



FLORIDA STATEWIDE REGIONAL EVACUATION STUDY PROGRAM



STORM TIDE ATLAS

HENDRY COUNTY



VOLUME 7-9

BOOK 4 OF 6

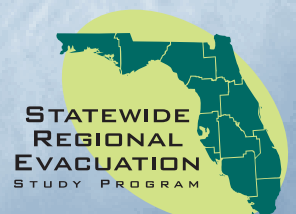
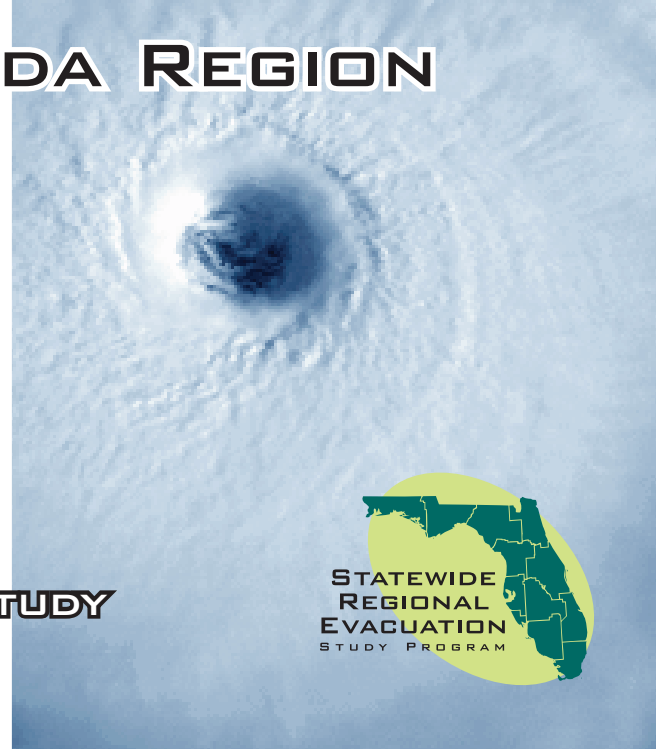
FLORIDA DIVISION OF
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Southwest Florida STORM SURGE ATLAS

Volume VII-9 Book 4 Hendry County

This Book is part of Volume VII of the ***Statewide Regional Evacuation Study*** (SRES) Program and one of six county books in the Southwest Florida Storm Tide Atlas Series. Book 1 covers Charlotte County; Book 2 covers Collier County; Book 3 covers Glades County; Book 4 covers Hendry County; Book 5 covers Lee County and Book 6 covers Sarasota County. This Atlas identifies those areas subject to potential storm surge lake flooding from the five categories of hurricane on the Saffir Simpson Hurricane Wind Scale as determined by NOAA's numerical storm surge model, SLOSH (updated 2009).

The Storm Surge Atlas, published in 2010, is the foundation of the hazards analysis for storm tide and a key component of the SRES. The Technical Data Report (Volume I) builds upon this analysis and includes the revised evacuation zones and population estimates, results of the evacuation behavioral data, shelter analysis and evacuation transportation analyses. The Study, which provides vital information to state and local emergency management, forms the basis for county evacuation plans. The final documents with summary information will be published and made available on the Internet (www.swfrpc.org) in June 2010.

The Atlas was produced by the Southwest Florida Regional Planning Council with funding by the Florida Legislature and the Federal Emergency Management Agency through the Florida Division of Emergency Management.



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VOLUME VII-9

Southwest Florida

STORM SURGE ATLAS

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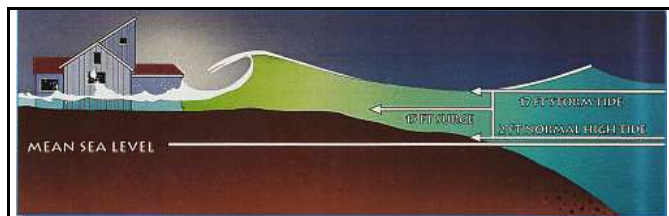
INTRODUCTION

A comprehensive emergency management program requires attention to four (4) key inter-related components: preparedness, response, recovery and mitigation. Preparing and avoiding or reducing potential loss of life and property damage - **preparedness and mitigation** - requires accurate and precise hazard and vulnerability analyses. These analyses are the foundation for evacuation and disaster response planning, as well as the development of local mitigation strategies designed to reduce the community's overall risk to disasters. This Atlas series provides information to state, county and local emergency management officials and planners for use in hurricane preparedness and coastal management in the Southwest Florida Region including Charlotte, Collier, Glades, Hendry, Lee, and Sarasota counties (Figure 1). It was part of a statewide effort to enhance our ability to respond to a hurricane threat, facilitate the evacuation of vulnerable residents to a point of relative safety and mitigate our vulnerability in the future. The ***Statewide Regional Evacuation Study Program*** provides a consistent, coordinated and improved approach to addressing the state and regional vulnerability to the hurricane threat.

The specific purpose of this Atlas is to provide maps which depict storm surge heights and the extent of stillwater, storm surge lake flooding inundation from hurricanes of five different intensities in the Southwest Florida area. The Atlas was prepared by the Southwest Florida Regional Planning Council as part of the *Statewide Regional Evacuation Study Program*. The Study is a cooperative effort of the Florida Department of Community Affairs, Division of Emergency Management, the Florida Regional Planning Councils and the county emergency management agencies.



Figure 1 The Southwest Florida Region



THE SLOSH MODEL

The principal tool utilized in this study for analyzing the expected hazards from potential hurricanes affecting the study area is the Sea, Lake and Overland Surges from Hurricane (**SLOSH**) numerical storm

surge prediction model. The primary purpose for this model is to determine if there is overtopping of the levee around the lake and the extent of storm surge flooding in the Fisheating Creek watershed.

The SLOSH computerized model predicts the storm surge heights that result from hypothetical hurricanes with selected various combinations of pressure, size, forward speed, track and winds. Originally developed for use by the National Hurricane Center (NHC) as a tool to give geographically

specific warnings of expected surge heights during the approach of hurricanes, the SLOSH model is utilized in regional studies for several key hazard and vulnerability analyses.

The SLOSH modeling system consists of the model source code and the model basin or grid. SLOSH model grids must be developed for this specific geographic lake area individually incorporating the unique local river configuration, water depths, bridges, roads and other physical features. In addition to lake flooding heights, one of the most valuable outputs of the SLOSH model for evacuation planning is its predictions of surge heights over land into inland areas.

The first Lake Okeechobee SLOSH model basin was completed in 1992 and represented the first application of SLOSH storm surge dynamics to a major lake in the United States. The model was developed by the Techniques Development Lab of the National Oceanic and Atmospheric Administration (NOAA) under the direction of the late Dr. Chester P. Jelesnianski.

The newest generation of the SLOSH model basin incorporated in the 2010 Statewide Regional Evacuation Study reflects major improvements, including higher resolution basin data and grid configurations. Faster computer speeds allowed additional hypothetical storms to be run for creation of the MOMs¹ or the maximum potential storm tide values for each category of storm.

Hypothetical Storm Simulations

Surge height depends strongly on the specifics of a given storm including, forward speed, angle of approach, intensity or maximum wind speed, storm size, storm shape, and landfall location. The SLOSH model was used to develop data for various combinations of hurricane strength, wind speed, and direction of movement. Storm strength was modeled using the central pressure (defined as the difference between the ambient sea level pressure and the minimum value in the storm's center), the storm eye size and the radius of maximum winds using the five categories of hurricane intensity as depicted in the Saffir-Simpson Hurricane Wind Scale (see Table 1).

¹ Maximum of MEOWs

Table 1 Saffir-Simpson Hurricane Wind Scale

Category	Wind Speeds	Potential Damage
Category 1	(Sustained winds 74-95 mph)	<i>Very dangerous winds will produce some damage</i>
Category 2	(Sustained winds 96-110 mph)	<i>Extremely dangerous winds will cause extensive damage</i>
Category 3	(Sustained winds 111-130 mph)	<i>Devastating damage will occur</i>
Category 4	(Sustained winds 131-155 mph)	<i>Catastrophic damage will occur</i>
Category 5	(Sustained winds of 156 mph and above)	<i>Catastrophic damage will occur</i>

The modeling for each tropical storm/hurricane category was conducted using the mid-range pressure difference (Δp , millibars) for that category. The model also simulates the storm filling (weakening upon landfall) and radius of maximum winds (RMW) increase.

Ten storm track headings (WSW, W, WNW, NW, NNW, N, NNE, NE, E, ENE) were selected as being representative of storm behavior in the West Central Florida regions, based on observations by forecasters at the National Hurricane Center. And for each set of tracks in a specific direction storms were run at forward speeds of 5, 10, 15 and 25 mph. And, for each direction, at each speed, storms were run at two different sizes (20 statute mile radius of maximum winds and 35 statute miles radius of maximum winds.) Each scenario was run at both 16 and 20 feet lake levels. A total of 10,640 runs (compared to the 735 runs in 2006) were made consisting of the different parameters shown in Table 2.

Table 2 Southwest Florida Lake Okeechobee Basin Hypothetical Storm Parameters

Directions, speeds, (Saffir/Simpson) intensities, number of tracks and the number of runs.

Direction	Speeds (mph)	Size (Radius of Maximum winds)	Intensity	Lake Level	Tracks	Runs
WSW	5, 10,15, 25 mph	20 statute miles & 35 statute miles	T.S., 1 through 5	16'/20'	13	1,040
W	5, 10,15, 25 mph	20 statute miles & 35 statute miles	T.S., 1 through 5	16'/20'	13	1,040
WNW	5, 10,15, 25 mph	20 statute miles & 35 statute miles	T.S., 1 through 5	16'/20'	13	1,040
NW	5, 10,15, 25 mph	20 statute miles & 35 statute miles	T.S., 1 through 5	16'/20'	13	960
NNW	5, 10,15, 25 mph	20 statute miles & 35 statute miles	T.S., 1 through 5	16'/20'	13	960
N	5, 10,15, 25 mph	20 statute miles & 35 statute miles	1 through 5	16'/20'	13	1,040
NNE	5, 10,15, 25 mph	20 statute miles & 35 statute miles	1 through 5	16'/20'	13	1,040
NE	5, 10,15, 25 mph	20 statute miles & 35 statute miles	1 through 5	16'/20'	14	1,120
ENE	5, 10,15, 25 mph	20 statute miles & 35 statute miles	1 through 5	16'/20'	15	1,200
E	5, 10,15, 25 mph	20 statute miles & 35 statute miles	1 through 5	16'/20'	15	1,200
TOTAL						10,640

The Grid for the Lake SLOSH Model

Figure 2 illustrates the area covered by the grid for the Lake SLOSH Model. To determine the surge values the SLOSH model uses a square grid as its unit of analysis with 17,280 grid cells. Use of the grid configuration allows for individual calculations per grid square which is beneficial in two ways: (1) provides increased resolution of the storm surge at the shoreline, while decreasing the resolution in the deep water where detail is not as important; and (2) allows economy in computation.

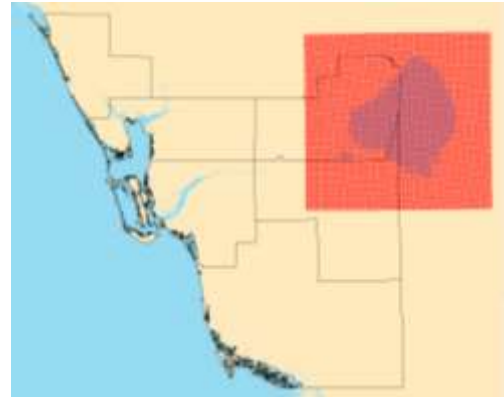


Figure 2 Lake Basin Grid

Storm Scenario Determinations

As indicated, the SLOSH model is the basis for the "hazard analysis" portion of hurricane evacuation plans. Thousands of hypothetical hurricanes are simulated with various Saffir-Simpson Wind categories, forward speeds, landfall directions, and landfall locations. An envelope of high water containing the maximum value a grid cell attains is generated at the end of each model run. These envelopes are combined by the NHC into various composites which depict the possible flooding. One useful composite is the MEOW (Maximum Envelope



Figure 3 SLOSH Grid with Surge Values

of Water) which incorporates all the envelopes for a particular category, speed, and landfall direction. Once surge heights have been determined for the appropriate grids, the maximum surge heights are plotted by storm track and tropical storm/hurricane category. These plots of maximum surge heights for a given storm category and track are referred to as MEOWs. The MEOWs or Reference Hurricanes can be used in evacuation decision making when and if sufficient forecast information is available to project storm track or type of storm (different landfalling, paralleling, or exiting storms).

The MEOWs provide information to the emergency managers in evacuation decision making. However, in order to determine a scenario which may confront the county in a hurricane threat 24-48 hours before a storm is expected, a further compositing of the MEOWs into Maximums of the Maximums (MOMs) is usually required.

The MOM (Maximum of the MEOWs) combines all the MEOWs of a particular category. The MOMs represent the maximum surge expected to occur at any given location, regardless of the specific storm track/direction of the hurricane. The only variable is the intensity of the hurricane represented by category strength (Category 1-5).

The MOM surge heights, which were furnished by the National Hurricane Center, have 2 values of lake level, 16 feet and 20 feet. All elevations are now referenced to the NAVD88 datum.

These surge heights were provided within the SLOSH grid system as illustrated on Figure 2. The range of maximum surge heights (low to high) for each scenario is provided for each category of storm (MOM) on Table 3. **It should be noted again that these surge heights represent the maximum surge height recorded in the county from the storm tide analysis including inland and up riverine areas where the surge can be magnified dependent upon storm parameters.**

Table 3 Potential Storm Surge Height (s) by County

(In Feet above NAVD88)

*Storm Strength	Charlotte	Collier	Lee	Sarasota	Lake O 16ft	Lake O 20ft
TS	Up to 5.2	Up to 5.8	Up to 6.1	Up to 5.6	NA	NA
1	Up to 7	Up to 8.2	Up to 8.7	Up to 6.9	Up to 21.1	Up to 25
2	Up to 17	Up to 14.1	Up to 15.5	Up to 15.4	Up to 26.6	Up to 30.6
3	Up to 26	Up to 19.5	Up to 23	Up to 26	Up to 33.2	Up to 35.5
4	Up to 32.3	Up to 24.5	Up to 27.6	Up to 33.2	Up to 36.4	Up to 37.2
5	Up to 37.7	Up to 41.9	Up to 41.7	Up to 35.4	Up to 38.9	Up to 40

**Based on the category of storm on the Saffir-Simpson Hurricane Wind Scale*

*** Surge heights represent the maximum values from SLOSH MOMs*

CREATION OF THE STORM SURGE ZONES

The maps in this atlas depict SLOSH-modeled heights of storm surge and extent of flood inundation for hurricanes of five different intensities. As indicate above, the storm surge was modeled using the Maximum of Maximums (MOMs) representing the potential flooding from the five categories of storm intensity of the Saffir/Simpson Hurricane Wind Scale.

Determining Storm Surge Height and Flooding Depth

SLOSH and SLOSH-related products reference storm surge heights relative to the model vertical datum, NAVD88. In order to determine the inundation depth of surge flooding at a particular location the ground elevation (relative to NAVD88) at that location must be subtracted from the potential surge height.²

Surge elevation, or water height, is the output of the SLOSH model. At each SLOSH grid point, the maximum surge height is computed at that point.

Within the SLOSH model an average elevation is assumed within each grid square. Height of water above terrain was not calculated using the SLOSH average grid elevation because terrain height may vary significantly within a SLOSH grid square. For example, the altitude of a 1-mile grid square may be assigned a value of 1.8 meters (6 feet), but this value represents an average of land heights

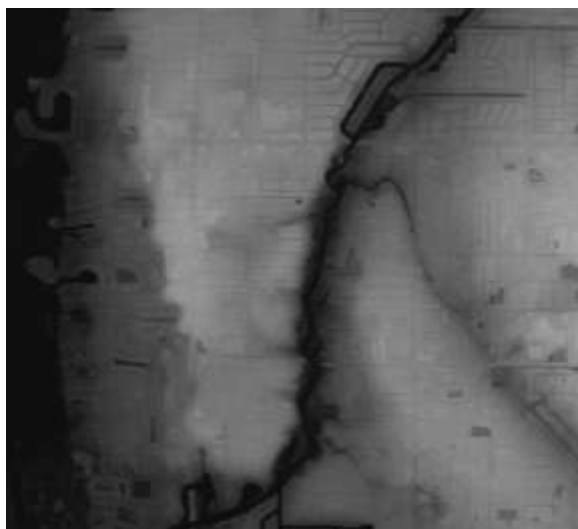


Figure 4 Digital Elevation from LIDAR

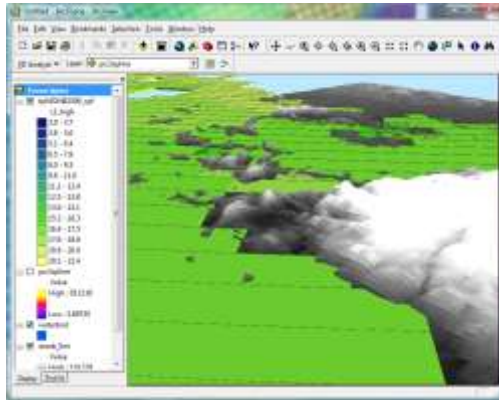
that may include values ranging from 0.9 to 2.7 meters (3 to 9 feet). In this case, a surge value of 2.5 meters (8 feet) in this square would imply a 0.7 meters (2 feet) average depth of water over the grid's terrain. However, in reality within the grid area portion of the grid would be "dry" and other parts could experience as much as 1.5 meters (5 feet) of inundation. Therefore, in order to determine the storm surge limits, the depth of surge flooding above terrain at a specific site in the grid square is the result of subtracting the terrain height determined by remote sensing from the model-generated storm surge height in that grid square.³

² It is important to note that one must use a consistent vertical datum when post-processing SLOSH storm surge values

³ Note: This represents the regional post-processing procedure. When users view SLOSH output within the SLOSH Display Program, the system uses average grid cell height when subtracting land.

Storm Surge Post-Processing

The Atlas was created using a Toolset wrapped into ESRI's ArcGIS mapping application, ArcMap. The surge tool was developed for the Statewide Regional Evacuation Study Program by the Tampa Bay Regional Planning Council, who had used a similar tool for the previous Evacuation Study Update (2006). This tool enabled all regions within the state of Florida to process the SLOSH and elevation data with a consistent methodology.



The tool basically performs the operation of translating the lower resolution SLOSH grid data into a smooth surface resembling actual storm tide and terrain; processing it with the high resolution elevation data derived from LIDAR. The image on the left represents how the data would look as it appears directly from SLOSH Model output.

Processing all the data in the raster realm, the tool is able to digest large amounts of data and output detailed representations of surge inundation.

Figure 5 SLOSH Display

The program first interpolates the SLOSH height values for each category into a raster surface using spline interpolation. This type of interpolation is best for smooth surfaces, such as water and slow changing terrain. The result is a raster surface representing the surge height for a category that can be processed against the raster Digital Elevation Model from the LIDAR. The "dry" values (represented as 99.9 in the SLOSH Model) are replaced by an average of the inundated grids surrounding current processed grid. An algorithm performs this action utilizing the range of values in the current category of storm being processed.

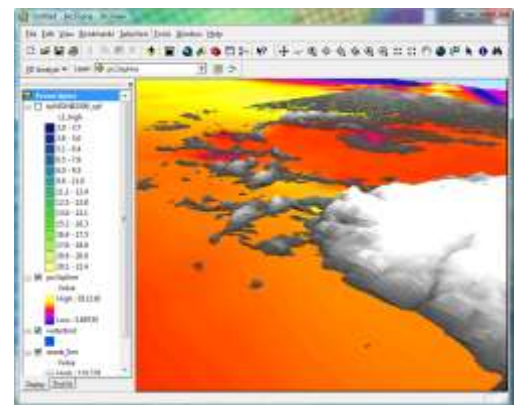
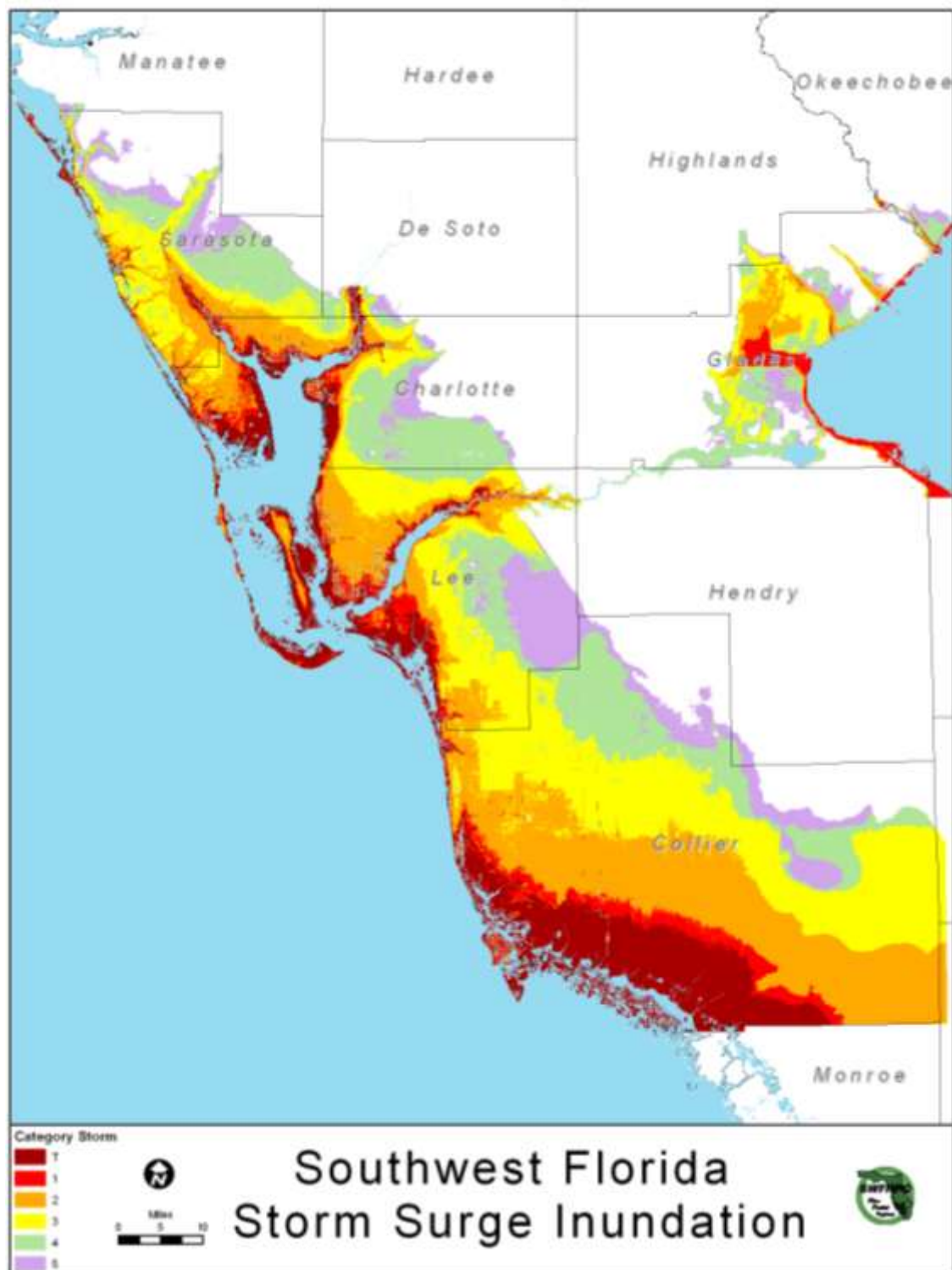


Figure 6 SLOSH Display Post-Processing

Using this methodology, once the elevation is subtracted from the projected storm surge, the storm surge limits are determined. The output of the tool is a merged polygon file holding all the maximum inundation zones for Category 1 through Category 5. The output, depicted in this Storm Surge Atlas is determined consistent with the coastal areas throughout the state. Figure 7 presents a compilation of the *Storm Surge Atlas* for the region.

Figure 7 Storm Surge Limits for the Southwest Region

VARIATIONS TO CONSIDER

Variations between modeled versus actual measured storm surge elevations are typical of current technology in coastal storm surge modeling. Interpreting the data, emergency planners should recognize the uncertainties characteristic of mathematical models and severe weather systems such as hurricanes. The storm surge elevations developed for this study and presented in the ***Storm Surge Atlas*** should be used as guideline information for planning purposes.

Storm Surge & Wave Height

Regarding interpretation of the data, it is important to understand that the configuration and depth (bathymetry) of the lake bottom and lake level heights will have a bearing on surge and wave heights. Wave height is NOT calculated by the SLOSH model and is not reflected within the storm surge delineations.

Forward Speed

Under actual storm conditions it may be expected that a hurricane moving at a slower speed could have higher storm surges for Lake Okeechobee than those depicted from model results. At the same time, a fast moving hurricane would have less time to move storm surge water over the top of the Lake Okeechobee Levee. For example, in 2004 Category 2 Hurricane Jeanne and Frances when it moved close to the north side of Lake Okeechobee had average forward speeds and caused erosion of the levee but those storms did not overtop the levee. In the newest version of the Southwest SLOSH model, for each set of tracks in a specific direction, storms were run at forward speeds of 5, 10, 15 and 25 mph.

Radius of Maximum Winds

As indicated previously, the size of the storm or radius of maximum winds (RMW) can have a significant impact on storm surge especially in bay areas and along the Gulf of Mexico but will not have an effect on Lake Okeechobee. The Lake surges are primarily affected by wind and forward speed of a hurricane. All of the hypothetical storms were run at two different sizes, 20 mile radius of maximum winds and 35 mile radius of maximum winds.

Accuracy

As part of the Statewide Regional Evacuation Study, all coastal areas as well as areas surrounding Lake Okeechobee were mapped using remote-sensing laser terrains mapping (LIDAR⁴) providing the most comprehensive, accurate and precise topographic data for this analysis. As a general rule, the vertical accuracy of the laser mapping is within a 15 centimeter tolerance. However, it should be noted that the accuracy of these elevations is limited to the precision and tolerance in which the horizontal accuracy for any given point is recorded. Other factors such as artifact removal algorithms (that remove buildings and trees) can affect the recorded elevation in a particular location. For the purposes of this study, the horizontal accuracy cannot be assumed to be greater than that of a standard USGS 7 minute quadrangle map, or a scale of 1:24,000.

⁴ Light Imaging Detection and Ranging

POINTS OF REFERENCE

County emergency management agency selected reference points which include key facilities or locations critical for emergency operations. The table below includes the map identification number, descriptions of the selected points and the elevation of the site. The elevation is based on the digital elevation data provided by the LIDAR. It should be noted that if the site is large, elevations may vary significantly. The table also provides the storm surge value from the SLOSH value and the depth of inundation (storm surge value minus the ground elevation) at the site.

Table 4 Selected Points of Reference

Hendry County 16Ft Lake Level Flood Depth

ID	LOCATION	SURGE	BASE_ELEV	C1_DEPTH	C2_DEPTH	C3_DEPTH	C4_DEPTH	C5_DEPTH
1	Del Monte/Magnolia	2	17.90	DRY	0.40	2.35	3.68	4.28
2	80/CR 835	2	20.52	DRY	0.82	3.27	4.97	5.82

Hendry County 20Ft Lake Level Flood Depth

ID	LOCATION	SURGE	BASE_ELEV	C1_DEPTH	C2_DEPTH	C3_DEPTH	C4_DEPTH	C5_DEPTH
1	Del Monte/Magnolia	1	17.90	0.17	2.29	4.17	5.38	5.98
2	80/CR 835	1	20.52	0.76	3.38	5.72	7.37	8.15

STORM SURGE ATLAS

The surge inundation limits (MOM surge heights minus the ground elevations) are provided as GIS shape files and graphically displayed on maps in the *Hurricane Storm Tide Atlas for the Southwest Florida Region*. The *Atlas* was prepared by Southwest Florida Regional Planning Council under contract to the State of Florida, Division of Emergency Management, as part of this study effort. The maps prepared for the *Atlas* consist of base maps (1:24000) including topographic, hydrographic and highway files (updated using 2008 county and state highway data). Detailed shoreline and storm surge limits for each category of storm were determined using the region's geographic information system (GIS).

The purpose of the maps contained in this Atlas is to reflect a worst probable scenario of the hurricane storm tide inundation and to provide a basis for the hurricane evacuation zones and study analyses. **Hendry County surge atlas is comprised of two sets of maps to reflect the uniqueness of Lake Okeechobee. The Lake Okeechobee storm surge model is measured at two lake levels, 16ft and 20ft. This effort is intended to exhibit the variations in the Lake Okeechobee water levels which experience fluctuations caused by northern fresh water flow from the Kissimmee River as well as rain. The first set of maps represents the 16ft lake level surge zones and the second set represents the 20ft lake level.**

Figure 8 provides an index of the map series.

NOTES ON STORM TIDE LIMITS

Historically, the SLOSH storm surge analysis had focused on "average" storm parameters (size and forward speed), although the intensity and angle of approach was modeled to include direct strikes and catastrophic intensity. In the 2010 Regional Evacuation Study Update, 12,000 hypothetical hurricanes were included in the SLOSH suite of storms modeled varying forward speeds and the radii of maximum winds to include the large storm events and different forward speeds. This allowed for the development of a truer picture of the storm surge vulnerability in the region. The five categories of hurricane reflect a "worst probable" storm tide limit for hurricanes holding the wind speed constant (consistent with the Saffir Simpson Hurricane Wind Scale) while varying storm parameters include size, forward speed, and angle of approach.

This has led to some confusion regarding evacuation decision-making since hurricane evacuations are based primarily on storm surge vulnerability. The National Oceanic and Atmospheric Administration (NOAA) is working to enhance the analysis and prediction of storm surge. Direct estimates of inundation are being communicated in the NHC's Public Advisories and in the Weather Forecast Office's (WFO) Hurricane Local Statements. NHC's probabilistic storm surge product, which provides the likelihood of a specific range of storm surge values, became operational in 2009, and the NWS Meteorological Development Laboratory is providing experimental, probabilistic storm surge products for 2010. In addition, coastal weather forecast offices will provide experimental Tropical Cyclone Impacts Graphics in 2010; these include a qualitative graphic on the expected storm surge impacts. Finally, the NWS is exploring the possibility of issuing explicit Storm Surge Warnings which could be implemented in the next couple of years. In all of these efforts, the NWS is working to provide specific and quantitative information to support decision-making at the local level¹. NOAA continues to emphasize that the hurricane forecasts are not 100% accurate and dependent upon many factors.

The tables (16 and 20 feet lake level) below depict the storm surge limits identified for Hendry County under the five (5) categories of hurricane on the Saffir Simpson Hurricane Wind Scale. It is important to recognize the following:






- The surge tide values represent the highest surge height elevation above a standard datum (NAVD88) predicted by the model in the entire county and will only be appropriate for selected areas.
- Typically the highest surge tide values are NOT the surge heights predicted at the coast. The highest storm tide values are typically experienced inside bays and up rivers and inlets (water above ground).
- Storm Tide ranges by category of storm are presented on Table 3 on page 11 of this document.
- For surge heights at specific locations, please refer to Table 4 on page 16 which provides the expected storm surge elevation at points of reference and the actual inundation (water depth) at that site.

¹http://www.nhc.noaa.gov/sshws_statement.shtml

Hendry County

Legend

CATEGORY : 16ft Lake Level

	1 : Up to 21.1 ft
	2 : Up to 26.6 ft
	3 : Up to 33.2 ft
	4 : Up to 36.4 ft
	5 : Up to 38.9 ft

Hendry County

Legend

CATEGORY : 20ft Lake Level






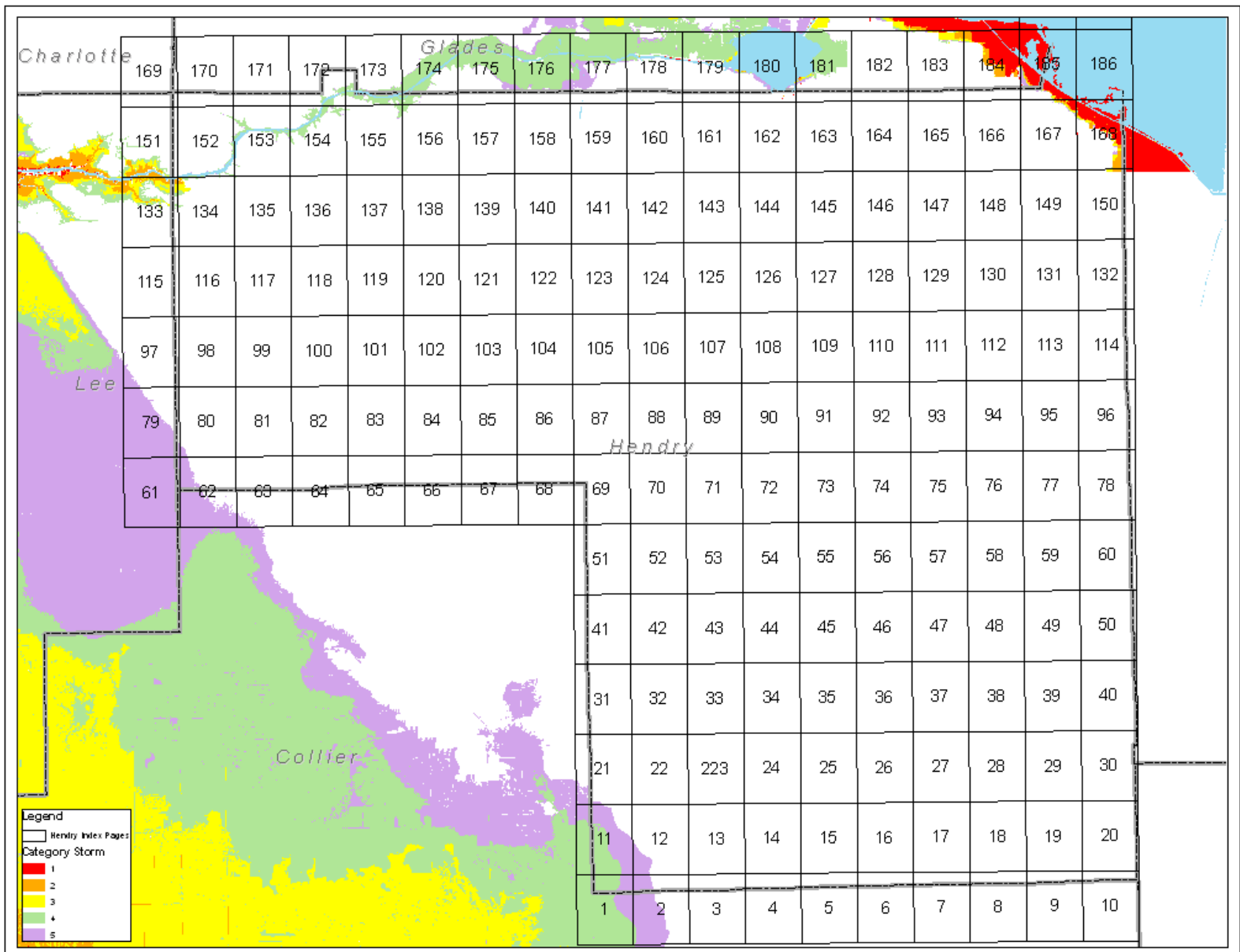
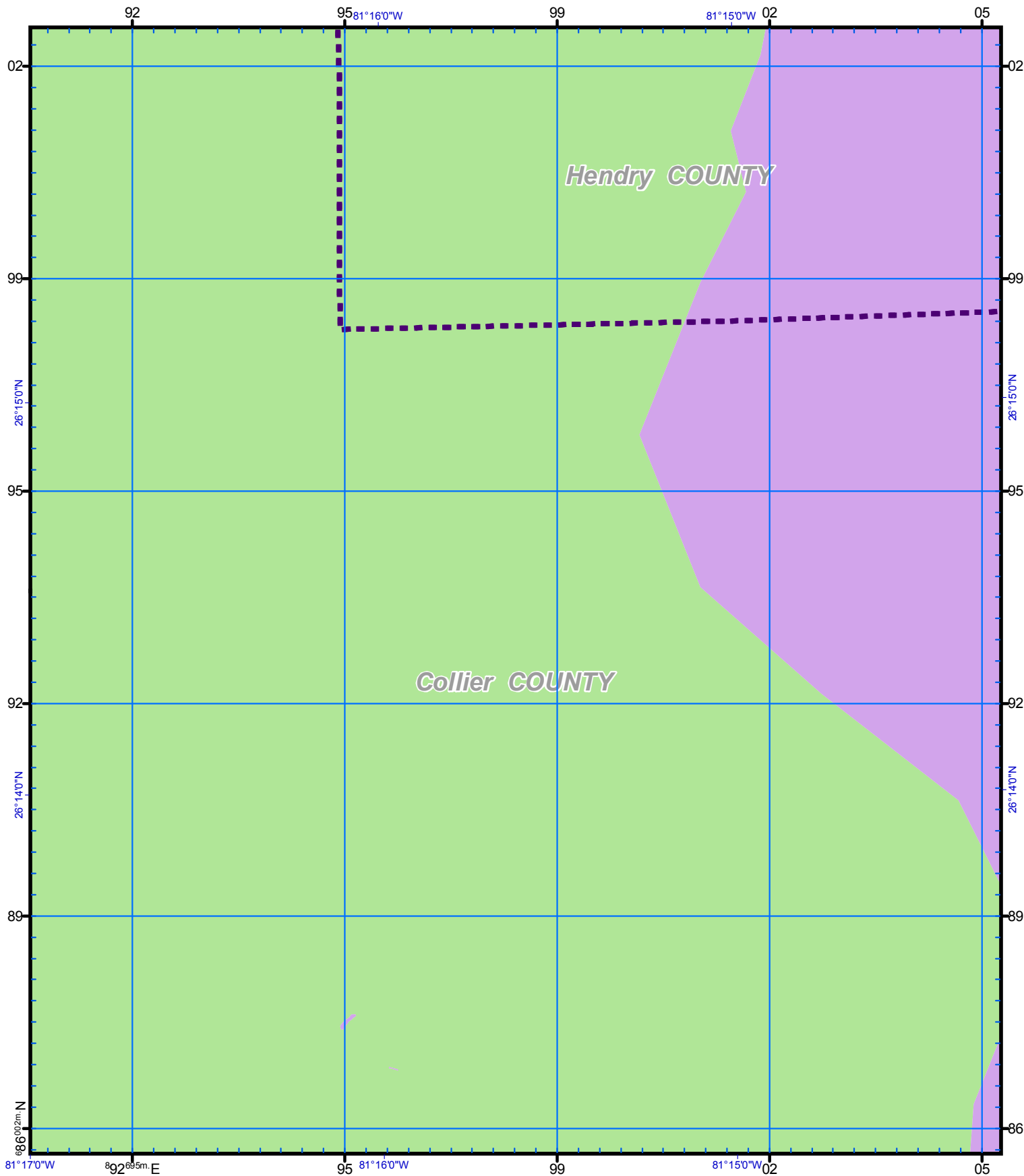
	1 : Up to 25 ft
	2 : Up to 30.6 ft
	3 : Up to 35.5 ft
	4 : Up to 37.2 ft
	5 : Up to 40 ft

Figure 8 Hendry County Atlas Map Index



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US National Grid
100,000-m Square ID
MK
Grid Zone Designation
17R
Datum = NAD 1983, 1,000-m USNG



Notes:
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Lake Surge Zones 16ft Lake Level Hendry County, 2010

Scale - 1:24,000
0 2,000 Feet

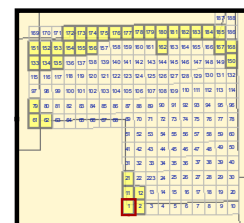
USNG Page **17R MK 72 00**

Map Plate **1**

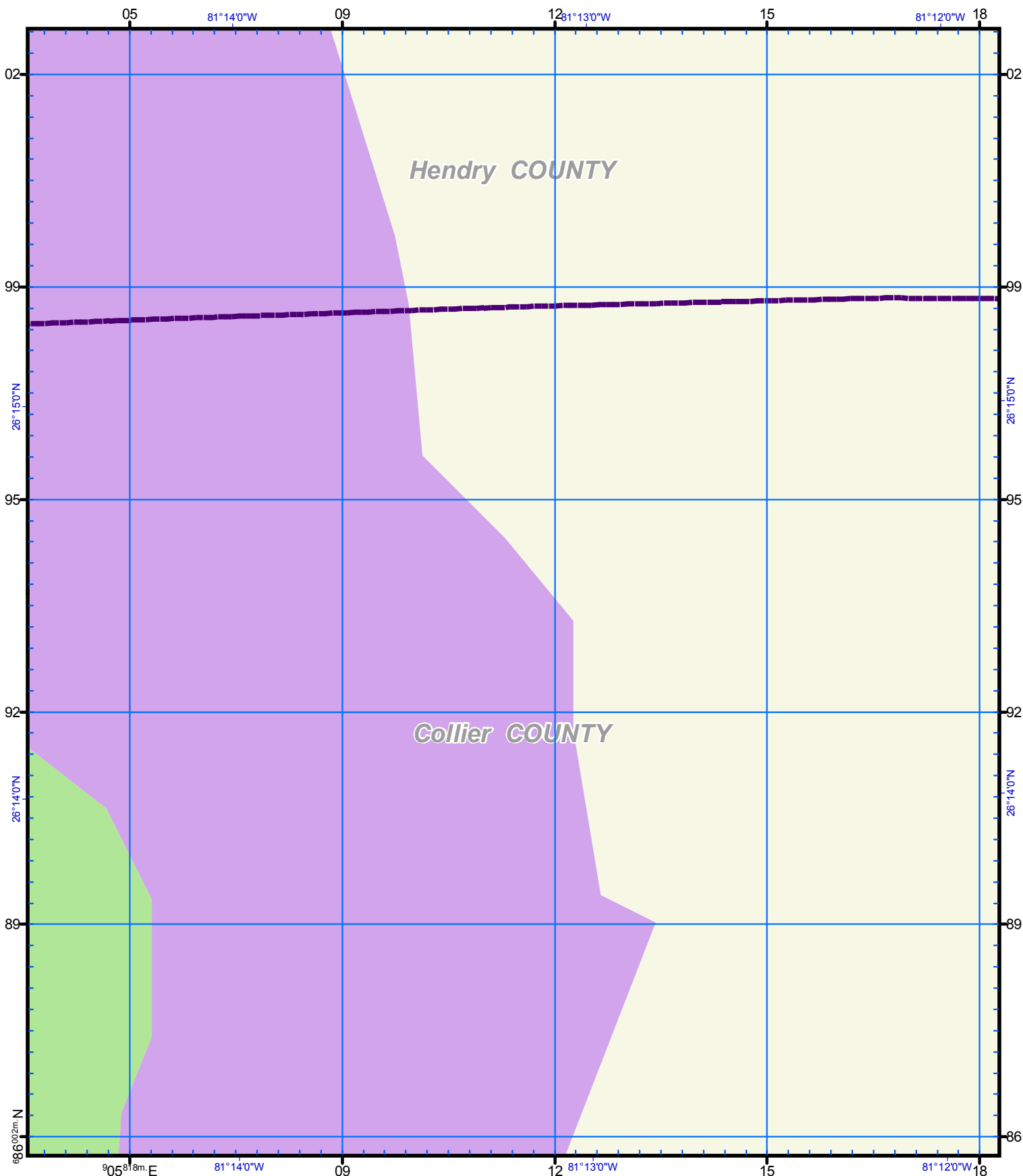
Page 21

Legend

Reference Point	Cat 1
HOSPITAL	Cat 2
City Limits	Cat 3
Evacuation Route	Cat 4
Existing Water	Cat 5



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US National Grid
100,000-m Square ID
MK
Grid Zone Designation
17R
Datum = NAD 1983, 1,000-m USNG

GN
Diagram
Not to Scale
Mag. Declination
4° 31' W
Changing by
5° W per yr
Date 2009

Notes:
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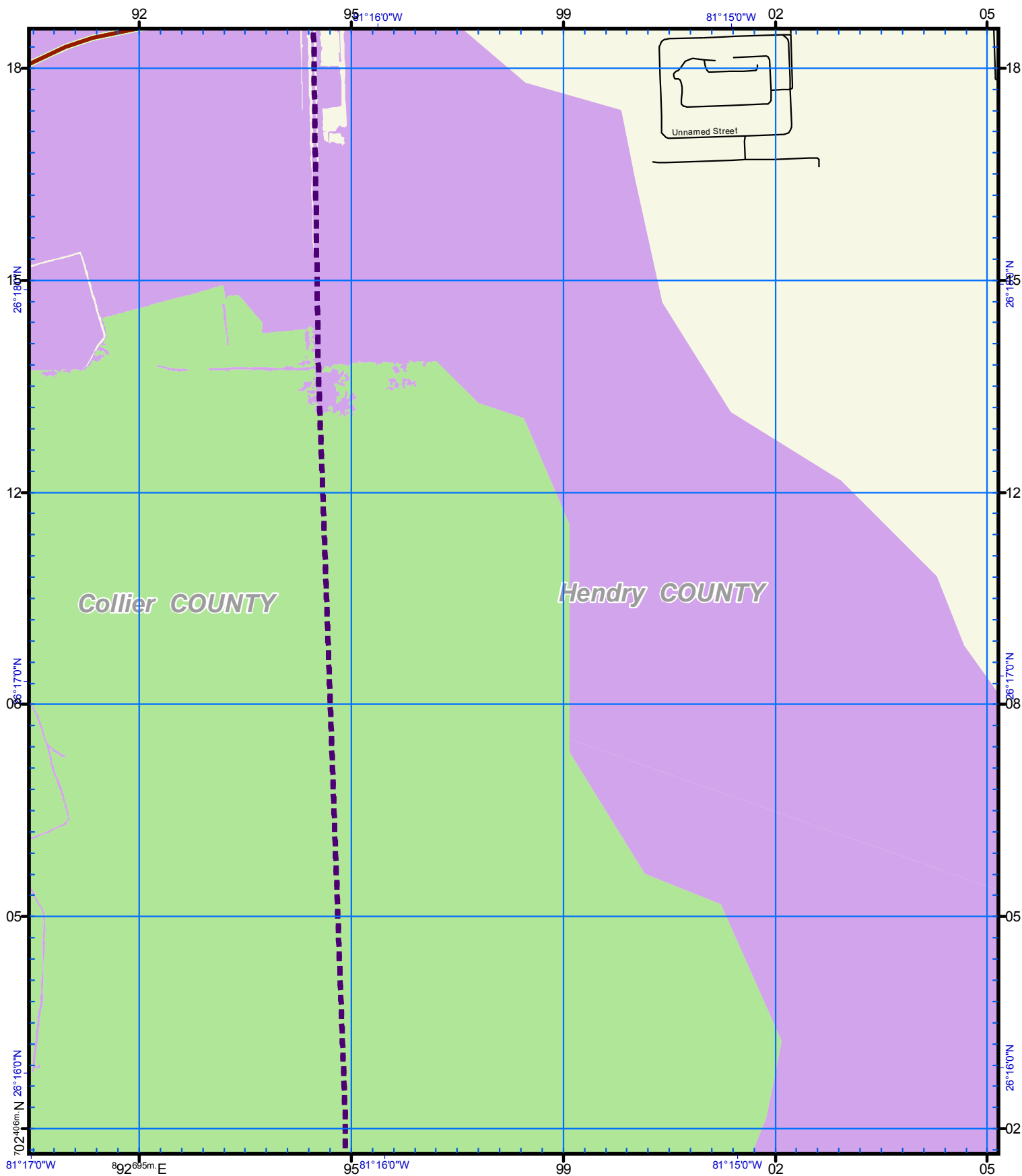
Lake Surge Zones
16ft Lake Level
Hendry County, 2010
Scale - 1:24,000
0 2,000 Feet

USNG Page **17R MK 76 00**
Map Plate **2**
Page **22**

Legend
● Reference Point
H HOSPITAL
City Limits
Evacuation Route
Existing Water
Cat
1
2
3
4
5



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US National Grid
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MK
Grid Zone Designation
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Lake Surge Zones 16ft Lake Level Hendry County, 2010

Scale - 1:24,000
0 2,000 Feet

USNG Page 17R MK 72 05

Map Plate 11

Page 23

Legend

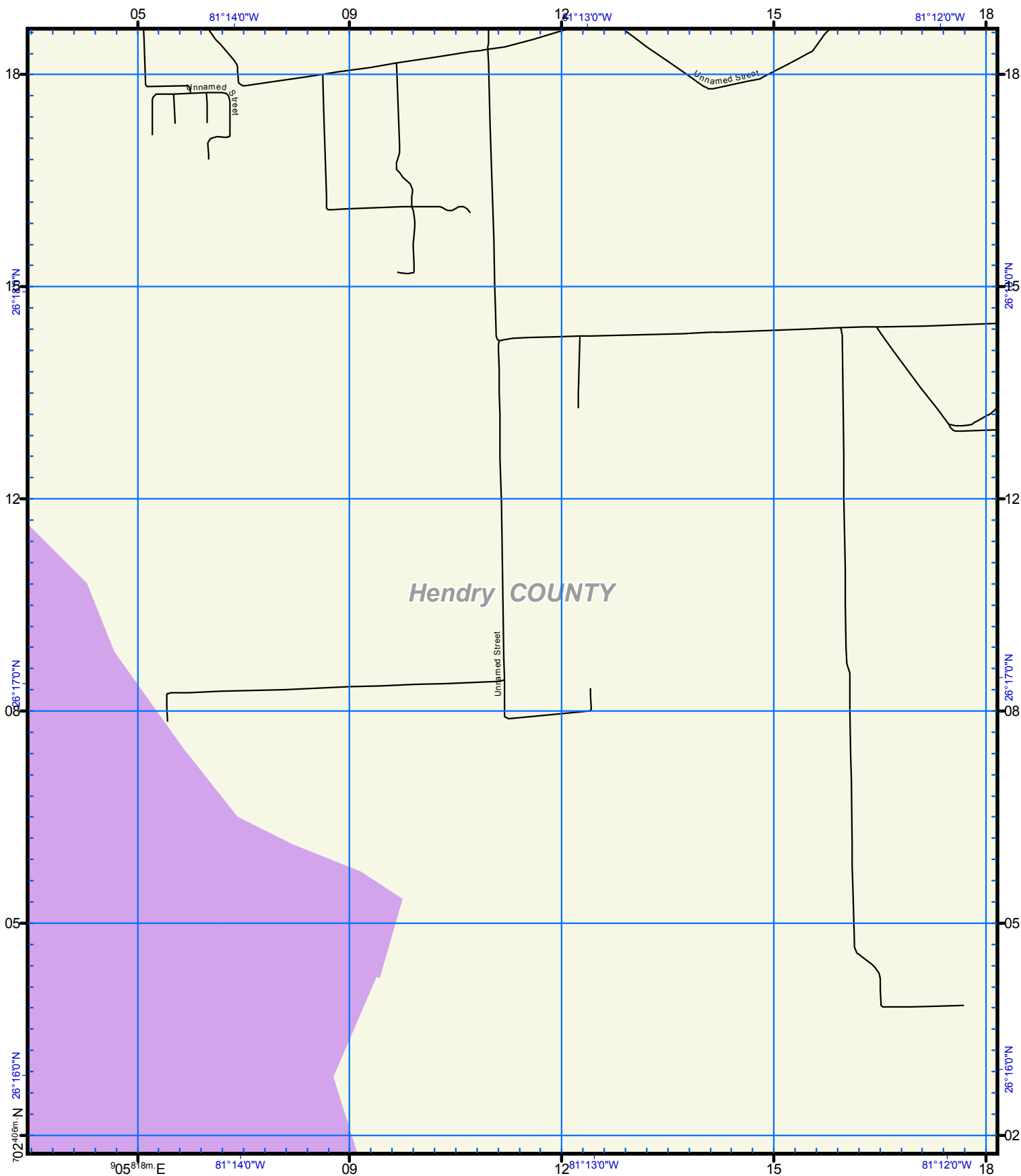
- Reference Point
- HOSPITAL
- City Limits
- Evacuation Route
- Existing Water

Cat

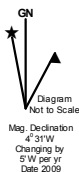
- 1
- 2
- 3
- 4
- 5



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US National Grid
100,000-m Square ID
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Lake Surge Zones 16ft Lake Level Hendry County, 2010

Scale - 1:24,000
0 2,000 Feet

USNG Page **17R MK 76 05**

Map Plate **12**

Page 24

Legend

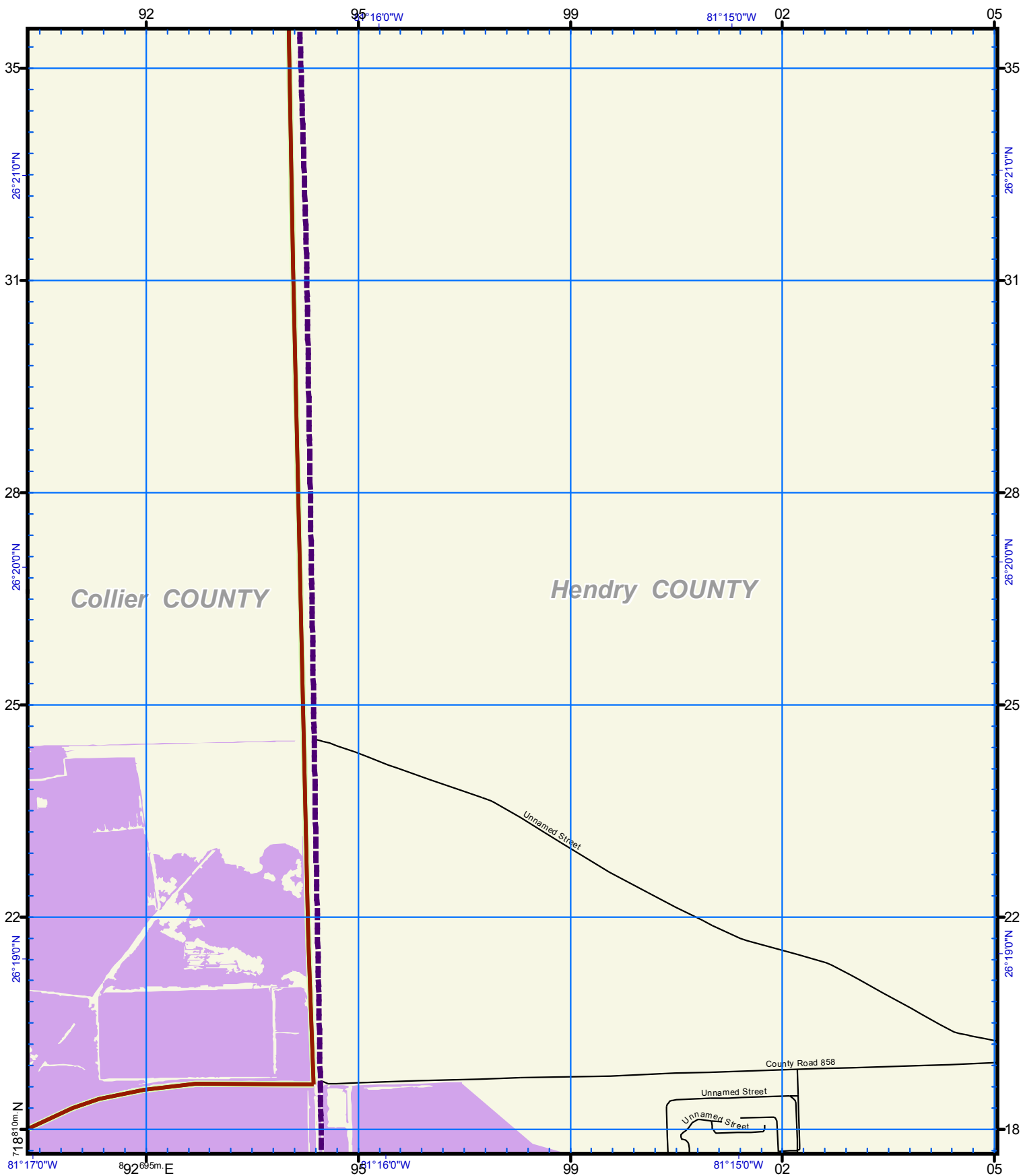
- Reference Point
- HOSPITAL
- City Limits
- Evacuation Route
- Existing Water

Cat

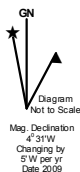
- 1
- 2
- 3
- 4
- 5



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US National Grid
100,000-m Square ID
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Lake Surge Zones 16ft Lake Level Hendry County, 2010

Scale - 1:24,000
0 2,000 Feet

USNG Page 17R MK 72 10

Map Plate 21

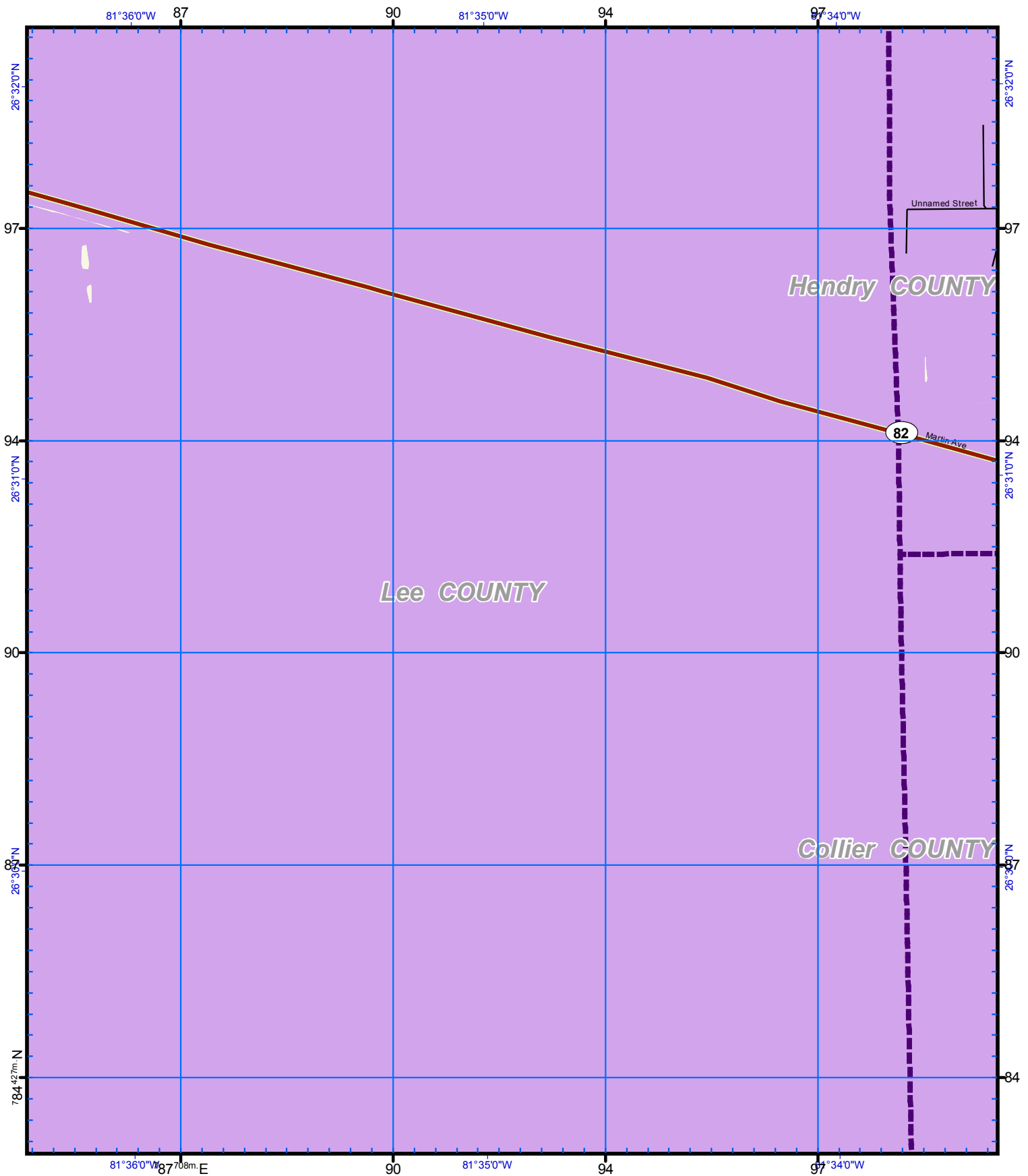
Page 25

Legend

	Reference Point		Cat 1
	HOSPITAL		Cat 2
	City Limits		Cat 3
	Evacuation Route		Cat 4
	Existing Water		Cat 5



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US National Grid
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Lake Surge Zones 16ft Lake Level Hendry County, 2010

Scale - 1:24,000
0 2,000 Feet

USNG Page 17R MK 40 30

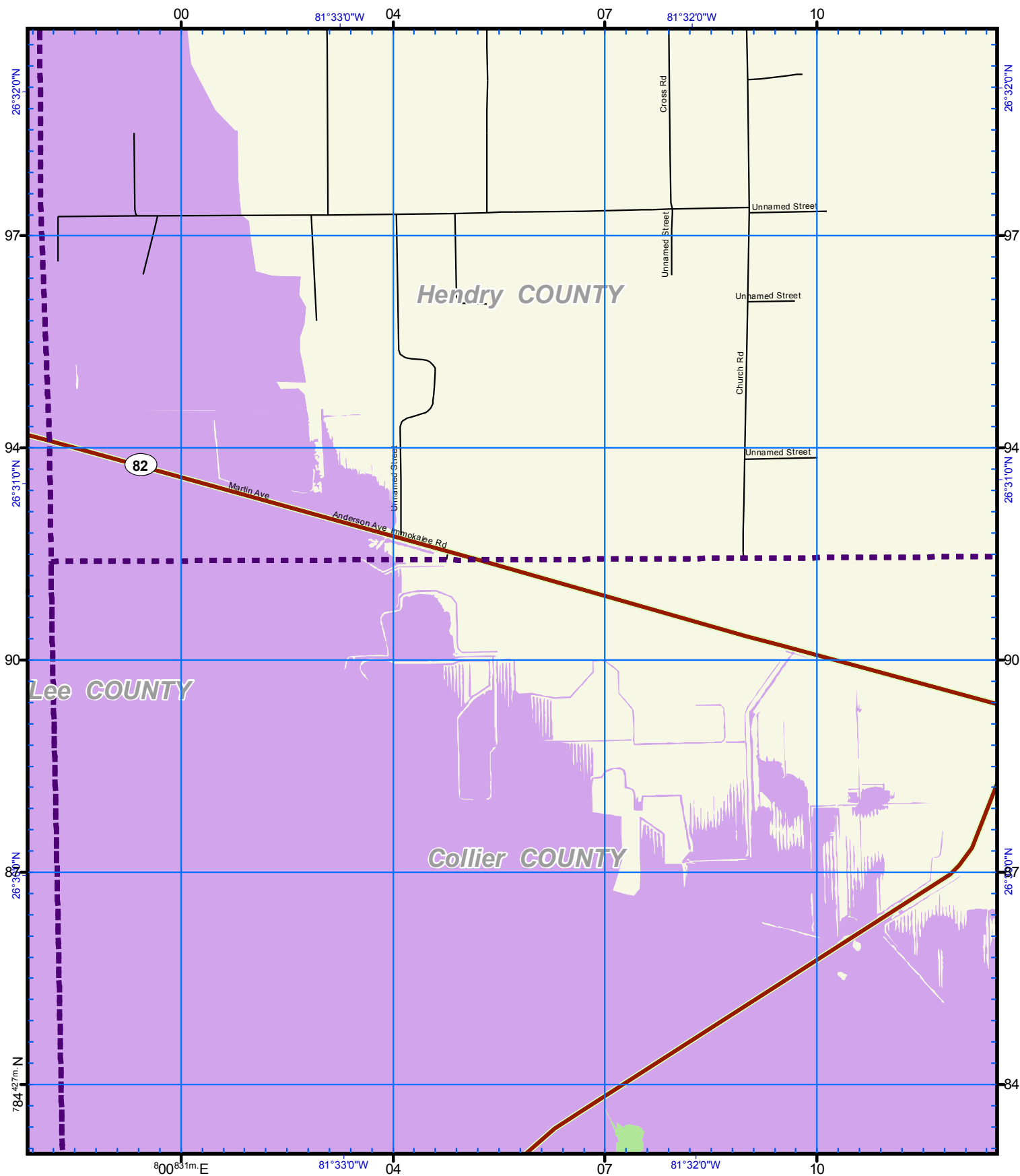
Map Plate 61

Page 26

Legend	
	Reference Point
	HOSPITAL
	City Limits
	Evacuation Route
	Existing Water
	Cat 1
	Cat 2
	Cat 3
	Cat 4
	Cat 5



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US National Grid
100,000-m Square ID
MK
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17R

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Lake Surge Zones 16ft Lake Level Hendry County, 2010

Scale - 1:24,000

0 2,000 Feet

USNG Page 17R MK 44 30

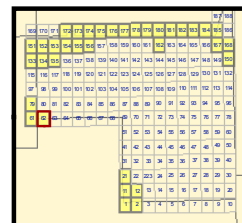
Map Plate 62

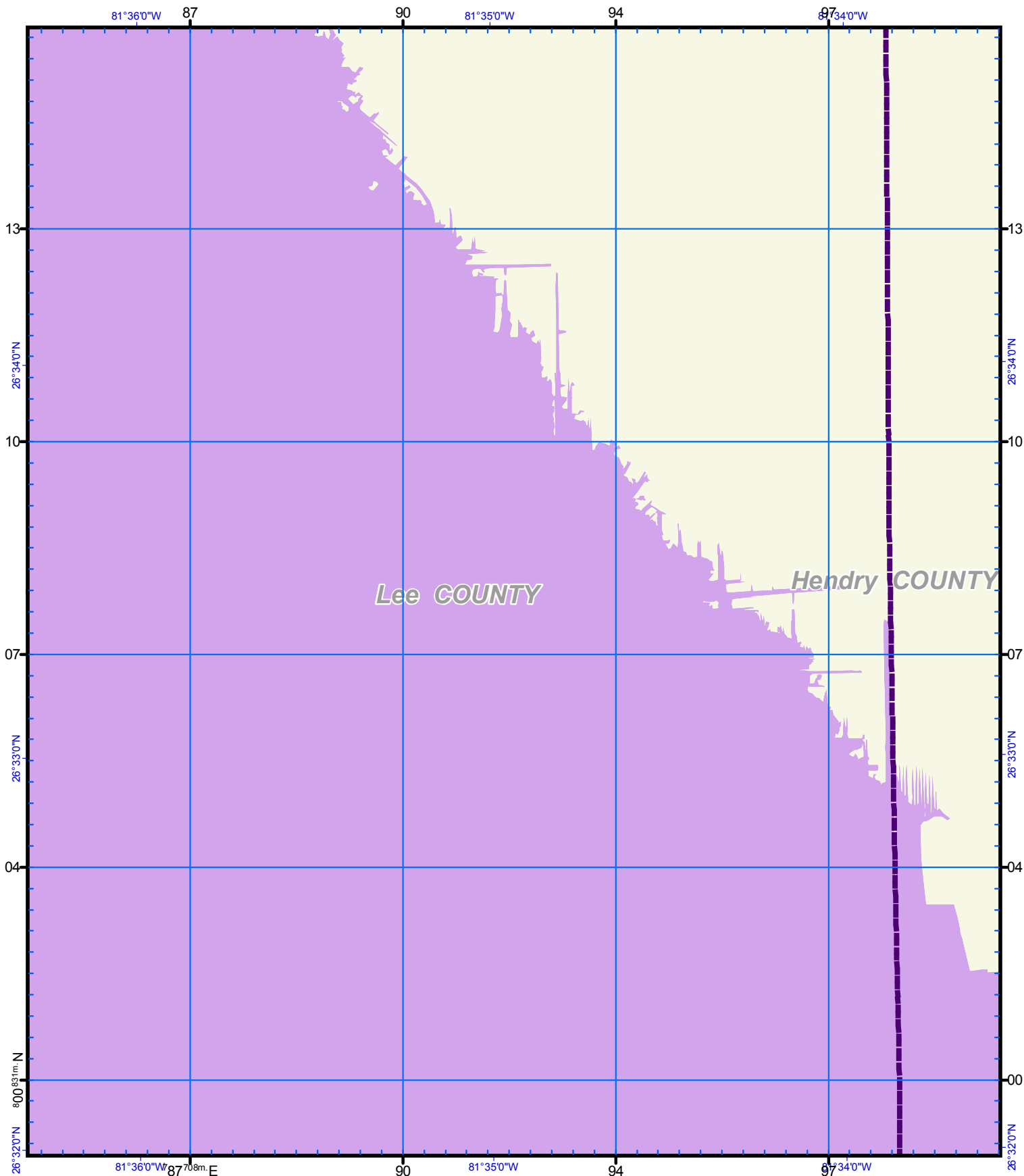
Page 27

Legend

- Reference Point
- HOSPITAL
- City Limits
- Evacuation Route
- Existing Water

Cat
1
2
3
4
5





US National Grid
100,000-m Square ID
MK

Grid Zone Designation
17R

Datum = NAD 1983, 1,000-m USNG



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Lake Surge Zones 16ft Lake Level Hendry County, 2010

Scale - 1:24,000
0 2,000 Feet

USNG Page 17R MK 40 35

Map Plate 79

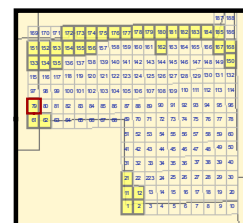
Page 28

Legend

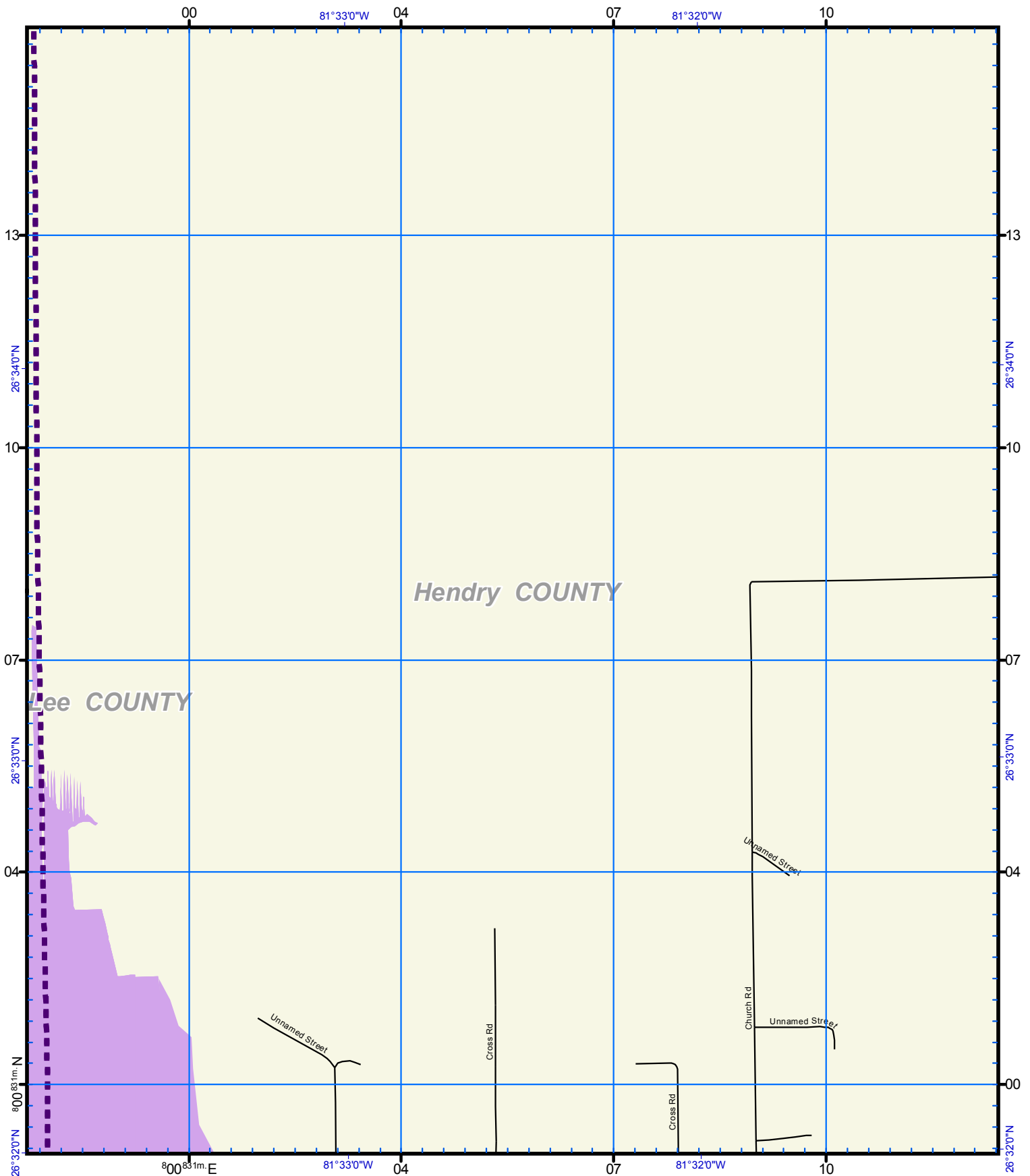
- Reference Point
- HOSPITAL
- City Limits
- Evacuation Route
- Existing Water

Cat

- 1
- 2
- 3
- 4
- 5



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US National Grid
100,000-m Square ID
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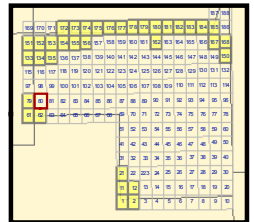
Notes:
1. Surge limits are based on still water storm tide height elevation above NAVD88 at high tide with no wave setup.
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Lake Surge Zones **16ft Lake Level** **Hendry County, 2010**

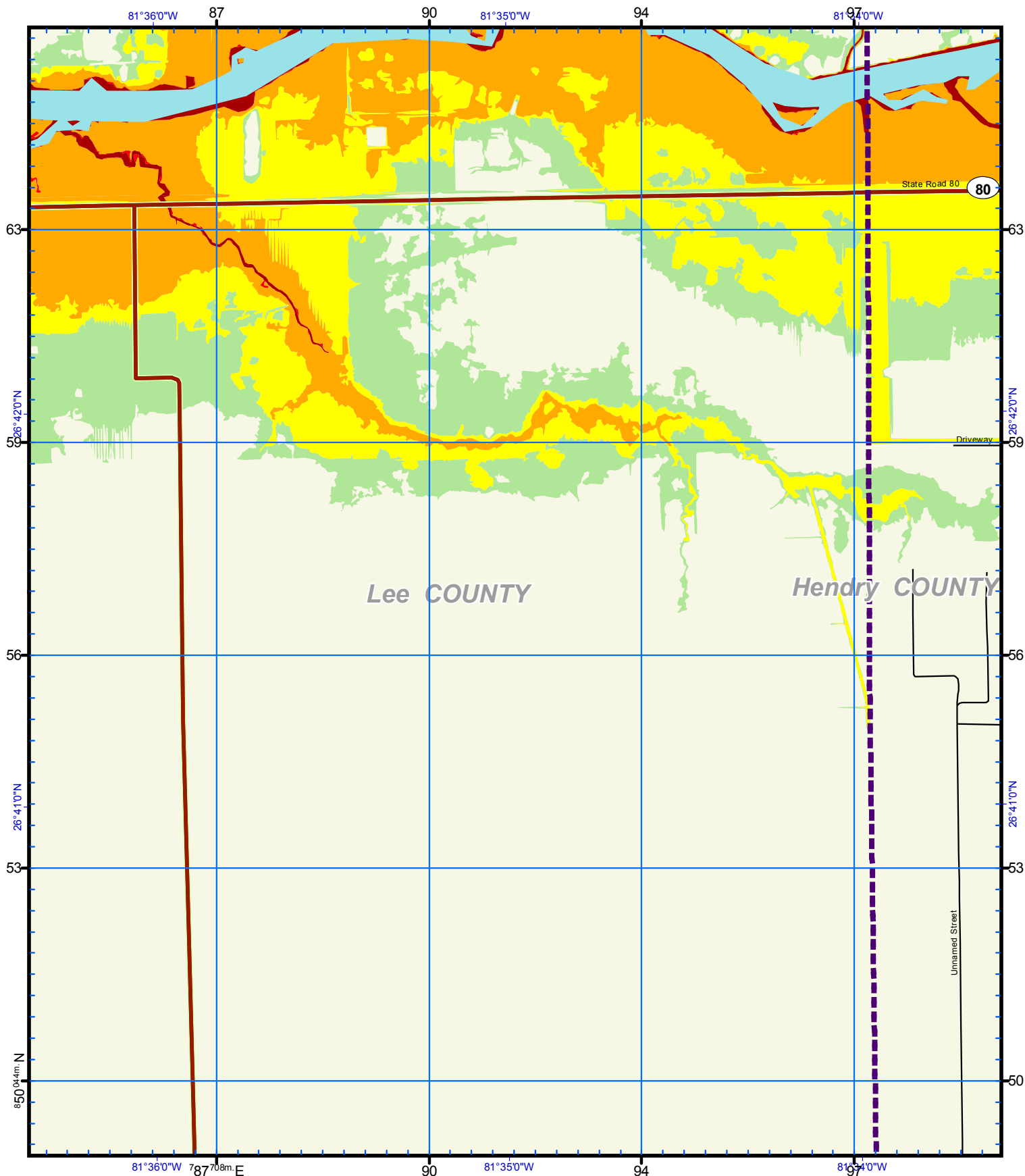
Scale - 1:24,000
0 2,000 Feet
USNG Page 17R MK 44 35
Map Plate 80
Page 29

Legend

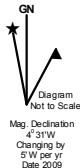
	Reference Point		Cat 1
	HOSPITAL		Cat 2
	City Limits		Cat 3
	Evacuation Route		Cat 4
	Existing Water		Cat 5



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US National Grid
100,000-m Square ID
MK
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Lake Surge Zones 16ft Lake Level Hendry County, 2010

Scale - 1:24,000
0 2,000 Feet

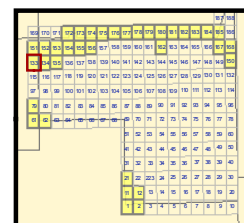
USNG Page 17R MK 40 50

Map Plate 133

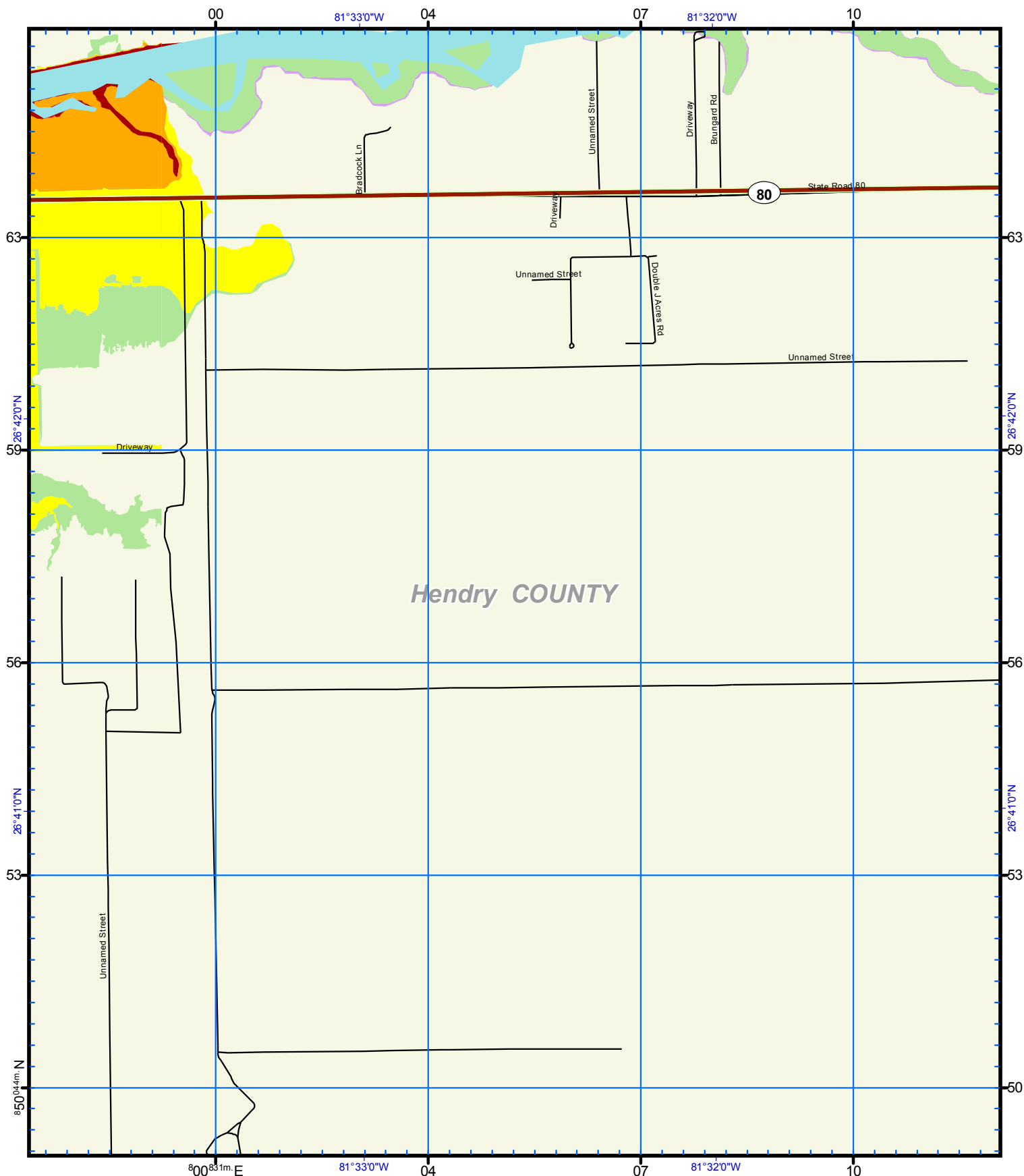
Page 30

Legend

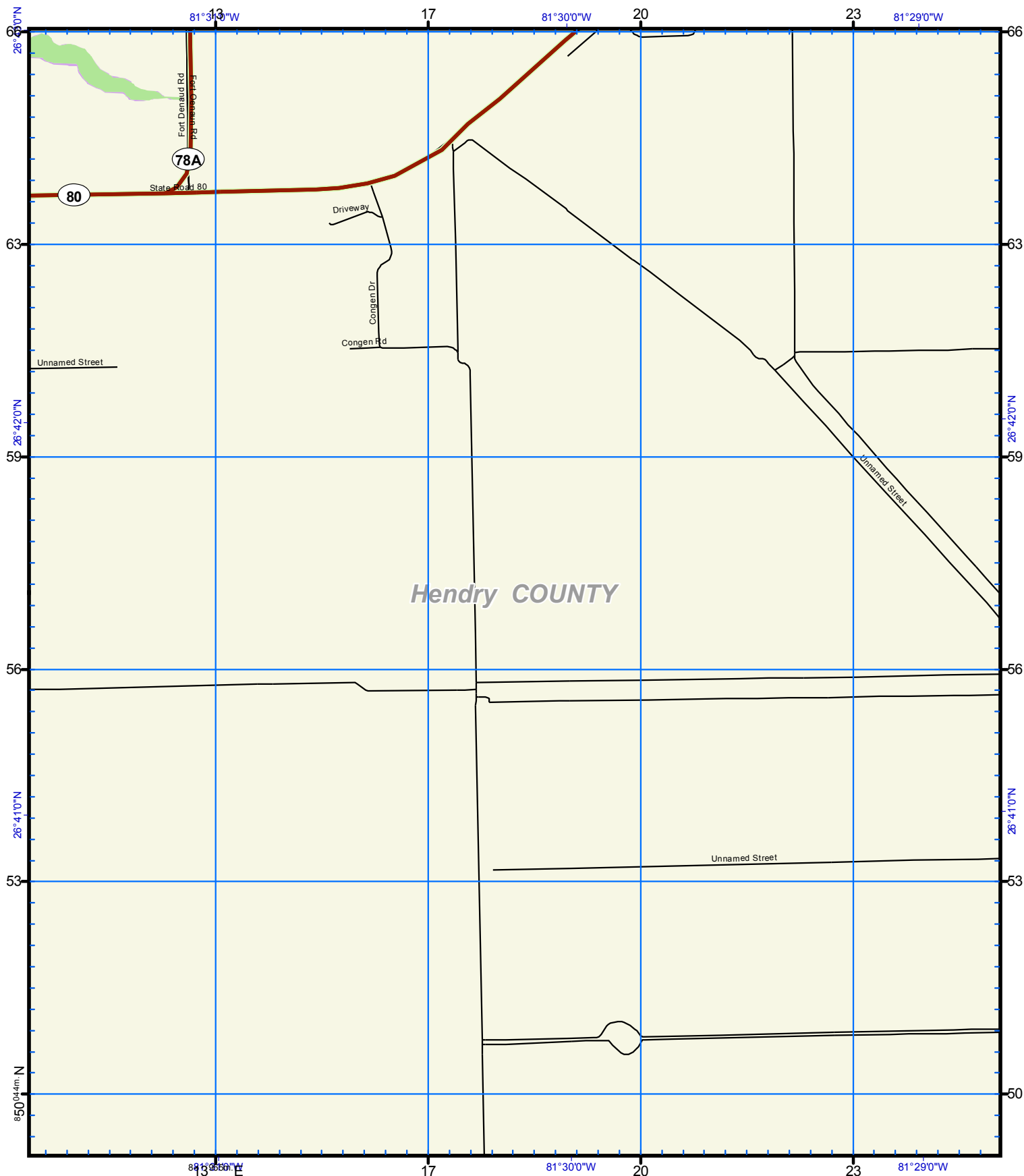
- Reference Point
 - HOSPITAL
 - City Limits
 - Evacuation Route
 - Existing Water
- | Cat | Color |
|-----|-------------|
| 1 | Red |
| 2 | Orange |
| 3 | Yellow |
| 4 | Light Green |
| 5 | Dark Green |



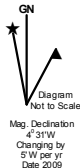
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US National Grid
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Lake Surge Zones 16ft Lake Level Hendry County, 2010

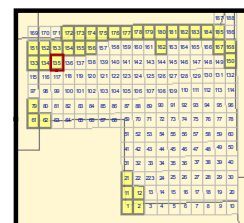
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0 2,000 Feet

USNG Page 17R MK 48 50

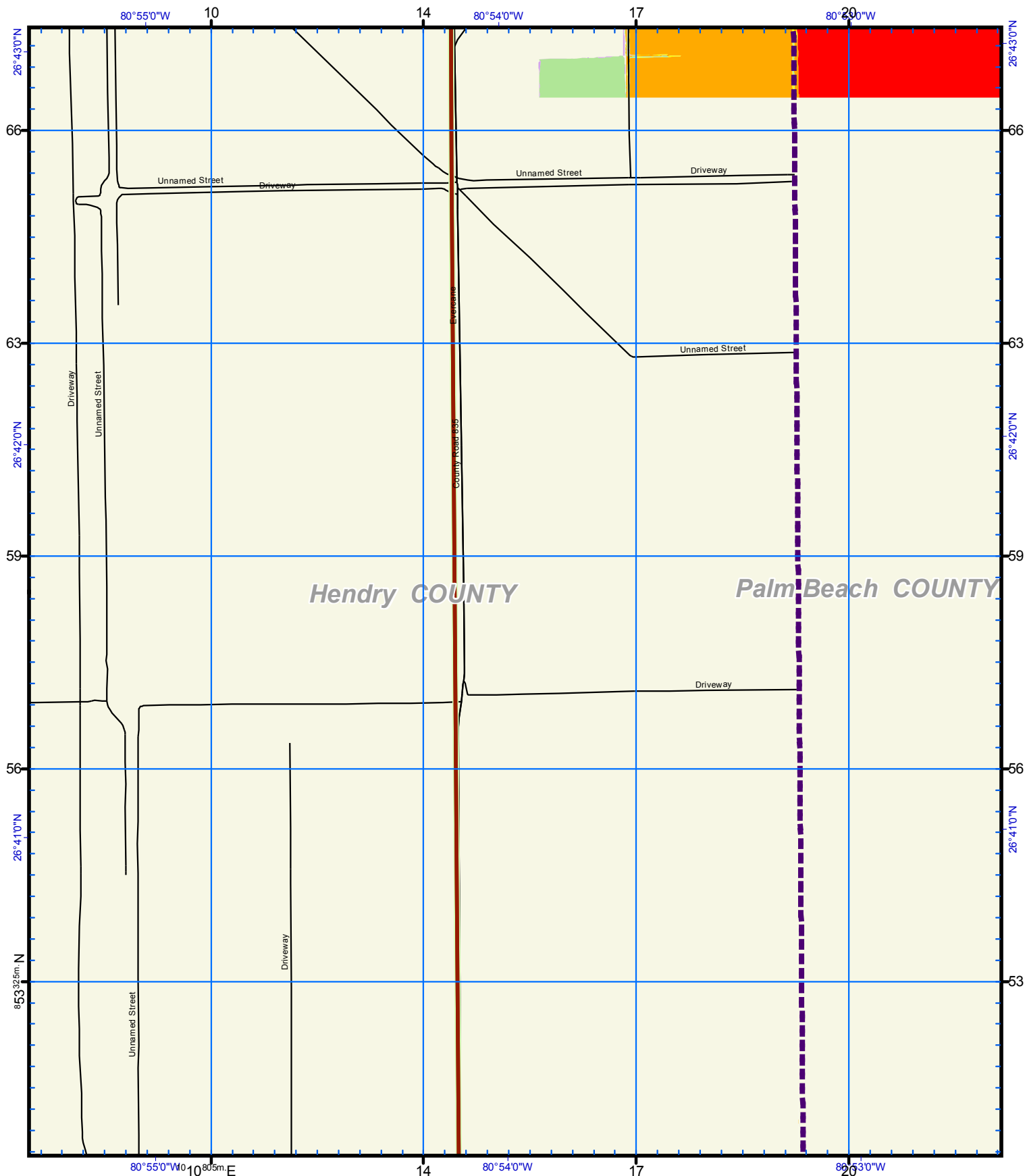
Map Plate 135

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Legend	
	Reference Point
	HOSPITAL
	City Limits
	Evacuation Route
	Existing Water
	Cat
	1
	2
	3
	4
	5



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US National Grid
100,000-m Square ID
NK
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Lake Surge Zones

16ft Lake Level

Hendry County, 2010

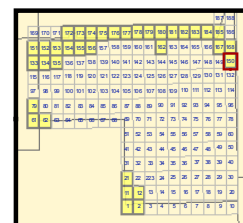
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0 2,000 Feet

USNG Page **17R NK 08 50**

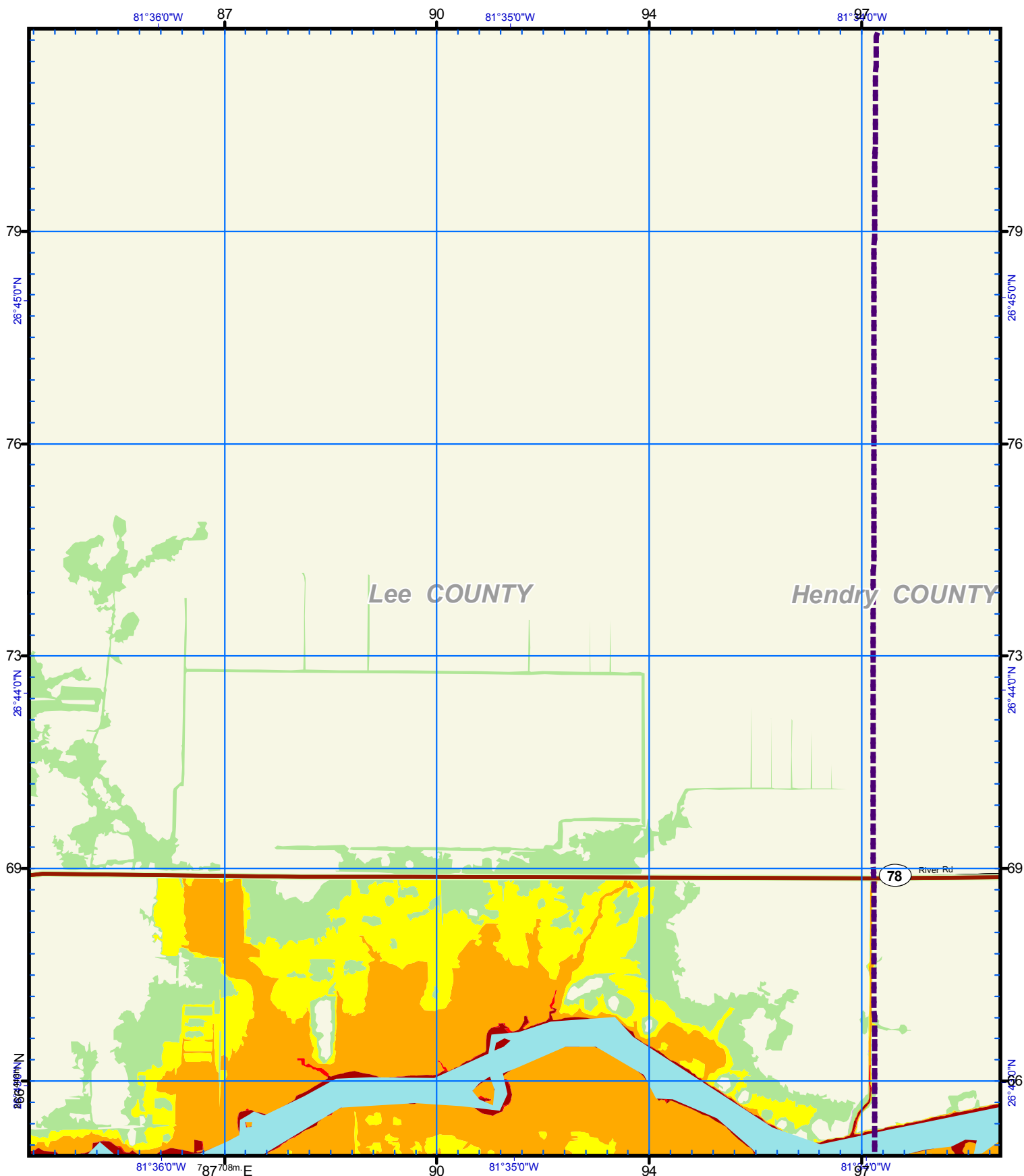
Map Plate **150**

Page **33**

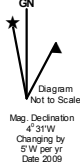
Legend	
	Reference Point
	HOSPITAL
	City Limits
	Evacuation Route
	Existing Water
	Cat
	1
	2
	3
	4
	5



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Lake Surge Zones

16ft Lake Level

Hendry County, 2010

Scale - 1:24,000
0 2,000 Feet

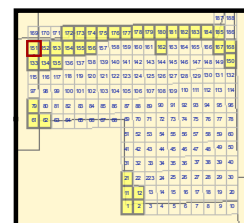
USNG Page 17R MK 40 55

Map Plate 151

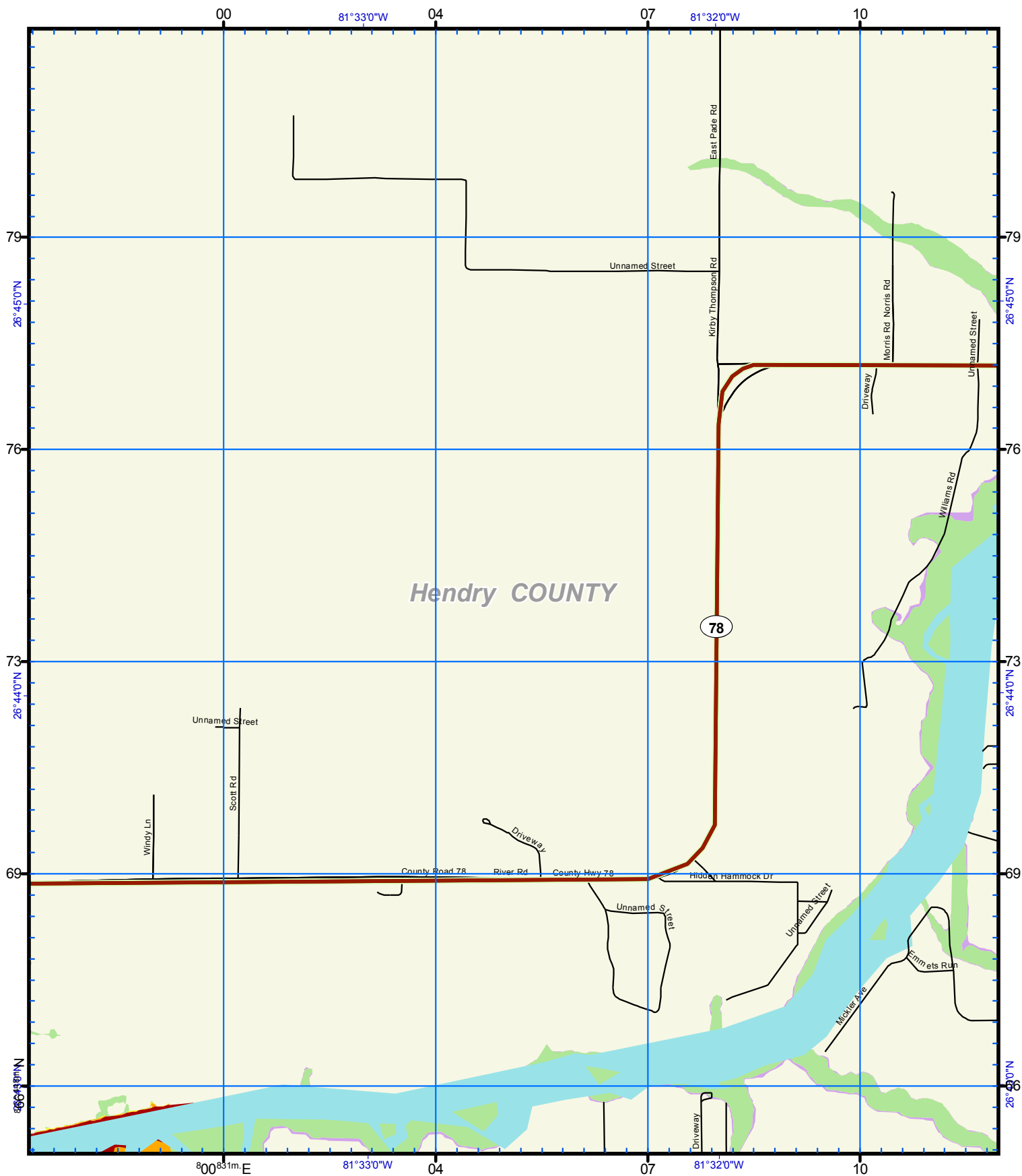
Page 34

Legend

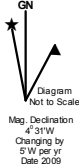
- Reference Point
 - HOSPITAL
 - City Limits
 - Evacuation Route
 - Existing Water
- | Cat | 1 | 2 | 3 | 4 | 5 |
|-----|-----|--------|--------|-------------|------------|
| 1 | Red | | | | |
| 2 | | Orange | | | |
| 3 | | | Yellow | | |
| 4 | | | | Light Green | |
| 5 | | | | | Dark Green |



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Lake Surge Zones 16ft Lake Level Hendry County, 2010

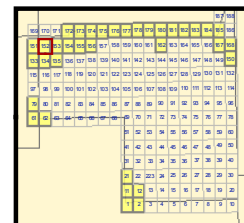
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USNG Page 17R MK 44 55

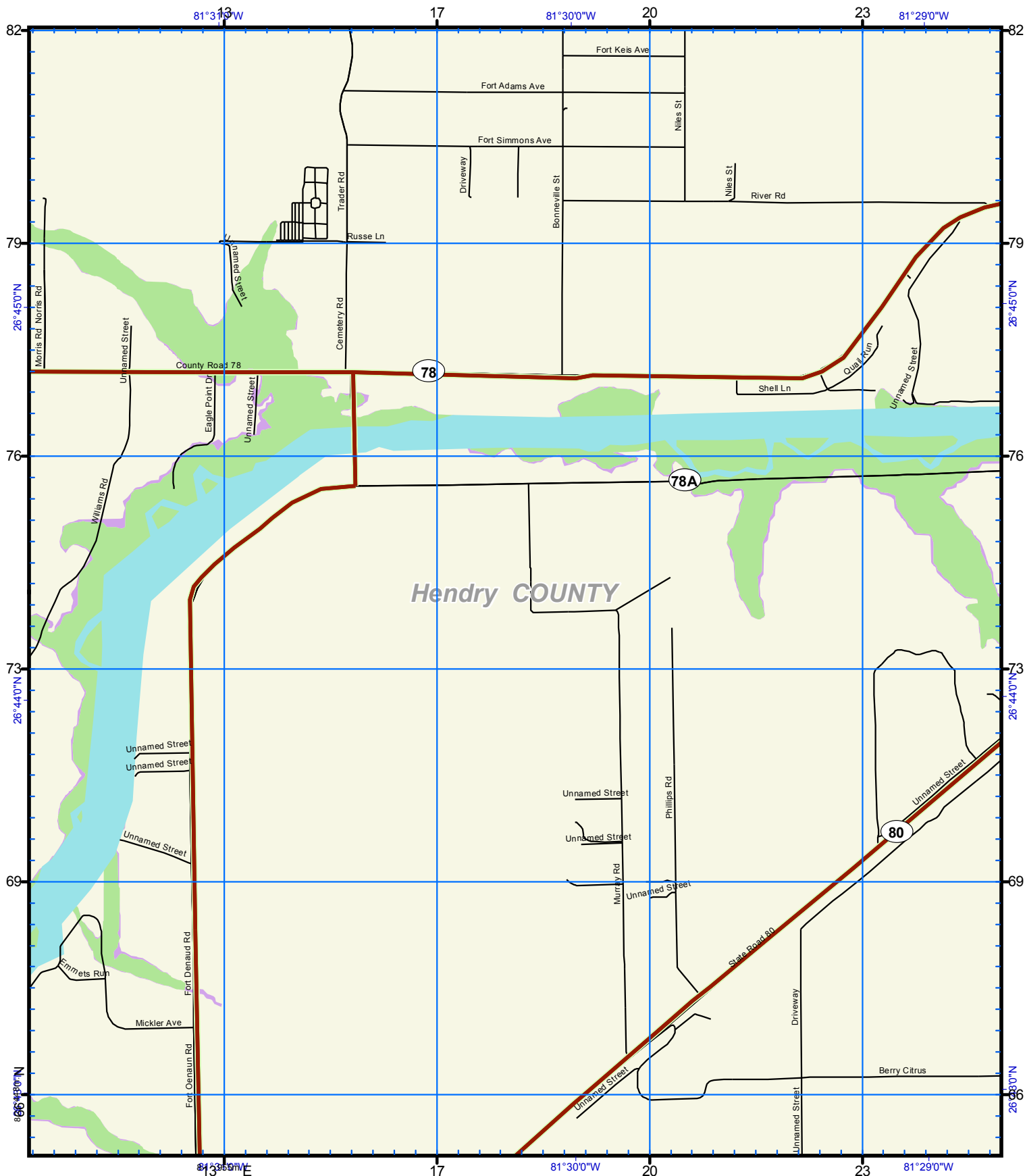
Map Plate 152

Page 35

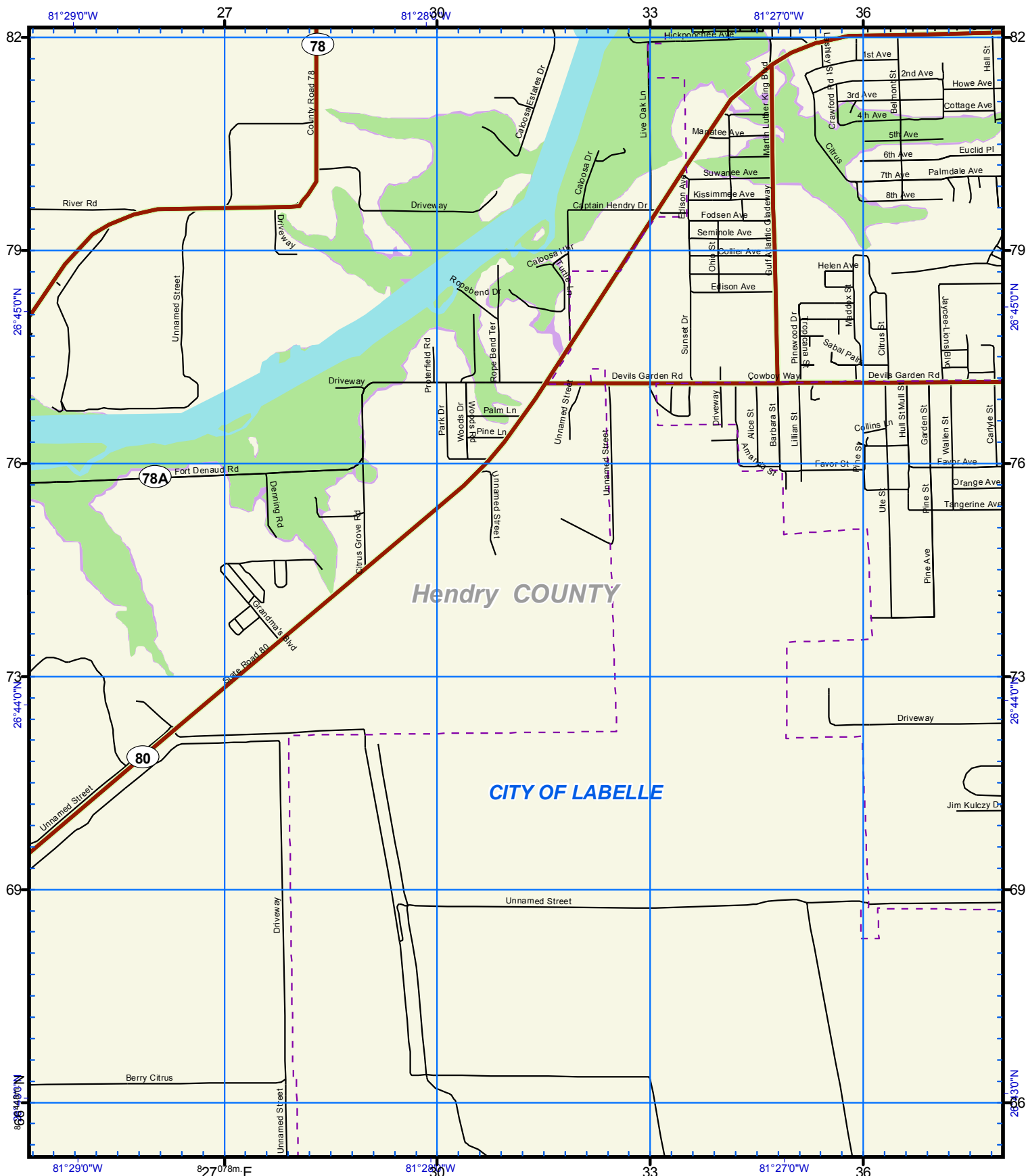
Legend		Cat
●	Reference Point	1
⚡	HOSPITAL	2
⬜	City Limits	3
—	Evacuation Route	4
⬜	Existing Water	5



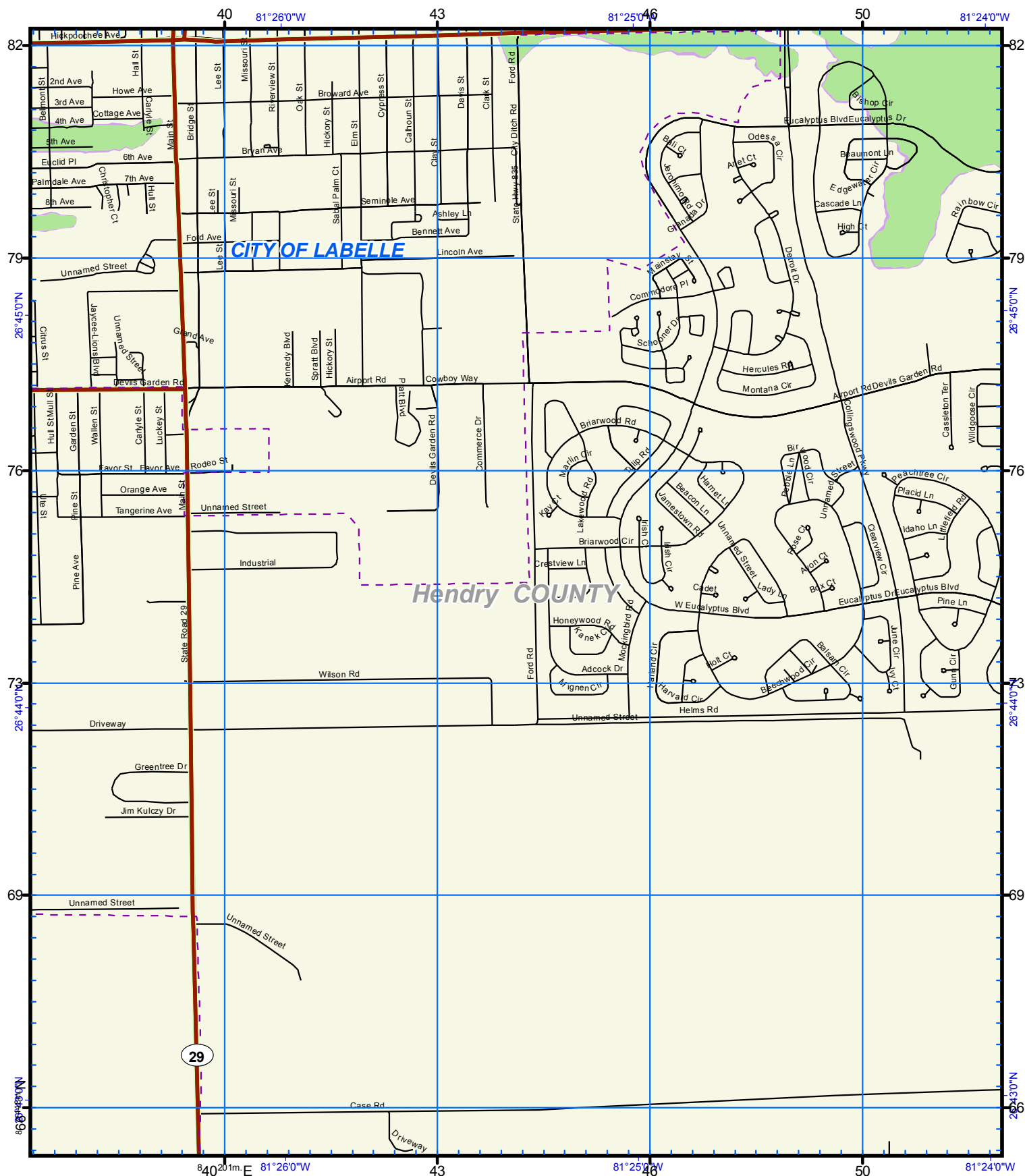
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US National Grid
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Lake Surge Zones 16ft Lake Level

Hendry County, 2010






Scale - 1:24,000



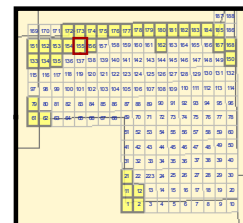
USNG Page 17R MK 56 55

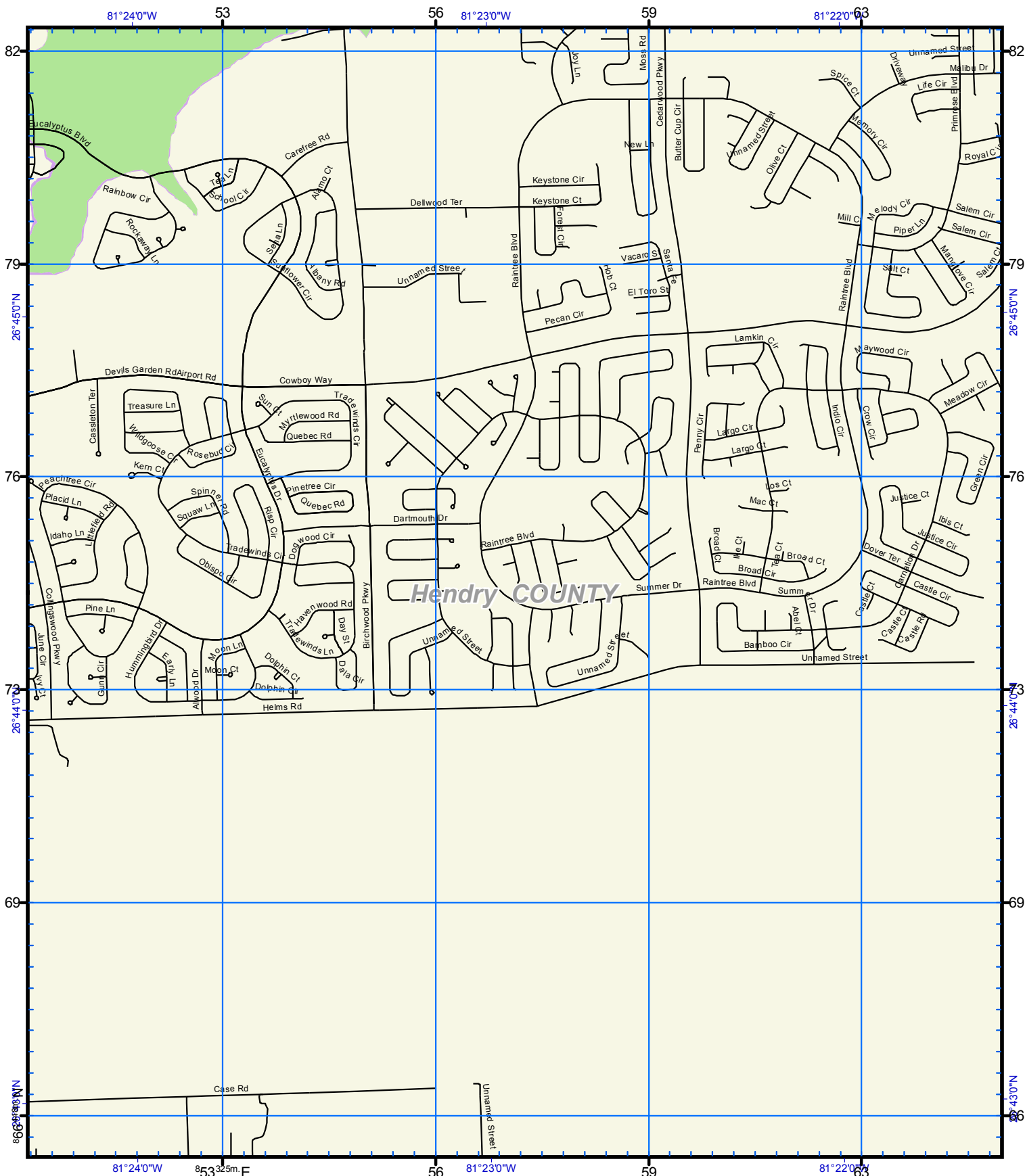
Map Plate **155**

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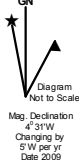
- Legend**
-  Reference Point
 -  HOSPITAL
 -  City Limits
 -  Evacuation Route
 -  Existing Water

- | | |
|---|---|
|  | 1 |
|  | 2 |
|  | 3 |
|  | 4 |
|  | 5 |





US National Grid
100,000-m Square ID
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Grid Zone Designation
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Lake Surge Zones 16ft Lake Level Hendry County, 2010

Scale - 1:24,000
0 2,000 Feet

USNG Page 17R MK 60 55

Map Plate 156

Page 39

Legend

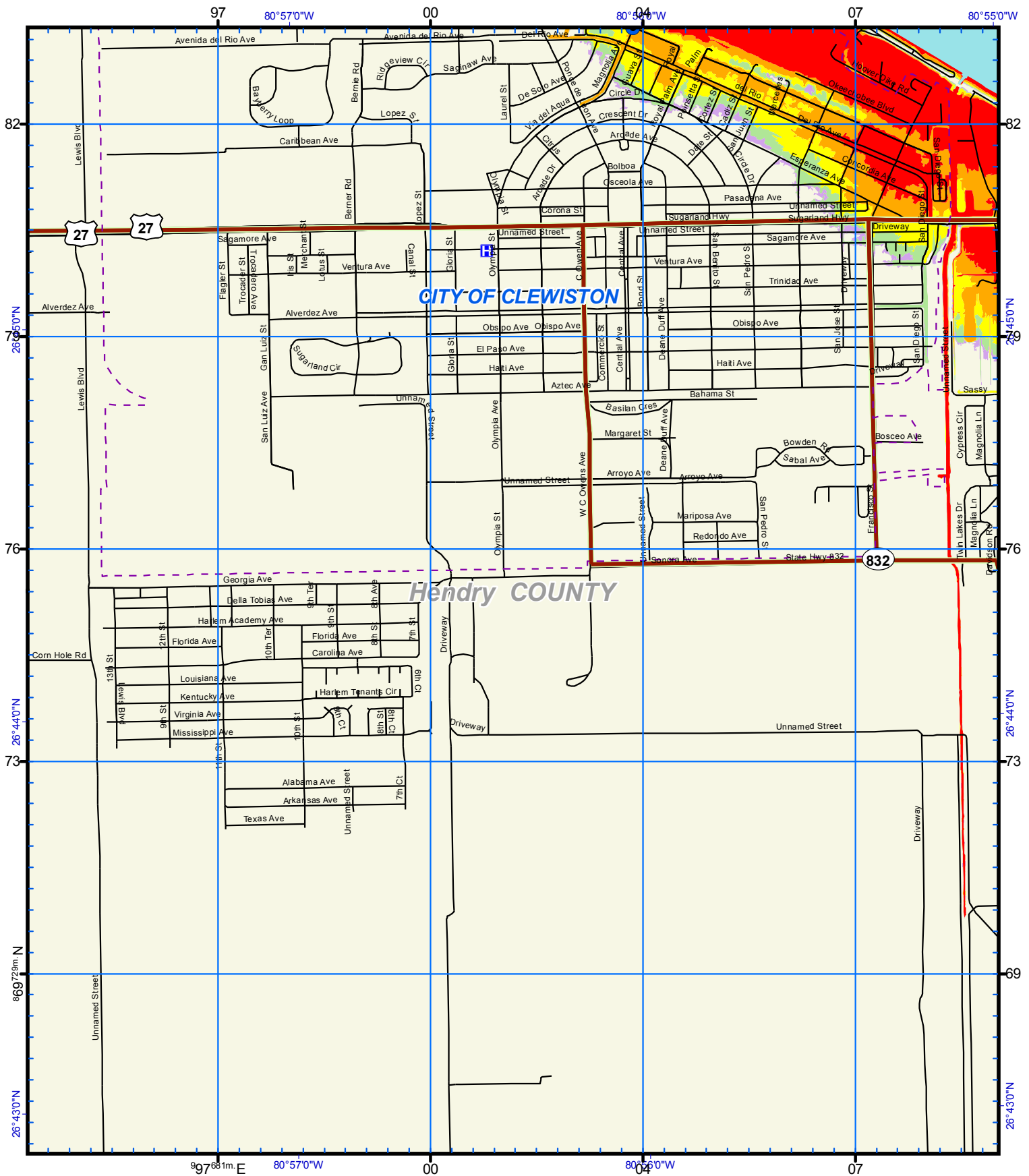
- Reference Point
- HOSPITAL
- City Limits
- Evacuation Route
- Existing Water

Cat

- 1
- 2
- 3
- 4
- 5



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NK
Grid Zone Designation
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Datum = NAD 1983, 1,000-m USNG



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Lake Surge Zones
16ft Lake Level
Hendry County, 2010
Scale - 1:24,000

0 2,000 Feet
USNG Page **17R NK 04 55**
Map Plate **167**
Page 40

Legend

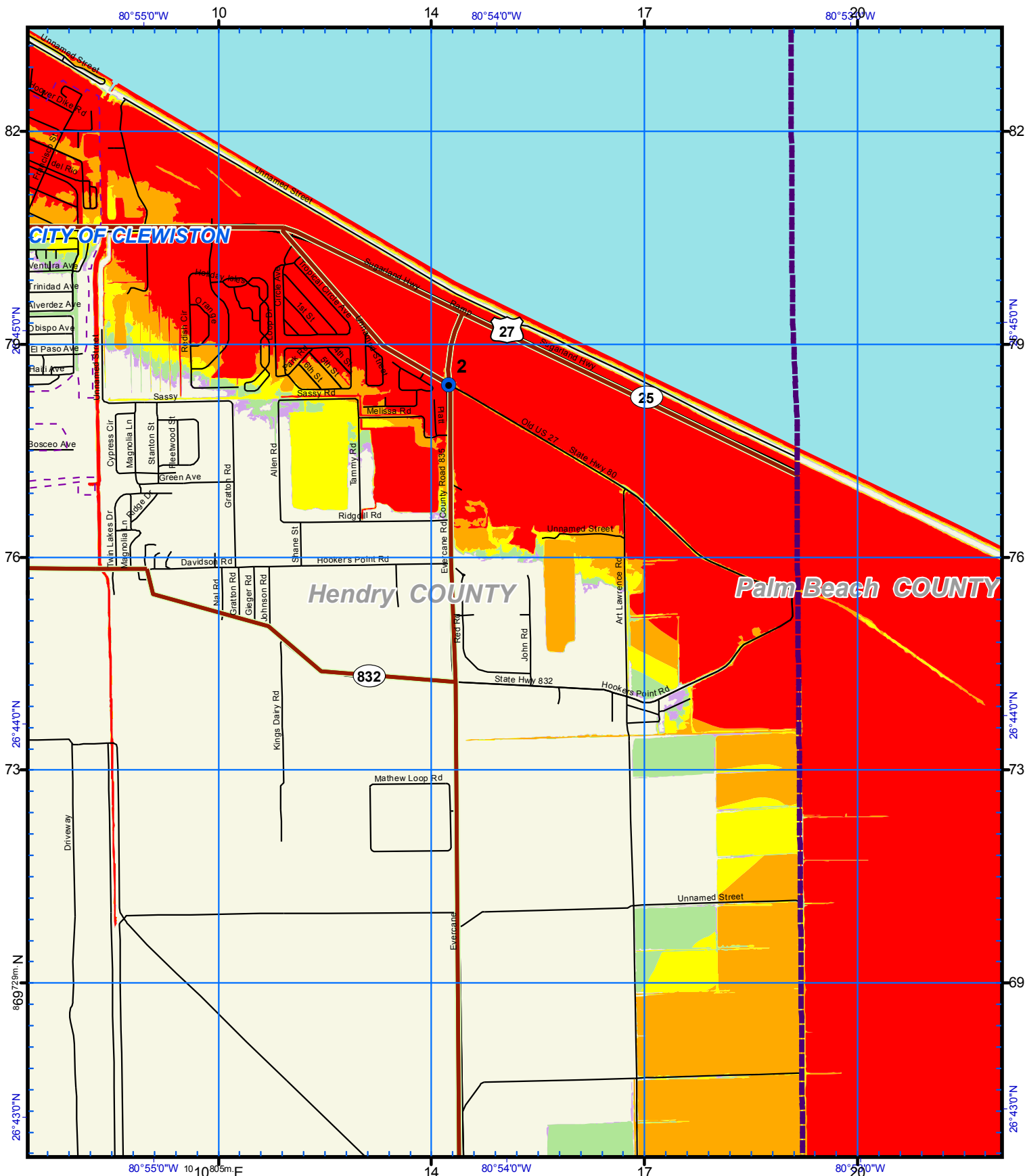
- Reference Point
- HOSPITAL
- City Limits
- Evacuation Route
- Existing Water

Cat

- 1
- 2
- 3
- 4
- 5

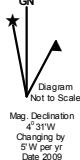


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US National Grid
100,000-m Square ID
NK
Grid Zone Designation
17R
Datum = NAD 1983, 1,000-m USNG

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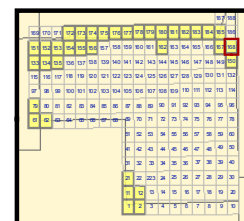


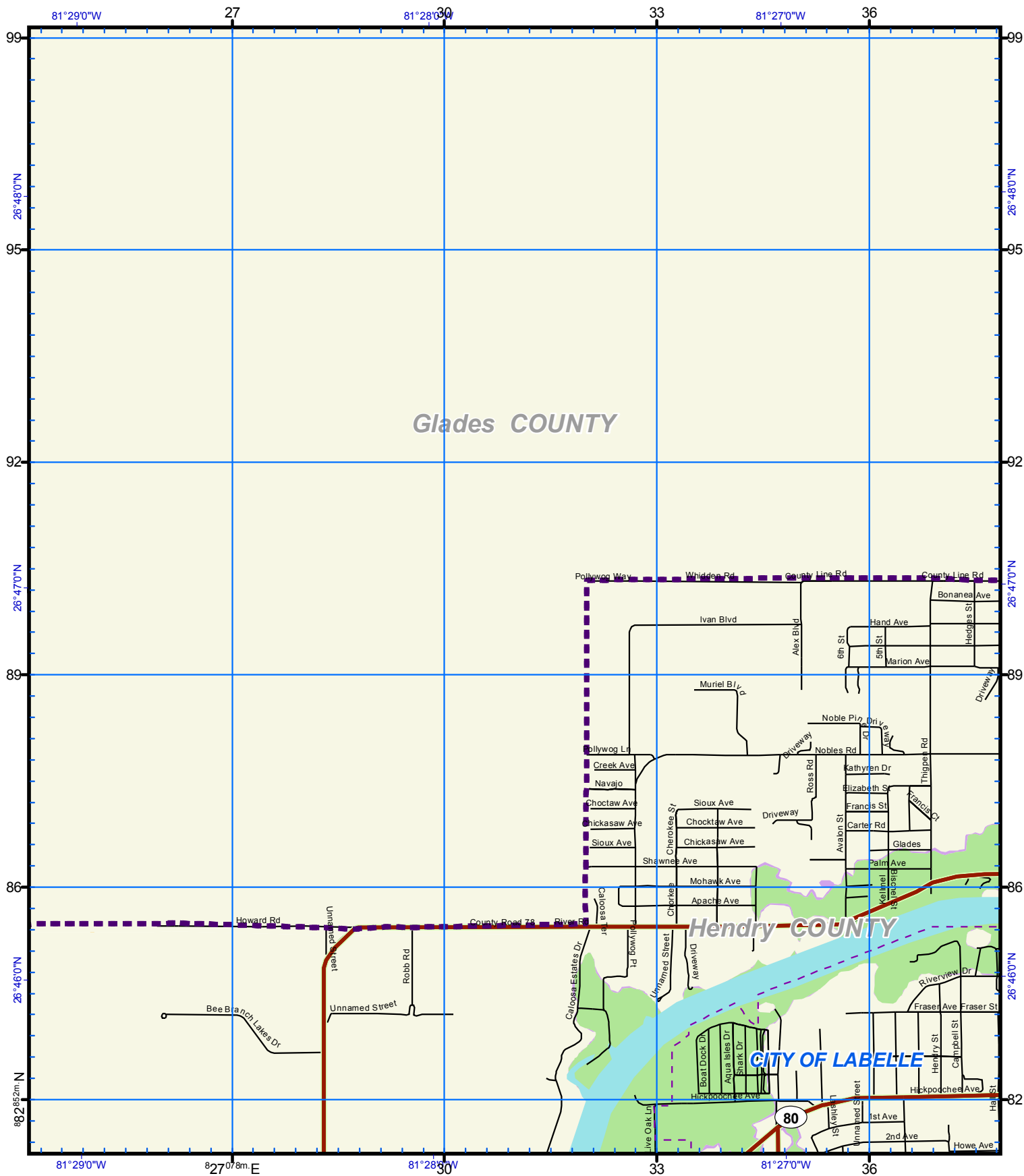
Notes:
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Lake Surge Zones
16ft Lake Level
Hendry County, 2010
Scale - 1:24,000
0 2,000 Feet
USNG Page **17R NK 08 55**
Map Plate **168**
Page 41

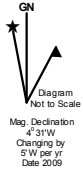
Legend

Reference Point	Cat 1
HOSPITAL	Cat 2
City Limits	Cat 3
Evacuation Route	Cat 4
Existing Water	Cat 5





US National Grid
100,000-m Square ID
MK
Grid Zone Designation
17R
Datum = NAD 1983, 1,000-m USNG



Notes:
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Lake Surge Zones

16ft Lake Level

Hendry County, 2010

Scale - 1:24,000
0 2,000 Feet

USNG Page 17R MK 52 60

Map Plate 172

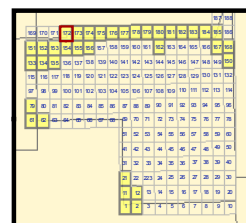
Page 42

Legend

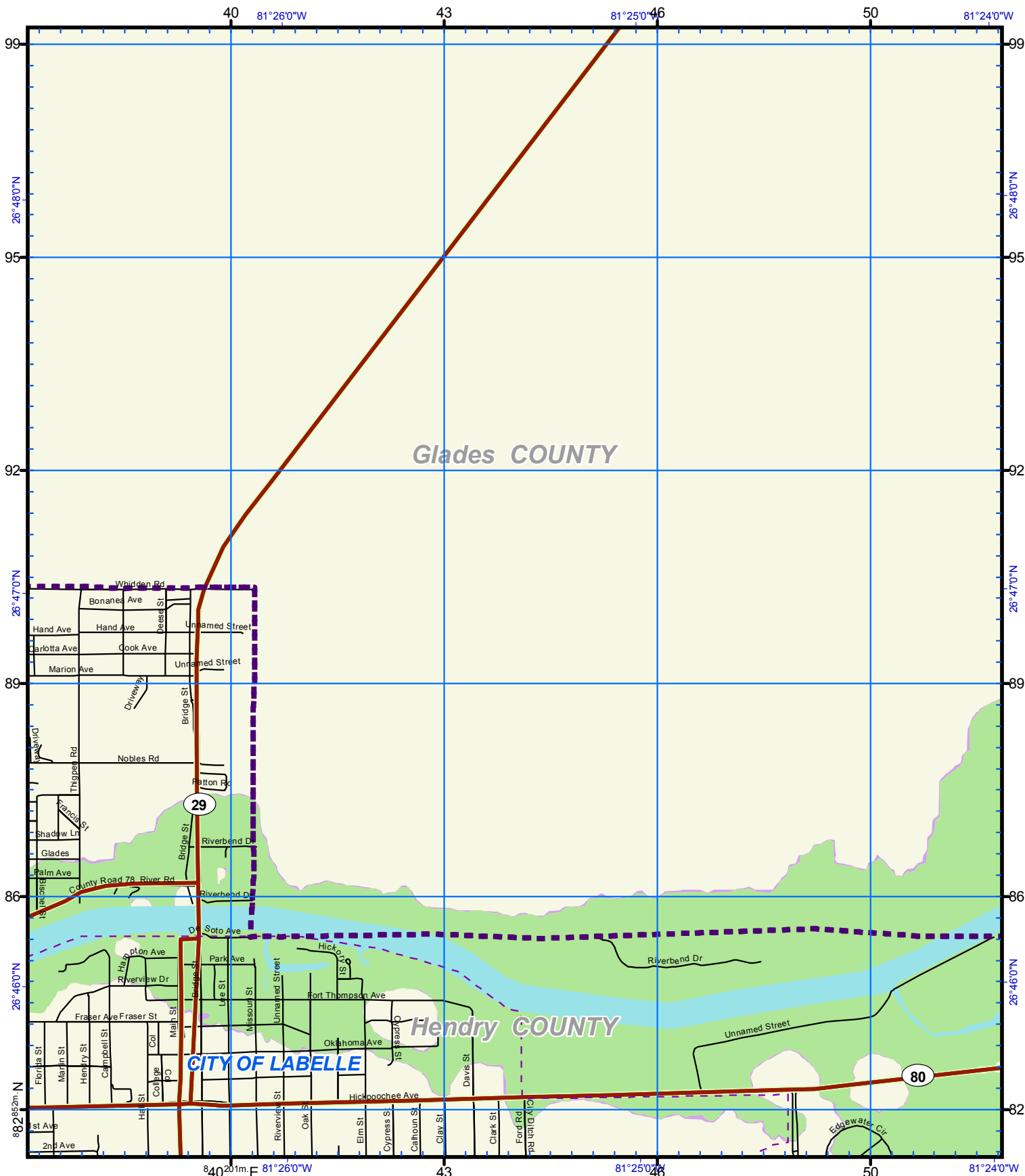
- Reference Point
- HOSPITAL
- City Limits
- Evacuation Route
- Existing Water

Cat

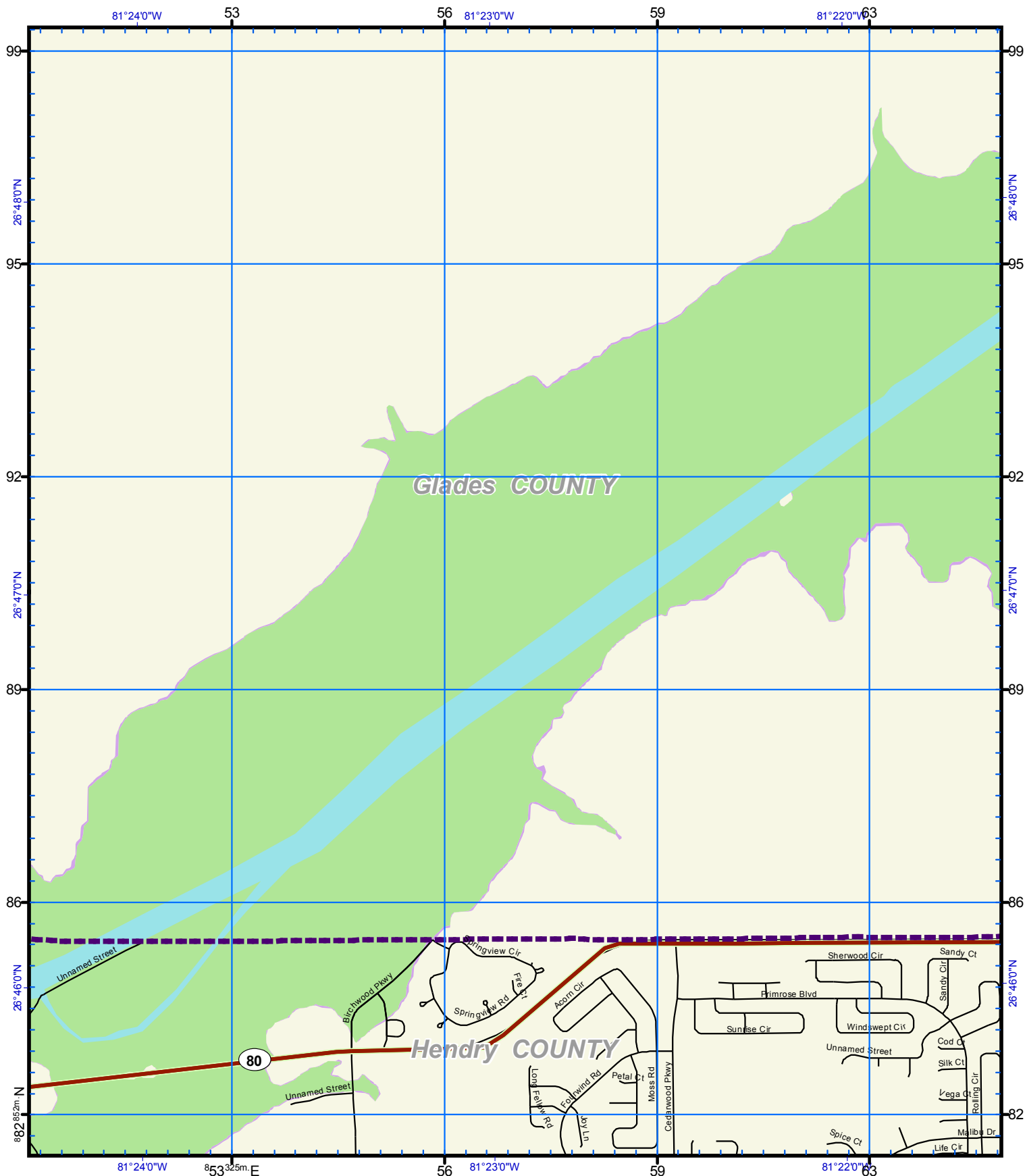
- 1
- 2
- 3
- 4
- 5



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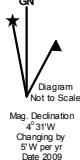
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US National Grid
100,000-m Square ID
MK
Grid Zone Designation
17R

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Lake Surge Zones

16ft Lake Level

Hendry County, 2010

Scale - 1:24,000

0 2,000 Feet

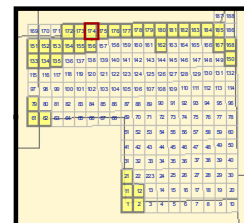
USNG Page 17R MK 60 60

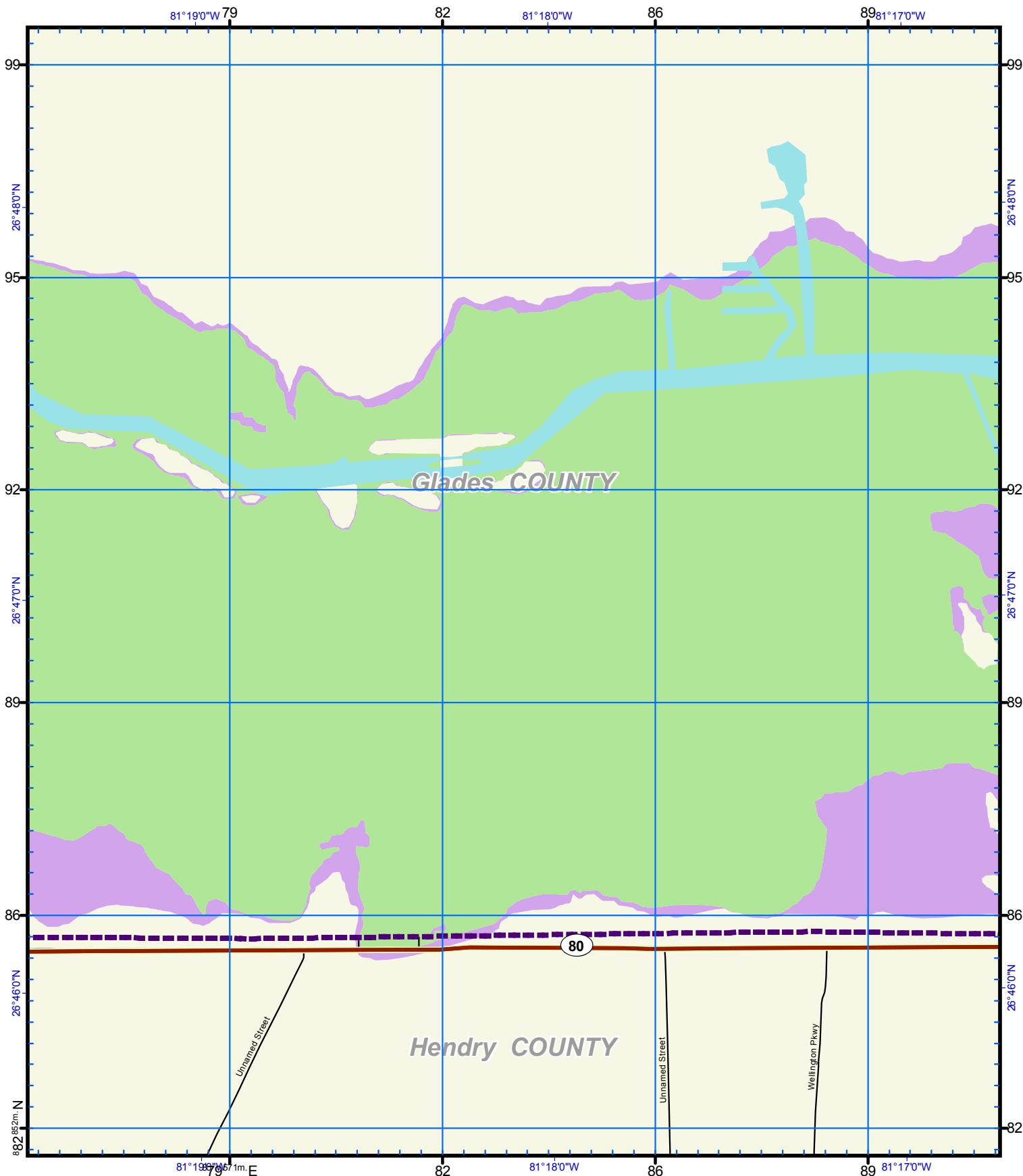
Map Plate 174

Page 44

Legend

- Reference Point
 - HOSPITAL
 - City Limits
 - Evacuation Route
 - Existing Water
- | Cat | Color |
|-----|-------------|
| 1 | Red |
| 2 | Orange |
| 3 | Yellow |
| 4 | Light Green |
| 5 | Purple |





US National Grid
100,000-m Square ID
MK
Grid Zone Designation
17R
Datum = NAD 1983, 1,000-m USNG

GN
★
Diagram
Not to Scale
Mag. Declination
4° 31' W
Changing by
5° W per yr
Date 2009

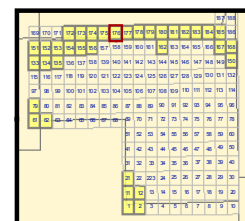
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1. Surge limits are based on still water storm tide height elevation above NAVD88 at high tide with no wave setup.
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Lake Surge Zones
16ft Lake Level
Hendry County, 2010
Scale - 1:24,000

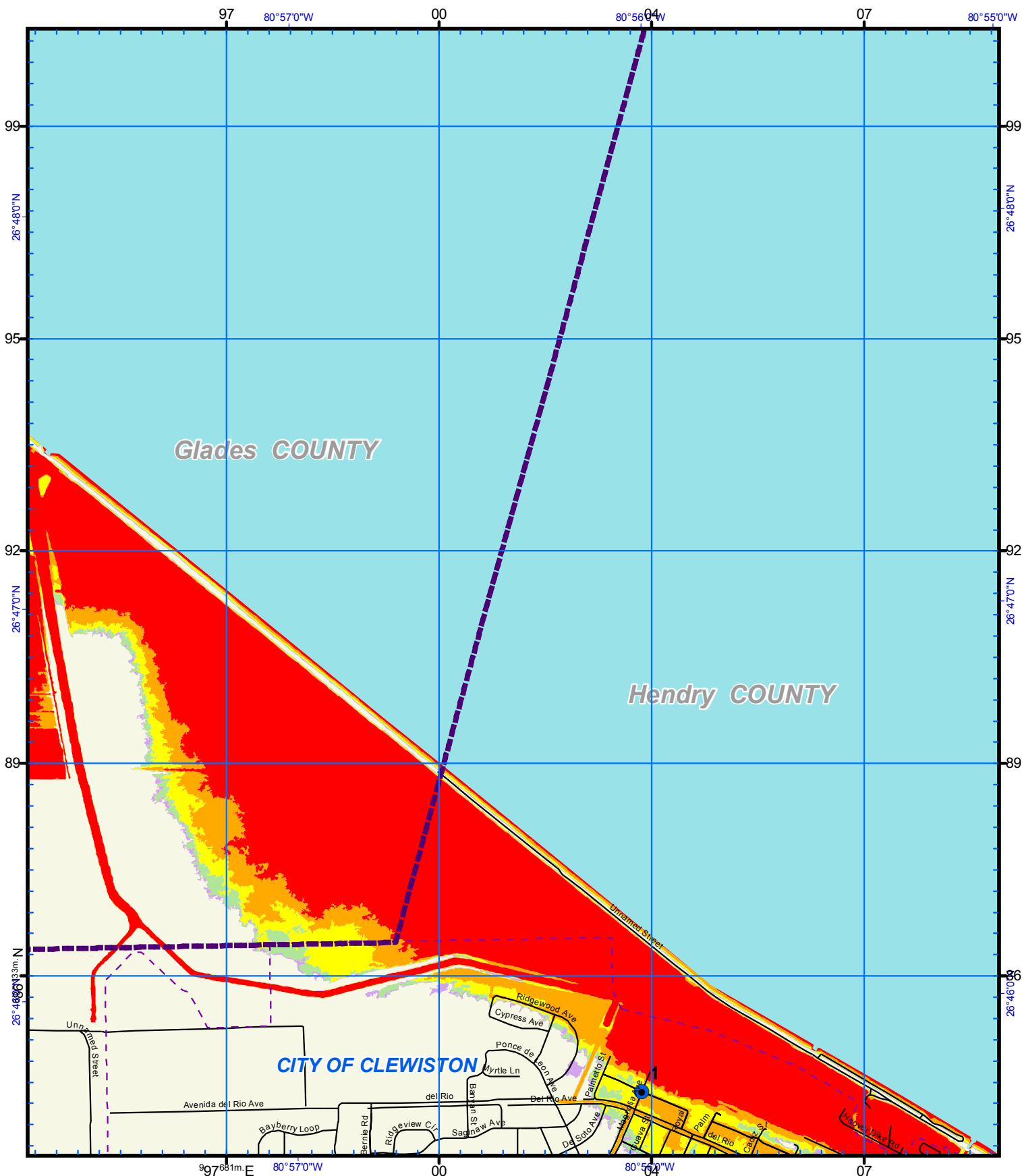
0 2,000 Feet
USNG Page 17R MK 68 60

Map Plate 176
Page 45

Legend
● Reference Point
HOSPITAL
City Limits
Evacuation Route
Existing Water
Cat
1
2
3
4
5



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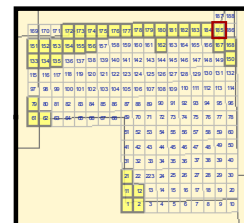
US National Grid
100,000-m Square ID
NK
Grid Zone Designation
17R
Datum = NAD 1983, 1,000-m USNG

GN
Diagram
Not to Scale
Mag. Declination
4°31'W
Changing by
5°W per yr
Date 2009

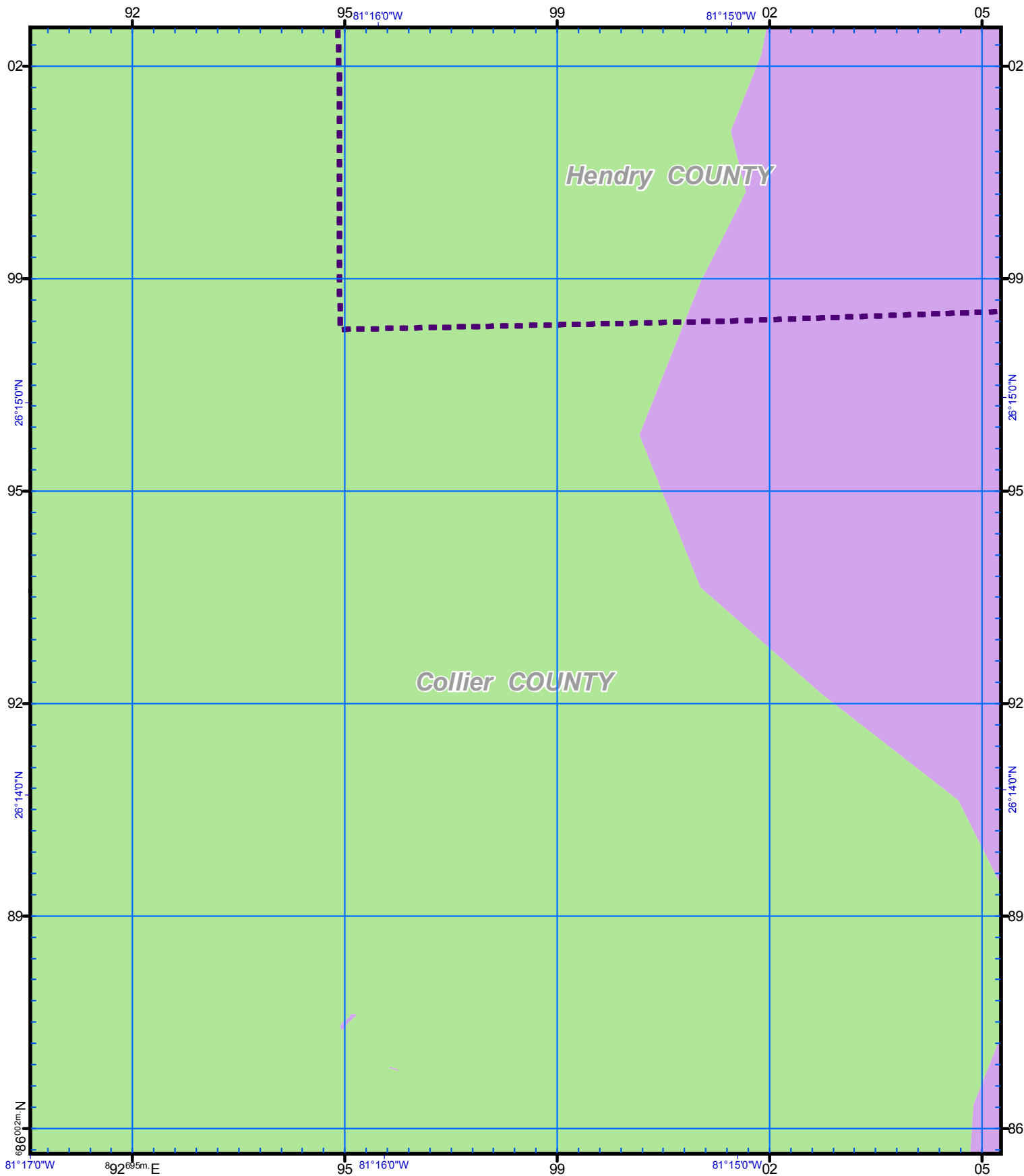
Notes:
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Lake Surge Zones
16ft Lake Level
Hendry County, 2010
Scale - 1:24,000
0 2,000 Feet
USNG Page **17R NK 04 60**
Map Plate **185**
Page 46

Legend
● Reference Point
H HOSPITAL
City Limits
Evacuation Route
Existing Water
Cat
1
2
3
4
5

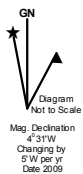


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US National Grid
100,000-m Square ID
MK
Grid Zone Designation
17R

Datum = NAD 1983, 1,000-m USNG



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Lake Surge Zones 20ft Lake Level Hendry County, 2010

Scale - 1:24,000

0 2,000 Feet

USNG Page 17R MK 72 00

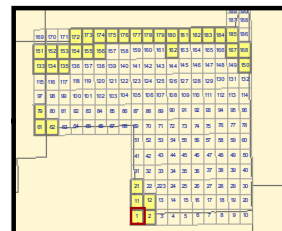
Map Plate 1

Page 47

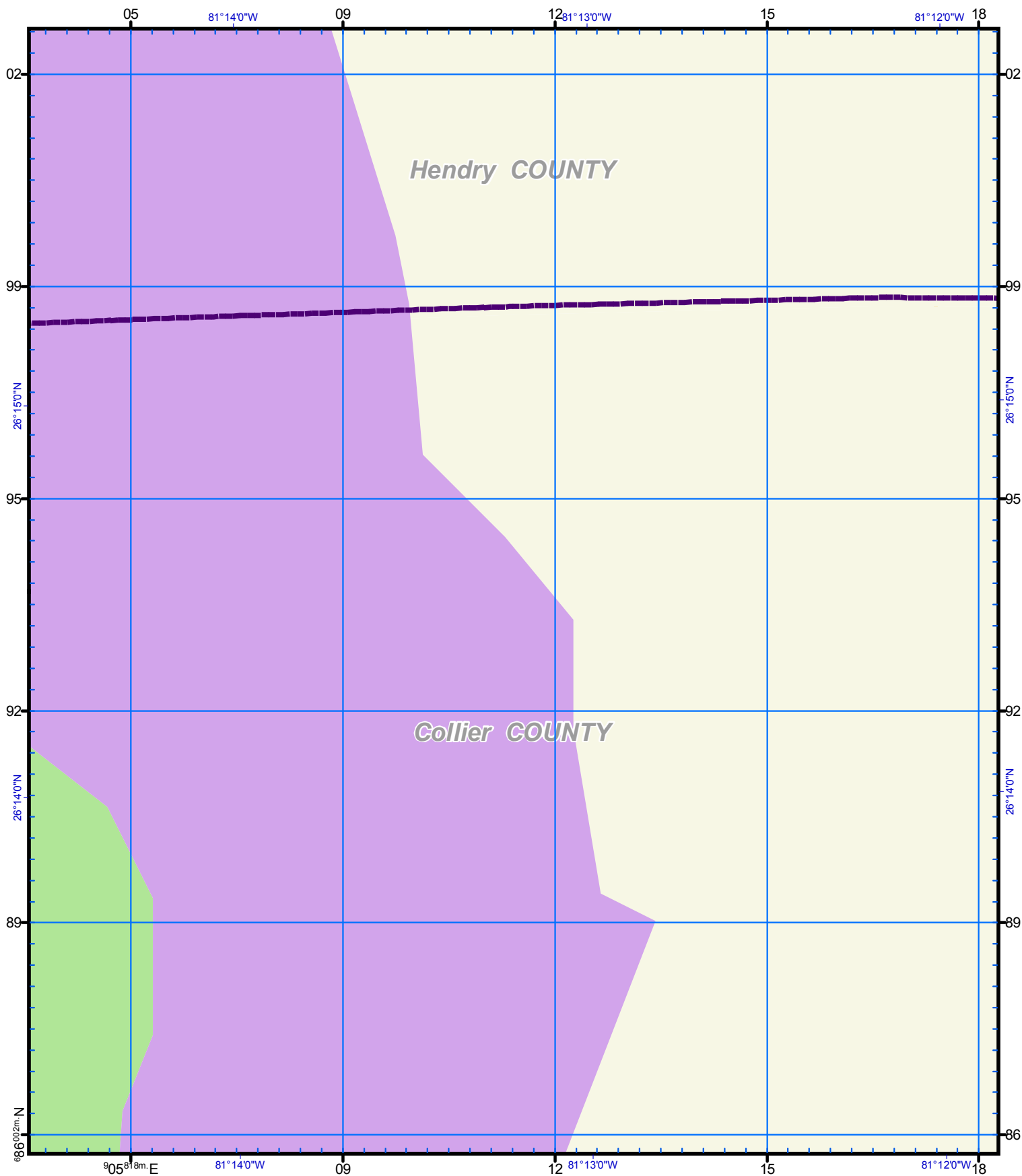
Legend

- Reference Point
- HOSPITAL
- City Limits
- Evacuation Route
- Existing Water

- Cat
- 1
 - 2
 - 3
 - 4
 - 5

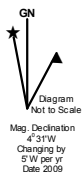


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US National Grid
100,000-m Square ID
MK
Grid Zone Designation
17R

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Lake Surge Zones 20ft Lake Level Hendry County, 2010

Scale - 1:24,000

0 2,000 Feet

USNG Page 17R MK 76 00

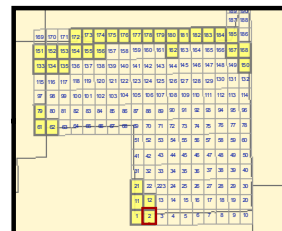
Map Plate 2

Page 48

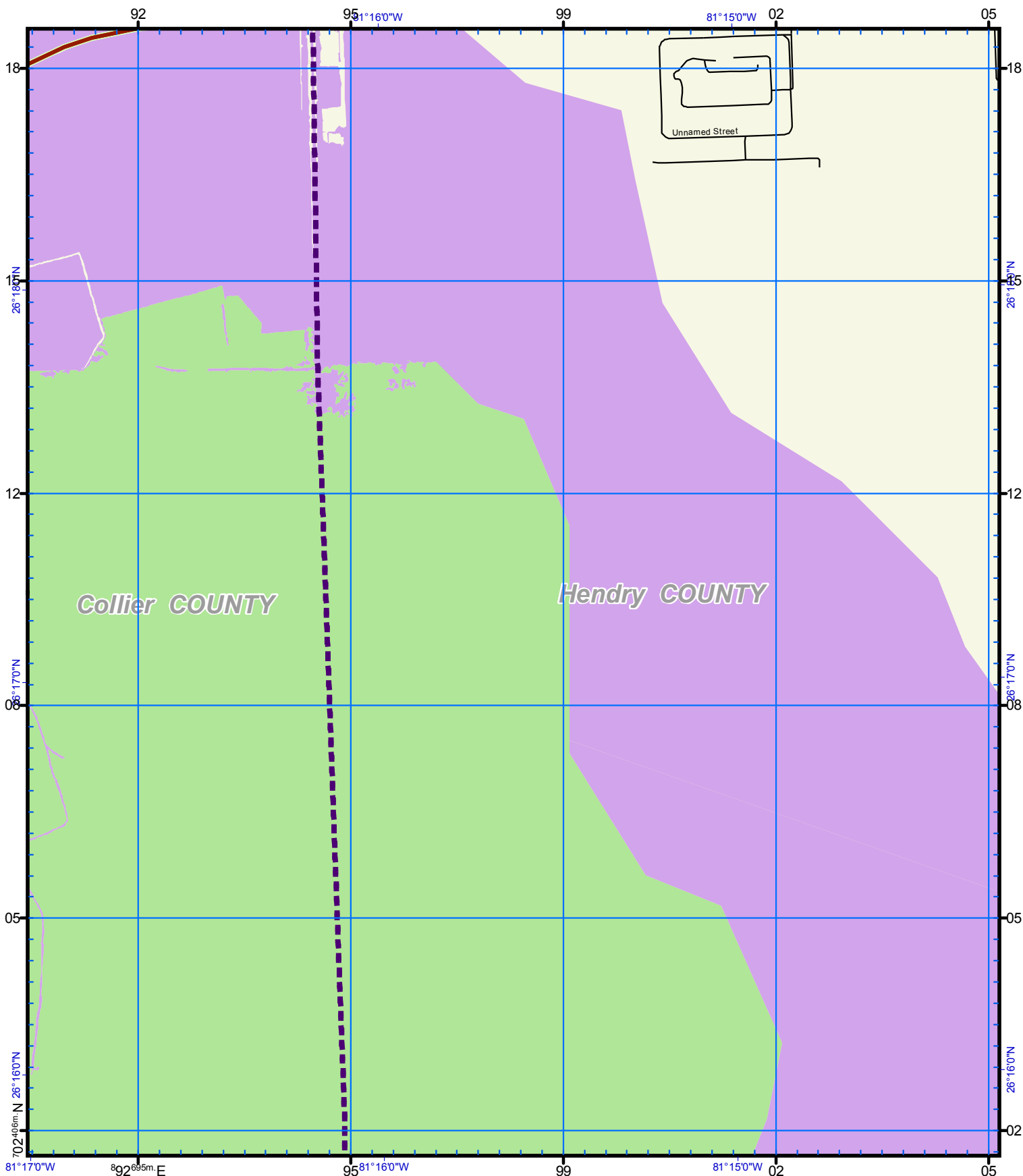
Legend

- Reference Point
- H HOSPITAL
- City Limits
- Evacuation Route
- Existing Water

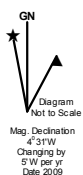
- Cat**
- 1
 - 2
 - 3
 - 4
 - 5



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US National Grid
100,000-m Square ID
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Maximums surge heights
over LIDAR based digital
elevation.
3. The Points of Reference are
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relevant to emergency man-
agement officials.

Lake Surge Zones

20ft Lake Level

Hendry County, 2010

Scale - 1:24,000

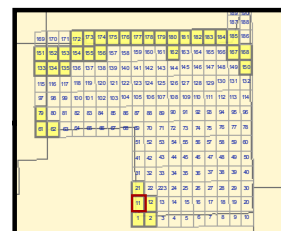
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USNG Page 17R MK 72 05

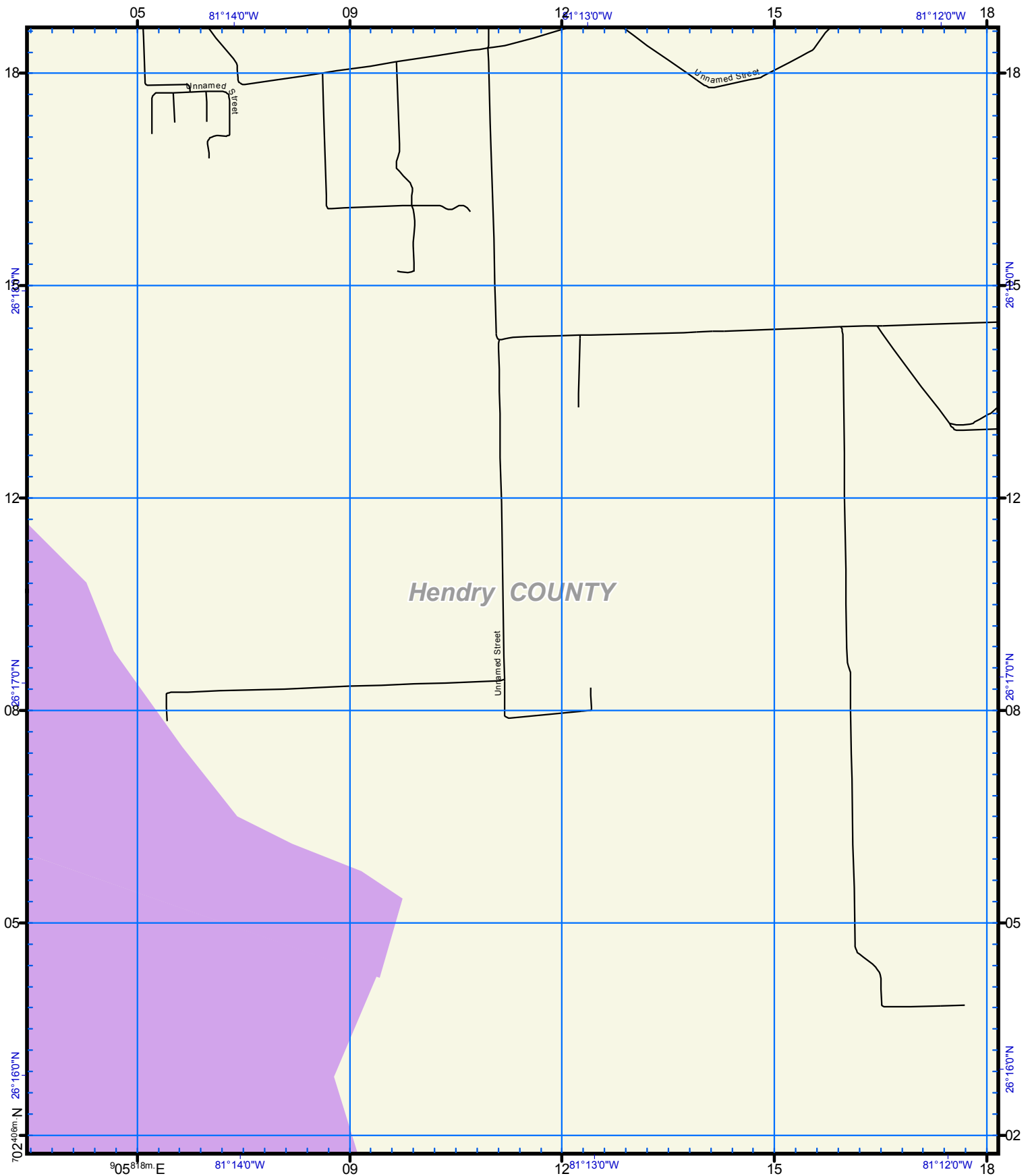
Map Plate 11
Page 49

Legend

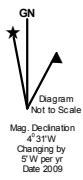
- Reference Point
- H HOSPITAL
- City Limits
- Evacuation Route
- Existing Water

- Cat**
- 1
 - 2
 - 3
 - 4
 - 5





US National Grid
100,000-m Square ID
MK
Grid Zone Designation
17R
Datum = NAD 1983, 1,000-m USNG



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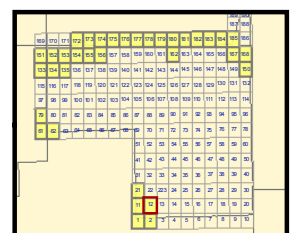
Lake Surge Zones
20ft Lake Level
Hendry County, 2010
Scale - 1:24,000
0 2,000 Feet
USNG Page 17R MK 76 05
Map Plate 12
Page 50

Legend

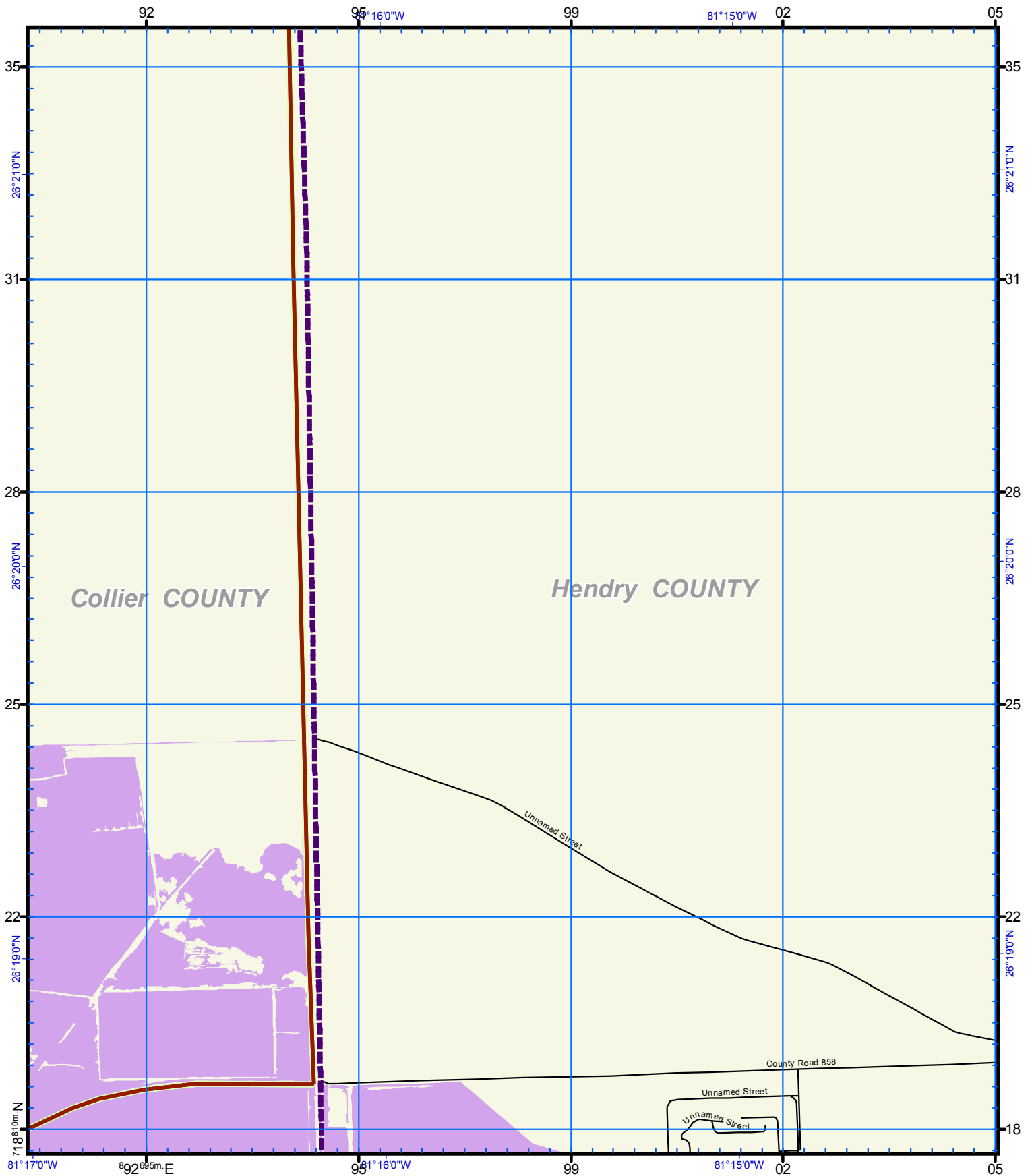
- Reference Point
- HOSPITAL
- City Limits
- Evacuation Route
- Existing Water

Cat

- 1
- 2
- 3
- 4
- 5

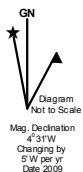


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US National Grid
100,000-m Square ID
MK
Grid Zone Designation
17R

Datum = NAD 1983, 1,000-m USNG



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Lake Surge Zones 20ft Lake Level Hendry County, 2010

Scale - 1:24,000

0 2,000 Feet

USNG Page 17R MK 72 10

Map Plate 21

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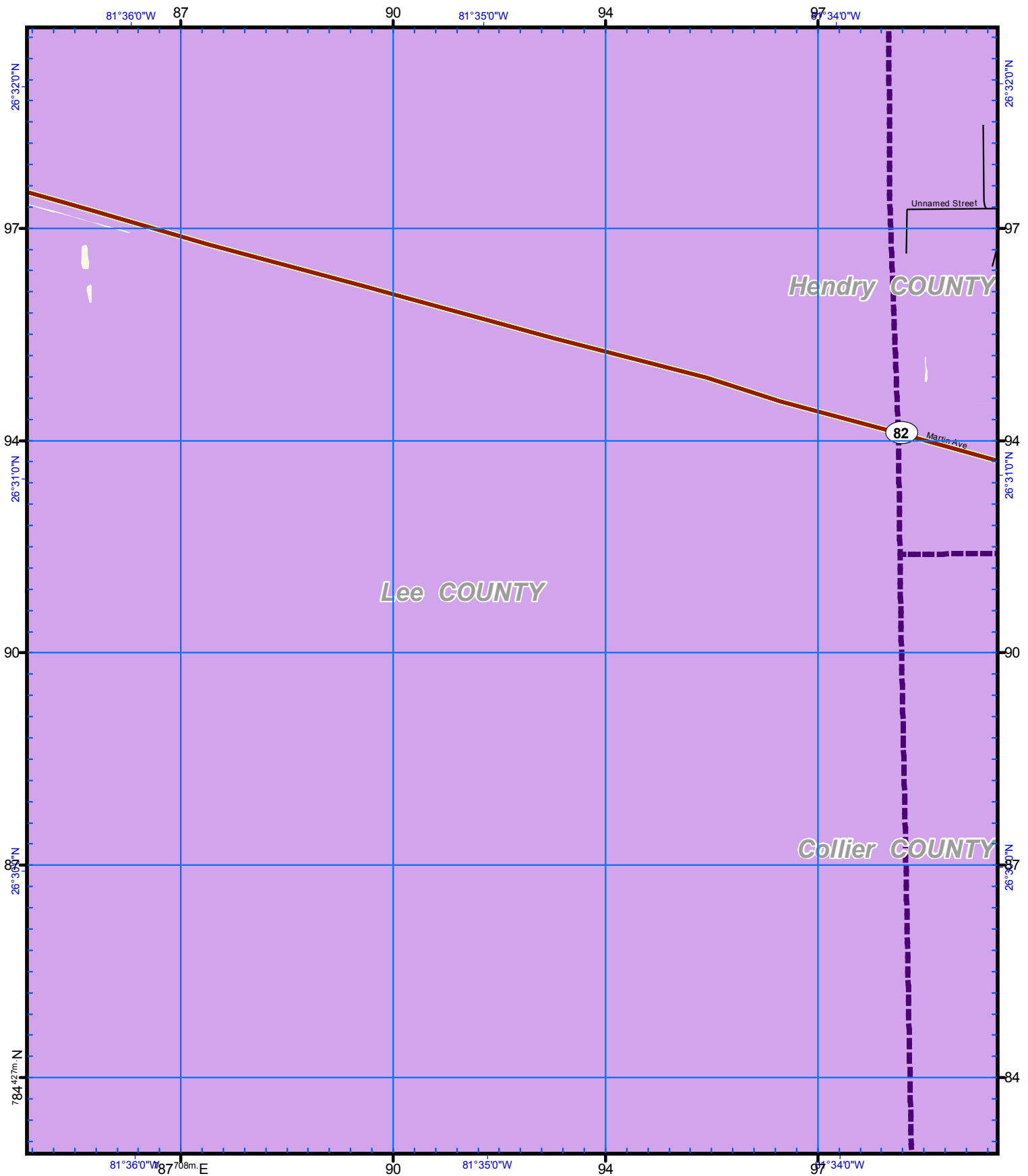
Legend

- Reference Point
- ⌂ HOSPITAL
- City Limits
- Evacuation Route
- Existing Water

- Cat
- 1
 - 2
 - 3
 - 4
 - 5



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agement officials.

Lake Surge Zones 20ft Lake Level Hendry County, 2010

Scale - 1:24,000

0 2,000 Feet

USNG Page 17R MK 40 30

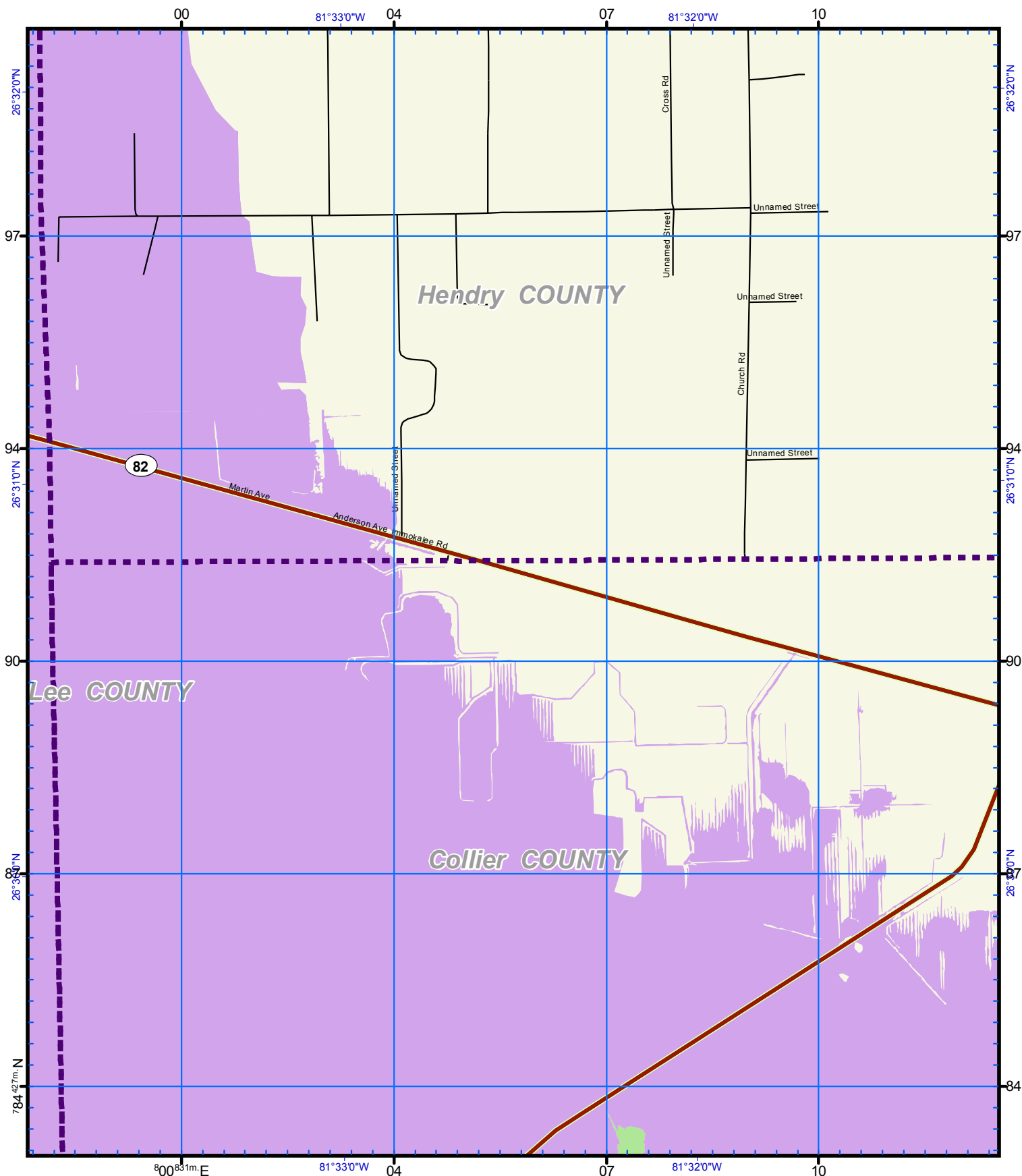
Map Plate 61

Page 52

Legend

- Reference Point
 - ⌂ HOSPITAL
 - ⌂ City Limits
 - Evacuation Route
 - Existing Water
- | Cat | 1 | 2 | 3 | 4 | 5 |
|-----|-----|--------|--------|-------------|--------------|
| 1 | Red | Orange | Yellow | Light Green | Light Purple |





US National Grid
100,000-m Square ID
MK
Grid Zone Designation
17R

Datum = NAD 1983, 1,000-m USNG

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Lake Surge Zones 20ft Lake Level Hendry County, 2010

Scale - 1:24,000

0 2,000 Feet

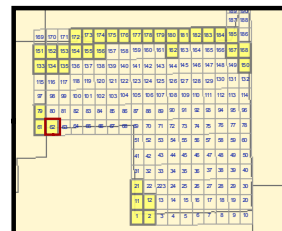
USNG Page 17R MK 44 30

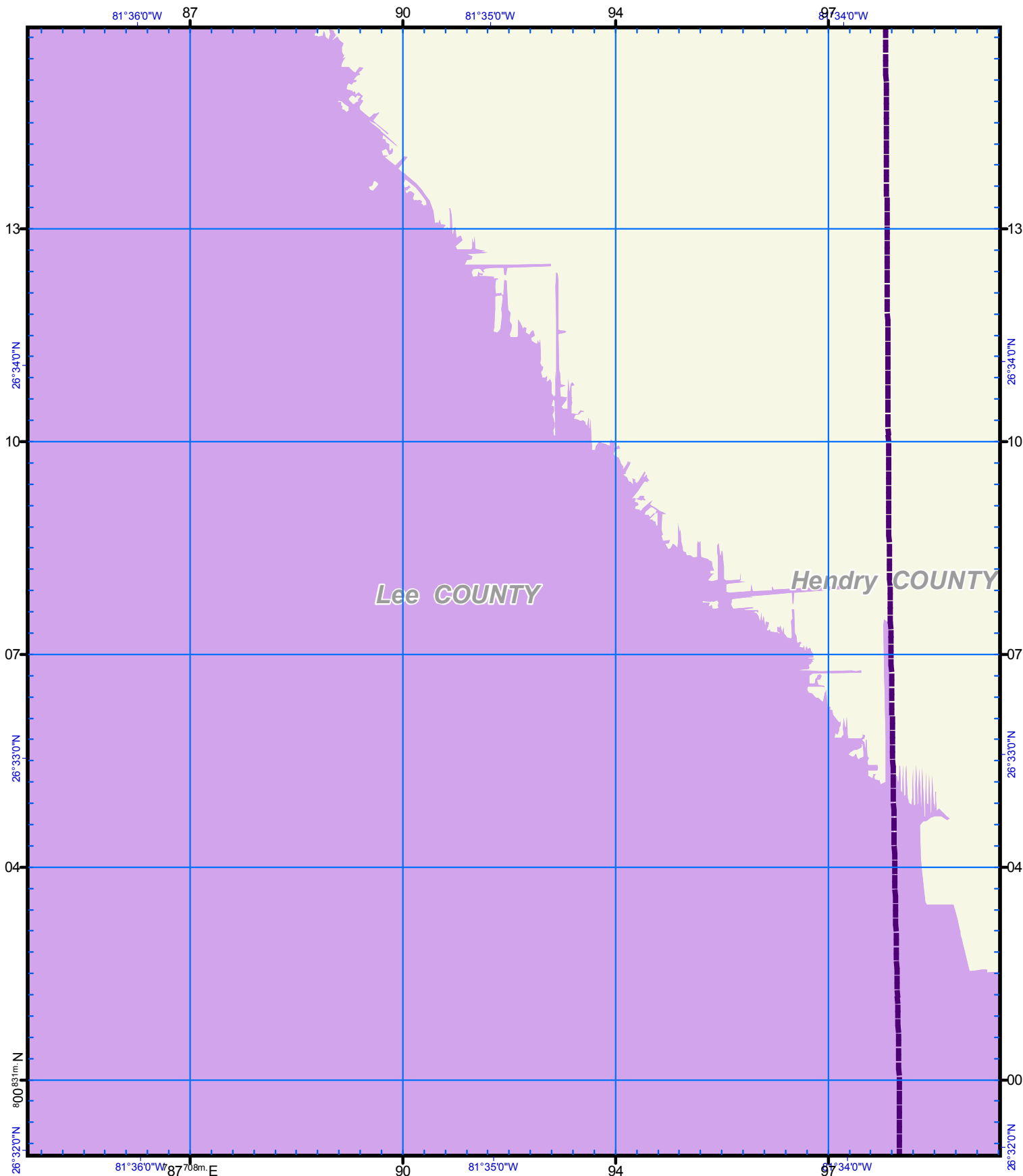
Map Plate 62

Page 53

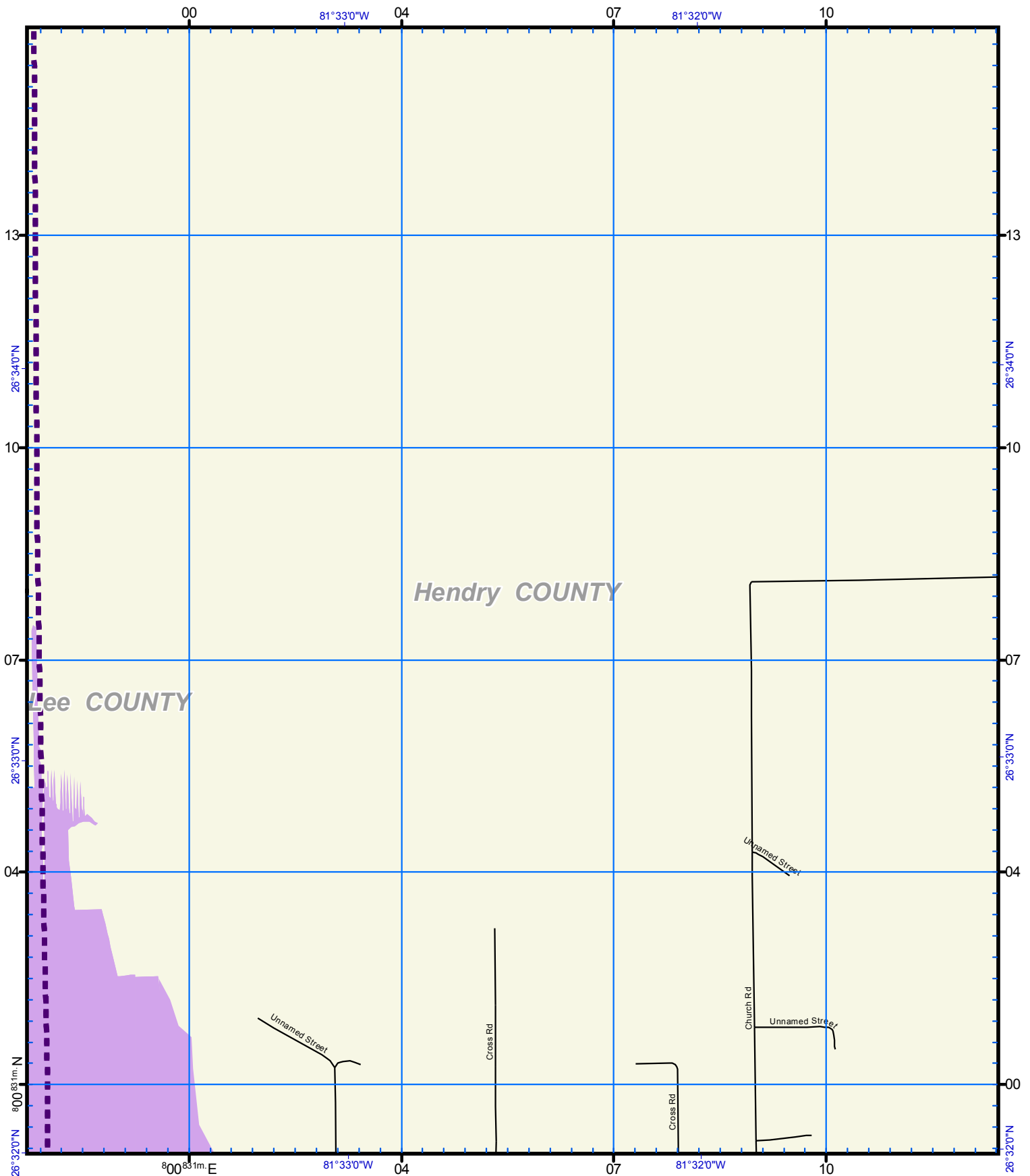
Legend

- Reference Point
 - ⌘ HOSPITAL
 - ⬜ City Limits
 - Evacuation Route
 - Existing Water
- | Cat | 1 | 2 | 3 | 4 | 5 |
|-----|-----|--------|--------|-------------|--------|
| 1 | Red | Orange | Yellow | Light Green | Purple |



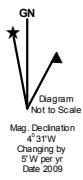


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US National Grid
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Grid Zone Designation
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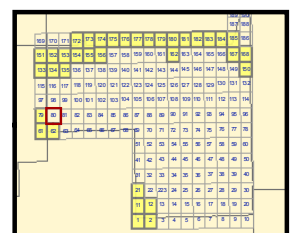
Lake Surge Zones
20ft Lake Level
Hendry County, 2010
Scale - 1:24,000
0 2,000 Feet
USNG Page 17R MK 44 35
Map Plate 80
Page 55

Legend

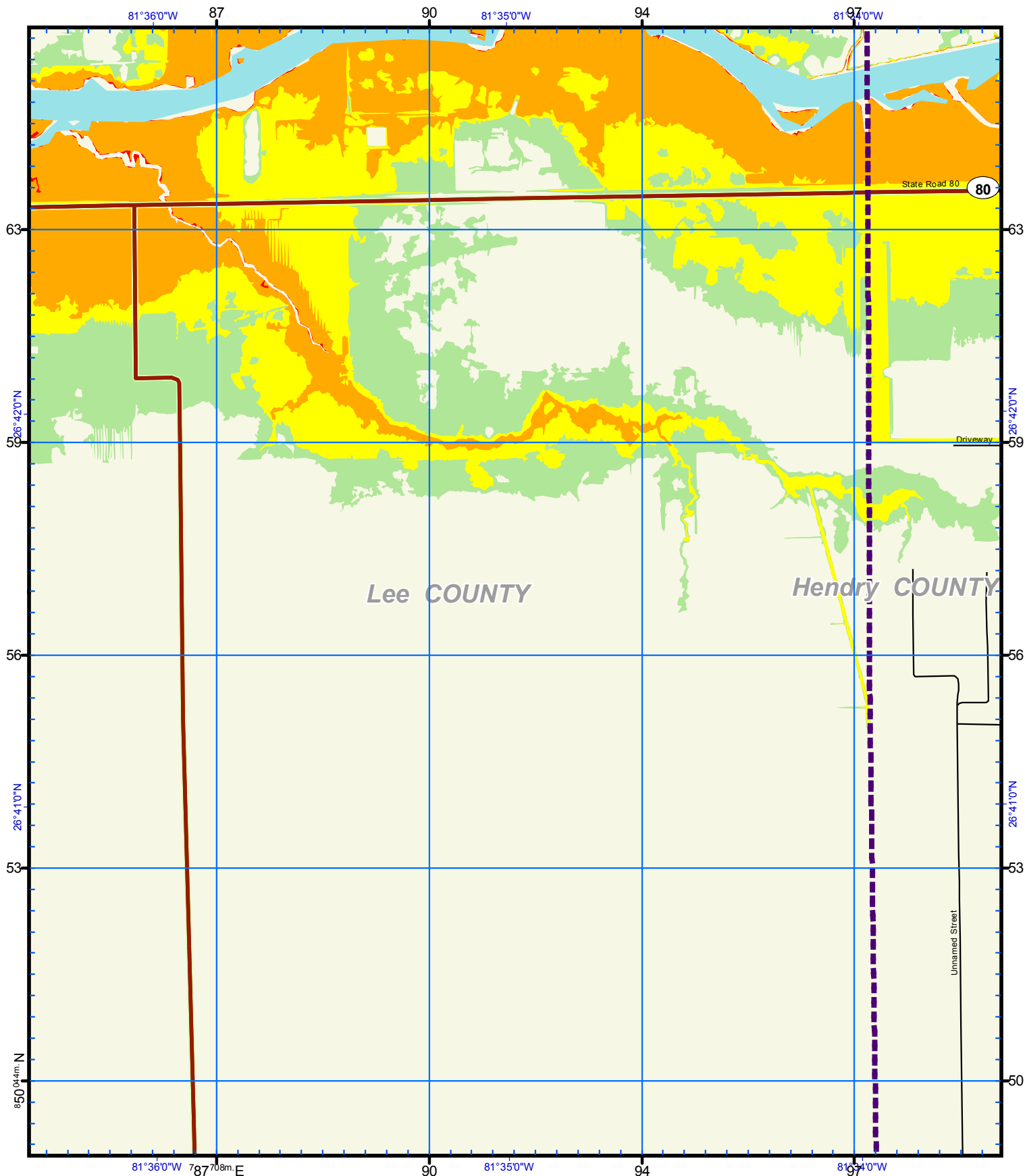
- Reference Point
- HOSPITAL
- City Limits
- Evacuation Route
- Existing Water

Cat

- 1
- 2
- 3
- 4
- 5



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US National Grid
100,000-m Square ID
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Lake Surge Zones

20ft Lake Level

Hendry County, 2010

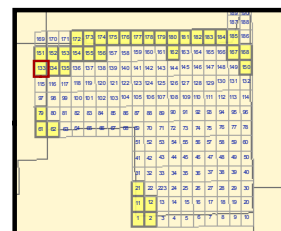
Scale - 1:24,000

0 2,000 Feet
USNG Page 17R MK 40 50

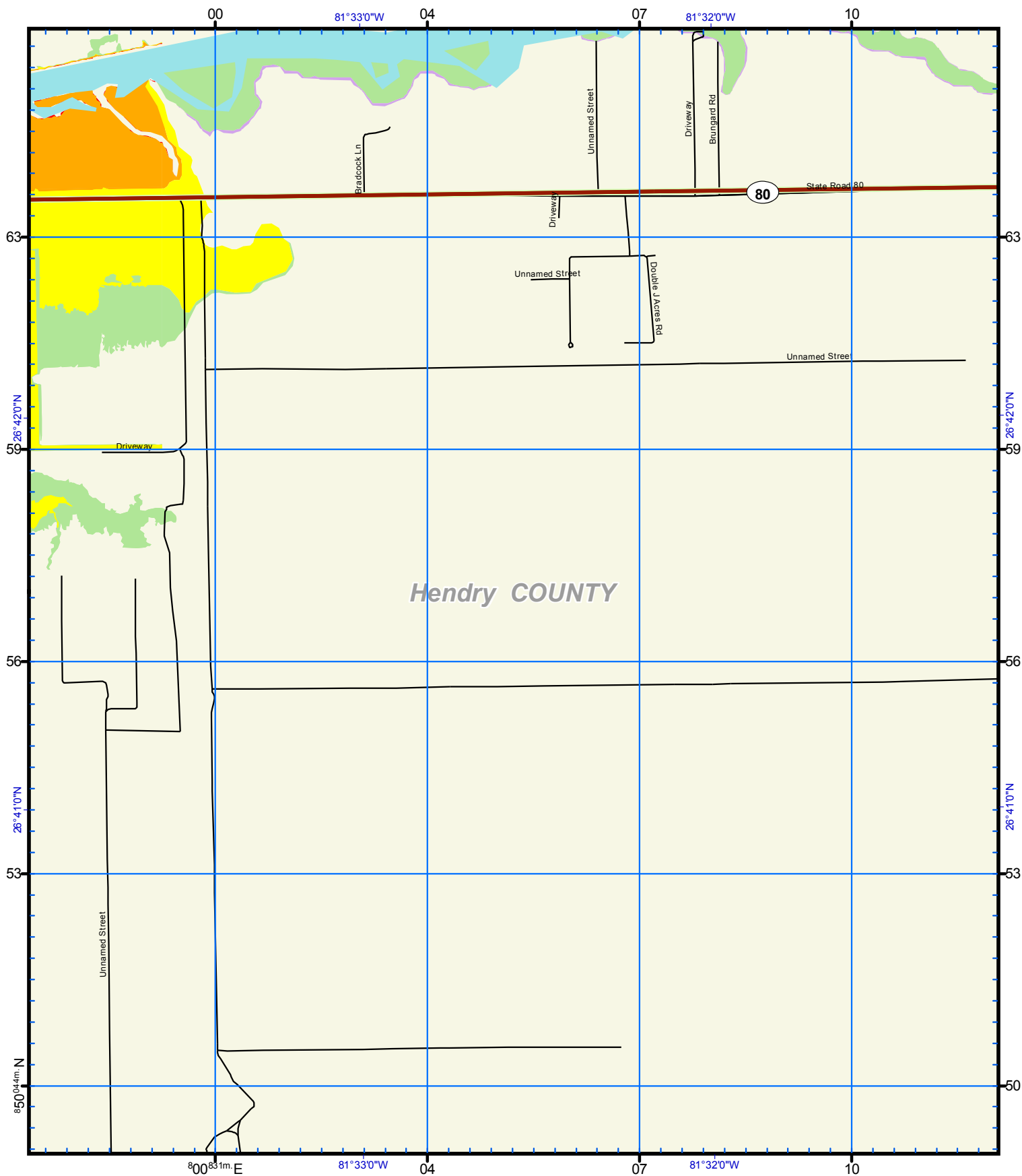
Map Plate 133
Page 56

Legend

- Reference Point
 - ⌘ HOSPITAL
 - ⌘ City Limits
 - Evacuation Route
 - Existing Water
- | Cat | 1 | 2 | 3 | 4 | 5 |
|-----|--------|--------|-------|--------|--------|
| 1 | Orange | Yellow | Green | Purple | Purple |



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US National Grid
100,000-m Square ID
MK
Grid Zone Designation
17R
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Lake Surge Zones

20ft Lake Level

Hendry County, 2010

Scale - 1:24,000



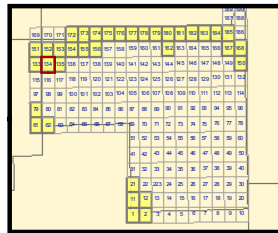
USNG Page 17R MK 44 50

Map Plate 134

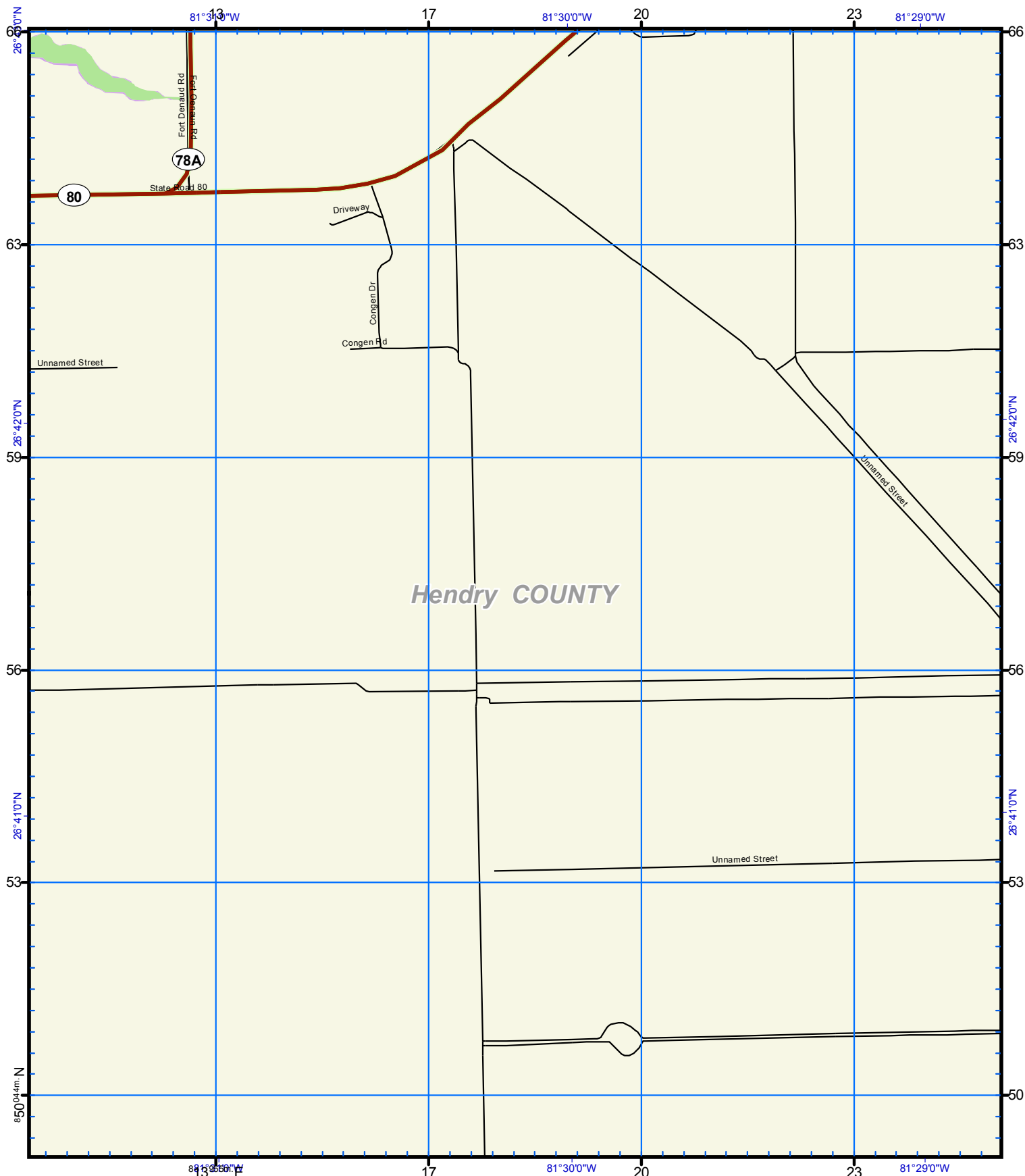
Page 57

Legend

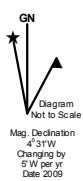
- Reference Point
 - H HOSPITAL
 - City Limits
 - Evacuation Route
 - Existing Water
- | Cat | 1 | 2 | 3 | 4 | 5 |
|-----|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |



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US National Grid
100,000-m Square ID
MK
Grid Zone Designation
17R
Datum = NAD 1983, 1,000-m USNG



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Lake Surge Zones
20ft Lake Level
Hendry County, 2010
Scale - 1:24,000
0 2,000 Feet
USNG Page 17R MK 48 50
Map Plate 135
Page 58

Legend

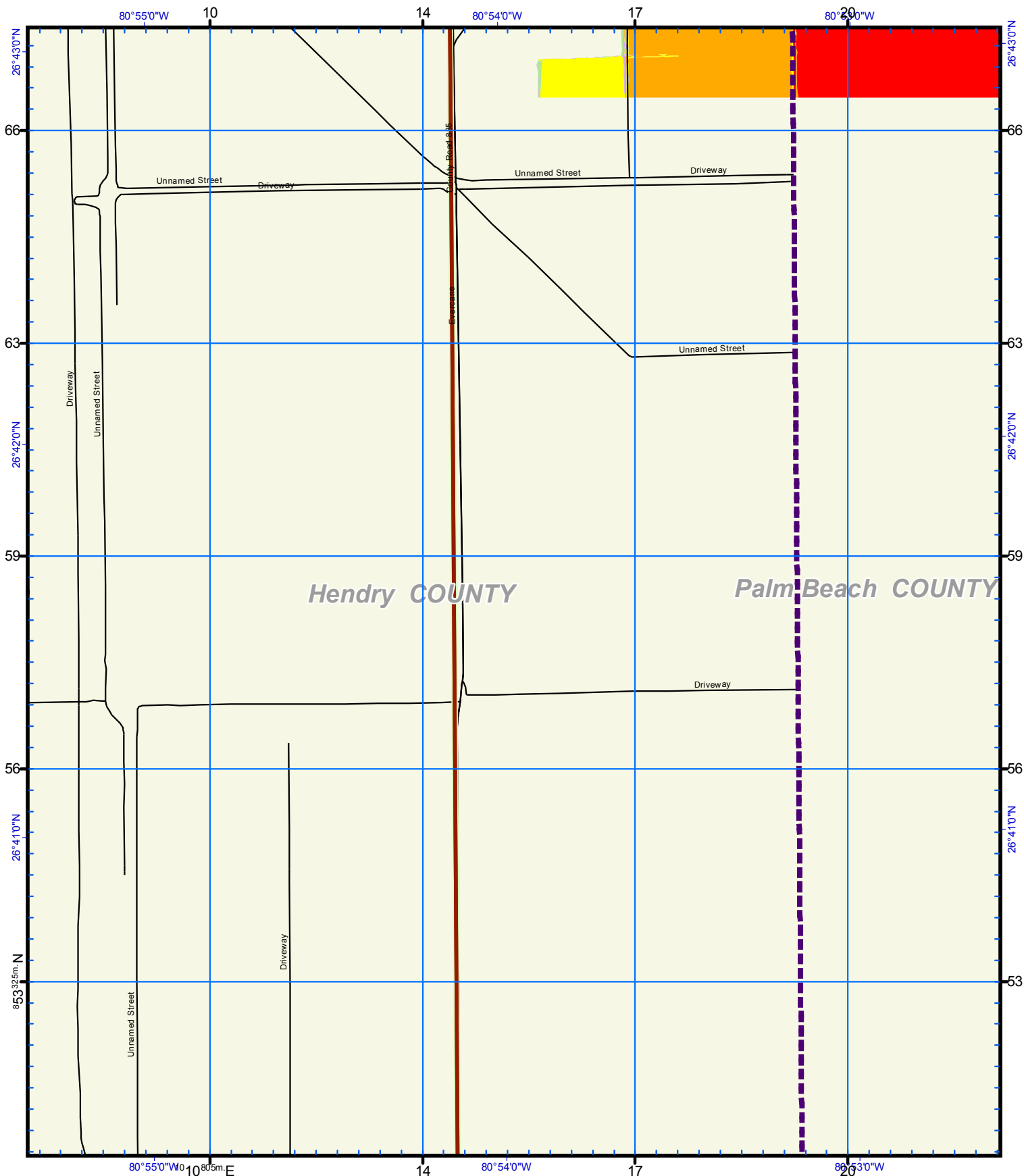
- Reference Point
- HOSPITAL
- City Limits
- Evacuation Route
- Existing Water

Cat

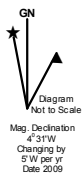
- 1
- 2
- 3
- 4
- 5



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US National Grid
100,000-m Square ID
NK
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Datum = NAD 1983, 1,000-m USNG



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Lake Surge Zones

20ft Lake Level
Hendry County, 2010

Scale - 1:24,000

0 2,000 Feet
USNG Page 17R NK 08 50

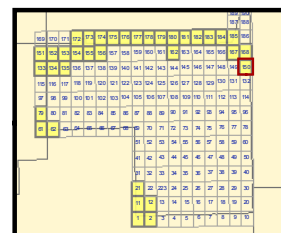
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Page 59

Legend

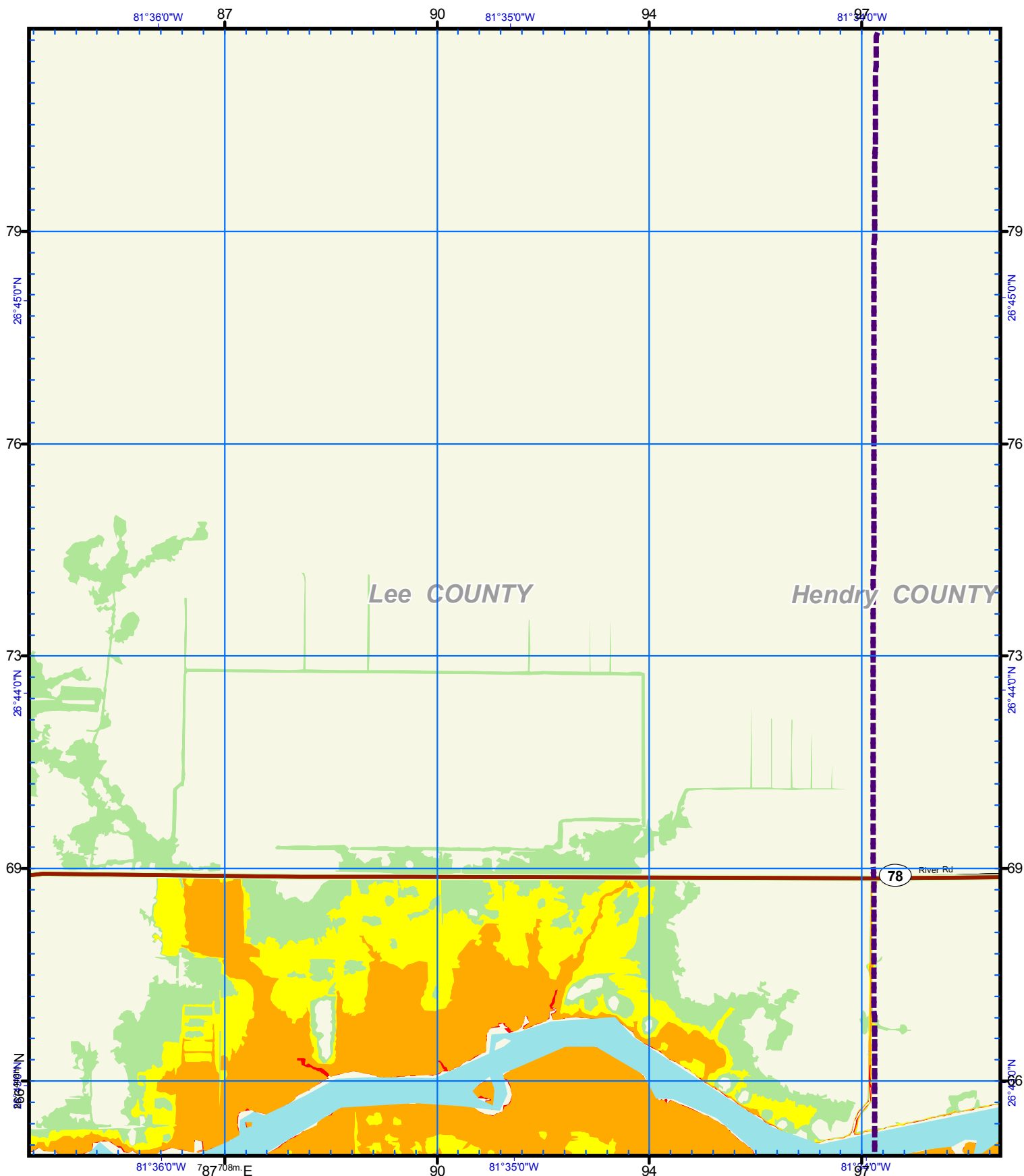
- Reference Point
- H HOSPITAL
- City Limits
- Evacuation Route
- Existing Water

Cat

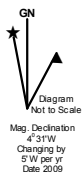
- 1
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management implementation are local responsibilities.
Please consult with local authorities.



US National Grid
100,000-m Square ID
MK
Grid Zone Designation
17R
Datum = NAD 1983, 1,000-m USNG



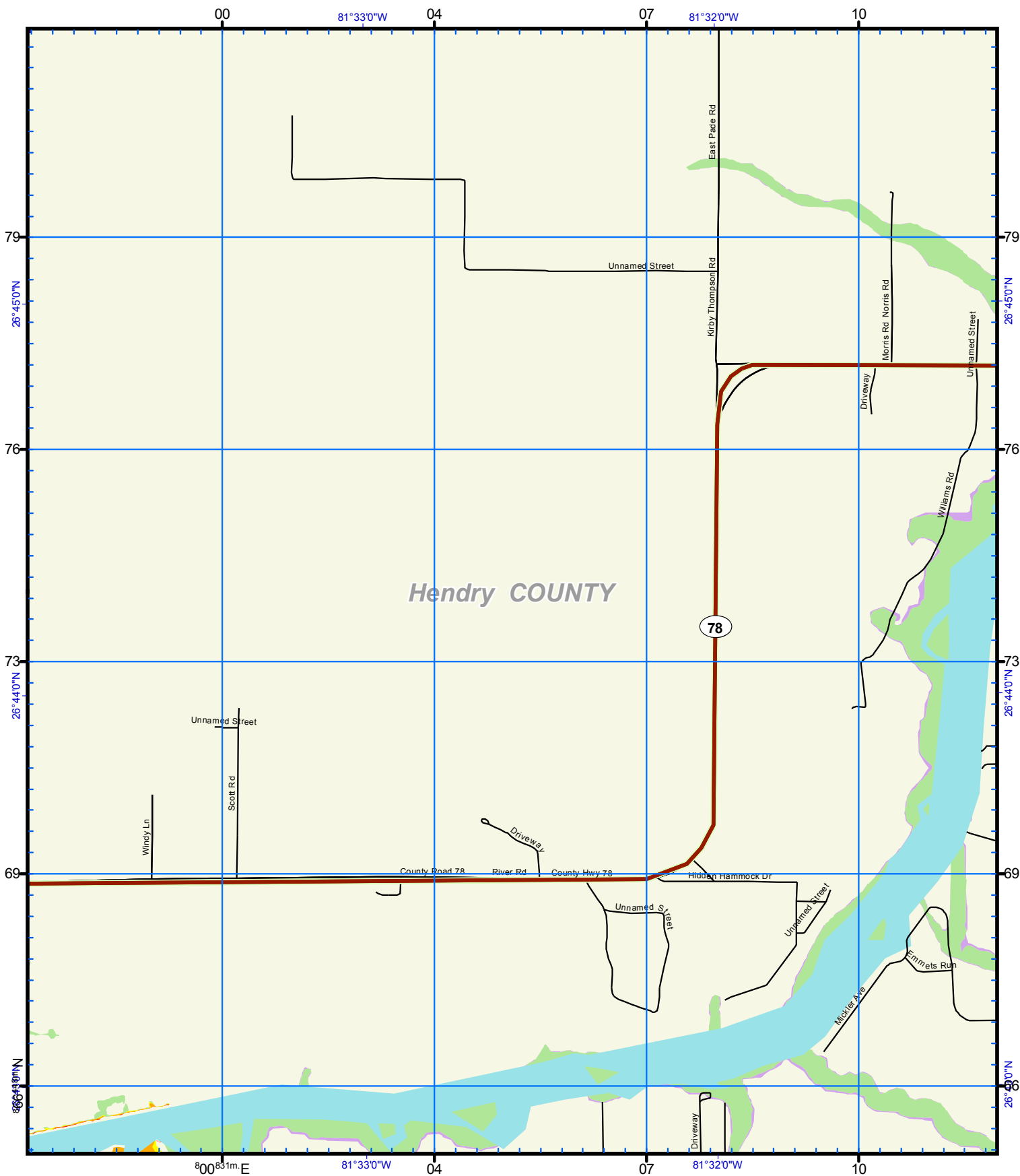
Notes:
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2. Total Storm Tide limits were derived from Maximum of Maximum surge heights over LIDAR based digital elevation.
3. The Points of Reference are locations determined to be relevant to emergency management officials.

Lake Surge Zones
20ft Lake Level
Hendry County, 2010
Scale - 1:24,000
0 2,000 Feet
USNG Page 17R MK 40 55
Map Plate 151
Page 60

Legend
● Reference Point
H HOSPITAL
City Limits
Evacuation Route
Existing Water
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US National Grid
100,000-m Square ID
MK
Grid Zone Designation
17R

Datum = NAD 1983, 1,000-m USNG



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Lake Surge Zones 20ft Lake Level Hendry County, 2010

Scale - 1:24,000

0 2,000 Feet

USNG Page 17R MK 44 55

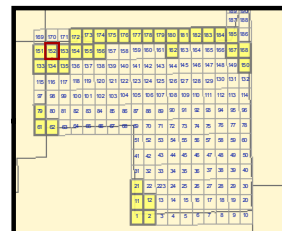
Map Plate 152

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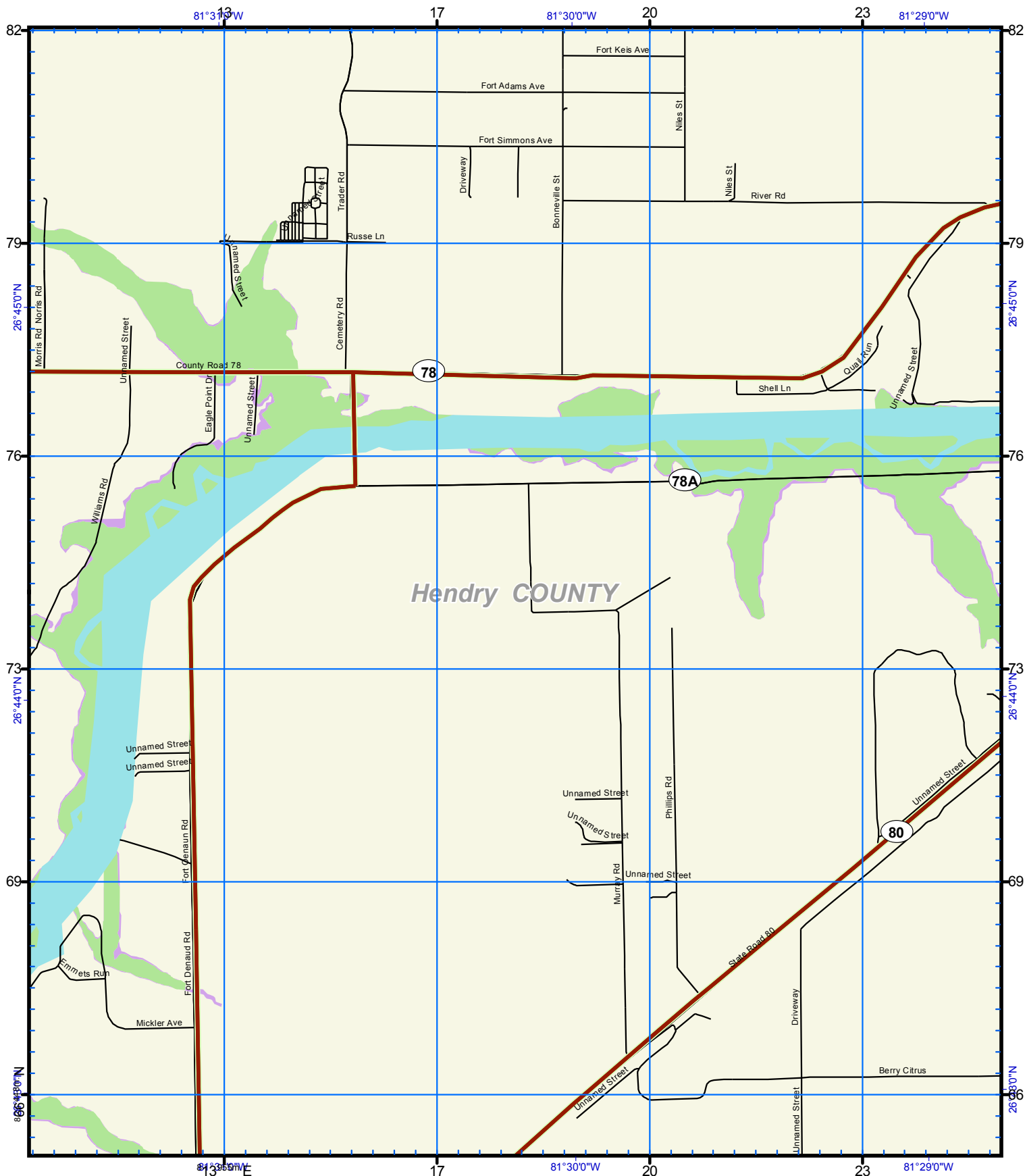
Legend

- Reference Point
- ⌘ HOSPITAL
- ⬜ City Limits
- Evacuation Route
- Existing Water

- Cat
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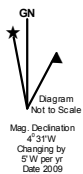


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US National Grid
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Lake Surge Zones

20ft Lake Level

Hendry County, 2010

Scale - 1:24,000

0 2,000 Feet

USNG Page 17R MK 48 55

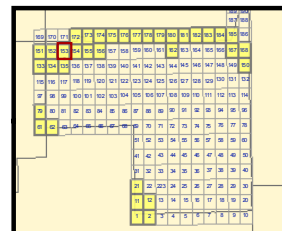
Map Plate 153

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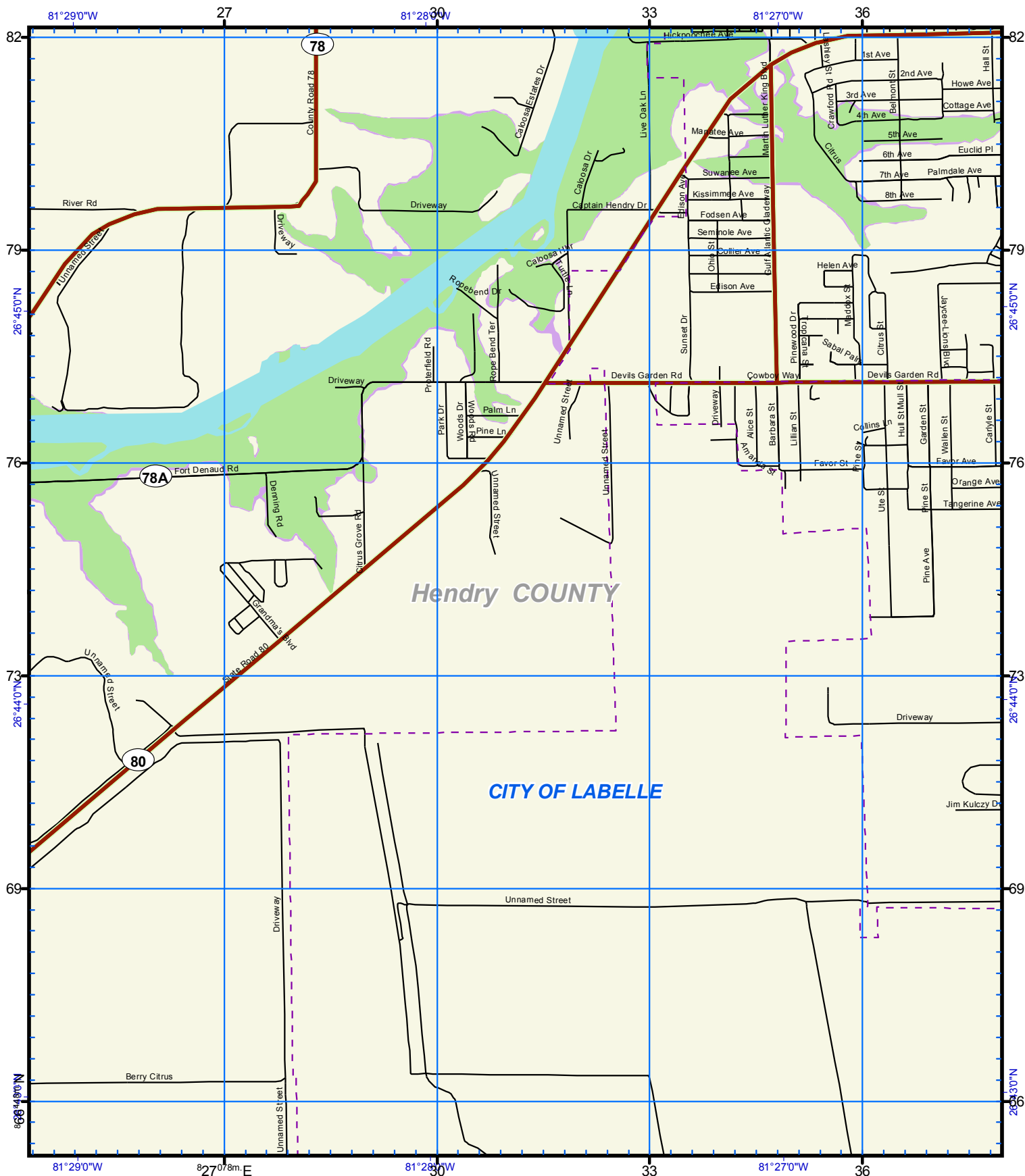
Legend

- Reference Point
- ⌘ HOSPITAL
- ⬜ City Limits
- Evacuation Route
- Existing Water

- | Cat | 1 | 2 | 3 | 4 | 5 |
|-----|-----|--------|--------|-------|--------|
| 1 | Red | Orange | Yellow | Green | Purple |

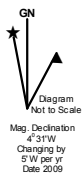


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US National Grid
100,000-m Square ID
MK
Grid Zone Designation
17R

Datum = NAD 1983, 1,000-m USNG



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Lake Surge Zones

20ft Lake Level

Hendry County, 2010

Scale - 1:24,000

0 2,000 Feet

USNG Page 17R MK 52 55

Map Plate 154

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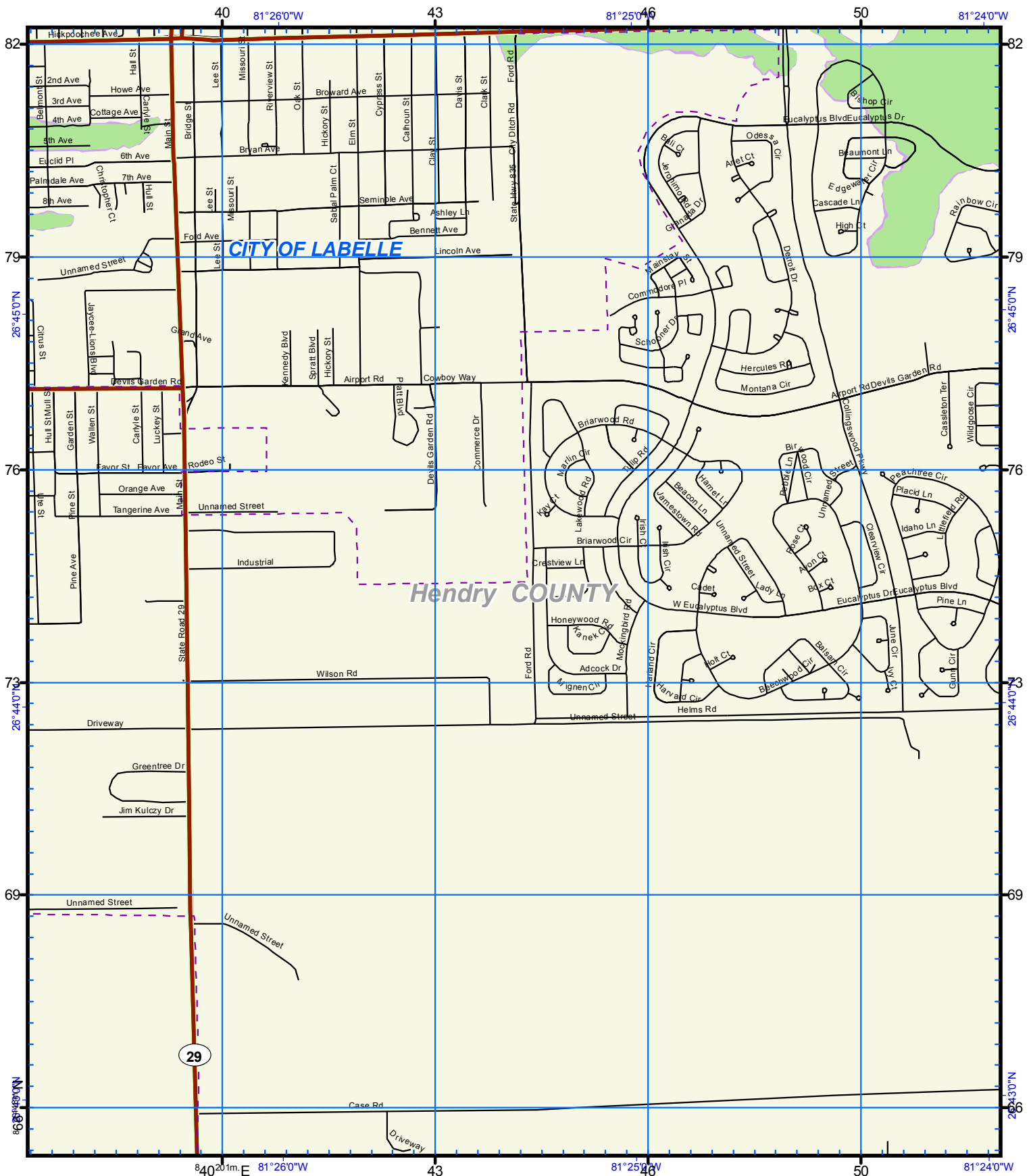
Legend

- Reference Point
- ⌘ HOSPITAL
- ⬜ City Limits
- Evacuation Route
- Existing Water

- Cat
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Lake Surge Zones

20ft Lake Level

Hendry County, 2010

Scale - 1:24,000

0 2,000 Feet

USNG Page 17R MK 56 55

Map Plate 155

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Legend

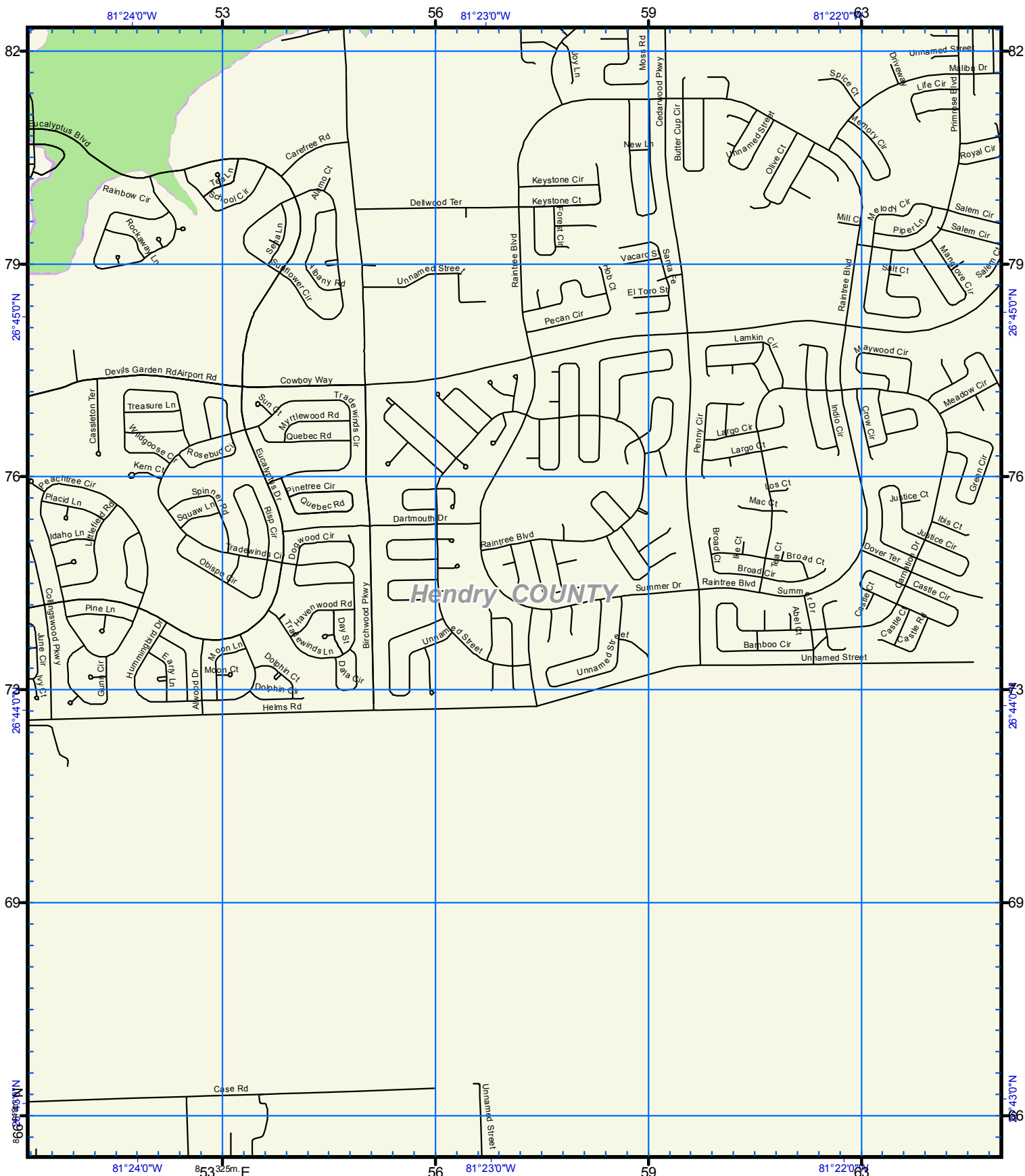
- Reference Point
- HOSPITAL
- City Limits
- Evacuation Route
- Existing Water

Cat

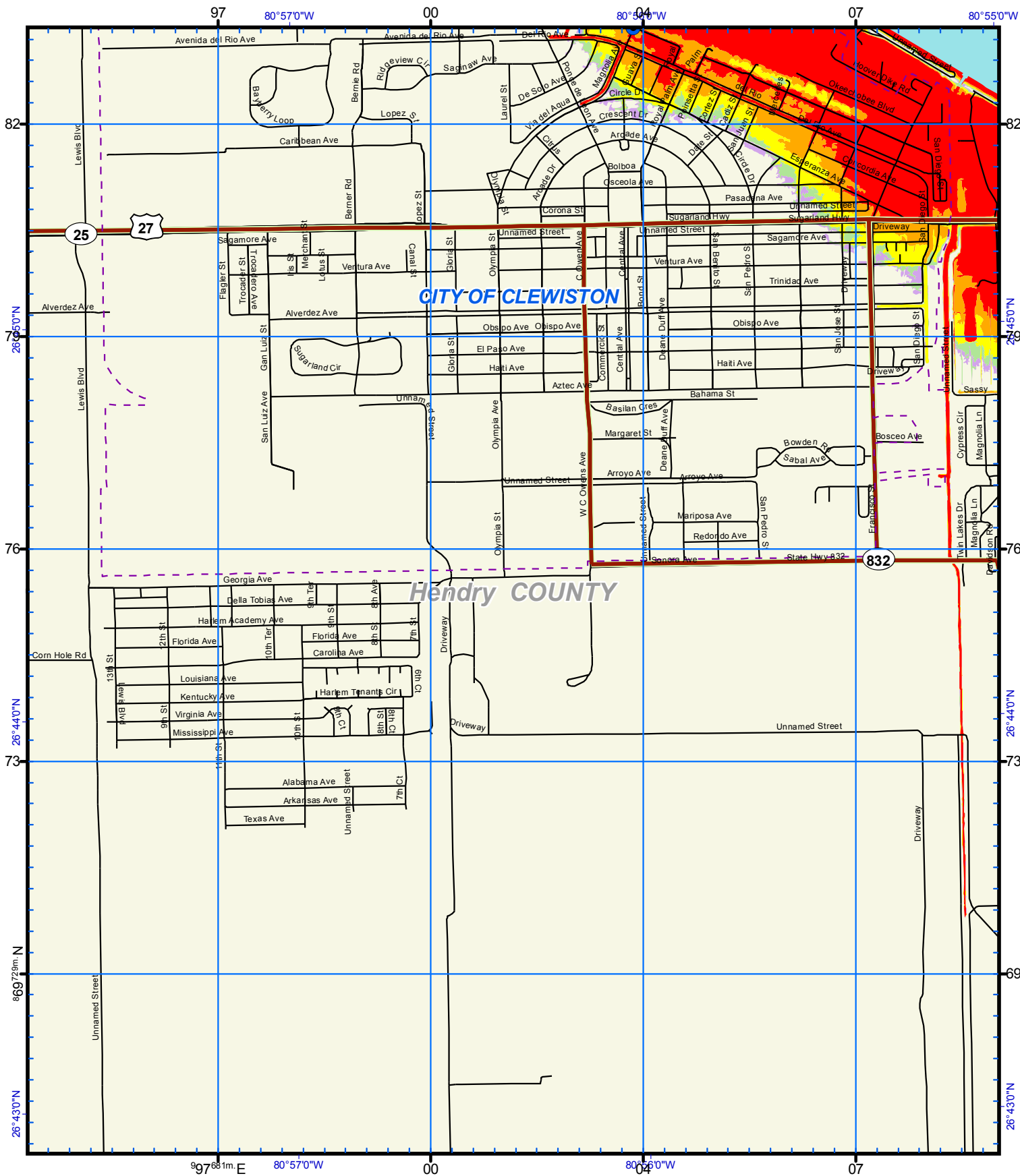
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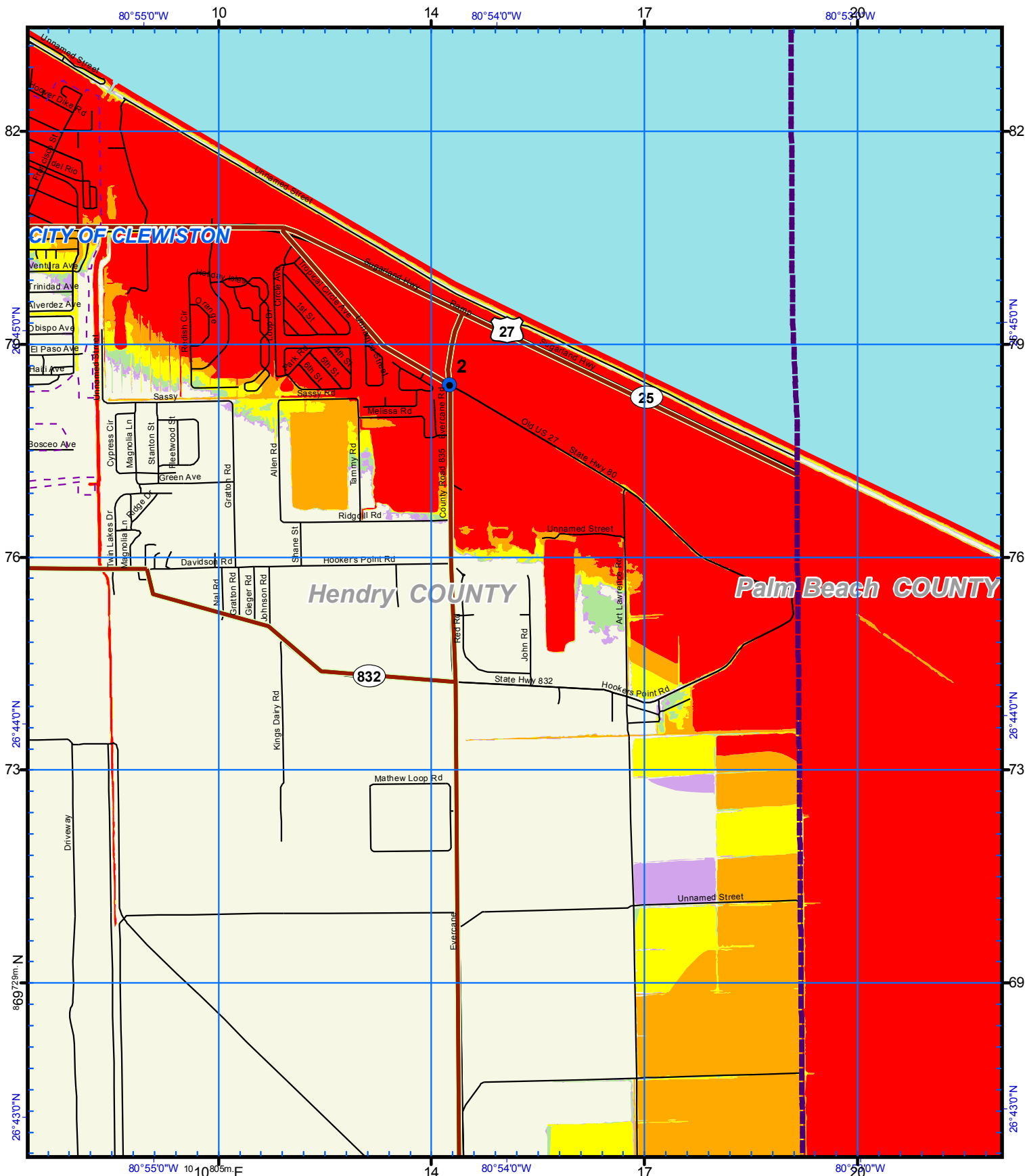
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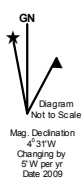
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Lake Surge Zones

20ft Lake Level

Hendry County, 2010

Scale - 1:24,000

0 2,000 Feet
USNG Page 17R NK 08 55

Map Plate 168

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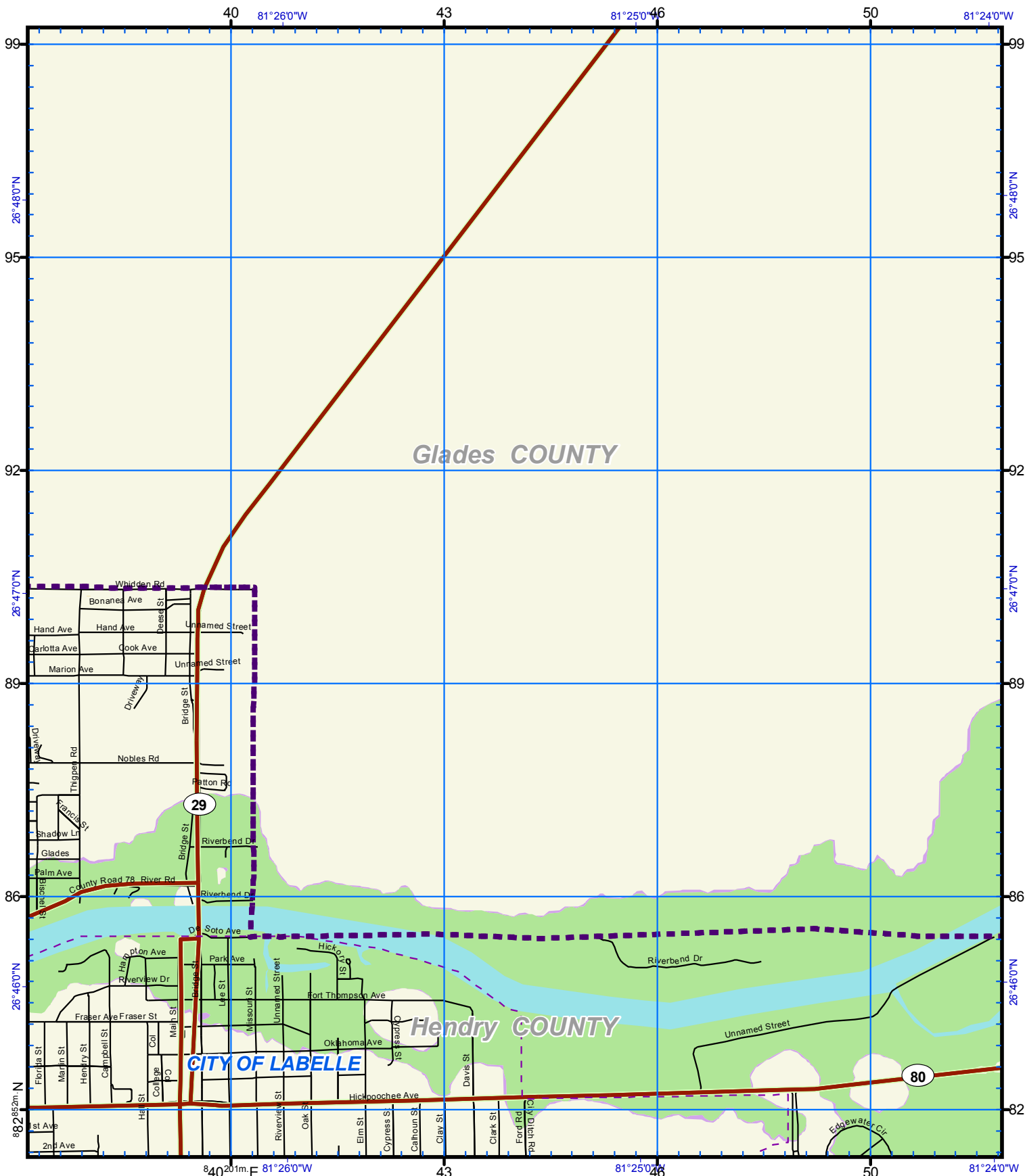
Legend

- Reference Point
- H HOSPITAL
- City Limits
- Evacuation Route
- Existing Water

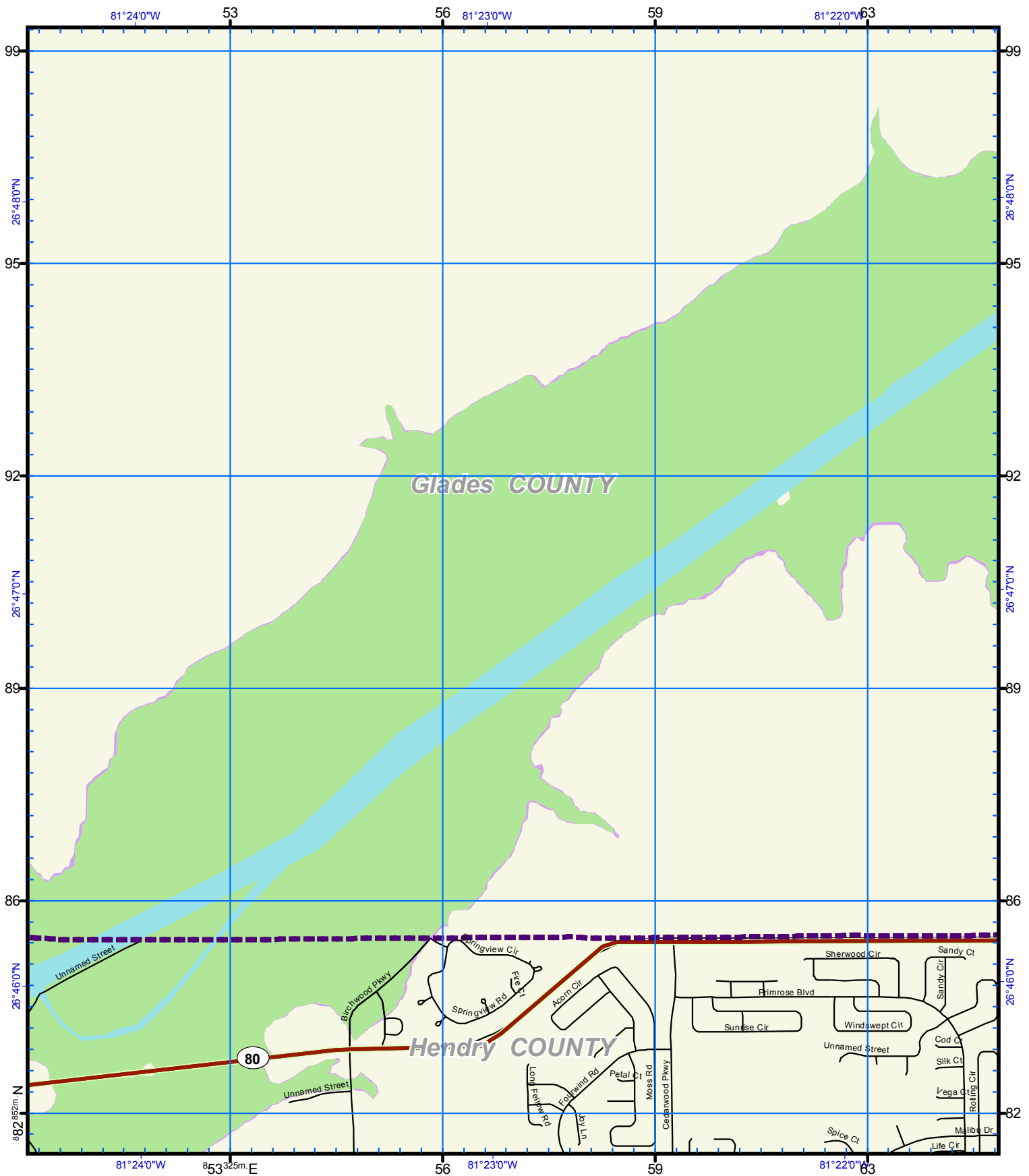
- Cat
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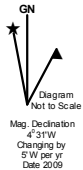


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Lake Surge Zones

20ft Lake Level
Hendry County, 2010

Scale - 1:24,000

0 2,000 Feet

USNG Page 17R MK 60 60

Map Plate 174

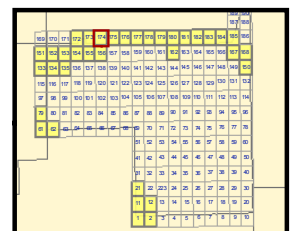
Page 70

Legend

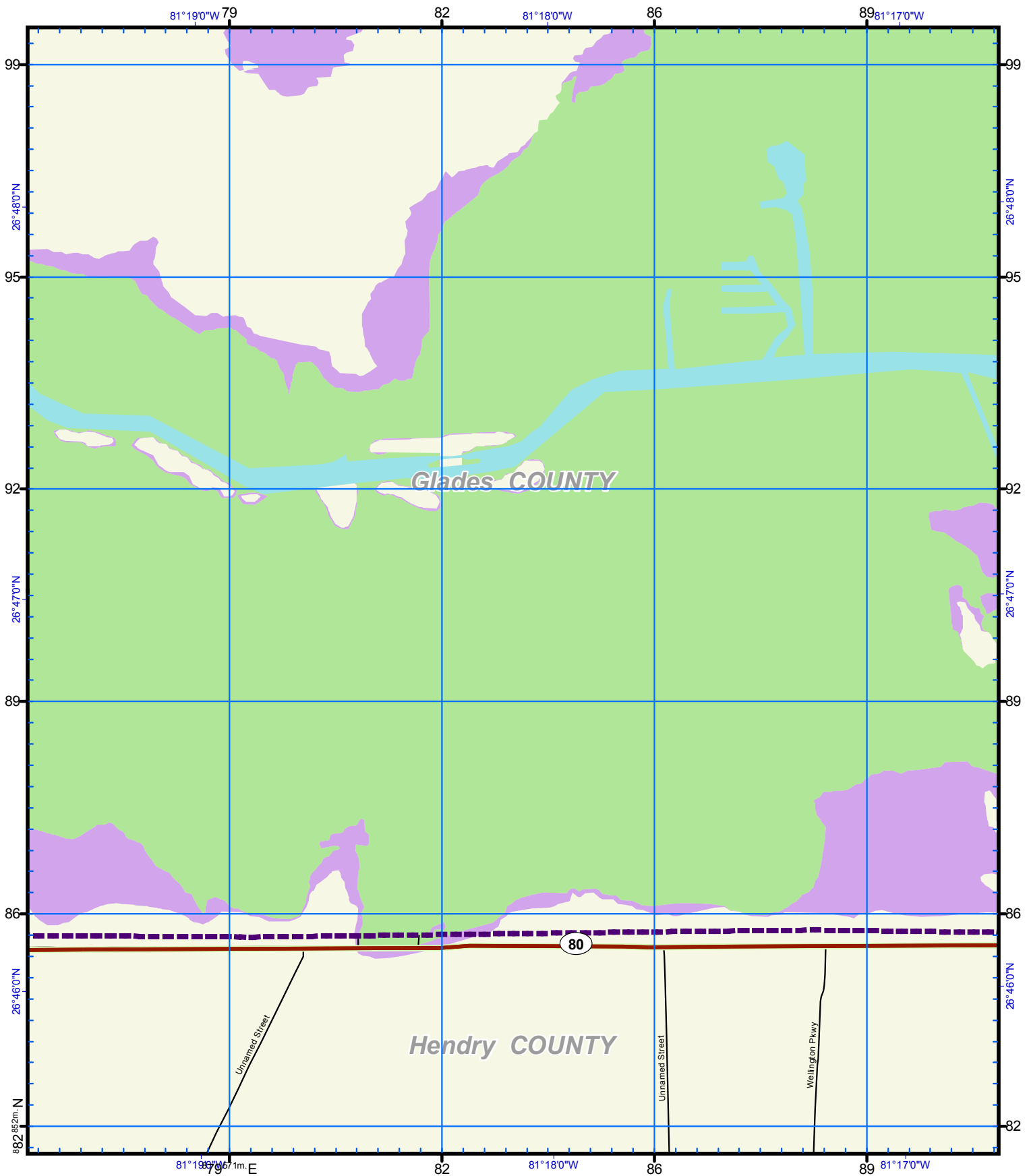
- Reference Point
- ⌘ HOSPITAL
- ⬜ City Limits
- Evacuation Route
- Existing Water

Cat

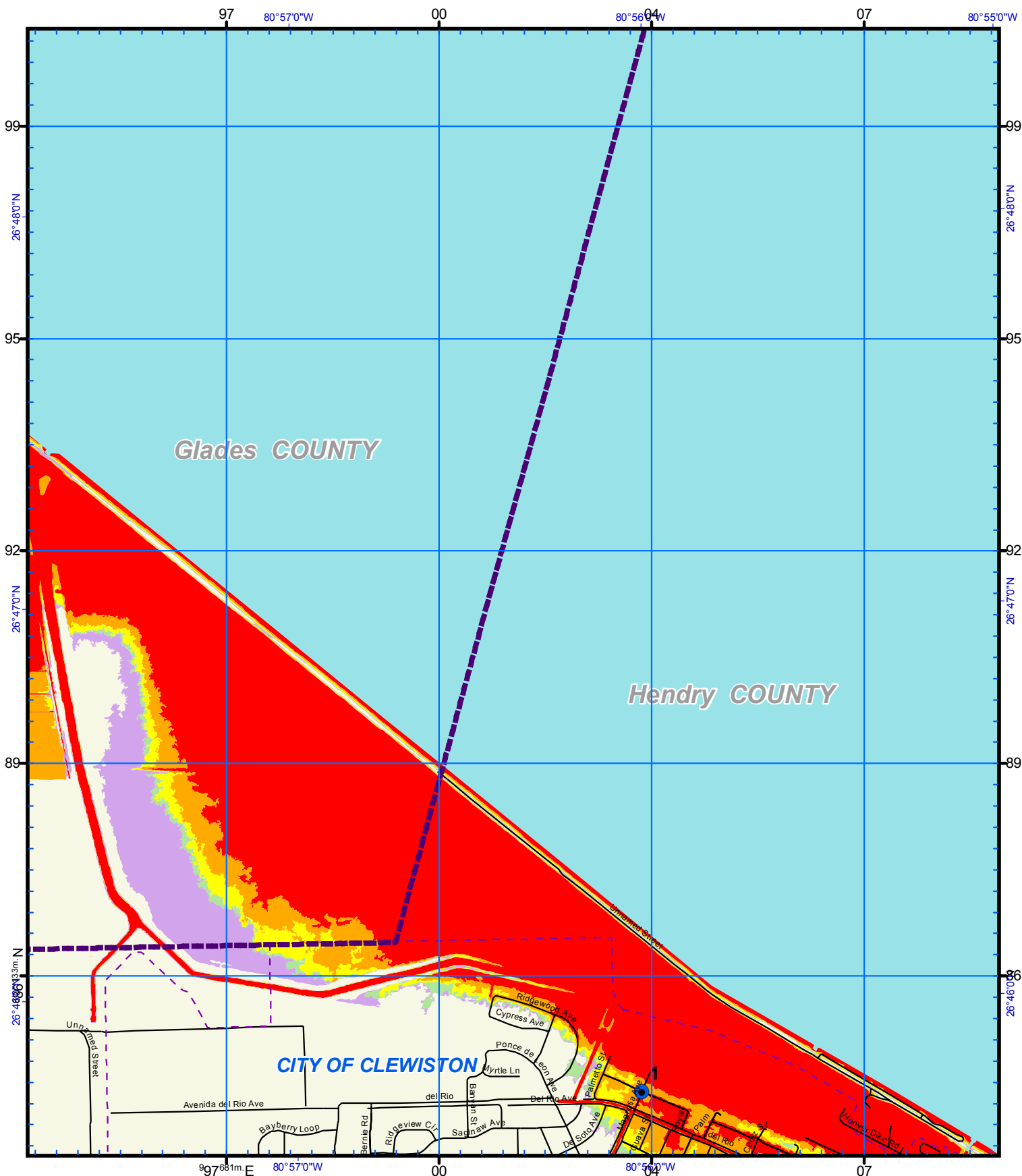
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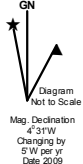
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Lake Surge Zones

20ft Lake Level
Hendry County, 2010

Scale - 1:24,000

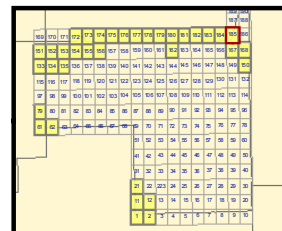
0 2,000 Feet
USNG Page 17R NK 04 60

Map Plate 185
Page 72

Legend

- Reference Point
- H HOSPITAL
- City Limits
- Evacuation Route
- Existing Water

- Cat**
- 1
 - 2
 - 3
 - 4
 - 5



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