Staying Ahead of the Land Development "Curve:"

Watershed-Level Planning for Little Cypress Creek using Dynamic HEC-RAS

April 27, 2017

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Lockwood, Andrews & Newnam, Inc.
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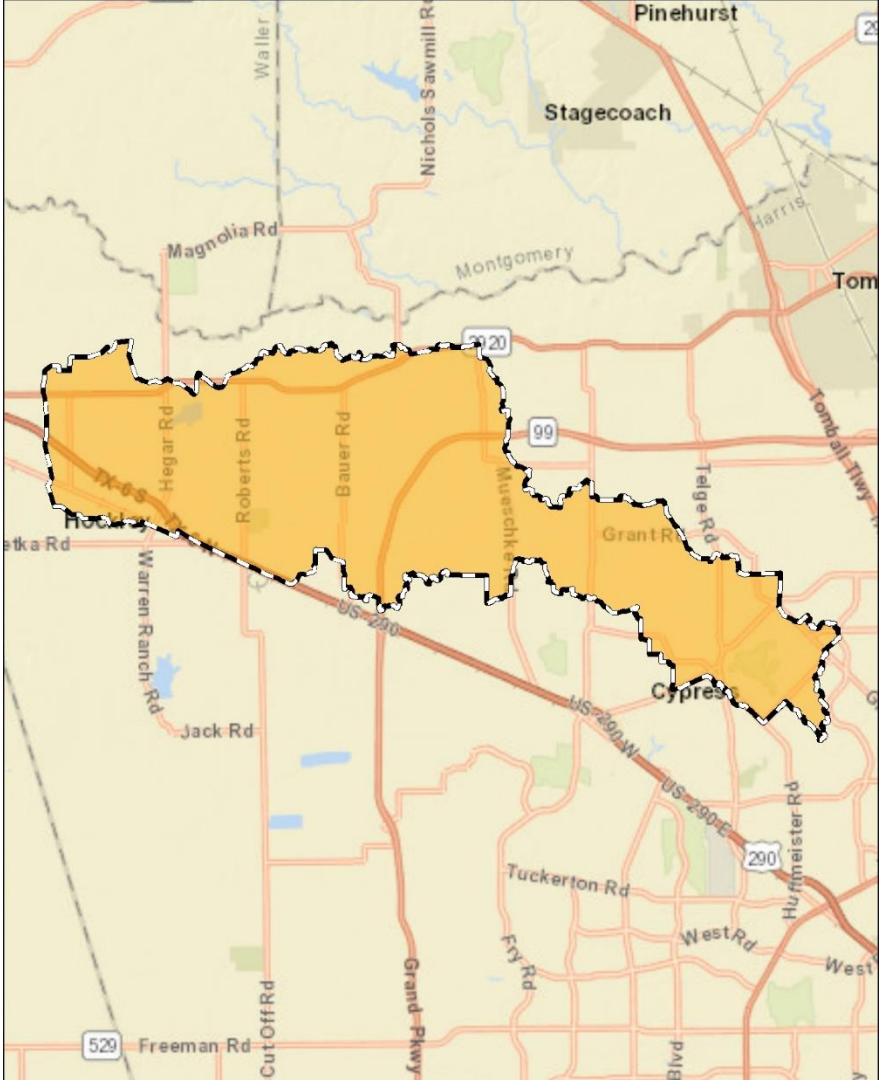
HARRIS COUNTY FLOOD CONTROL DISTRICT

Little Cypress Creek

- 55 sq. miles
- 20 mi. studied Channels
- Mostly undeveloped
- Ongoing Master Drainage Plan
- Frontier Program



Frontier Program Purposes

- Planning for Regional Drainage Infrastructure
  - Ahead of Future Land Development
- Provide Outfall Depth for Future Development
- Minimize Onsite Detention
  - Provided within Regional Basins
- Provide flood risk reduction

- Plan for the Future BEFORE flooding becomes a problem

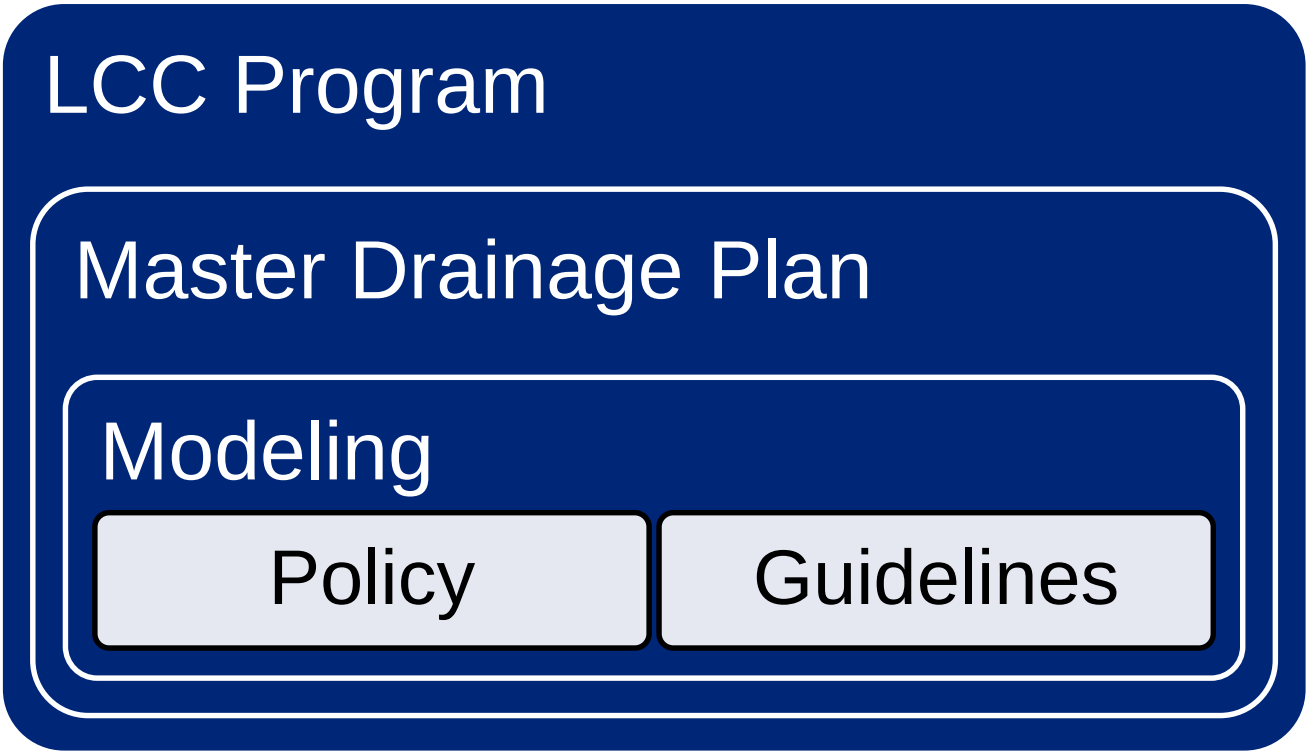
Frontier Program within LCC

- Developers participate with:
  - $4,000/acre impact fee
  - Excavation within HCFCD property
- Impact Fee Purpose
  - ROW acquisition
- Development of multiple regional basins
- Development of future proposed channels

Program Components

- Active Acquisitions of:
  - Multiple basins
  - Channel ROW
- Continuous land owner interaction with developments
  - Excavation
  - Property, ROW
- Ongoing Construction & Excavation

LCC Program Structure



What is the Master Drainage Plan?

- Revised Existing Conditions
- Calibrated Existing Conditions
- Ultimate Conditions Land Use
- Ultimate Conditions Hydrology
- Ultimate Conditions Channels & Basins
- Develop Watershed Improvement Projects
- Develop Plan for the Watershed
- Support Finalizing Interim Guidelines

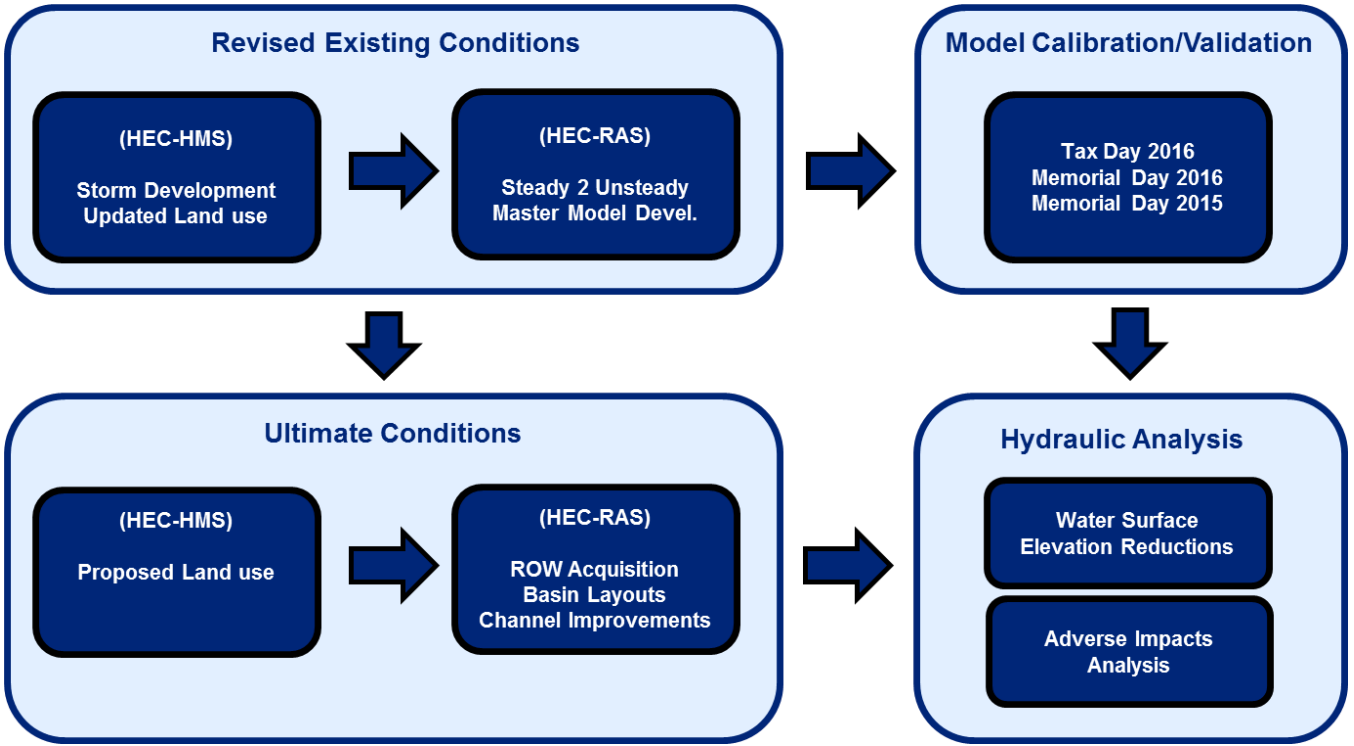
Why Dynamic HEC-RAS?

- Holistic understanding of storage and conveyance
  - Storage distributed throughout watershed
- Understanding of interrelated basins
- Timing relationships

Benefits of Dynamic HEC-RAS

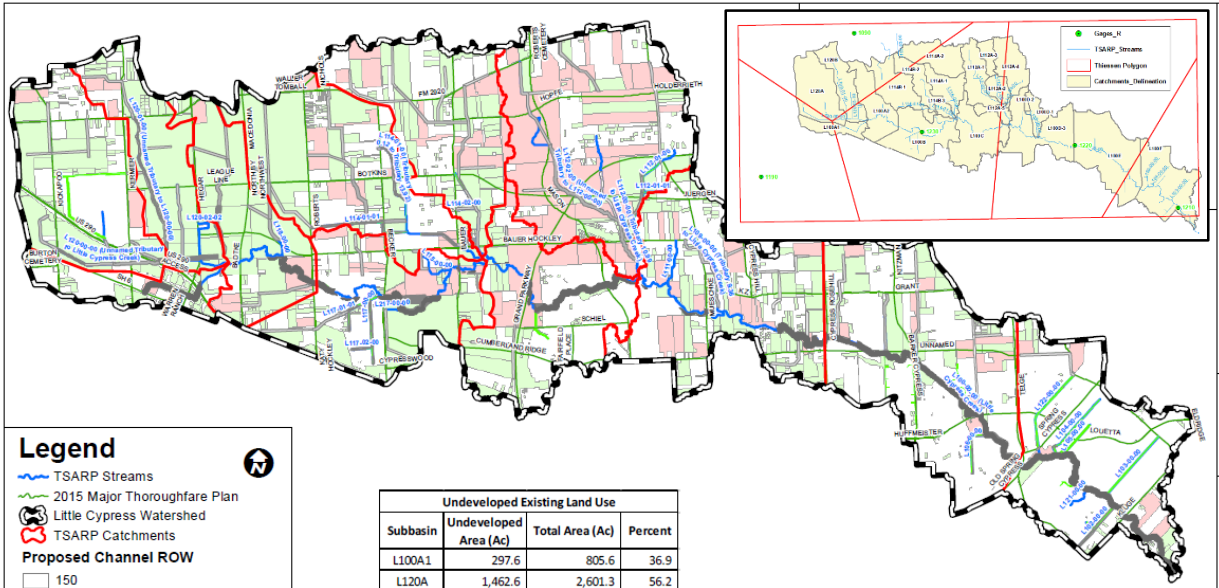
- Higher level understanding of basins
- More realistic implementations
- Advanced control structure understanding
- Better accounting routing & attenuation

MDP Modeling Workflow



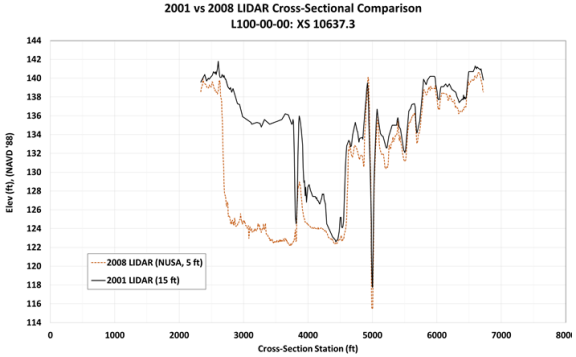
HARRIS COUNTY FLOOD CONTROL DISTRICT

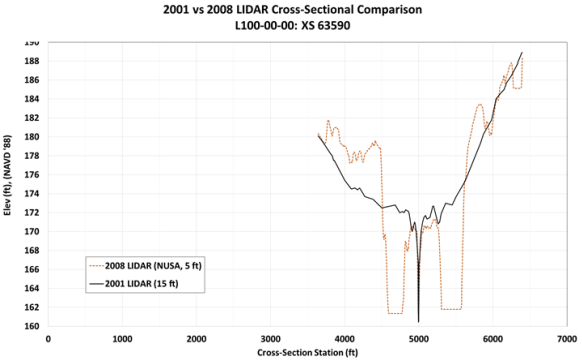
Revised Existing Conditions
(Hydrology)

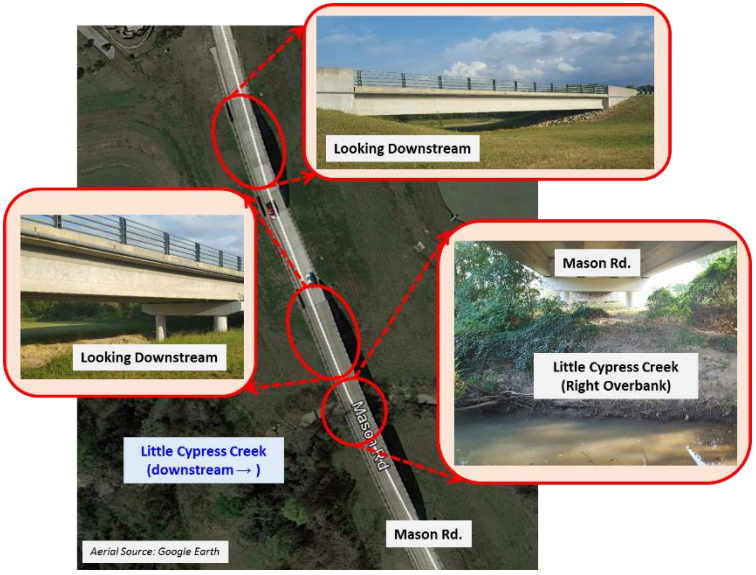


Undeveloped Existing Land Use			
Subbasin	Undeveloped Area (Ac)	Total Area (Ac)	Percent
L100A1	297.6	805.6	36.9
L120A	1,462.6	2,601.3	56.2
L120B	1,408.3	1,651.6	85.3
L100A2	1,735.9	1,913.9	90.7
L114B	1,531.8	2,600.6	58.9
L114A	2,057.5	3,086.5	66.7
L100B	1,675.2	2,631.0	63.7
L112A	3,077.4	4,259.5	72.2
L100C	1,337.2	2,715.5	49.2
L100D	1,753.4	3,581.0	49.0
L100E	1,294.0	4,290.0	30.2
L100F	405.1	3,361.5	12.1

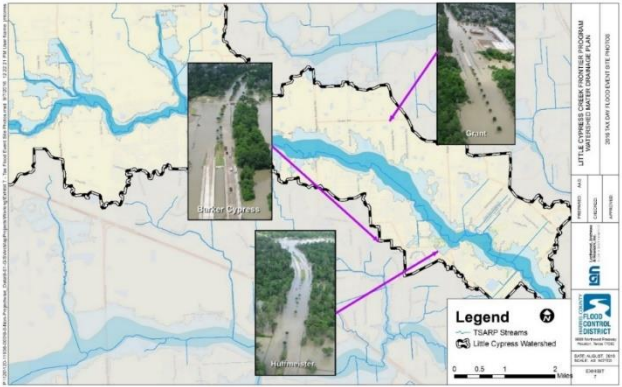
Revised Existing Conditions
(Hydraulics)

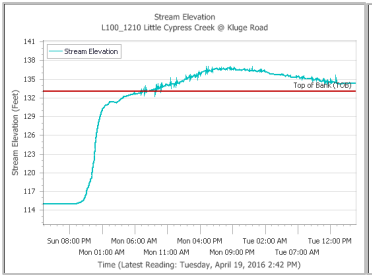


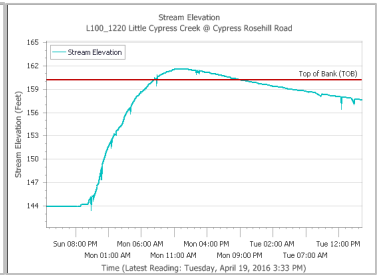


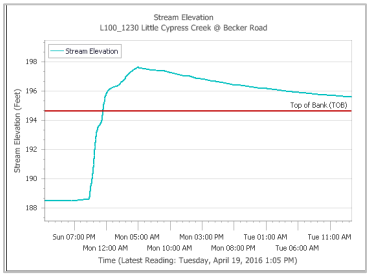


Calibration
(2016 Tax Day Event)

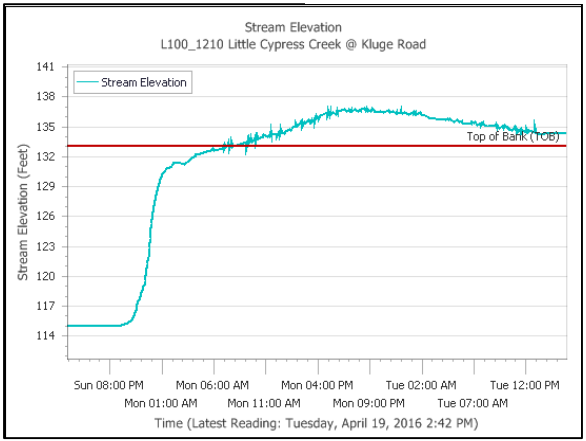








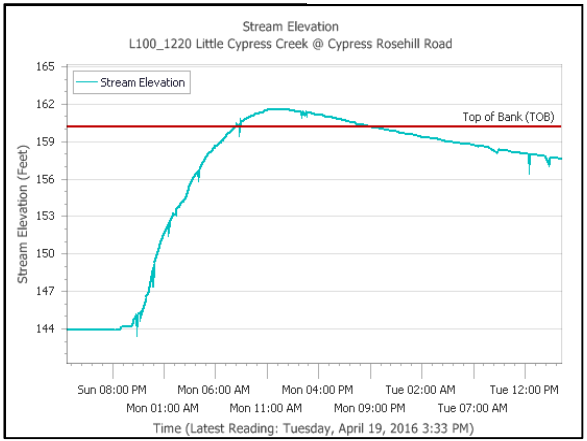
Calibration
(2016 Tax Day Event)



Event Date	HWM
10-18-94	136.30’
11-14-98	133.91’
Allison (01)	135.31’
Ike (08)	128.70’
4-25-09	133.40’
7-12-12	135.40’
4-18-16	136.40’

Flood Frequency	Elevation
10% (10-year)	132.50’
2% (50-year)	134.50’
1% (100-year)	135.10’
.2% (500-year)	136.10’

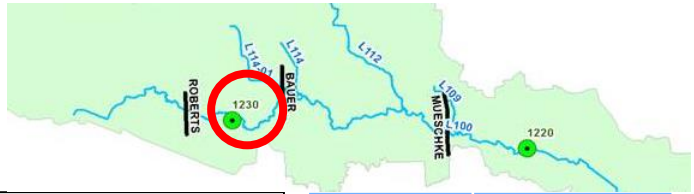
Calibration
(2016 Tax Day Event)

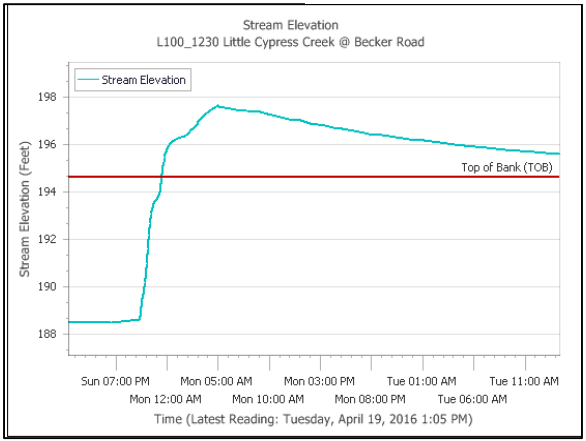


Event Date	HWM
10-18-94	159.13’
10-19-98	160.23’
11-14-98	159.23’
Allison (01)	159.53’
Ike (08)	156.00’
4-28-09	158.60’
7-12-12	160.40’
4-18-16	161.62’

Flood Frequency	Elevation
10% (10-year)	158.00’
2% (50-year)	159.10’
1% (100-year)	159.50
.2% (500-year)	160.70

Calibration
(2016 Tax Day Event)



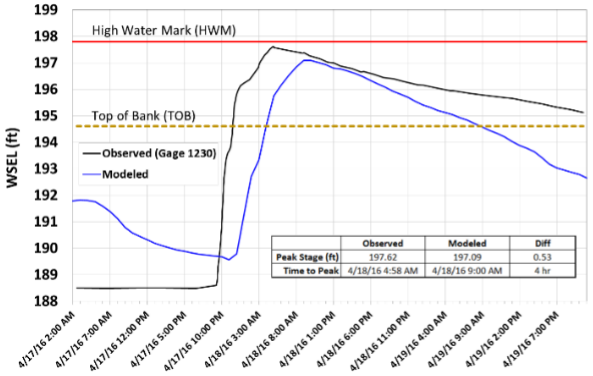


Event Date	HWM
10-18-94	197.10’
10-19-98	195.80’
Allison (01)	196.40
Ike (08)	193.50’
4-28-09	195.40’
7-12-12	197.20’
4-18-16	197.80’

Flood Frequency	Elevation
10% (10-year)	195.20’
2% (50-year)	196.00’
1% (100-year)	196.20
.2% (500-year)	196.90

Calibration (2016 Tax Day Event)

a)



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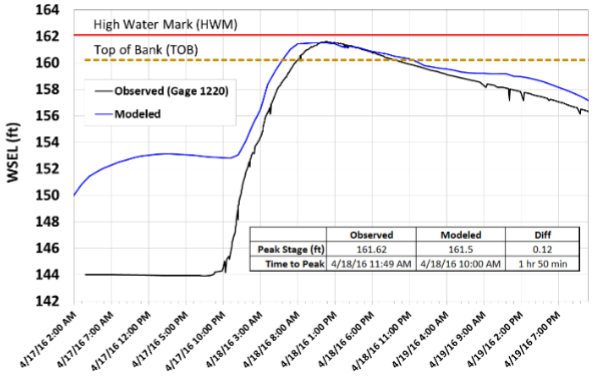
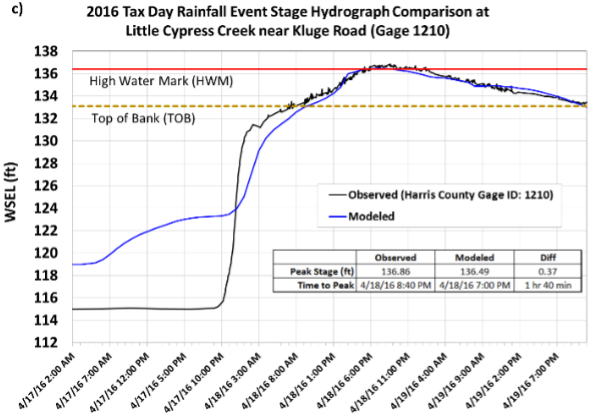


c)



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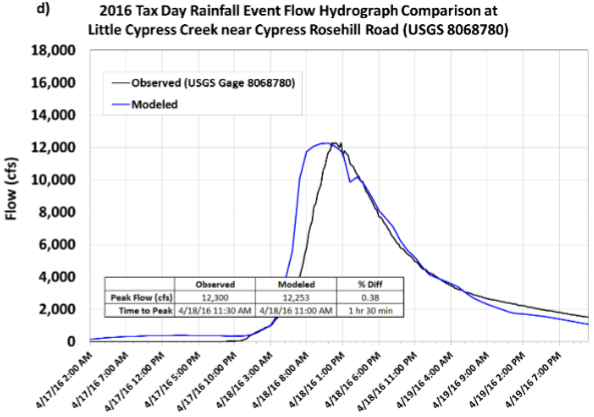
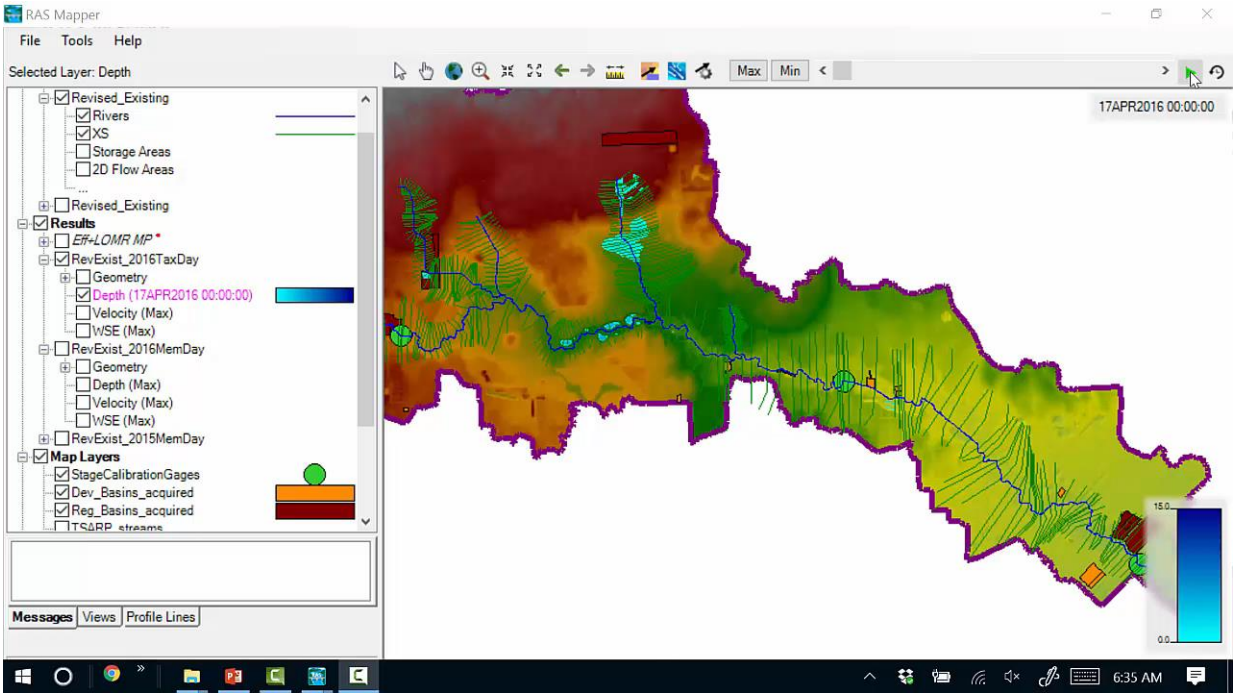
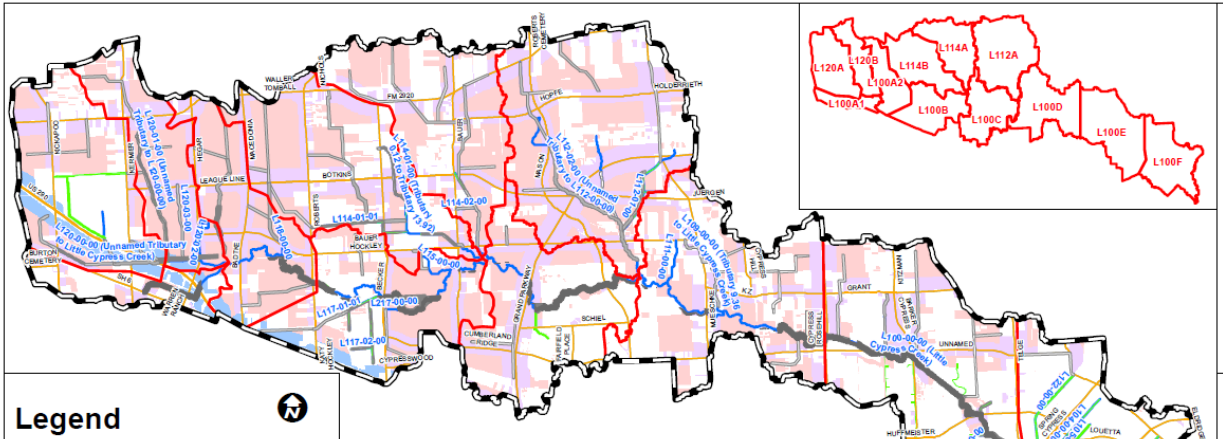


Calibration (2016 Tax Day Event)



Ultimate Conditions



Subbasin	Undeveloped Existing Area (Ac)	Proposed Land Use Area		
		Commercial/Industrial/ Mixed Use Area, Ac	Residential Area, Ac	Residential - Rural Lot(>20 Ac)
L100A1	297.6	269.7	0.5	27.4
L120A	1,462.6	1,308.5	37.5	116.6
L120B	1,408.3	1,267.5	67.8	73.0
L100A2	1,735.9	1,518.5	8.9	208.5
L114B	2,057.5	1,656.6	33.1	367.8
L114A	1,675.2	1,050.2	120.4	504.6
L100B	1,531.8	1,049.5	94.9	387.4
L112A	3,077.4	811.9	48.1	2,217.4
L100C	1,337.2	596.8	85.9	654.5
L100D	1,753.4	959.3	249.5	544.5
L100E	1,294.0	796.1	163.7	334.2
L100F	405.1	128.6	87.3	189.3

LITTLE CYPRESS CREEK FRONTIER PROGRAM
WATERSHED MASTER DRAINAGE PLAN
PROPOSED LAND USE

PREPARED: AAG
CHECKED: JMT
APPROVED: MJM

Lockwood, Andrews & Newnam, Inc.

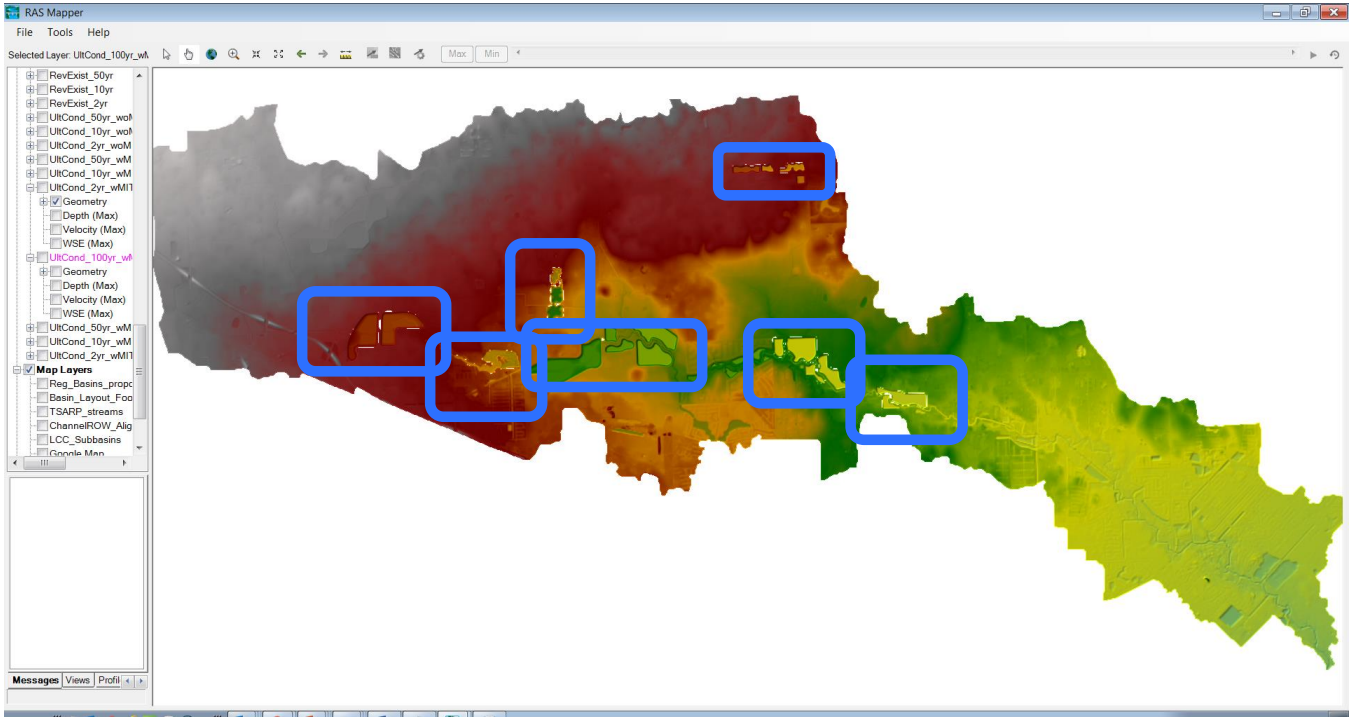
HARRIS COUNTY FLOOD CONTROL DISTRICT
9900 Northwest Freeway
Houston, Texas 77092

DATE: JANUARY, 2017
SCALE: AS NOTED

EXHIBIT
21

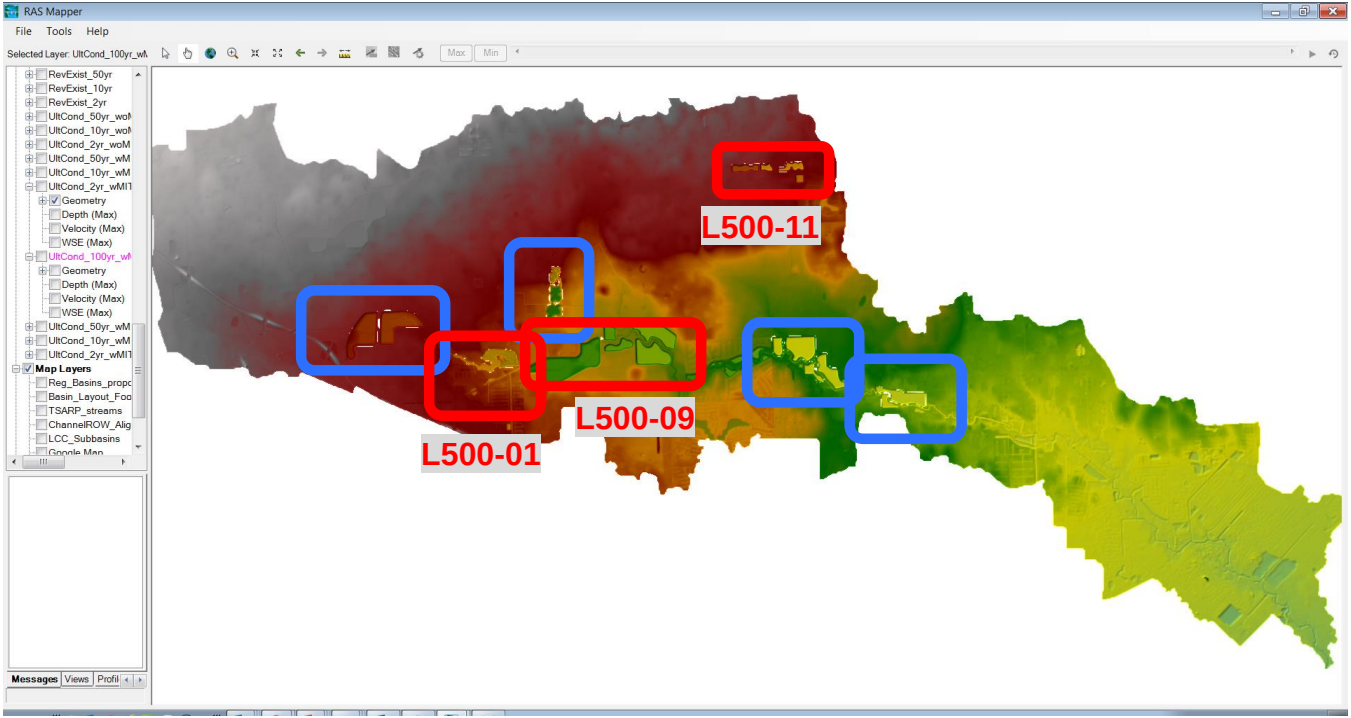
Ultimate Conditions

7 Basins “Burned” into Terrain Model

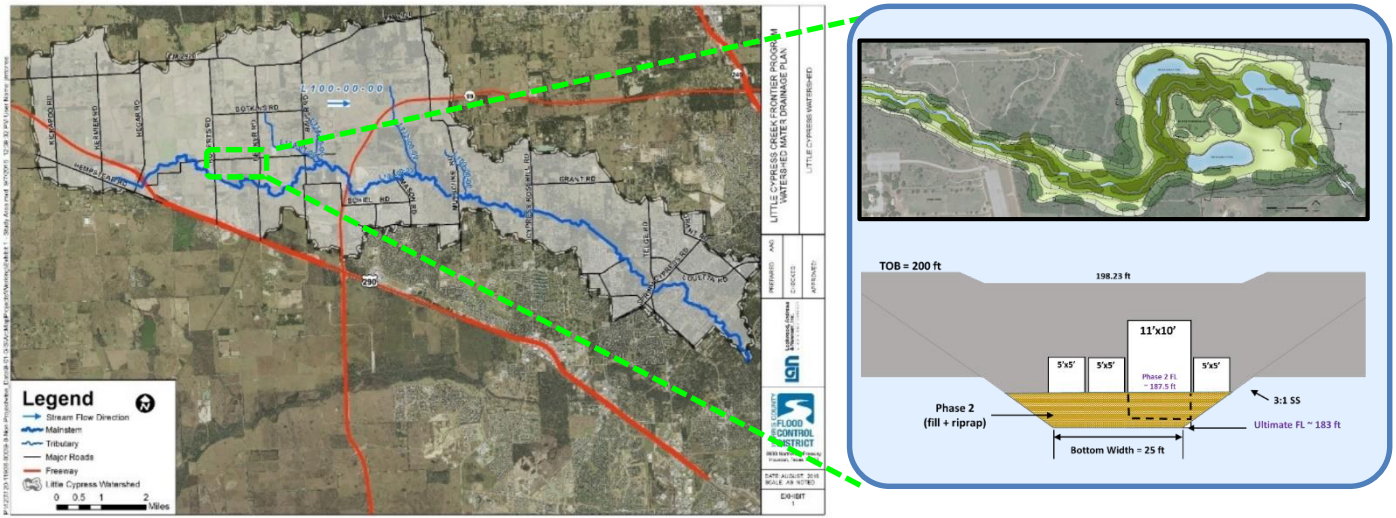


Ultimate Conditions

7 Basins “Burned” into Terrain Model

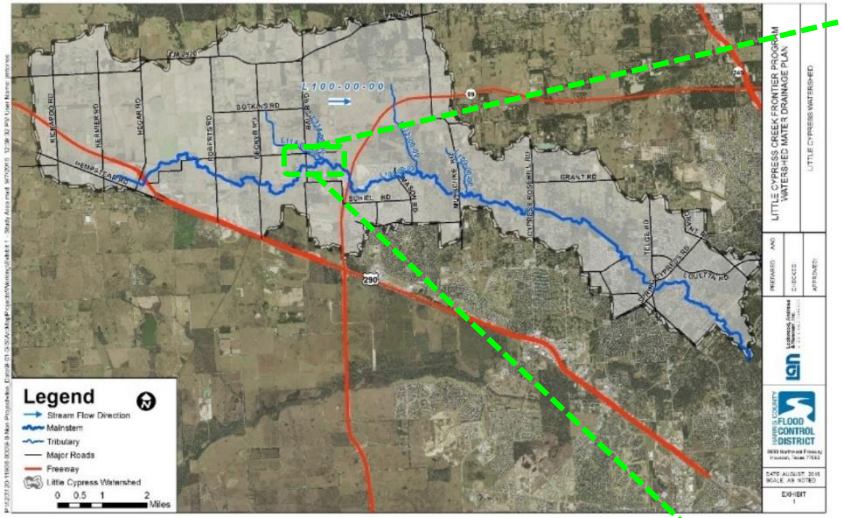


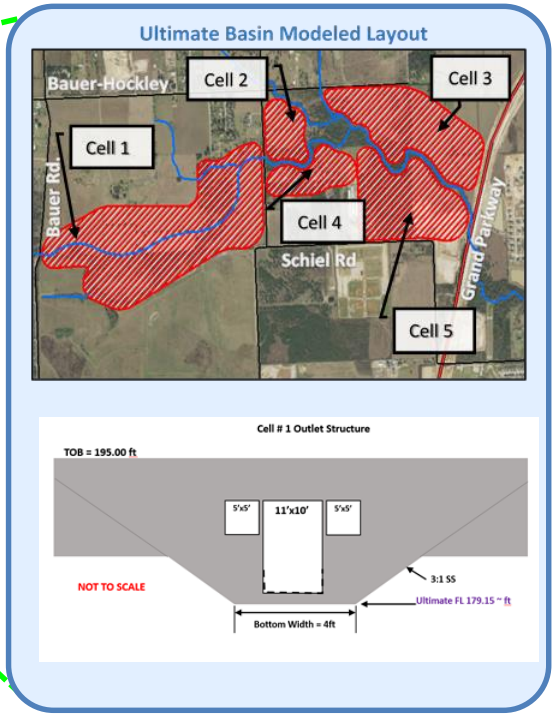
Zube Park Detention (L500-01-00)



L500-01 Zube Detention Basin	
Basin Footprint Area	90.4 acres
Zube Park Area	226 acres
Target Storage Capacity	600 acre-feet
Provided Storage Capacity	756 acre-feet
Provided Storage Capacity w/ Freeboard Provided	667 acre-feet

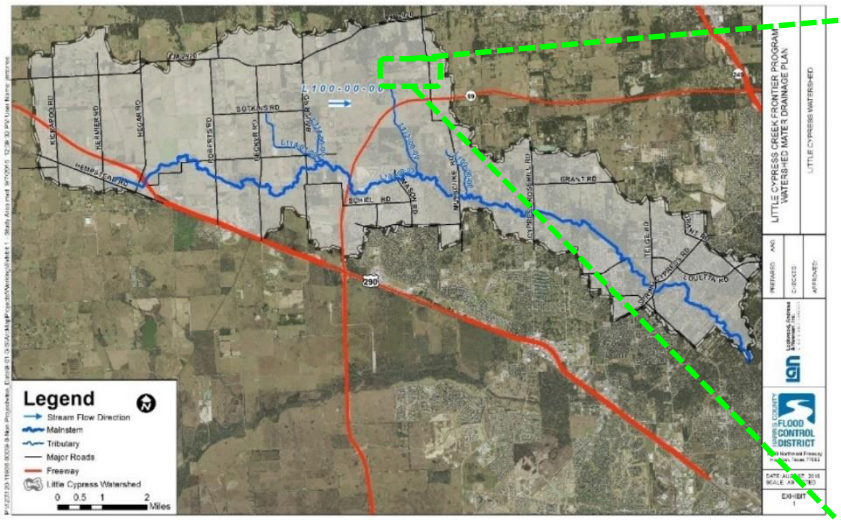
Schiel Basin (L500-09-00)

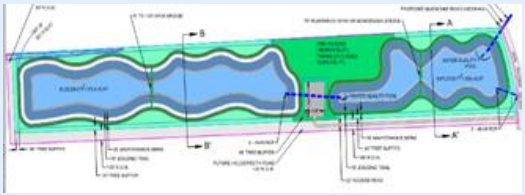


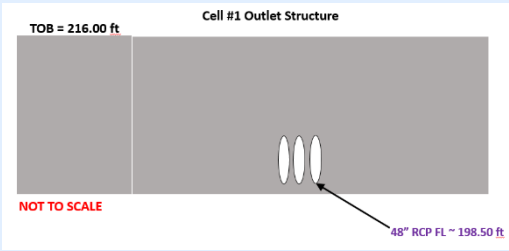


L500-09 Schiel Detention Basin	
Basin Footprint Area	470.6 acres
Target Storage Capacity	4,000-6,000 acre-feet
Provided Storage Capacity	7,401 acre-feet
Provided Storage Capacity w/ Freeboard	7,200 acre-feet

Kleb-Mueschke Basin (L500-11-00)

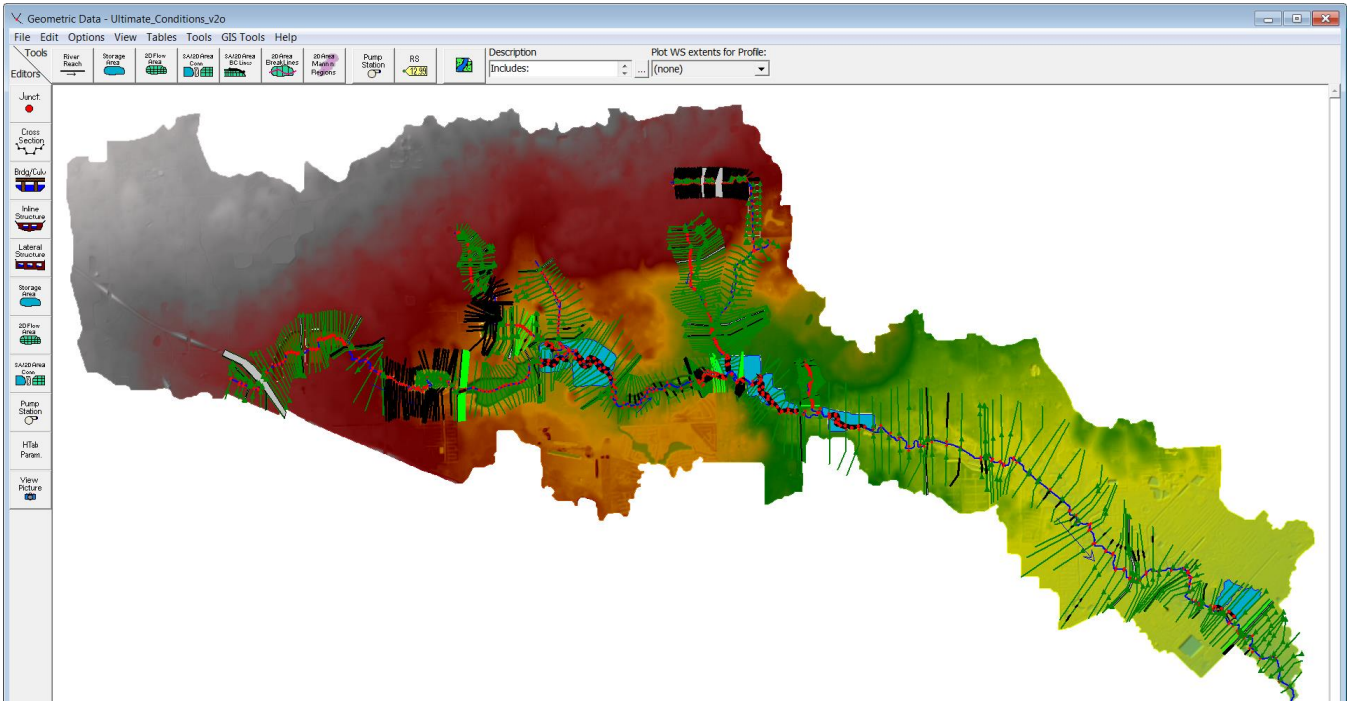




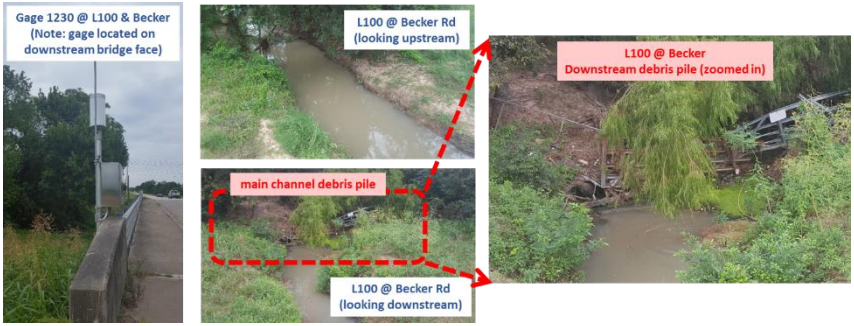


L512-01 Kleb-Mueschke Detention Basin	
Basin Footprint Area	62.9 acres
Target Storage Capacity	645 acre-feet
Provided Storage Capacity	665 acre-feet
Provided Storage Capacity w/ Freeboard Provided	635 acre-feet

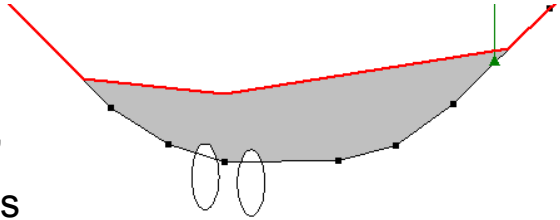
Ultimate Conditions
(Dynamic HEC-RAS Master Model)

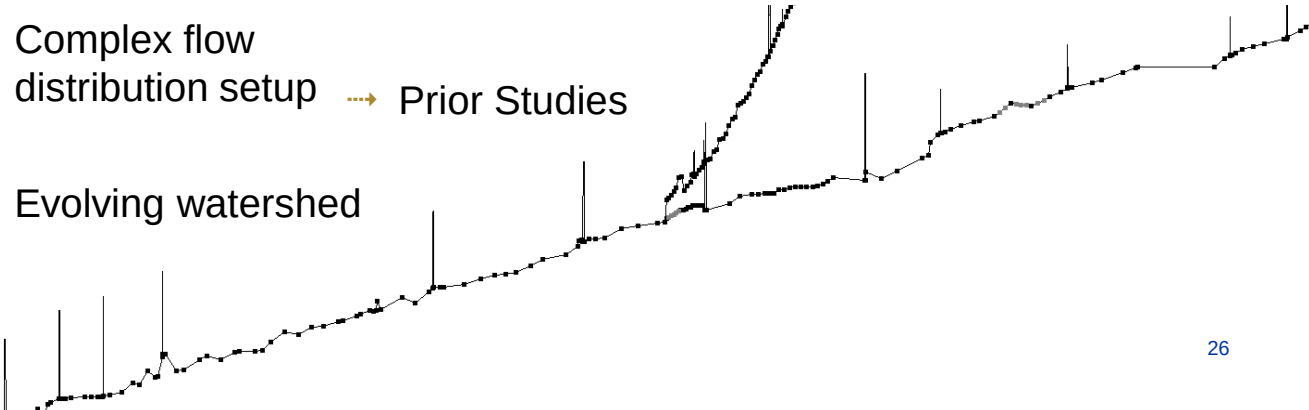


Challenges of Dynamic HEC-RAS



- Conversion of steady to unsteady
- General numerical instability
- Complex flow distribution setup
- Evolving watershed
- Channel Debris
- Mixture of “steep” and “flat” channels
- Prior Studies





Modeling Insights

Offline Basins Pros/Cons

Pros	Cons
More stable	Potential less storage yield
More efficient for attenuation	Storage double counting
Easier to update	
Control structure flexibility	

Inline Basins Pros/Cons

Pros	Cons
Potentially more storage yield	Stability
Aesthetically pleasing	Geometry updates
	More difficult to phase

General Takeaways

- Strategic ROW acquisition
- Dynamic modeling for rapid screening of mitigation alternatives
- Routine stakeholder coordination
- Revised Existing conditions provides “stable” “base” model
- Holistic system understanding

Questions?

Thank you!

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