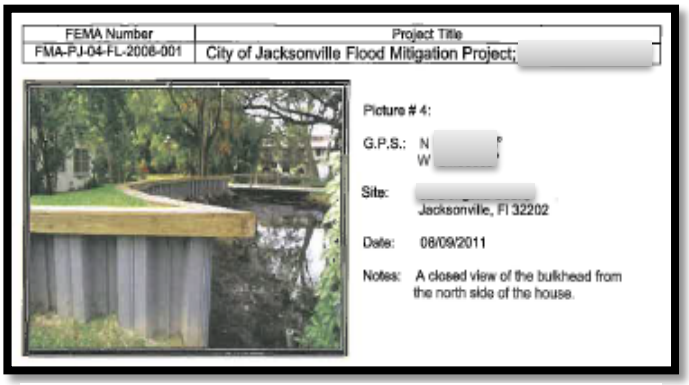
Analysts first performed a high level review using ArcGIS to determine what level of coordinate authentication would be required. For instance, project site location points which landed in water or far outside of the county within which their respective projects were funded alerted analysts to the need to confirm project site locations. Results of this high level analysis indicated that more thorough location confirmation methods would be needed.

Building Modification Projects

To confirm coordinates for building modification projects, analysts obtained addresses for each location during the data gathering phase. Analysts imported addresses into a tool that converts them into location coordinates.

Analysts plotted these coordinates for each address in ArcGIS for comparison. In instances where coordinates in the project file were clearly incorrect, the original coordinates were replaced in the master spreadsheet. Analysts adjusted coordinates for 46 of the 132 structures evaluated (35%).

Florida is in the process of obtaining better technology for capturing site coordinates during final inspection.




Coordinates for each mitigated structure were extracted from the final inspection report in the project file.

Analysts adjusted coordinates for structures identified in building modification project files.

Drainage and Special Project Coordinates

Analysts determined coordinates for each structure expected to benefit from a particular drainage or special project. These structures are identified in project applications. Analysts used the stated project description and location, as well as any supporting documentation, such as maps and "as-built" plans.

Using cadastral data from the Florida Department of Revenue, analysts selected parcels within each project area in ArcGIS. To represent the location of the structure located on each parcel, the center point of the parcel was calculated using an ArcGIS tool. Once the center point for each parcel in the project area had been determined, coordinates for this point were calculated in ArcGIS. Maps of each drainage or special project are included in Appendix B along with other project-specific documentation.

Analysts identified 10,406 structures that are expected to benefit from the 60 drainage projects evaluated.

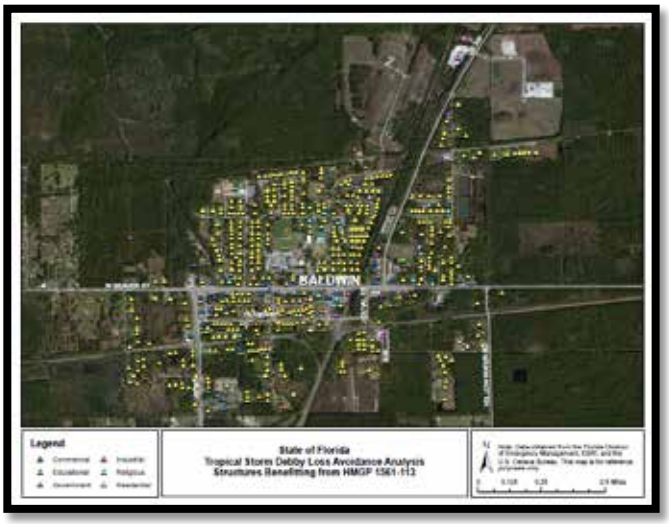
For the eight special projects evaluated, analysts identified location coordinates. These projects often benefitted infrastructure, such as a roadway, pier, or bridge.

## Event Data Collection

The second half of data required for loss avoidance assessment is only available after the event itself. Event data paints a picture of the event's impact to the project area (e.g., rainfall, flood depth) and the project's performance, or success, during the event. Data needs and the various methods to gather this data are outlined in Section C Event Data Collection and Processing of Florida's System and Strategy.

At the time Tropical Storm Debby hit, the Division had not yet implemented a strategy to collect impact data at mitigation project sites (see Lessons Learned in Part I of this report). Florida's first approach following Debby was to consider relying upon data collected by other partners in mitigation. Some of the state's water management districts, as well as several counties, generously provided data. Unfortunately, when this information was cross-referenced with the locations of mitigation project sites being evaluated, analysts determined that high water marks were often too distant for easy use.

Florida next considered using various modeling methodologies (see Section C Event Data Collection and Processing of Florida's System and Strategy). Analysts added rain gauge data, precipitation data, and other event information to that already received.




Analysts confirmed the locations of structures identified in the project file as benefitting from each drainage / special project.

*As a result of interviews, Florida decided to also analyze impacts from several other recent flood events.*

High water marks were collected and generously provided by some of Florida's Water Management Districts (photo courtesy of the Northwest Florida Water Management District)

The Division would like to ensure that any activities used to conduct this first loss avoidance assessment using the new system and strategy could be easily replicated by existing staff, as well as other organizations that may wish to conduct loss avoidance assessments. As such, the decision was made to abandon methodologies reliant upon sophisticated modeling techniques in favor of a more simplistic and easily replicated approach, with a broader range of potential benefits.

Florida ultimately decided to conduct interviews with local mitigation partners to supplement event data already collected.

Analysts developed a questionnaire to obtain information about the event's impact to each project site and project performance. This questionnaire is provided in Appendix D.

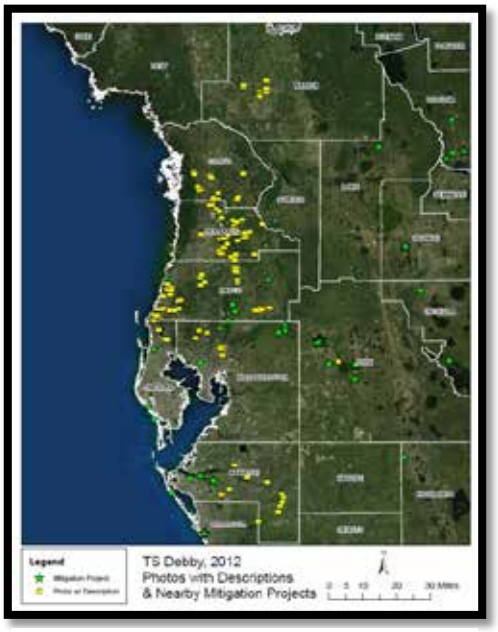
### The Benefits of Interviewing Local Partners

Florida quickly discovered the unique benefits associated with working through local partners to obtain event information.

- Locals understand what works and does not work for their communities and are valuable in identifying best practices.
- Locals often have frontline knowledge of project performance, not just for the event in question, but through the life of the project.
- While presumably not as accurate as high water marks, interviews with locals were able to provide much needed quantitative data in the form of estimated flood depths.
- Several local partners provided qualitative data in the form of homeowner testimonials, photographs of project performance, and other content rich with information that would not have been obtained otherwise.

In fact, as a result of the state's experience with local partners, Florida decided to also analyze impacts from the following events which have occurred since 2007:

- 2012 June Unnamed Flood Event
- 2009 North Florida Flood Event (DR-1831)
- 2008 Tropical Storm Fay (DR-1785)




Event data collected by other agencies or local partners in mitigation, while incredibly useful for other purposes, often did not coincide with the location of completed mitigation projects.

Local partners were able to provide photographs of Tropical Storm Debby's impact, such as this sinkhole, along with personal knowledge of project performance (photo courtesy of City of Live Oak).

## A System for Interviewing Local Partners

In order to efficiently gather event information through interviews with local partners, analysts needed a systematic approach. Not every county in the state of Florida was part of Tropical Storm Debby's presidential declaration. In addition, it is not realistic to expect that the only impacts experienced were within declared counties. As such, analysts used a two pronged approach to conduct information gathering phone calls.

1. Calls were made for every project in a declared county.
2. Projects outside of declared counties were considered based on the likelihood that their sites were impacted by Tropical Storm Debby.

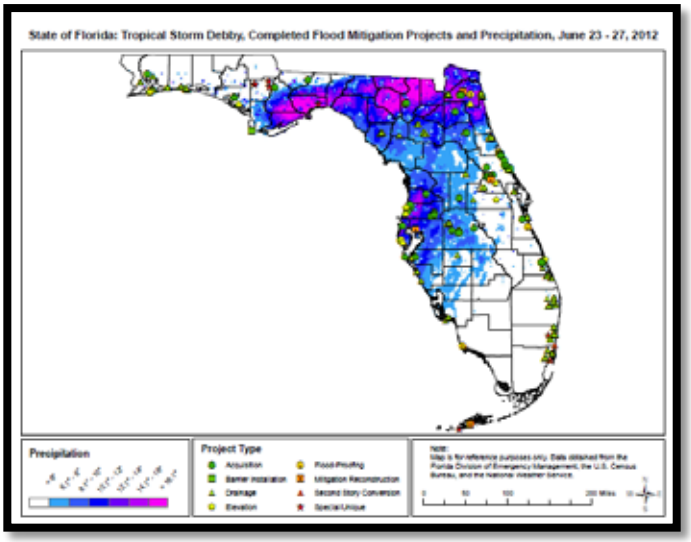
Analysts used precipitation and stream gauge data provided by the National Weather Service's Advanced Hydrologic Prediction Service to identify project sites which could have been impacted by the storm. Analysts based a presumption of impact on the two year return interval and greater. The two year return interval was selected because several projects were implemented to mitigate historical impacts as low as the two year return interval.

Analysts identified return intervals through a spreadsheet comparison of rainfall to Intensity-Duration-Frequency curves provided by Florida's Department of Transportation. This typically resulted in phone calls being made for project sites which received greater than six inches of rain from June 23 through 27, 2012.

As staff proceeded to speak with local experts concerning the impact to and performance of the mitigation projects, it became clear that the state may be able to also conduct loss avoidance assessment for past events within the life of the projects being analyzed. Analysts gathered precipitation data for Tropical Storm Fay (2008), the North Florida Flood Event of 2009, and the June 2012 flood event which occurred just prior to Tropical Storm Debby. Calls were made following the same system described above with the added criterion that the project completion date be prior to the date of the event in question.

In all, 83 flood projects were complete and contained sites within the area of impact of at least one of the four events analyzed. Six of these 83 projects were actually located within the area of impact of two events analyzed.

Many other project sites were within the area of impacts of the events, but were not complete at the time. Appendix B provides individual reports for the projects analyzed.




Precipitation and stream gauge data guided Florida in determining which project sites may have been impacted and, hence, which local partners should be contacted.

## Calculating Losses Avoided

Analysts entered project data and information into the calculators according to instructions provided in the appropriate Loss Avoidance Assessment System and Strategy.

It is important to note that, for building modification projects, analysts conducted a separate assessment for each project site. This is due to the fact that locations may be impacted differently by the same event.

Analysts used the historical losses methodology and calculators to conduct the assessment for drainage and special projects. Detail concerning this methodology is provided in Florida's Loss Avoidance Assessment System and Strategy and need not be duplicated here.

Analysts noted any assumptions in the calculators' comments sections. Reports for each project site for building modification projects and each project area for drainage and special projects can be printed directly from the calculator. These reports are provided in Appendix B and include the noted assumptions. Detailed Results are provided later in this report.

For a thorough description of how the calculator generates results in present day dollar amounts, see Section E Technical Details of the system and strategy.

## Caveats

- This loss avoidance assessment reviews flood mitigation projects.

Tropical Storm Debby was a flood event. As such, this loss avoidance assessment reviews the performance of flood mitigation projects and does not include the benefits of wind mitigation projects or other project types such as codes and standards, community planning, outreach, and research.

The loss avoidance calculator can be used to assess what losses would have occurred with alternative planning scenarios, but such assessments are best performed at the neighborhood or community level.

- This loss avoidance assessment captures direct monetary losses that would have occurred without the projects.

This assessment captures different types of benefits, dependent upon project type.

Assessment of building modification projects captures building, content, inventory, and displacement losses. Losses avoided in the form of loss of function, casualties, shelter needs, emergency response measures, debris clean-up, employment loss, and other related losses are not captured. There are many qualitative benefits, such as life disruption avoided, that are also not captured.

As such, the results of this assessment for building modification projects can be considered to be quite conservative.

Analysts performed assessment of drainage and special project losses avoided using the historical losses method. As such, losses avoided are provided in terms of those losses that have been recorded for similar event return intervals in the past. Any growth or change to the project area is not captured, but loss of function figures for present day are factored, as appropriate.

As historical losses recorded in the project file are often only those minimally necessary to ensure that projects are deemed cost-effective during benefit cost analysis, loss avoidance results for these project types are considered conservative.

For more regarding the make-up of this assessment, please see the Loss Avoidance Assessment System and Strategy on the Division of Emergency Management website, www.floridadisaster.org/mitigation.

- Results are presented in terms of net present value.

Any subsequent loss avoidance assessments will include the results from this assessment and all results will be normalized to present-day dollar amounts. Please see Detailed Results in this report and the Loss Avoidance Assessment System and Strategy for more information.

# Event History

Four events in recent history have been selected for this loss avoidance assessment, as follows:

| Event | Declaration | Event Dates |
|---|---|---|
| Tropical Storm Debby | FEMA-4068-DR-FL | June 23-27, 2012 |
| June 2012 Floods | Undeclared Event | June 8-11, 2012 |
| North Florida Floods | FEMA-1831-DR-FL | March 26-28, 31, & April 1-2, 2009 |
| Tropical Storm Fay | FEMA-1785-DR-FL | August 18-25, 2008 |

## Tropical Storm Debby – June 23-27, 2012

Tropical Storm Debby (Debby) was a tropical system of the 2012 Atlantic Hurricane Season. The most significant impacts from Debby were related to torrential rainfall and the associated flash and river flooding. Seven deaths in Florida were attributed to the storm.

President Barack Obama signed a Major Presidential Disaster Declaration, FEMA-4068-DR-FL, on July 3, 2012. As a result of Tropical Storm Debby, 22 counties were declared for Individual Assistance and 30 counties were declared for Public Assistance (FEMA, 2012).

NASA Terra Satellite Imagery, Tropical Storm Debby, June 24, 2012

### Storm Track

Debby originated from a broad area of low pressure that developed over the southern Gulf of Mexico. This low pressure system moved slowly northward across the Gulf and strengthened to a tropical storm on June 23, 2012. Debby moved gradually toward the northeast Gulf of Mexico. The storm made its closest approach to St. George Island in the Florida Panhandle on June 25th, before taking an eastward turn and making landfall near the Steinhatchee on the afternoon of June 26th with 40 mph winds. After landfall, the storm weakened to a tropical depression and continued its eastward direction over central Florida until leaving the state on the afternoon of June 27, 2012 (NWS, 2012).

### Precipitation

The most significant impacts were related to torrential rainfall. The storm produced numerous severe storms with eighteen confirmed tornadoes in the Florida peninsula. Flash flood warnings occurred in eighteen counties. Rainfall amounts above twelve inches were observed over large swaths in north Florida, from Apalachicola to Jacksonville, and along the Florida west coast, from Pinellas County northward to Hernando County. Several locations in north Florida reported 24 hour rainfall amounts greater than twenty inches, with 26.21 inches observed in the City of Sanborn and 28.27 inches near the City of St. Marks. Such extreme rainfall led to the flooding of several rivers throughout north Florida and west central Florida. The Sopchoppy and St. Mary's Rivers crested at record levels and major flooding occurred on the Santa Fe and Suwannee Rivers (FDEM, 2012).

### Damages

Although Debby never achieved hurricane strength, the slow movement allowed a moderate storm surge to move onshore. This surge also caused severe beach erosion in Pinellas and Manatee counties. Over 1,200 residences were affected by flooding, with approximately 198 residences destroyed.

The Unnamed June 2012 flood event produced significant rainfall and flooding in Escambia and Santa Rosa counties (NOAA Satellite, June 10, 2012).

## Unnamed June 2012 Event – June 8-11, 2012

A low pressure system stalled off the northern Gulf coast resulting in a prolonged period of significant rainfall over the Florida Panhandle. Large bands of heavy rain developed over the northern Gulf of Mexico and moved inland over Escambia and Santa Rosa counties. Portions of Escambia County received up to 24 inches of rainfall within two days, which generated flash flooding across portions of Escambia County. Rainfall up to sixteen inches was recorded in Santa Rosa County during the same period (AP, 2012).

This event was not declared despite a request and subsequent appeal by Florida Governor Rick Scott.

### n Damages

Due to the event, several roads were impassable. Residences and businesses sustained flood damage from several feet of water and a 200-unit apartment complex was forced to evacuate due to rising flood waters. The Escambia County Jail went without power after the rains left more than five feet of water in the bottom floor. This damaged the electrical system, kitchen, and laundry facilities. Several patrol cars and fleet vehicles sustained damage when the sheriff's office parking lot became flooded. Damage to public buildings exceeded $10 million. According to Escambia County's preliminary damage assessment, the Sheriff's office suffered around $3 million in damage. Damage to public infrastructure totaled more than $24 million, including $4.5 million to roads, bridges, and drainage systems. Approximately, 78 homes and four businesses experienced significant damage and 150 homes and 11 businesses sustained minor damage (Moore, 2012).

## North Florida Flooding – March 26-28, 31, & April 1-2, 5, 2009

A series of severe storms, characterized by frequent low-pressure systems and accompanied by heavy rains in late March and early April 2009 in North Florida caused major flooding of rivers and streams within several counties in the Florida Panhandle and eastward.

President Barack Obama signed a Major Presidential Disaster Declaration, FEMA-1831-DR-FL, on April 21, 2009. As result of the severe storms, 17 counties were declared for Individual Assistance and 22 counties were declared for Public Assistance (FEMA, 2009).

### n Storm Description

On March 26-28, and 31 of 2009, classic pre-frontal squall lines dumped heavy rain across the Panhandle and north Florida. Eight tornados touched down and the system deposited rain in excess of ten inches in some areas. Rain in Georgia and Alabama caused excessive run-off and resulted in flooding from the Choctawhatchee, Chipola, Shoal, and Ochlocknee Rivers in the Florida Panhandle.

On March 31, 2009, a second series of thunderstorms and severe weather dropped an additional three to five inches of rain on already saturated areas. Flooding continued along the Chipola, Ochlocknee, and Choctawhatchee Rivers.

April 2, 2009 brought a third series of thunderstorms and severe weather. An additional five to ten inches of rainfall affected Georgia, Alabama, and Florida. West of Tallahassee to the south in the Big Bend, the Withlacoochee, Alapaha, Suwannee, and Santa Fe Rivers flooded.

On April 5, 2009, a small cluster of severe thunderstorms cut a swath across South Georgia further

exacerbating the flooding situation downstream in Florida (NWS, 2009).

### River Crests

- Pinetta, Florida on the Withlacoochee River – Record Flood. The Pinetta crested at a new record of 88.51 feet on April 6, 2009. The old record was 85.05 on April 5th 1948.
- Ellaville, Florida on the Suwannee River – Major Flood. The Ellaville crested at a level of 63.8 feet on April 10th. Florida Department of Transportation was forced to close U.S. highways 84 and 90 and Interstate 10 was also threatened.
- Havana, Florida on the Ochlockonee River – Major Flood. The Havanna crested at 33.45 feet, a major flood, and just under the 2nd highest flood on record. The 2nd highest flood on record was 33.71 feet.
- Altha, Florida on the Chipola River – Major Flood. The Altha crest at 30.66 feet with was the 4th highest level on record.

### Damages

Record river levels were observed across the Florida Big Bend and Panhandle. Flooding on the Withlacoochee and Suwannee Rivers forced the closure of U.S. Highways 84 and 90. The floods claimed two lives in late March in Okaloosa County. An elderly man was swept away April 5 by Withlacoochee floodwaters in Madison County.

The heavy rains across North Florida delayed field work for row crops such as corn and peanuts. Fields prepared for planting flooded with some reported soil erosion. The pasture condition was affected by cold and flooding in the Panhandle and northern counties and by drought in the central and southwest counties. The hardest hit industry was potato farming in Volusia, Putnam, and Flagler counties. Crops were in the middle of the harvest season and many fields were left under water. The three-county area estimated $45 million Crop damage (Orlando Sentinel, 2009).

## Tropical Storm Fay – August 18-25, 2008

Tropical Storm Fay (Fay) was a slow moving tropical system of the 2008 Atlantic hurricane season. Fay made a total of eight landfalls, including a record four landfalls in Florida. The storm is predominately known for torrential rainfall and subsequent extensive flooding. Fay caused $390 million in damages and indirectly resulted in five deaths in the State of Florida.

President George W. Bush signed a Major Presidential Disaster Declaration, FEMA-1785-DR-FL on August 24, 2008. As result of Tropical Storm Fay, 27 counties were declared for Individual Assistance and 41 counties were declared for Public Assistance (FEMA, 2008).

### Storm Track

Fay first made landfall in Florida in the Florida Keys near Key West late evening on August 18, 2008 with winds of sixty miles per hour. After passing north of Key West over the warm waters of Florida Bay, Fay became better organized towards the southwestern Florida coast. The storm made landfall south of Naples between Cape Romano and Everglades City early morning on August 19th with 65 mph winds. Fay strengthened shortly after landfall and a well-defined eye formed on satellite and

Tropical Storm Fay was known for its heavy rainfall and flooding across much of Florida (photo courtesy of NASA Terra Satellite Imagery, Tropical Storm Fay, August 19, 2008)

radar imagery as the storm crossed central Florida. Fay reached a peak intensity of approximately 69 mph when the center was near the western end of Lake Okeechobee on August 19th. The storm steadily declined in strength until its center reached Atlantic waters off the east-central coast of Florida on August 19th. Steering currents then weakened. This turned the storm northward and slowed it to a speed of about four mph.

Fay slowly moved along Florida's eastern coastline from August 19-21. Slow moving bands brought widespread flooding to the east-central Florida region. A ridge to the north of Fay built westward, causing the tropical storm to turn west on August 21st (Stewart and Beven, 2009).

Fay made its third landfall the evening of August 21st near Flagler Beach. The storm maintained its westward motion and emerged over the northeastern Gulf of Mexico on August 22nd.

Fay made its fourth and final Florida landfall near the City of Carrabelle in the Florida Panhandle on August 23rd. The storm moved slowly west-northwest, turned north, weakened into a tropical depression then a remnant low-pressure system over northern Alabama on August 26th (Verdi and Holt, 2009).

### n Precipitation

The slow movement of Fay produced heavy rainfall across all parts of Florida. The storm consistently had access to either Atlantic Ocean or Gulf of Mexico moisture. This resulted in intense rainfall bands that impacted the same locations for several hours at a time. In south-central Florida, parts of northeastern Hendry and southeastern Glades counties received in excess of ten inches of rain. The City of Moore Haven recorded total rainfall of 16.17 inches over two days. Total rainfall was greater than twenty five inches in parts of east-central Florida and northern Florida. A maximum rainfall total of 27.65 inches was recorded eight miles northwest of the City of Melbourne in Brevard County (Stewart and Beven, 2009).

### n Damages

Flooding associated with Tropical Storm Fay caused five deaths in Florida and $390 million in damages. Rainfall-induced inland flooding was the primary cause of damage; more than 15,000 structures flooded. Drainage systems in several counties and towns in northern and central Florida were overwhelmed. After the storm had passed over the east-central region of Florida, the St. John's River continued to rise, causing major flooding in Seminole and Volusia County.

Fay additionally spawned 19 tornados across Florida. The majority were classified as an EF0, although a few were classified as an EF1 and EF2 on the Enhanced Fujita Scale. An EF2 tornado caused $1.2 million in damages in the City of Wellington.

Storm surge and other associated effects from Fay were relatively minimal (Stewart and Beven, 2009).

Sources for Event History:

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