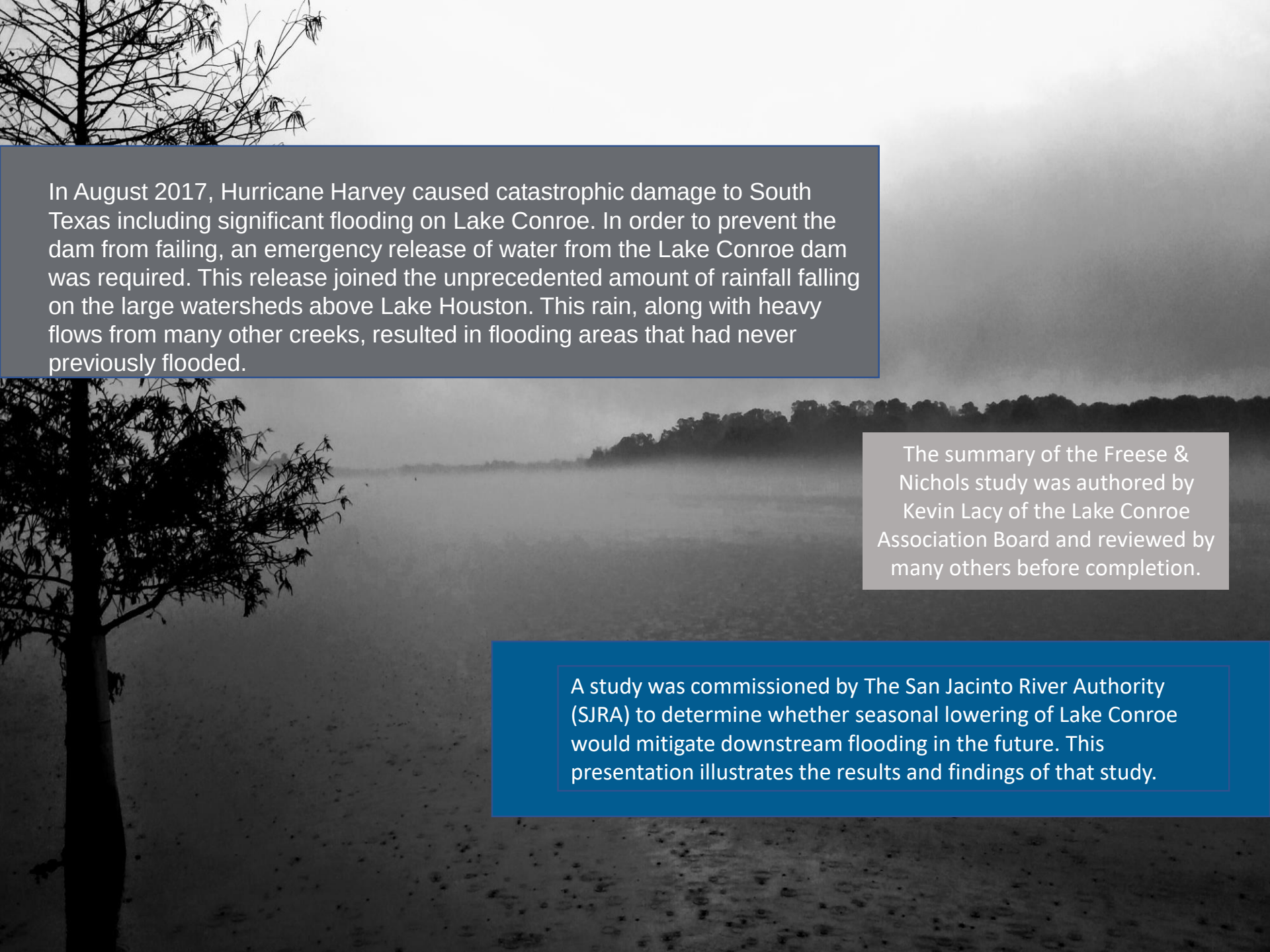


In August 2017, Hurricane Harvey caused catastrophic damage to South Texas including significant flooding on Lake Conroe. In order to prevent the dam from failing, an emergency release of water from the Lake Conroe dam was required. This release joined the unprecedented amount of rainfall falling on the large watersheds above Lake Houston. This rain, along with heavy flows from many other creeks, resulted in flooding areas that had never previously flooded.

The summary of the Freese & Nichols study was authored by Kevin Lacy of the Lake Conroe Association Board and reviewed by many others before completion.

A study was commissioned by The San Jacinto River Authority (SJRA) to determine whether seasonal lowering of Lake Conroe would mitigate downstream flooding in the future. This presentation illustrates the results and findings of that study.

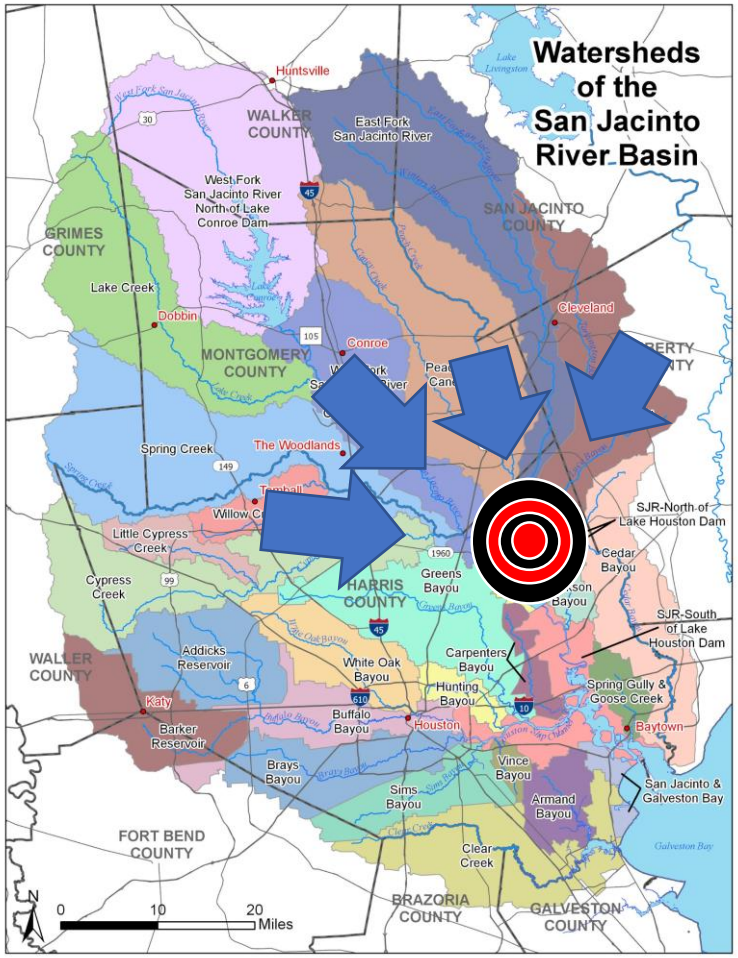
The Bullseye Effect

Hurricane Harvey brought a peak 400,000 cfs of water into the Lake Houston area.

The SJRA has said 10-20% of the total flow was from Lake Conroe emergency releases, necessary to prevent dam failure. Independent reviews calculate it at 16% based upon SJRA data.

The watershed below Lake Conroe is roughly 5 times larger than the watershed above Lake Conroe.

Given equal rainfall over the area, the watershed <u>below</u> Lake Conroe will channel <u>5 times</u> more rainfall than can be captured by Lake Conroe.

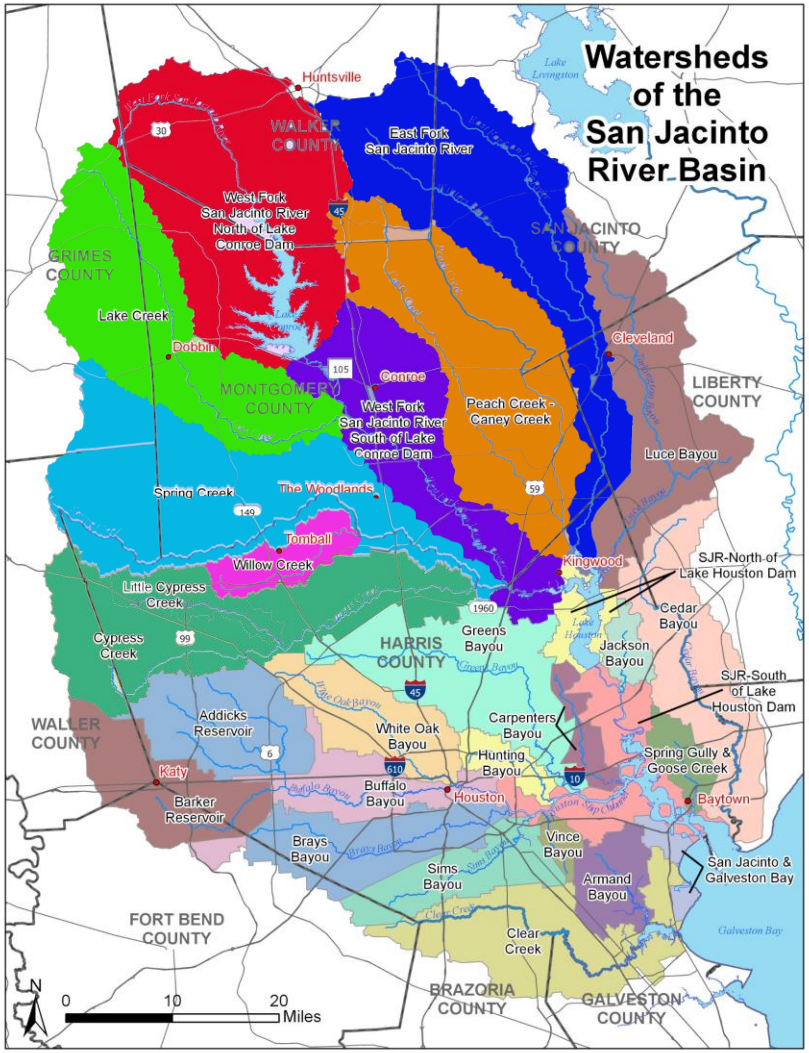


The San Jacinto River Authority has jurisdiction over the full San Jacinto watershed except in Harris County.

Harris County communities at the end of these watersheds are in a bullseye from the runoff from <u>many uncontrolled</u> water sources including rain.

Lowering Lake Conroe attempts to achieve a significant reduction in flooding at Lake Houston.

It is not possible to make a <u>significant impact</u> by changing a small contributor of the total flow into Lake Houston.



1 **Lake Conroe** Rain Inflow 130,000 cfs

Dam Outflow @ Hwy105 76,000

Est Basin Rain 15,000 cfs

2 **Lake Creek** 62,600 cfs

3 **Dam & Lake Creek Combined** Flow @I45 115,000 cfs

4 **West Fork Combined Flow** Porter + Basin Rain (29-31") 130,000 cfs = 32.5%

Est Basin Rain 5300 cfs

5 **Caney Creek** 37,000 cfs =9.3%

6 **Peach Creek** 31,300 cfs =7.8%

7 **East Fork** Flow + Basin Rain (27") 73,600 cfs =18.4%

10 **Est Basin Rain** (35") 16,400cfs = 4%

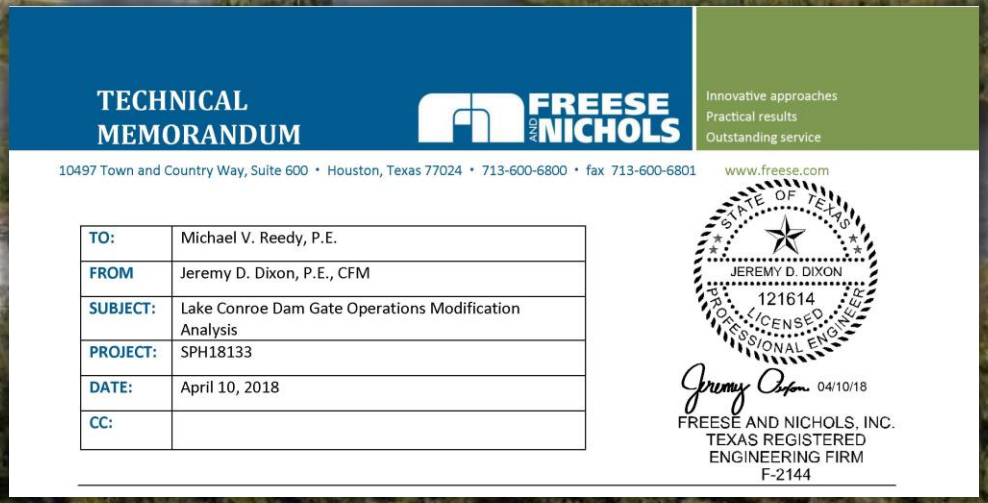
8 **Spring Creek** 82,100 cfs =20.5%

9 **Cyprus Creek** 24,100 cfs =6%

Data From SJRA – "Upstream Lake Houston Basin Area Estimated Peak Inflow from West Fork, Spring Creek, East Fork and Cypress Creek plus Near Basin Rain (35") 400,000 cfs"

The Effects of Various Lake Conroe Water Levels on Downstream Flooding

Data provided by the Freese and Nichols Report:
"Lake Conroe Dam Gate Operations Modification Analysis"
Apr 10, 2018 Prepared for The San Jacinto River Authority (SJRA)



TECHNICAL MEMORANDUM

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TO:	Michael V. Reedy, P.E.
FROM	Jeremy D. Dixon, P.E., CFM
SUBJECT:	Lake Conroe Dam Gate Operations Modification Analysis
PROJECT:	SPH18133
DATE:	April 10, 2018
CC:	

STATE OF TEXAS
JEREMY D. DIXON
121614
LICENSED
PROFESSIONAL ENGINEER

Jeremy Dixon 04/10/18

FREESE AND NICHOLS, INC.
TEXAS REGISTERED
ENGINEERING FIRM
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Understanding F&N Study Key Conclusions

The Freese and Nichols study is a highly detailed technical report that had a very narrow and specific goal.

Harvey events and most river / creek flows into Lake Houston were not part of the F&N study.

References to Hurricane Harvey are provided for context and to put some of the F&N report in perspective.

The F&N study is based upon a computer model using assumptions and not actual measurements.

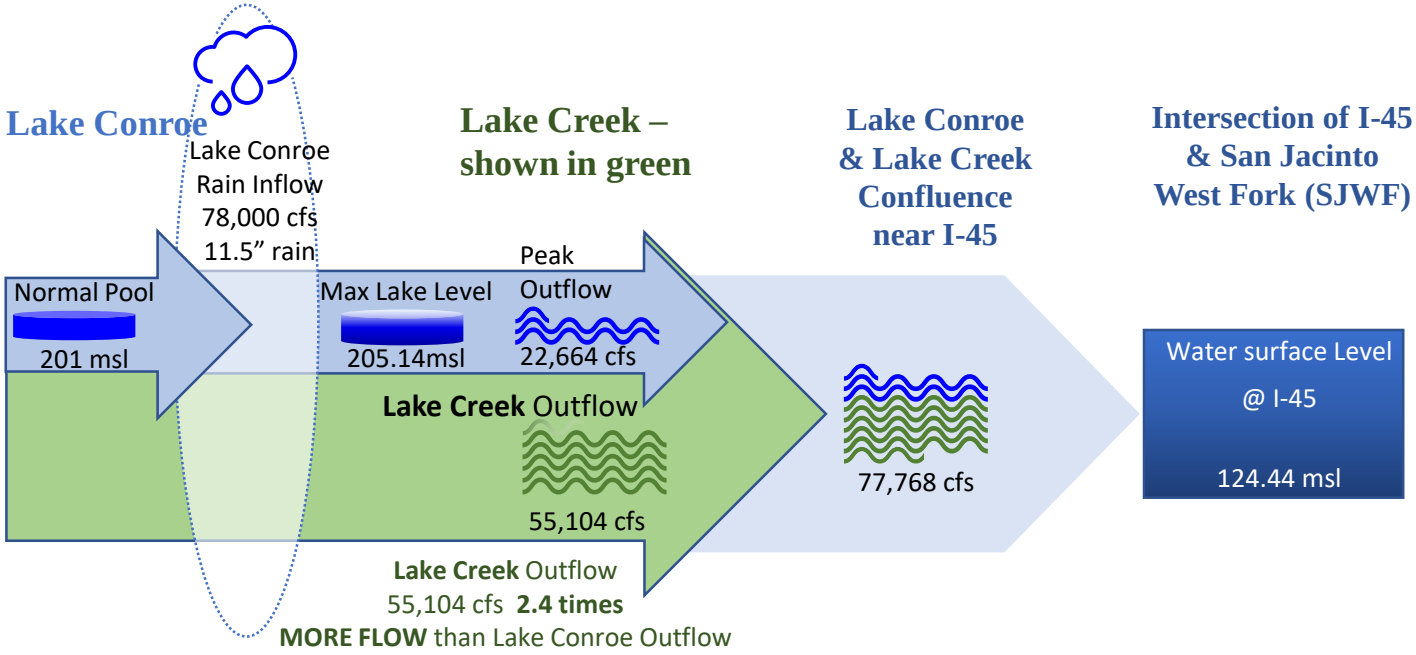
The F&N study did not model Harvey rain and flows and limited its model to impacts near Lake Conroe.

As the F&N study was completed in 2018 - before West Fork dredging – the drainage improvements are not included in the study. It is reasonable to conclude the F&N study results would be even less supportive of lake lowering if recent dredging was included and study boundaries extended to Lake Houston.

A new extended study building upon the original F&N study would likely provide stronger support of the 2018 conclusions that seasonal lake lowering is not materially effective.

SJRA F&N Technical Study on Impact of Lake Lowering – 100-year storm

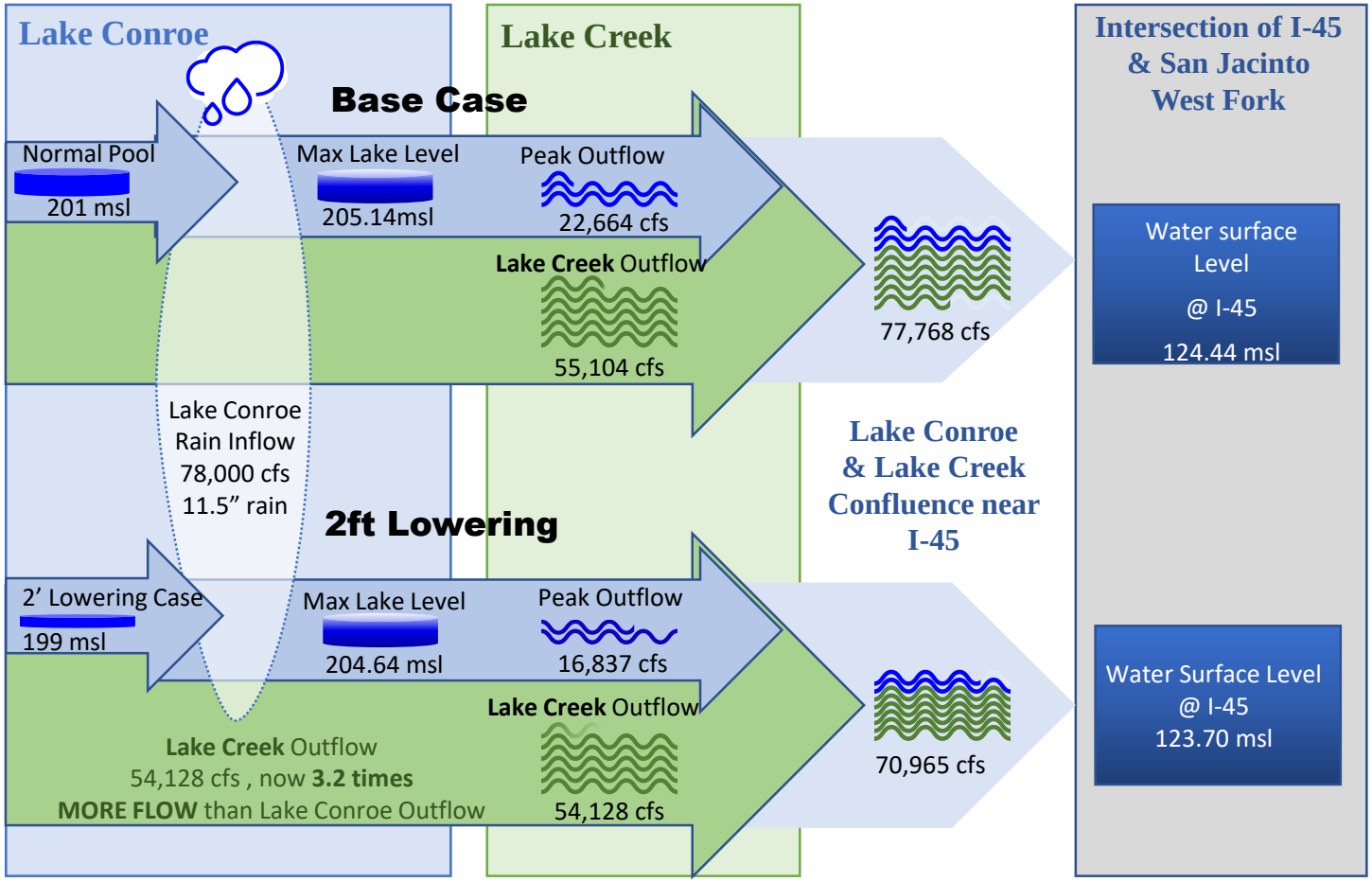
The Base Case – 100 year storm event



Lake Conroe has a "normal" or average water level of 201 feet above mean seal level (201 msl).
According to the F&N study when a 100-year storm event occurs (11.5 inches of rain falls) the following happen:

- The lake level rises to 205.14msl and the peak outflow would be 22,664 cubic ft per sec (cfs)
- This outflow joins the Lake Creek outflow (55,104 cfs) making the combined flow at the confluence 77,768 cfs
- In this scenario Lake Creek outflow is **2.4 times** that of Lake Conroe
- At I-45 and the SJWF intersection the water surface level would be 124.44msl

SJRA F&N Technical Study on Impact of Lake Lowering – 100-year storm

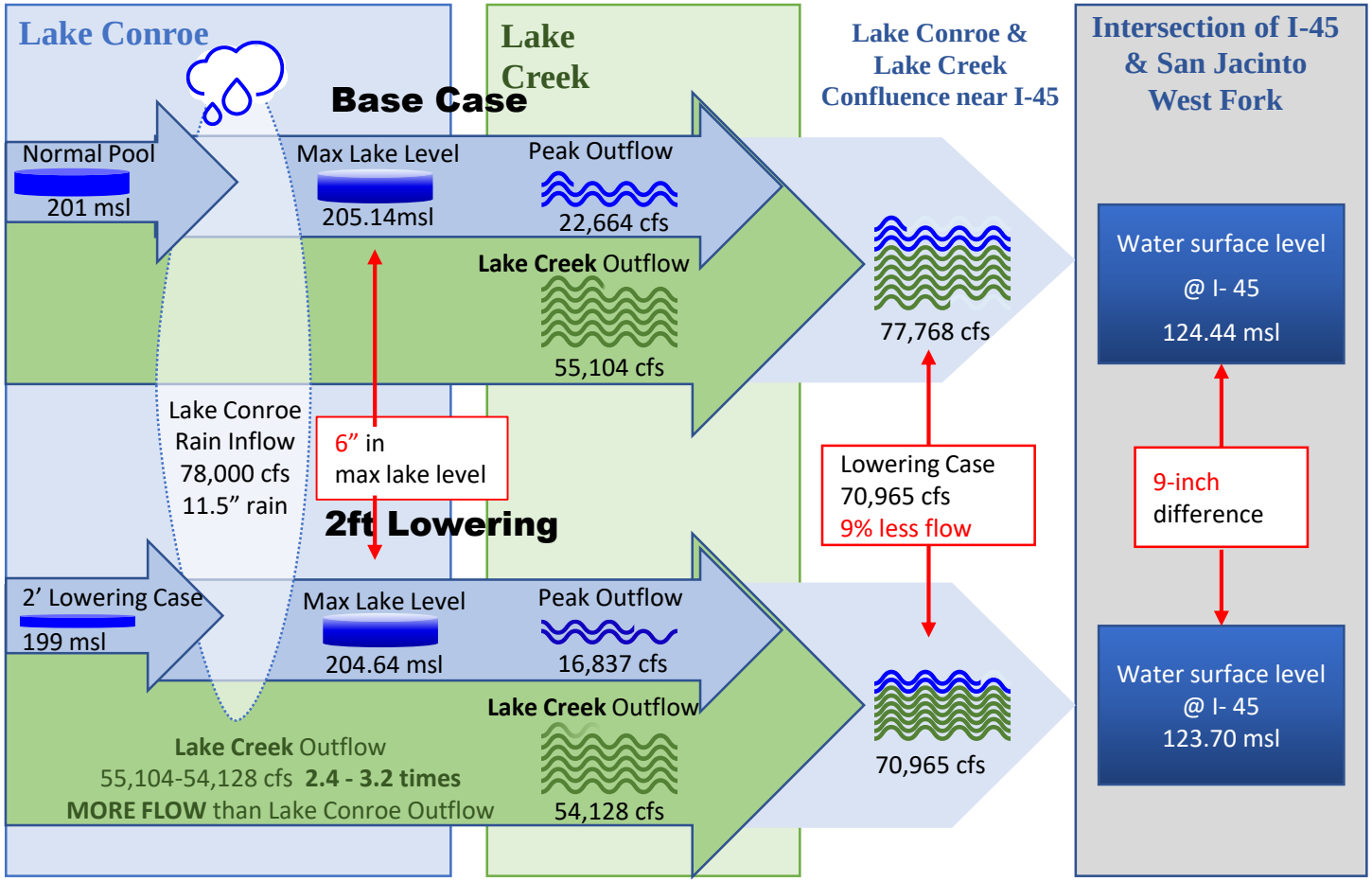


Now let us consider what changes if the Lake Conroe water level lowered 2 feet prior to the storm.

Starting with a water level of 199msl:

- when a 100-year storm event occurs the lake level rises from 199 to 204.64msl
- The peak dam outflow would be 16,837 cfs
- This joins with the Lake Creek outflow of 54,128cfs making combined flow at the confluence 70,965cfs
- And the water surface level at I-45 and SJWF becomes 123.7 msl

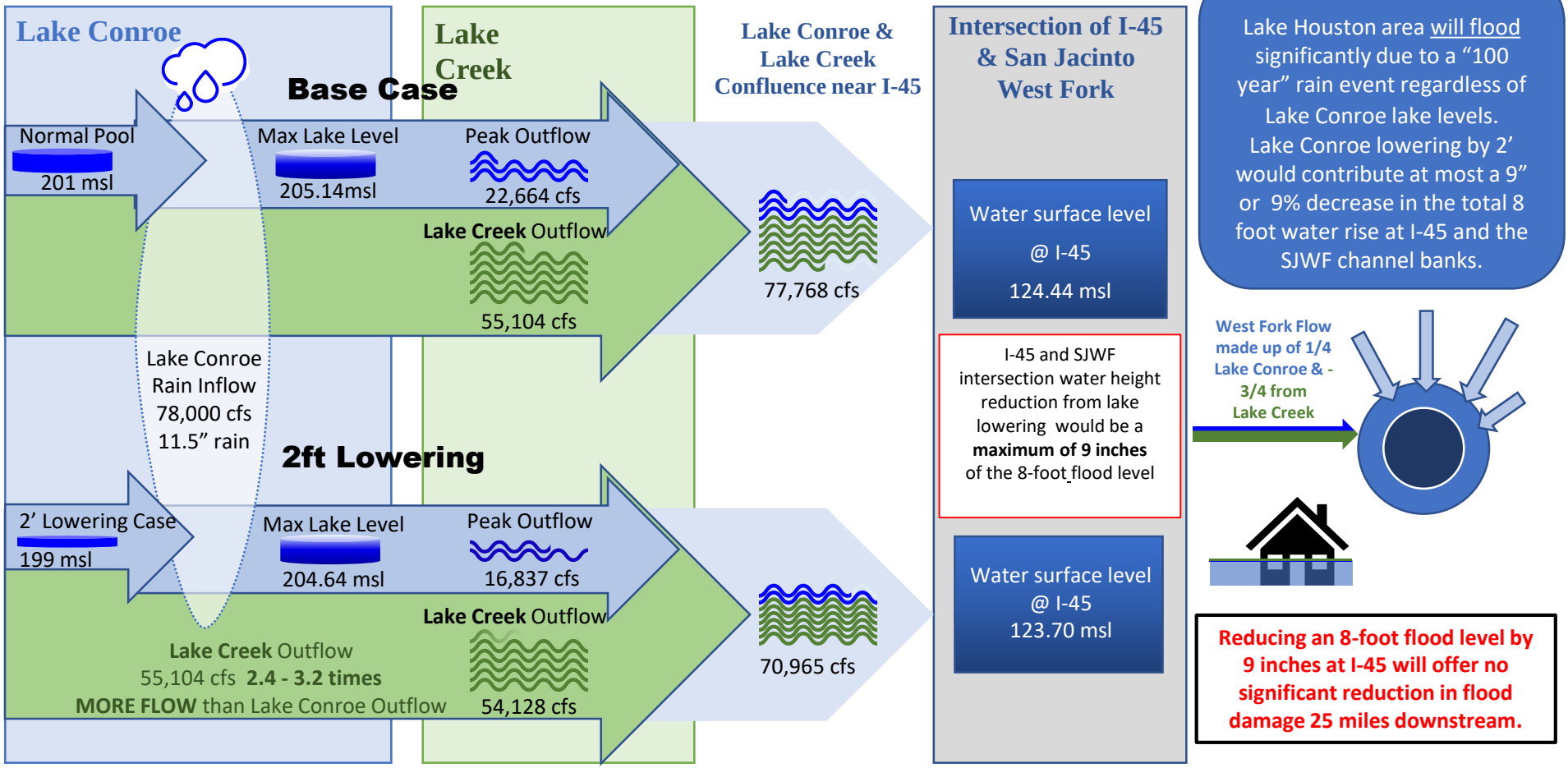
SJRA F&N Technical Study on Impact of Lake Lowering – 100-year storm



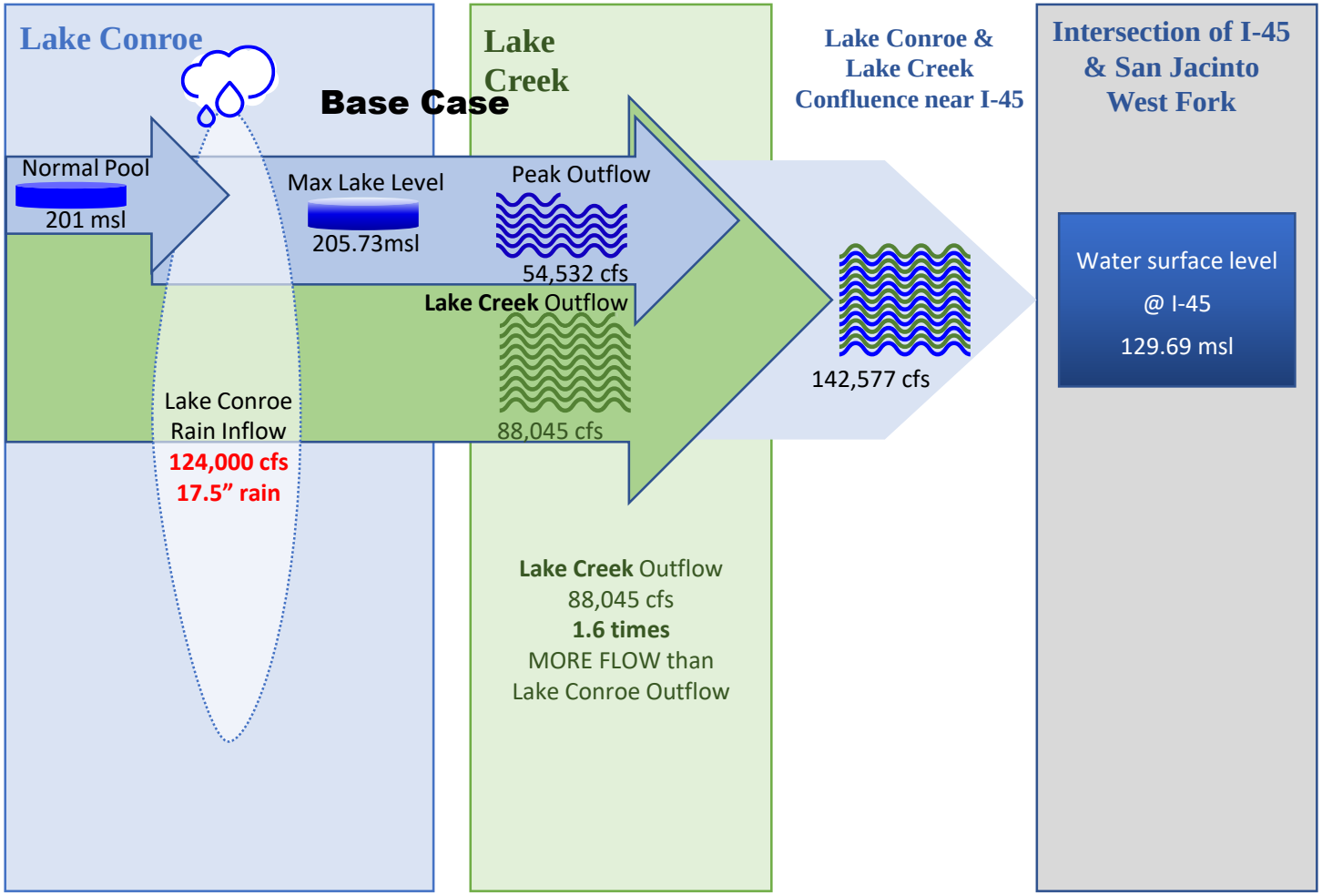
What is particularly noticeable here is that

1. the maximum lake level is only 6" lower
2. there is 9% less flow at the confluence
3. And at I-45 and the SJWF intersection there is only a 9-inch difference in the surface water level due to a 2 ft lake level lowering

SJRA F&N Technical Report on Impact of Lake Lowering – 100-year storm



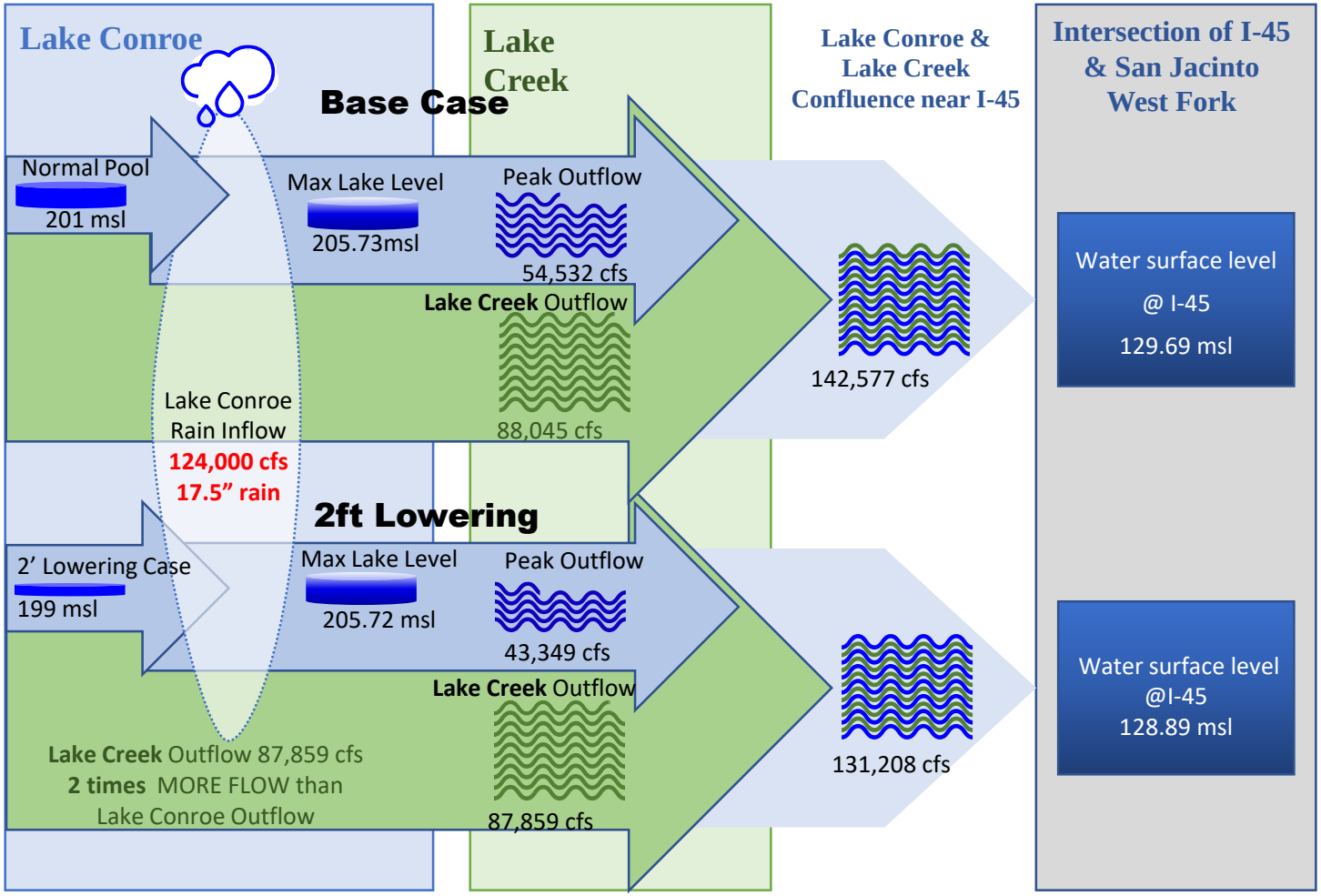
SJRA F&N Technical Study on Impact of Lake Lowering – 500-year storm



Now let us consider what changes if the storm is a 500-year event, with 17.5 inches of rain falling on Lake Conroe:

- the base case lake level rises to 205.73msl
- the peak dam outflow would be 54,532 cfs
- This joins with the Lake Creek outflow of 88,045cfs
- the combined flow at the confluence will be 142,577 cfs
- and the resulting water level at the I-45 and SJWF intersection will be 129.69 msl

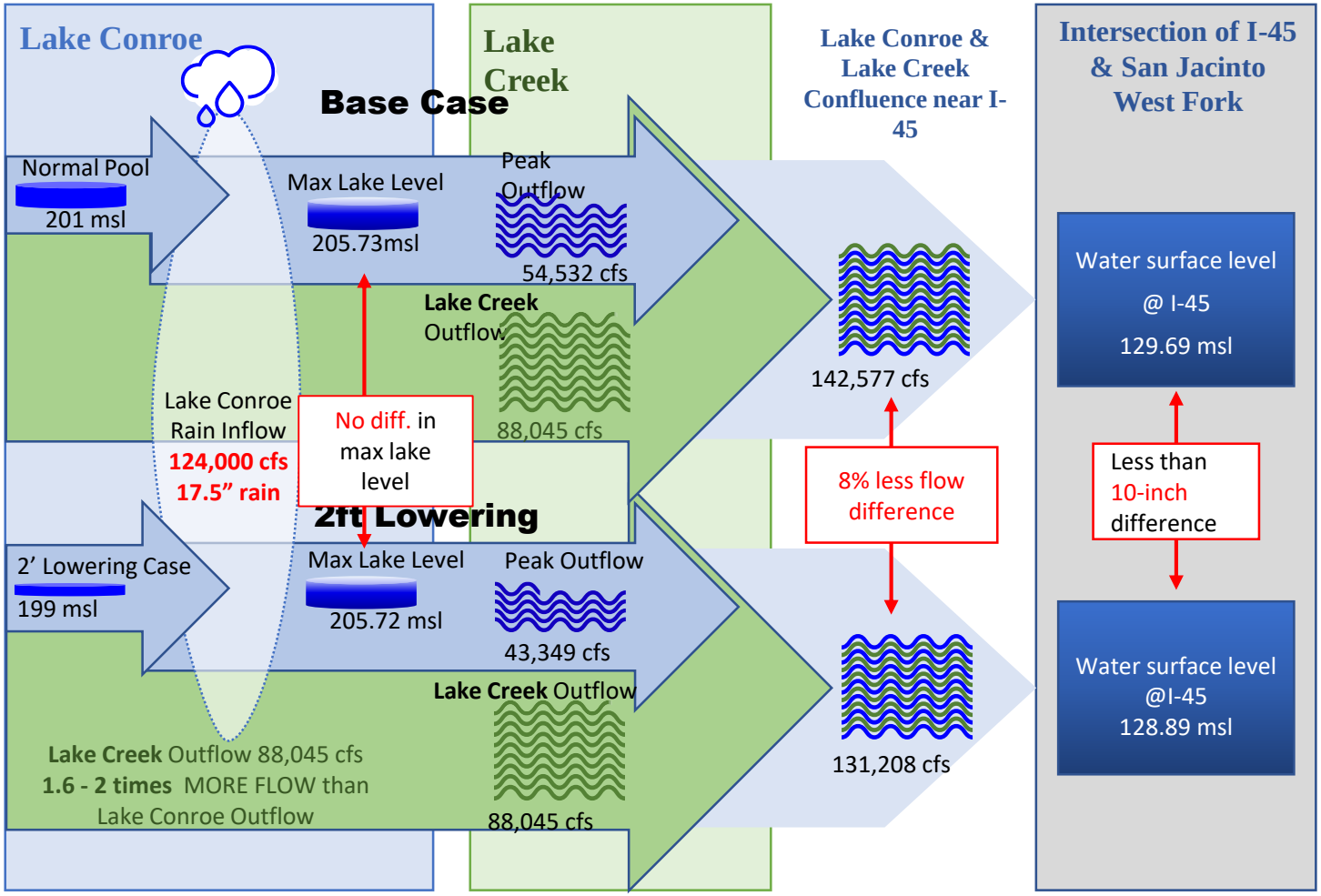
SJRA F&N Technical Study on Impact of Lake Lowering – 500-year storm



If the lake level were lowered 2ft prior to the storm (to 199msl)

- Max lake level rises to 205.72msl
- The peak dam outflow would be 43,349 cfs
- This joins with the Lake Creek outflow 87,859cfs
- causing the combined flow at the confluence to be 131,208cfs
- and the water surface level at the I-45 and SJWF intersection to be 128.89msl

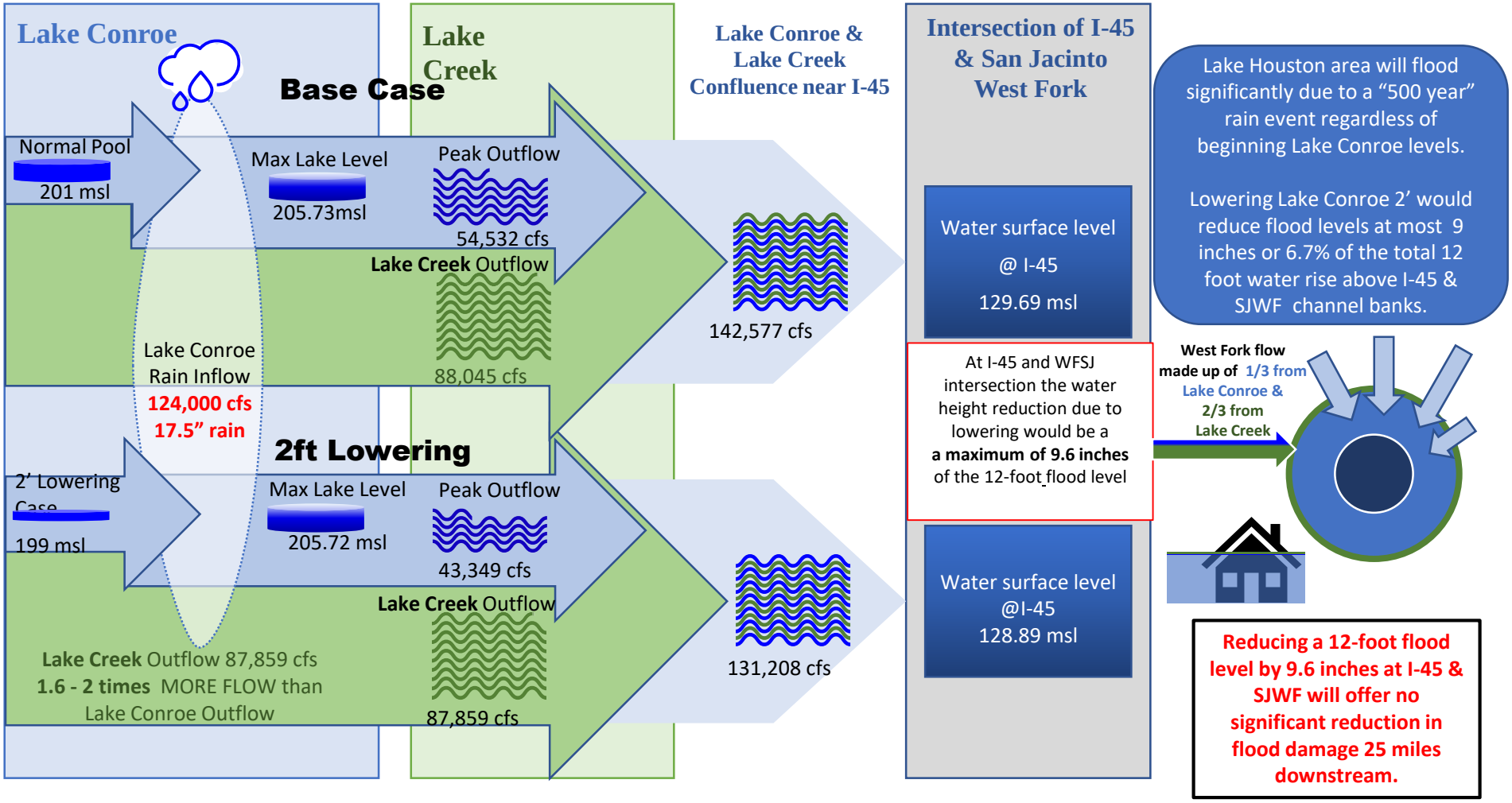
SJRA F&N Technical Study on Impact of Lake Lowering – 500-year storm



What is particularly noticeable here is that

1. There is no difference in maximum lake level
2. there is 8% less flow at the confluence
3. At the I-45 and SJWF intersection there is less than a 10-inch difference in the water surface level

SJRA F&N Technical Study on Impact of Lake Lowering – 500-year storm



Our Conclusions

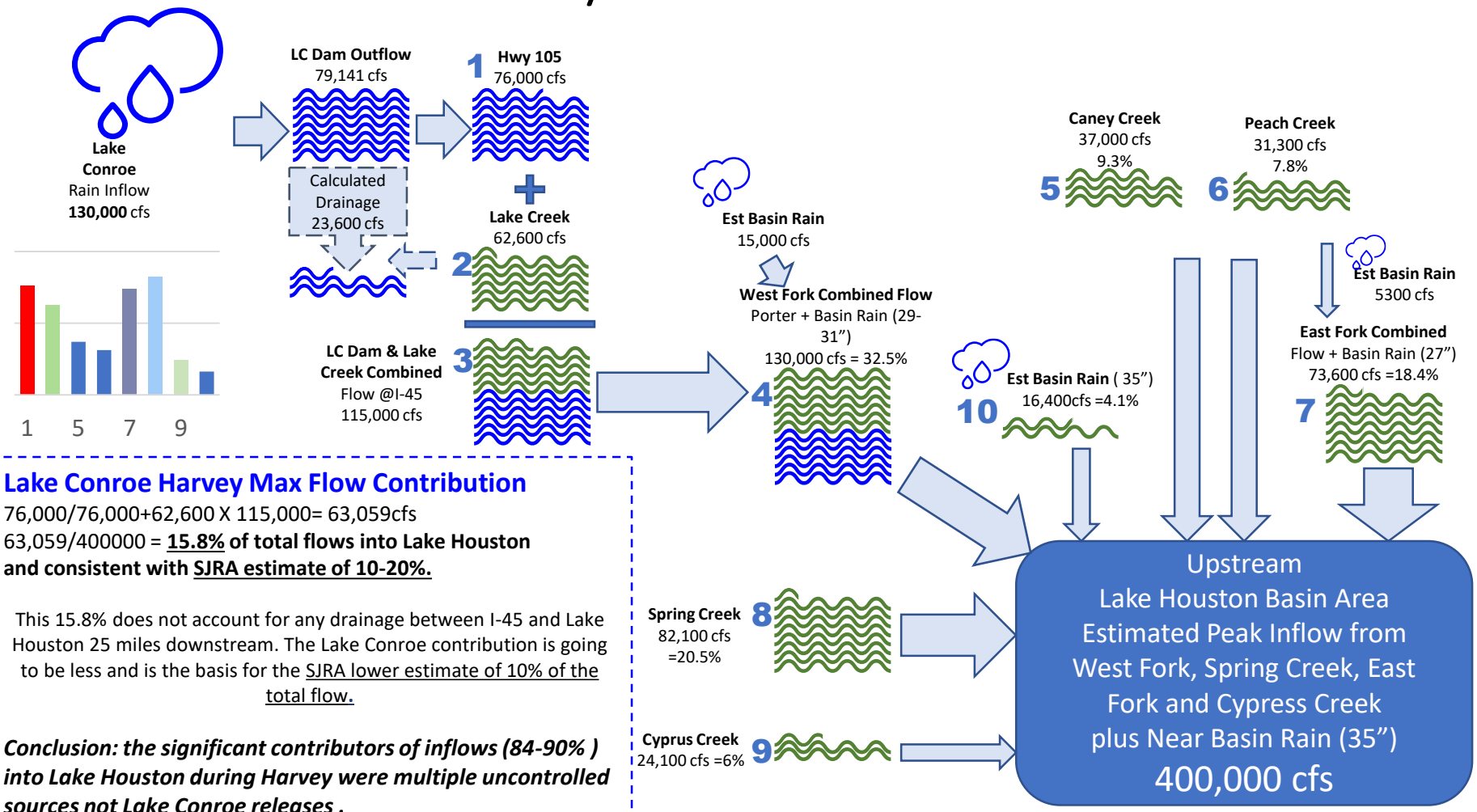
Lowering Lake Conroe by 2' results in minimal impact to downstream flooding.

- Lowering Lake Conroe 2ft makes less than 10% difference to the amount of required water releases from the dam into the West Fork and
- The Upper West Fork contributes only about 1/3 of the total water flowing into Lake Houston
- A significant impact can not be achieved by slightly reducing a small contributor to the water flow.
- Seasonal lowering of Lake Conroe offers no material flood impact reduction measured by either flood water height or the spatial extent (spreading beyond the riverbanks) of the flood footprint.

Conclusions from F&N Study

As mentioned above, the approximate extents of flooding for the compared scenarios are shown in Exhibit 1 and Exhibit 2, and Water Surface Elevation profiles of the West Fork San Jacinto River between Lake Conroe Dam and Interstate Highway 45 are shown in Exhibit 3. The benefits to those downstream, though the water surfaces are reduced by a foot or more in places, are generally not enough to be considered wholesale improvements to the flood hazard and show minimal differences in spatial extent.

Hurricane Harvey Peak Inflows Into Lake Houston



Lake Conroe Harvey Max Flow Contribution

76,000/76,000+62,600 X 115,000= 63,059cfs

63,059/400000 = **15.8% of total flows into Lake Houston and consistent with SJRA estimate of 10-20%.**

This 15.8% does not account for any drainage between I-45 and Lake Houston 25 miles downstream. The Lake Conroe contribution is going to be less and is the basis for the SJRA lower estimate of 10% of the total flow.

Conclusion: the significant contributors of inflows (84-90%) into Lake Houston during Harvey were multiple uncontrolled sources not Lake Conroe releases .