# FELLSMERE WATER CONTROL DISTRICT
# EAST MASTER DRAINAGE PLAN AND STORMWATER HYDROLOGIC ANALYSIS OF THE GRAVITY DRAINAGE SYSTEM LOCATED BETWEEN THE EAST BOUNDARY, LATERAL U, THE MAIN CANAL, AND DITCH 24

## LOCATED IN INDIAN RIVER COUNTY

**PREPARED FOR**
**S.J.R.W.M.D. AND F.W.C.D.**

**DECEMBER, 2003**
**Updated 2007**
**Updated May 2014**

**PREPARED BY**

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# EXECUTIVE SUMMARY OF THE 2014 UPDATE

The Fellsmere Water Control District, SJRWMD, and the City of Fellsmere jointly funded the City of Fellsmere "Historic Fellsmere Stormwater and Flood Control Master Plan", which was finalized in December 2013. The overall Fellsmere Water Control District East Master Drainage Plan and Hydrologic Analysis of the Gravity Drainage System" model originally developed in 2003 (and updated in 2007) was used as the basis of the Historic Fellsmere study. The subject 2014 update includes significant improvements to the FWCD model which were incorporated for the 2013 Historic Fellsmere study. The parts of the Historic Fellsmere study which include anticipated future build out impervious area conditions, proposed regional lakes, and fill impacts are not included in this model. Model input data changes due to the lidar survey information and pipe conveyance upgrades since 2003 are included and they are significant. The peak flow and stage results presented in the following pages should be used in planning and designing future development projects within the gravity drained portions of the FWCD.

The following changes to the 2003 ICPR model input data were made. The model was then recalibrated to closely match the peak stage elevations observed during the Hurricane Frances event. This model is named Model #1, and includes the impervious areas and drainage improvements observed in 2004 at the time of Hurricane Frances.

Step 1 – Develop Model #1 and re-calibrate the model

1. The topographic survey of existing ground elevations throughout the watershed were updated based on the Lidar survey obtained by Hartley Surveying, Inc., (see the survey certification in Appendix 1). This is a significant improvement to the accuracy of the aerial photography topographic information utilized in the 2002 model.

2. The elevations are now based on the NAVD 88 datum rather than the NGVD 29 datum used in the 2003 model. The datum update was needed to match the datum used in the recently updated FEMA Flood Insurance Rate Maps. Also, most governmental agencies require new projects to be designed and permitted using the 1988 datum.

3. Miscellaneous basin area adjustments and added two FJV gravity connections.

Step 2 – Develop Model #2

Bring the Model #1 up to 2013 conditions. Model #2 was created using Model #1 as the basis and includes the following adjustments to the input data.

1. Pipes replaced between 2003 and 2013 in the FWCD sub-laterals were updated to reflect the new size, length, and material type in the model. For the most part these pipes were replaced in conjunction with Fellsmere program of street paving and drainage improvement projects.

2. Some of the large site plans submitted, approved, and constructed between 2003 and 2013 were included in the input data.

## HYDROLOGIC MODEL ASSUMPTIONS

The hydrologic model input data was based on the above noted information to the extent possible. However, due to budget and time restraints some assumptions were adopted to complete the input data requirements. The assumptions are based on engineering judgment and site observations and are the same for typical reach and basin inputs within the model. Some of the assumptions are noted below:

1) A limited seepage from the ground water into the drainage system is provided.
2) The boundary node (NF-10) is located in the Fellsmere Main Canal immediately downstream of the weir structure (RF-10). The boundary condition water level is assumed to start at a 1.5 and rise to a 3.0 NAVD 88 for the 25 yr event based on a review of the FEMA Maps for the Sebastian River**,** (ref. Map 12009C0710 E). The boundary condition for the 100 year event starts at elevation 3.0 and raises to elevation 4.5 NAVD 88.
3) The storm events modeled include a 25yr – 24 hr (9.2 inch) storm with a SCS Type 2 distribution, and a 100yr -96 hr (15 inch) storm with a SJRWMD 96 hour distribution.
4) Typical grove areas are modeled with a Cn of 72, utilizing a Santa Barbara Hydrograph, Tc= 30 min., and an initial water level in the grove ditches of 4 feet below natural ground. The groves are modeled with stage/ area curves based on a grove bed / furrow system.
5) Typical pasture areas are modeled with a Cn of 74, a peaking factor of 256, Tc = 60 min., and a typical stage/area curve adjusted to average natural ground.
6) Residential areas are modeled with a Cn of 86.8 at build out south of C.R. 512 where the lots are smaller and 86.3 north of C.R. 512, a peaking factor of 323, and a stage area/area curve adjusted to average natural ground.
7) Ranchette areas are modeled with a Cn of 78, a peaking factor of 323, Tc=34 min., and a .5 acre pond in each 5 acre sub-basin.
8) Wooded areas have a Cn of 70, peaking factor of 256, stage/area curve adjusted to natural ground.
9) Basins with more than one ground type previously mentioned vary from the typical as the numbers were combined using a percentage basis and engineering judgement.
10) Model #2 utilizes curve numbers in the residential and ranchette areas by closer approximating the current impervious areas present at this time.
11) Pipes have been modeled with a bottom clip to represent the typical sediment deposit in the invert of pipes. Entrance and exit losses are assumed to be .5 and .95 respectively.
12) The basin pipe connections to the sub-laterals are modeled as typical 12" CMP. One pipe is provided for each 5 acres of residential area, one pipe per 10 acres of grove and ranchette developments, and one pipe per 20 acres of woods and pastures areas.

# HYDROLOGIC STUDY

The purpose of this hydrologic study is to update the input data to reflect 2014 conditions and analyze the existing drainage improvements and to establish a baseline to assess the effects of proposed stormwater management construction projects, and to estimate the systems drainage capacity. The basis for the study is a computer model using ICPR (version 3.0) software to analyze the watershed area.

The watershed falls within the north east portion of the Fellsmere Water Control District (FWCD). In the early 1900's the FWCD plan of reclamation was developed and the resulting network of perimeter dikes, Main Canals, Laterals, and Sub-laterals were constructed. The subject watershed includes approximately 16,257 acres overall with the City of Fellsmere centrally located within the overall study area. The16,257 acre watershed lies between the north County line (Fellsmere Main Canal), the East Boundary Dike on the East, the Lateral U on the West, Sub-lateral Ditch No. 24 on the South. The system includes east-west sub-lateral ditches ¼ mile on center. The naturally occurring 10 mile ridge on which I-95 is constructed lies east of the 16,257 acres watershed. The land slopes generally from east to west from the 10 mile ridge. The west section drains west via the sub-laterals to Lateral U which flows north into the Fellsmere Main Canal. The east section drains west via the sub-laterals to Park Lateral and then also flows north.

Other highlights and observations of the study include:

- Land Use conditions are based on today's land uses and drainage improvements
- Two (2) large agricultural areas maintain an outfall to the gravity drainage system and are modeled as basins connected by pipe. The connections are at the south end of Lateral U and the south end of Park Lateral.
- The November 5, 2003 storm was utilized for the original model calibration. This 2014 model update is calibrated based on Hurricane Francis rainfall and high water marks surveyed at several bridge installations and stage recorder data recorded during the Francis event.
- The model #1 (calibration model) results differ from the four stage recorders from as little as 0.1 foot to approximately 1.3 feet. The .1′ difference is obviously within the acceptable range, however, the 1.3′ difference which occurs at the Park Lateral / Ditch 4 intersection is notably inconsistent. We note that the model results closely match the interpolated surveyed high water mark elevation, (19.63 vs. 19.54). Therefore, the stage recorder elevation of 18.62 is likely an erroneous data point.

FWCD MODEL CALIBRATION
HURRICANE FRANCES STORM EVENT (ALL ELEVATIONS NAVD)

| Node Name | Surveyed High Water Mark (NAVD) | Stage Recorders (NAVD) | Model Elevation (NAVD) | Difference From Field Observation |
|---|---|---|---|---|
| NP-10 | 18.76 | | 18.78 | 0.02 |
| NP-120 | 21.42 | | 21.17 | -0.25 |
| NP-140 | 21.54 | | 21.54 | 0.00 |
| NP-40 (Interpolated HWM) | 19.54 | 18.62 | 19.61 | 0.07 |
| NP-80 | 20.58 | | 20.46 | -0.12 |
| NP14C25 | | 24.5 | 23.55 | -0.95 |
| NP17SBP | | 23.34 | 23.41 | 0.07 |

## FLOOD ROUTE RESULTS

Using the results of the Advanced Interconnect Channel and Pond Routing (adICPR Ver. 3.0) computer model the peak flow rate (CFS) and the quantity (Ac-Ft) of runoff discharged from the 16,257 Acre watershed to the boundary node (NF-10) through hour 72 are presented, in the following table:

| **25YR – 24 HR (9.2" EVENT)** | **BOUNDARY (NF-10) CONDITIONS** |
|---|---|
| PEAK CFS, (Hr 30.3) | 1279 |
| TOTAL AC-FT | 5839 |

## FLOOD ROUTE RESULTS – PEAK STAGES @ STAGE RECORDER LOCATIONS AND REPRESENTATIVE NODES ALONG PARK LATERAL (NP-10 = DITCH 1, NP-200 = DITCH 20, ETC.)

| NAVD NODE | Frances Stage Recorder or Surveyed High Water Mark | Frances Fay Event 2004 Conditions | 24 HR - 25 YR 25 yr / 24 hr (9.2") 2014 Conditions | 96 HR - 100 YR 100 yr/96 hr (15") 2014 Conditions |
|---|---|---|---|---|
| NP-10 | 18.76 (HWM) | 18.78 | 18.81 | 19.24 |
| NP-40 | 19.54 (HWM) | 19.61 | 19.66 | 20.09 |
| NP-80 | 20.58 (HWM) | 20.46 | 20.52 | 20.93 |
| NP-120 | 21.42 (HWM) | 21.17 | 21.26 | 21.64 |
| NP-160 | | 21.76 | 21.86 | 22.21 |
| NP-170 | | 21.85 | 21.94 | 22.30 |
| NP-200 | | 22.02 | 22.10 | 22.46 |
| NP-240 | | 22.11 | 22.18 | 22.55 |
| NP14C25 | 24.5 | 23.55 | 23.46 | 23.84 |
| NP17SBP | 23.34 | 23.41 | 23.50 | 23.95 |
| NP17SBPA | | 23.40 | 23.50 | 23.93 |

# APPENDIX A

## INPUT DATA AND RESULTS FOR: (ON CD)
## - 2014 EXISTING CONDITIONS MODEL
## - 25 Yr – 24 Hr Storm Event
## -100 Yr – 96 Hr Storm Event
## - Basin / Node Map

# APPENDIX B

# NODE/BASIN COMPUTER MODEL MAPS FOR EXISTING CONDITIONS AS PREPARED BY CARTER ASSOCIATES, INC.

# APPENDIX C

# PEAK STAGE REPORTS FOR 25 AND 100 YR EVENTS

# APPENDIX D

# RAIN GAUGE AND STAGE RECORDER DATA
# FRANCIS EVENT

# APPENDIX E

# 2007 - 2014 MODEL INPUT DATA AND RESULTS COMPARISON FOR SPECIFIC NODES WITH LARGE PEAK STAGE DIFFERENCES