DRAFT Technical Memorandum Addendum

TO:	Mr. Jeff Walker, Executive Administrator Texas Water Development Board Stephen F. Austin Building 1700 N. Congress Avenue, 6th Floor Austin, Texas 78701	DATE:	Draft: February 16, 2022 To be submitted to TWDB on March 7, 2022
THROUGH	Chris Brown Executive Director Ark-Tex Council of Government 4808 Elizabeth Street Texarkana, TX 75503	AVO:	TWDB Contract No. 2101792501 Halff AVO 43790.001
FROM:	Joshua McClure, PhD, PE, CFM, PMP 3803 Parkwood Blvd. Suite 800 Frisco, Texas 75034-8641	SUBJECT:	Lower Red-Sulphur-Cypress Regional Flood Plan Task 4C – Technical Memorandum Addendum

Addendum Overview

In August 2021, TWDB extended the deadline for completion and submittal of three subtasks associated with the Technical Memorandum to be submitted as an addendum by March 7, 2022. The purpose of this extension was to accommodate the delayed release of the Fathom data associated with the TWDB's floodplain quilt (TWDB Data Hub, 2021). Results presented in this memorandum are considered interim due to ongoing incorporation of best available data into the floodplain quilt. The Technical Memorandum Addendum includes:

- Existing and potential future conditions flood risk (Task 4C.1.c);
- Flood hazard data gaps and additional flood-prone areas (Task 4C.1.d); and
- Available hydrologic and hydraulic models needed to evaluate FMS's and FMP's (Task 4C.1.e)

Task 4C – Technical Memorandum Addendum Deliverables

The following sections introduce the technical memorandum addendum deliverables associated with the March 7th extension. Several additional attachments are included at the end of this document. **Table 1** indicates which subtasks and information are contained in each one.

Table 1: Technical Memorandum Addendum Attachments

Attachment	TWDB Task	Description
2,3,4	4C.1.c	A geodatabase and associated maps for: region-wide 1.0% annual chance flood event and 0.2% annual chance flood event inundation boundaries, and the source of flooding for each area, for use in its risk analysis, including indications of locations where such boundaries remain undefined. Includes TWDB-required Tables 3 and 5.
2,3	4C.1.d	A geodatabase and associated maps that identifies additional flood-prone areas not included in the floodplain quilt based on hydrologic features, historic flooding, and or local knowledge.
2,3	4C.1.e	A geodatabase and associated maps in accordance with TWDB Flood Planning guidance documents that identifies areas where existing hydrologic and hydraulic models needed to evaluate FMSs and FMPs are available

4C.1.c – Existing and potential future conditions flood risk

Existing Conditions Flood Quilt

As of May 20, 2021, TWDB provided regional planning groups with an official version of the existing conditions floodplain quilt. The quilt was provided to establish a starting point in identifying flood risk within the region. The floodplain quilt compiled flood risk boundaries from several sources.

- National Flood Hazard Layer (NFHL) Pending Data
- National Flood Hazard Layer (NFHL) Preliminary Data
- National Flood Hazard Layer Effective Data (Detailed Study Areas only)
- Estimated Base Flood Elevation Data
- National Flood Hazard Layer (NFHL) Effective Data (Approximate Study Areas only)
- First American Flood Data Services (FAFDS)

On October 29, 2021, TWDB provided the planning group with Fathom floodplain data to estimate flood risk in locations where floodplain information was unavailable. Five counties within Region 2 had no flood quilt data while most others relied on outdated, approximate Zone A floodplain maps. Region 2 relied on the following methodology to prioritize the best available floodplain data for incorporation into the floodplain quilt, with the first being considered the best and the last being considered the least reliable.

1. Local Detailed Studies
    a. Local detailed studies were included only if they are city/county-wide studies completed to FEMA or TWDB standards.
    b. To date, no such studies have been provided that have not already been incorporated into FEMA Zone AE studies.
2. FEMA Zone AE Detailed Studies
    a. These are generally considered to be high quality studies and are typically used for regulatory and insurance purposes.
    b. Hydrologic and hydraulic models and supporting data are typically available for Zone AE mapped areas, although this data is less available in older study areas
    c. In Region 2, these are limited to most of Grayson County and the larger municipalities in the area.
    d. Typically includes 1% and 0.2% annual chance floodplains.
    e. Some cities, such as Sherman, Paris, and Texarkana have previously incorporated their own detailed studies.

3. Base Level Engineering (BLE)
    a. BLE is an approximate study based on recent high-resolution topographic data and typically lacks detailed hydrologic modeling, bridge and culvert modeling, and other details.
    b. Hydraulic models and study documentation are available for BLE areas, although hydrologic models are not typically available because of the hydrologic estimations used in lieu of detailed modeling
    c. BLE is not considered a regulatory product, but, where available, is considered to be better quality than similarly prepared, but older Zone A floodplain maps.
    d. Includes 1% and 0.2% annual chance floodplains.
    e. Currently, BLE is only available within the Lower Red River Basin portion of Region 2.
4. FEMA Zone A Approximate Studies
    a. FEMA Zone A floodplains are typically based on approximate hydrologic and hydraulic methods without floodplain details, such as bridges.
    b. Models are not usually available for such areas.
    c. The topographic data used to develop this mapping usually lower resolution and several decades older than that used for BLE mapping.
    d. Typically only includes 1% annual chance floodplains.
    e. For these reasons, FEMA Zone A floodplain is considered of lower reliability for flood planning than BLE in Region 2
    f. Zone As are a regulatory product and hold more weight in flood insurance rates and determinations.
    g. Zone As make up most of the effective floodplain mapping that is available in the region.
5. Fathom Cursory Floodplain Dataset
    a. Data sets provided by TWDB as a cursory floodplain dataset to be used in areas lacking other floodplain mapping.
    b. Includes 1% and 0.2% annual chance floodplains.
    c. Developed using recent, but moderately detailed topography.
    d. Developed using a proprietary, third-party methodology, that has not yet been vetted against FEMA standards.
    e. No modeling is publicly available for Fathom floodplains.
    f. For these reasons, Fathom is being used only where floodplain data does not exist:
        i. Fluvial
            1. Riverine/Channel flooding, similar to areas typically mapped by FEMA.
            2. Data will be used where no other floodplain data was available (Camp, Delta, Franklin, Marion and Morris Counties)
            3. Was used to replace FAFDS data.
        ii. Pluvial
            1. More upland/urban flooding than typically mapped by FEMA
            2. Fathom Pluvial data was added to all portions of the region to extend mapping beyond the typical FEMA mapping limits in order to more fully capture flood risks in the region.

This methodology was modified slightly from that proposed in the initial January 7 Technical Memo submittal by raising the prioritization of BLE above Zone A floodplains. An existing conditions flood hazard quilt was assembled using this prioritization approach and was made available, via a web map interface, to the RFPG, public and stakeholders between January 24 and February 24, 2022. Public comments from this and the RFPG meetings will be considered in the final flood plan.

Future Conditions Flood Quilt

The future condition methodology was based on Method 2 from the TWDB-approved Region 3 *Potential Future Conditions Flood Risk Methodology Memorandum* dated January 7, 2022, included as **Attachment 1**. Since limited hydrologic data is available in the basin, predicting future conditions is not feasible using currently available data. Therefore, the existing 0.2% annual chance floodplain was used as a proxy for the future 1.0% annual chance floodplain. This should be a conservatively high estimate of the impacts of development and climate change within Region 2, which are expected to have minimal impacts compared to other regions that are rapidly developing and experiencing more significant climate impacts.

Future 0.2% annual chance floodplain was developed using the horizontal buffer approach described in the Region 3 *Potential Future Conditions Flood Risk Methodology Memo*. The underlying assumption of this method is that if the existing 0.2% AC floodplain is a reasonable proxy for the future 1% AC floodplain, then a similar offset could be used to estimate the future 0.2% AC flood floodplain. A Region 2 specific analysis was conducted to determine this 0.2% AC buffer by comparing existing 0.1% and 0.2% AC floodplains to determine the average offset. Newly published Base Level Engineering data was analyzed, measuring cross-section distances between the existing 1.0% and 0.2% AC. The median distance between over 11,400 cross-sections was 22'. The future 0.2% annual chance area has been estimated by buffering the future 1.0% annual chance area 22 feet. Future flood condition methodology was presented to the RFPG February 10, 2022 and results were shown at the March 3, 2022 meeting.

Exposure and Vulnerability Analysis

On December 1, 2021, TWDB supplied the planning groups with the final buildings dataset to be used for the existing and future conditions flood exposure analysis. Exposure analysis was performed to determine the number of at-risk structures (buildings, roadways, critical facilities, etc.), population estimates, the length of impacted roadways and area of agricultural land contained within the previously developed existing and potential future flood hazard boundary. **Table 3** provides overall Lower Red Sulphur Cypress flood exposure results.

Table 2: Region 2 Existing and Potential Future Flood Exposure Analysis Results

Potential Flood Risk Event	Number of At-Risk Structures	Number of At-Risk Critical Facilities	Number of Roadway-Stream Crossings*	Impacted Agricultural Area (sq. mi.)
Existing 1% Annual Chance (100-year)	13,438	160	2,882	283
Future 1% Annual Chance (100-year)	15,023	166	2,927	299

**includes all locations of stream and road intersections*

Following the exposure analysis, a vulnerability analysis was performed for both existing and potential future conditions using the Social Vulnerability Index (SVI) dataset. The vulnerability analysis was performed to assess a community's resilience, with values closer to 1 denoting greater vulnerability.

The flood risk analyses (existing and potential future flood risk, exposure, and vulnerability) for this submittal are considered interim. TWDB-required **Table 3** and **Table 5** located in **Attachment 2** provide the results per county of the existing and future exposure and vulnerability analysis as outlined in the Technical Guidelines for Regional Flood Planning. A geodatabase and associated maps are provided in **Attachment 3** as digital data.

4C.1.d – Flood hazard data gaps and additional flood-prone areas

During review of the final floodplain quilt, a flood hazard data gap assessment was performed. Preliminary analysis identified gaps as areas with no prior mapping or recent detailed studies, which consists of most of the region except for the cities of Sherman, Paris, and Texarkana. An ongoing effort is being made to determine the validity of the associated hydrologic and hydraulic modeling in areas of greater risk.

In addition to incorporation of recently published BLE data and the Fathom dataset, a region-wide data collection and outreach effort was made to identify flood-prone areas. These areas were identified by the region's stakeholders along with public datasets and are based on hydrologic features, historic flooding, and local knowledge. These areas were all predominately captured by the revised flood quilt and there are no plans to modify the quilt accordingly, unless additional data is provided by stakeholders. A data gaps and additional flood-prone area feature class and associated **Maps 5 and 9** are provided in **Attachments 2 and 3** as digital data.

4C.1.e – Available hydrologic and hydraulic models needed to evaluate FMS's and FMP's.

A list of previous studies containing modeling data was submitted as part of the January 7, 2022 Technical Memorandum. The location of these studies were added to a geodatabase to provide a georeferenced representation of model- backed study areas for use when conducting FMS and FMP evaluations. It should be noted that for use in developing an FMS or FMP, these models will need some level of enhancement to provide fully detailed flood risk reduction evaluations per TWDB technical requirements. Available model locations geodatabase and associated **Map 13** are provided in **Attachment 3** as digital data.

4C.1.c,d,e – Technical Memorandum Addendum Geodatabase and Tables

As outlined in the TWDB Extension of Time to Complete Technical Memorandum dated August 17, 2021 and associated Technical Memorandum Data Deliverable Clarification dated October 29, 2021, documentation in **Attachment 3** outlines geodatabase deliverables included in this Technical Memorandum as well as spatial files and tables. Specific data deliverables align with the TWDB's Exhibit D: Data Submittal Guidelines for Regional Flood Planning. The geodatabase files require ArcGIS software to be used to view the files. The RFPG can provide these files to anyone requesting said files by emailing rfpg2@halff.com. Please keep in mind that these files will continue to be updated and enhanced throughout the development of the Regional Flood Plan and simply reflect a snapshot in time of the project as it stands today.

Attachment 1

Task 4C.1c – Potential Future Conditions Flood Risk Methodology Memorandum

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MEMORANDUM

TO:	Texas Water Development Board Regional Flood Planning 1700 N Congress Ave Austin, TX 78701	DATE:	January 7, 2022
FROM:	Halff Associates, Inc. 4000 Fossil Creek Road Fort Worth, TX 76137	AVO:	43791
SUBJECT:	Flood Planning Data **Future Conditions Mapping**		

INTRODUCTION

For the 2020 – 2023 planning cycle, Regional Flood Planning Groups (RFPGs) are tasked with performing a future condition flood analysis to determine the potential location of both 1-percent (100-year) and 0.2 percent (500-year) annual-chance flood hazard. The estimated floodplain changes will be used solely for the purpose of estimating the general magnitude of potential future increases in flood risk under the equivalent of a "do-nothing" or "no-action" alternative and within the regional flood planning context will not, in any way, be used for developing new flood extent maps for any regulatory purposes.

In areas where future condition flood hazard data is not already available, Exhibit C of the Technical Guidelines for Regional Flood Planning outlines the following 4 methods for performing future condition flood identification.

1. Method 1: Increase water surface elevation based on projected percent population increase (as proxy for development of land areas)
2. Method 2: Utilize the existing condition 0.2 percent annual chance floodplain as a proxy for the future 1 percent level
3. Method 3: Combination of methods 1 and 2 or an RFPG-proposed method
4. Method 4: Request TWDB perform a Desktop Analysis

CONSIDERATIONS FOR DEVELOPING FUTURE CONDITIONS FLOOD RISK

When developing a predicative assessment for future conditions flood risk, Texas Water Development Board (TWDB) suggested each region consider two major factors: Unmitigated Population Increase and Projected Future Rainfall.

Population Increase

Within the Trinity River watershed region, concentrated population growth is predicted to occur within locations along the upper, mid, and lower region areas. The TWDB's Water User Group projects that within the upper portion of the region, ten (10) Dallas/Fort Worth surrounding communities could experience over 300% increase in population over the next 30 years. Larger communities, such as Athens and Corsicana within the mid basin area are projected to experience over 30% population growth. The lower region is expected to see overflow growth from Harris County, with significant growth occurring in Dayton and Liberty. Population growth generally correlates to an increase in urbanization. This, in turn, leads to an increase in impervious ground cover as land use changes. Unmitigated, urbanized areas will increase watershed rainfall runoff leading to higher water surface elevations in the region's rivers, creeks, and channels during extreme rainfall events.

Projected Future Rainfall

The other factor TWDB suggested the planning group consider when estimating future flood risk is future rainfall patterns. To aid the regional planning groups, the Office of the Texas State Climatologist provided TWDB with guidance on how to incorporate projected future rainfall in their April 16, 2021 report, titled *"Climate Change Recommendations for Regional Flood Planning."* The report states that 1-day 100-year rainfall amounts increased by approximately 15% between 1960 and 2020. The climatologist coupled historic rainfall data with results from climate models to develop a relationship between extreme rainfall amounts and future increases in global temperature. Percent increase in future precipitation was developed for both urbanized and rural watershed conditions. Due to the uncertainty of predicting weather patterns for extreme rainfall events, the climatologist provided a minimum and maximum range for estimating future rainfall increases. The climatologist found even more uncertainty when analyzing rural and large river catchments due to future decreases in soil moisture. This led them to providing a percent decrease as a minimum range. The climatologist recommendations for future percent rainfall increase are provided in Table 1.

Table 1: Range of Potential Future Rainfall Increase 2050-2060

Location	Range -Minimum	Range -Maximum
Urban Areas	12%	20%
Rural Areas/River	-5%	10%

CASE STUDIES - FUTURE CONDITIONS FLOOD RISK

In order to obtain a better understanding of how future conditions affect extreme rainfall flood risk within the Trinity region, preexisting available hydrologic and hydraulic models containing future flood risk data were analyzed. Results from these studies served as an estimation of how future land use and climate change impact floodplain elevations and widths when compared to existing conditions. Comparable studies were chosen based on availability, location, and similar hydrologic/hydraulic parameters. Figure 1 provides a location for the existing studies collected for this assessment.

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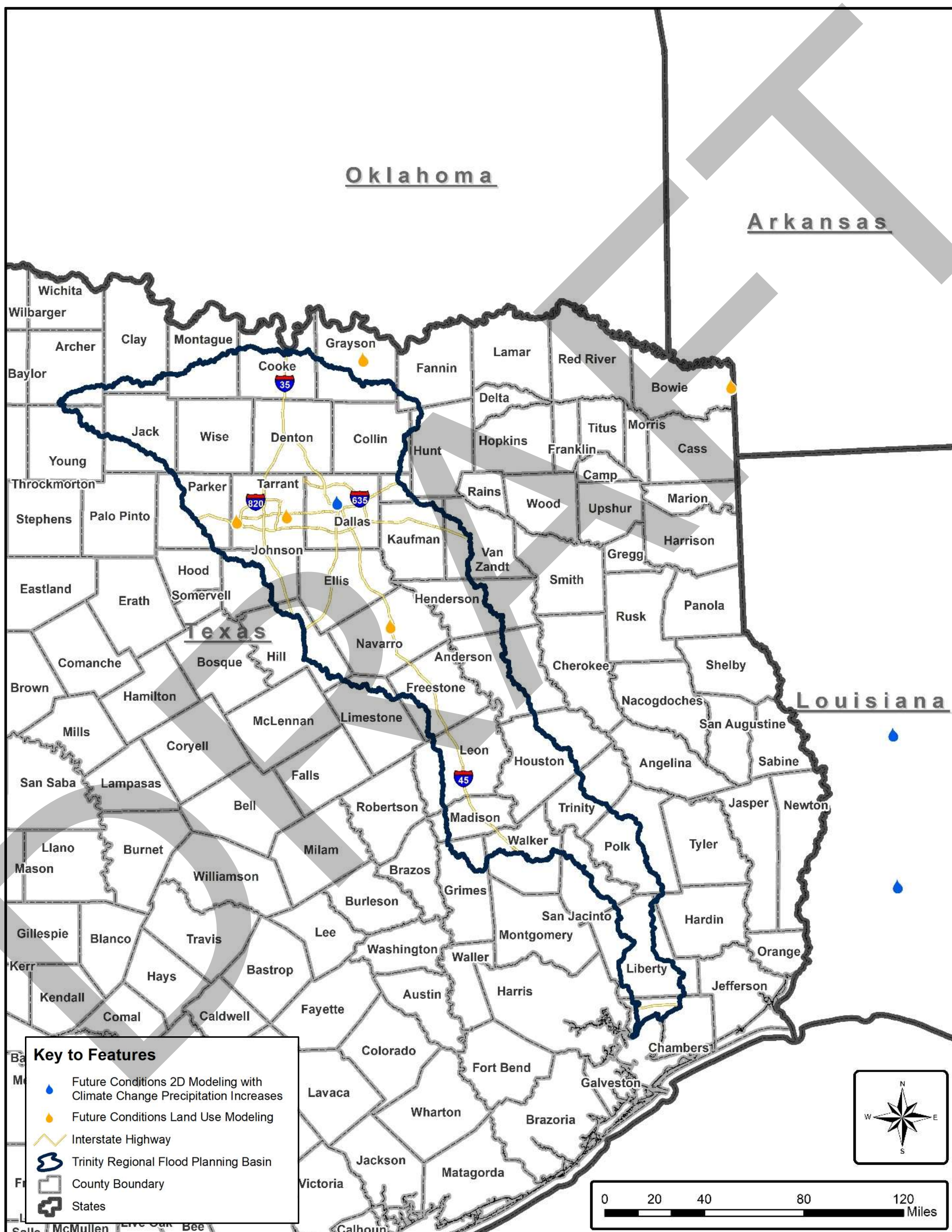

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Figure 1: Case Study Locations

Future Conditions - Land Use Studies

Five (5) drainage/floodplain master plans were utilized to assess potential flood risk increases due to future fully developed land use conditions. The future conditions analysis for these studies did not consider potential increases to rainfall data and are therefore based on land use changes only. A comparison was made between the existing and future conditions 100-year flood elevations. In addition to the future 100-year comparison, a flood elevation comparison was made between the existing 100-year and 500-year storm events to analyze the viability of utilizing Method 2 for future flood hazard data for this planning cycle. Results of the comparisons are provided in Table 2.

Table 2: Future Conditions Land Use Water Surface Elevation (WSEL) Comparison

Location	Flooding Source	Average WSEL Change Existing Vs Future 100yr (ft)	Average WSEL Change Existing 100yr vs 500yr (ft)
Parker County	Marys Creek	0.1	0.8
Grand Prairie	Fish, Kirby, Rush, Prairie Creek	0.2	1.4
Sherman	Post Oak, EF Post Oak, Sand Creek	0.7	1.0
Texarkana	Wagner, Swampoodle, Corral Creek	0.6	1.8
Corsicana	Post Oak, SF Post Oak, Mesquite Creek	0.2	1.0
Average		***0.4***	***1.2***

Future Conditions – Projected Future Rainfall

During the data collection phase, the consultant team was unable to obtain studies that analyzed future flood risk based on potential future rainfall predictions. As a substitute, two (2) large scale rain on grid studies were obtained: Dallas City-Wide Watershed Masterplan and the FEMA Louisiana Upper Calcasieu Base Level Engineering Analysis. The modeling methodology of these studies allowed for rainfall data to be quickly modified in accordance with the recommendations from the state climatologists. The 100-year storm event rainfall was increased by 15% for both studies and the flood elevation results were compared to the present-day conditions. The increase of 15% was chosen because it fell into the high range of rainfall increases and matched the historic period of record increase. The existing 100-year and 500-year flood elevations were also compared for the Method 2 consideration. Results of the comparisons are provided in Table 3.

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Table 3: Future Rainfall Increase WSEL Comparison

Location	Average WSEL Change Existing Vs Future 100yr (ft)	Average WSEL Change Existing 100yr vs 500yr (ft)
Dallas	0.2	Unavailable*
Upper Calcasieu	0.4	1.7
Average	***0.3***	***N/A***

** Dallas Watershed Master Plan only considered the 100-year storm event*

REGION 3 FUTURE CONDITIONS FLOOD HAZARD APPROACH

Potential Future 100-Year Flood Hazard Methodology

The potential future conditions 100-year flood hazard approach methodologies were discussed during the September 23, 2021 Region 3 RFPG meeting. Advantages and disadvantages of each methodology along with the results of the case studies were presented for consideration. Due to the relatively large coverage of adequate existing 500-year floodplain data within the region, Method 2 was considered the most reasonable approach. The planning group had reservations about the usage of the existing 500-year as a potential future 100-year flood risk proxy due to the case studies showing the floodplain may be too conservative of an approach.

From the future conditions land use case study results, the average change in potential future 100-year WSEL compared to existing conditions was only 0.4 feet while the comparison between the existing 100-year and existing 500-year water surface elevations yielded an average 1.2 feet change. By Increasing the average change in WSEL between existing and potential future conditions from Table 2 by the average taken from Table 3 to account for future rainfall projections, the results generally yielded a comparison less than that of the differences between the existing 100-year and existing 500-year water surface elevation.

The planning group also had concerns about the potential for Region 3 entities (communities and/or insurance companies) to mistakenly use the data for regulatory purposes. As a solution to both concerns, the planning group proposed that the potential future 100-year floodplain should be presented in this planning cycle as a range between the existing 100-year and the existing 500-year (zone of potential expanded risk). The methodology complies with the Method 2 approach and covers the uncertainty and variability resulting from the case study analysis. The exposure and vulnerability assessment data would be extracted from the maximum potential future 100-year floodplain limit.

Potential Future 500-Year Flood Hazard Methodology

The potential future conditions 500-year flood hazard approach methodology was discussed during the December 17, 2021 Region 3 RFPG meeting. Under Method 2 in the TWDB Technical Guidelines, an excerpt regarding the determination of the future 500-year flood hazard states: *"RFPGs will have to utilize an alternate approach to develop a proxy for the 0.2 percent annual chance future condition floodplain, such as adding freeboard (vertical) or buffer (horizontal) estimates. The decision on what specific approach or values to use, which may vary within the region (e.g., for urban vs rural areas), for these estimates will be up to the RFPGs, but technical justification should be provided to explain how the estimates were developed. This method cannot be applied to flood risk areas that do not already have a delineated existing condition 0.2 percent annual chance floodplain, (i.e., flood-prone areas)."* Based on this statement, reasonable buffer limits were researched based on the difference in existing top widths between the 100-year and 500-year floodplain quilt within the Trinity Region. It is reasonable to assume that the difference between top widths for the existing conditions, will be similar for potential future conditions. To establish a reasonable buffer zone to represent potential future 500-year flood risk, Base Level Engineering data previously collected for the plan was analyzed. Nine (9) large-scale studies were selected to form the basis for the buffering analysis. Figure 2 shows the general location and coverage of the nine (9) studies selected.

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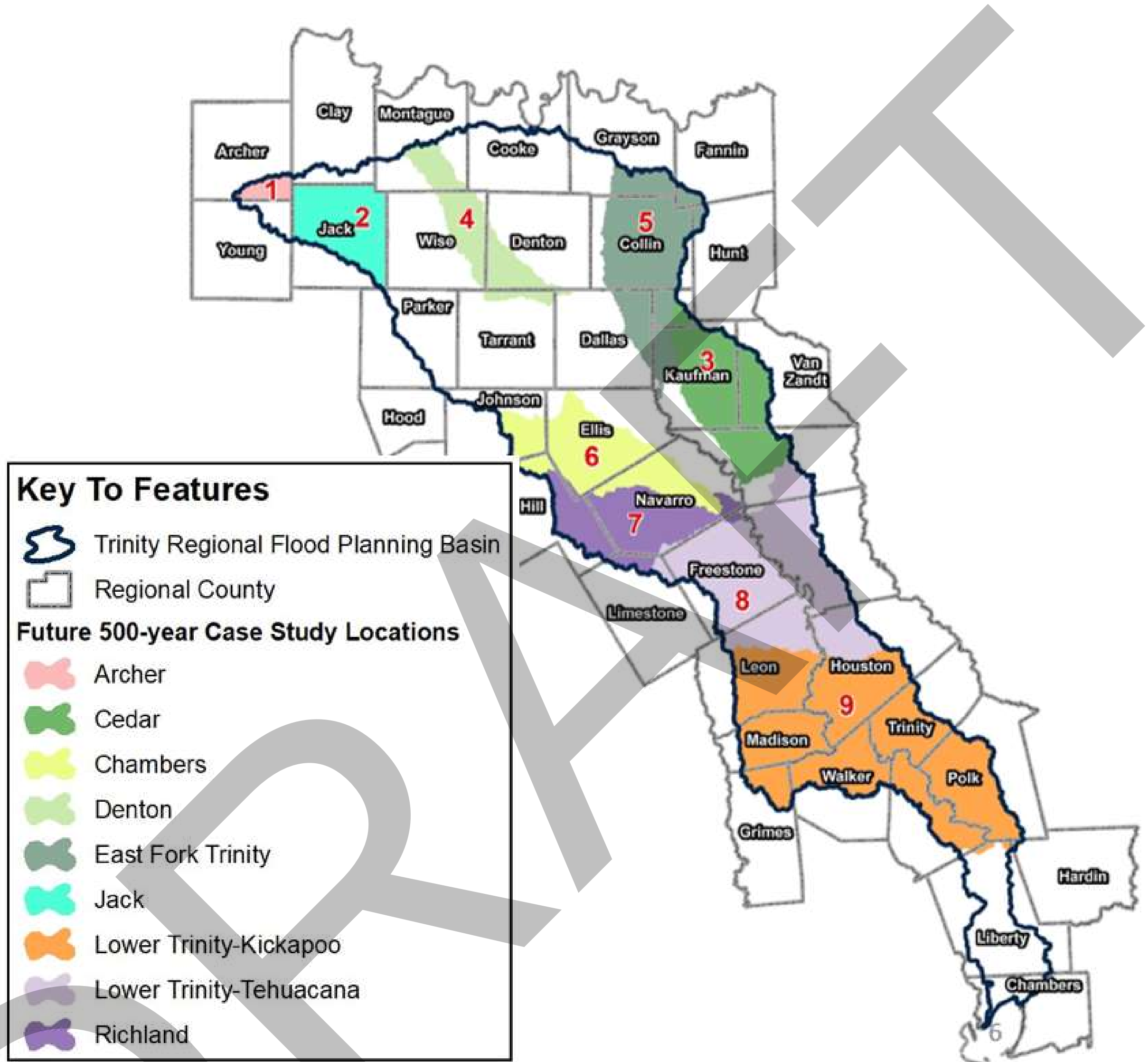

Figure 2: Future 500-year Case Study Locations

The nine (9) studies collected represent over 25,000 miles of floodplain, with over 300,000 cross-sections. Using automated means, 600,000 individual distance measurements were collected along these cross-sections between the existing 100-year and 500-year floodplains. Figure 3 shows an example of measurement locations.

Figure 3: Measurement Locations to Develop Potential Future Condition 500-Year Flood Risk Buffer

The measurements were then averaged for each of the nine (9) study locations. The average distance measurement along the right or left overbank of the floodplain ranged from 30 feet to 50 feet. The total average overbank measurement of all nine (9) studies was determined to be approximately 40 feet, representing 80 feet total change in top width. Similar to the future 100-year flood risk boundary, the future 500-year will be presented as a range between the existing 500-year flood risk boundary and the 40-foot buffer. Table 4 provides the average measurement results of the analysis.

Table 4: Average Change in Horizontal Distance

Location	Average Width Change (Left or Right Overbank) Existing 100yr vs 500yr (ft)
1. Archer	30.8
2. Jack	32.2
3. Denton	32.6
4. Cedar	30.8
5. East Fork Trinity	42.6
6. Chambers	37.2
7. Richland	44.5
8. Lower Trinity Tehuacana	36.3
9. Lower Trinity Kickapoo	47.6
Rounded Average	***40***

CONCLUSION

The Trinity RFPG and its consultant have developed a procedure for generating potential future 100-year and 500-year flood risk data that generally follows Method 2 of the TWDB's Technical Guidance document. The existing 500-year floodplain was selected to serve as a proxy for the potential maximum 100-year flood hazard. A 40-foot buffering of the existing 500-year flood hazard boundary was selected to serve as the potential maximum future 500-year flood hazard. Using the previously described buffering methodology for potential future 500-year conditions allows for rapid development of estimated expanded risk within the constraints of the flood plan timeline and lack of future 500-year detailed data throughout the planning area. A disadvantage of this approach is that average buffering is performed independent of topographic or water surface elevation changes. For areas with relatively flat terrain, the potential 500-year flood risk limit based on buffering may underestimate the expanded urban exposure risk. This disadvantage may be less impactful on rural floodplains whose exposure risks are large tracts of agricultural land. Table 5 shows the existing and range of potential future conditions flood risk approach summary. Figure 4 presents an example of the range of potential future flood risk.

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Table 5: Existing and Future Conditions Flood Hazard Approach

	Best Available		→		→		→		Most Approximate	
	Local Floodplain (if determined current)		NFHL AE		BLE		NFHL A / FAFDS		No FEMA or Better than Quilt	
	100YR	500YR	100YR	500YR	100YR	500YR	100YR	500YR	100YR	500YR
Existing	Local Study (if provided)	Local Study (if provided)	Floodplain quilt 100YR	Floodplain quilt 500YR	BLE 100YR	BLE 500YR	Replaced with Fathom 100YR	Replaced with Fathom 500YR	Fathom 100YR	Fathom 500YR
Future	Local Study (if provided)	Local Study (if provided)	Range between Existing 100-year and 500-year	40-foot buffer of the existing 500YR	Range between BLE Existing 100-year and 500-year	40-foot buffer of the existing 500YR	Range between Fathom Existing 100-year and 500-year	40-foot buffer of the existing 500YR	Range between Fathom Existing 100-year and 500-year	40-foot buffer of the existing 500YR

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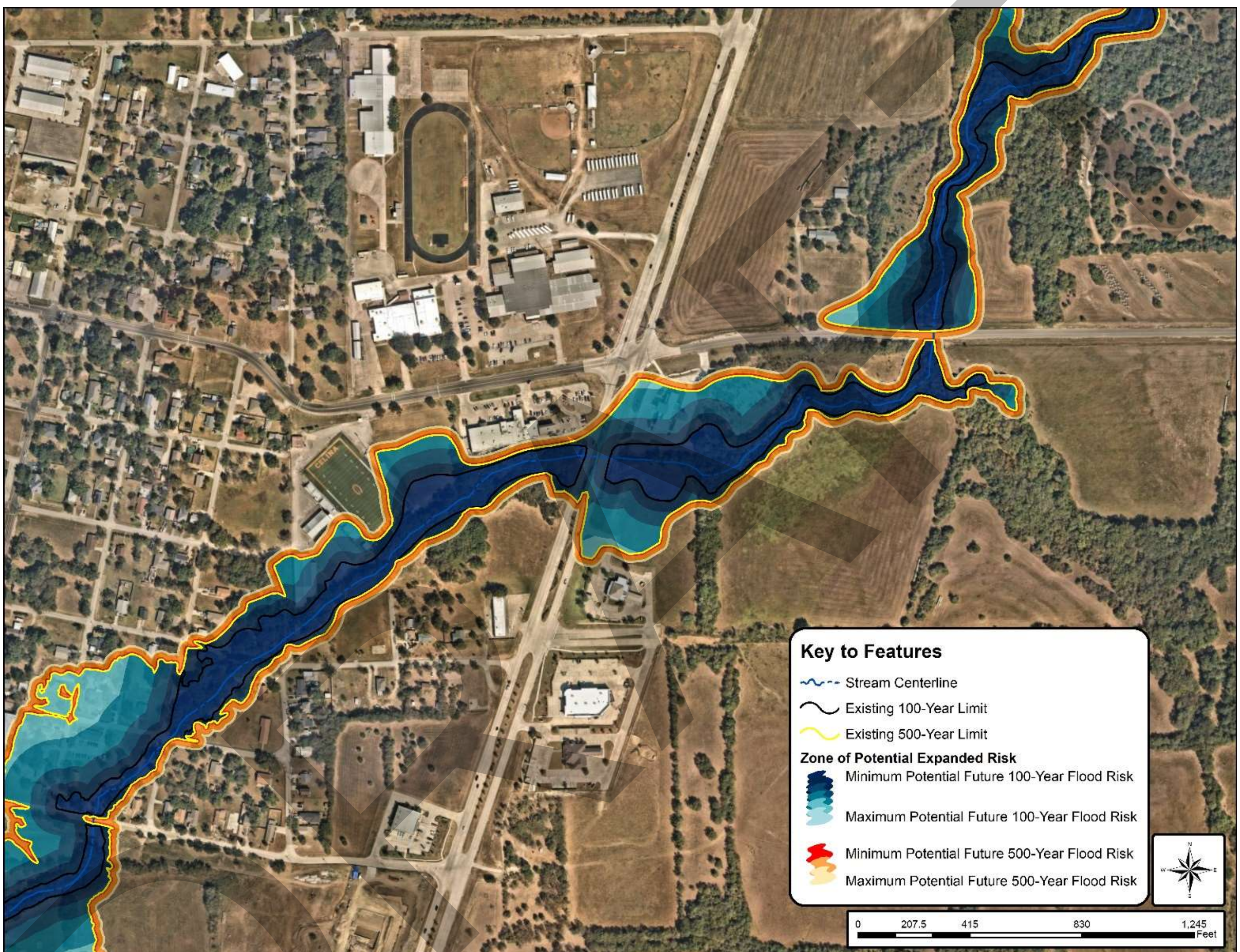

Figure 4: Example of 2020-2023 Planning Cycle Range of Potential Future Flood Risk Data

TWDB APPROVAL REQUEST

We are asking that the method discussed above be evaluated for approval to supplement future conditions mapping where data is unavailable.

Attachment 2

Task 4C.1c, 4C.1d – TWDB Required Table 3 and Table 5, Maps 4-13

- Map 4: Existing Condition Flood Hazard (2.2.A.1 Existing condition flood hazard analysis)
- Map 5: Existing Condition Flood Hazard - Gaps in Inundation Boundary Mapping and Identify Known Flood-Prone Areas (2.2.A.1 Existing condition flood hazard analysis)
- Map 6: Existing Condition Flood Exposure (2.2.A.2 Existing condition flood exposure analysis)
- Map 7: Existing Condition Vulnerability and Critical Infrastructure (2.2A.3 Existing condition vulnerability analysis)
- Map 8: Future Condition Flood Hazard (2.2.B.1 Future condition flood hazard analysis)
- Map 9: Future Condition Flood Hazard - Gaps in Inundation Boundary Mapping and Identify Known Flood-Prone Areas (2.2.B.1 Future condition flood hazard analysis)
- Map 10: Extent of Increase of Flood Hazard Compared to Existing Condition (2.2.B.1 Future condition flood hazard analysis)
- Map 11: Future Condition Flood Exposure (2.2.B.2 Future condition flood exposure analysis)
- Map 12: Future Condition Vulnerability and Critical Infrastructure (2.2.B.3 Future condition vulnerability analysis)
- Map 13- Map showing where existing hydrologic and hydraulic models needed to evaluate FMSs and FMPs are available

Due to the file sizes of the draft figures, they are available for individual download at the following link:
https://halff-my.sharepoint.com/:f:/p/ah4115/EiIKqJL_5FVLoqC_bvnxeYYBccg5j1O2nBIDcQf-IlOg3A?e=SE0M3V

Because this document is intended to show progress towards the development of the draft regional flood plan, these figures will be removed from the link on March 7, 2022 when the Technical Memorandum Addendum is submitted to the Texas Water Development Board. Updated versions of these figures will be included in the draft flood plan.

#	County	Area in Flood Planning Region (sq mi)	1% Annual Chance Flood Risk[1]								0.2% Annual Chance Flood Risk[1]							
			Area in Floodplain (sq mi)	Number of Structures in Floodplain[2]	Residential Structures in Floodplain[2]	Population[2]	Roadway Stream Crossings (#)	Roadways Segments (miles)	Agricultural Areas (sqmi)	Critical Facilities (#)	Area in Floodplain (sq mi)	Number of Structures in Floodplain[2]	Residential Structures in Floodplain[2]	Population[2]	Roadway Stream Crossings (#)	Roadways Segments (miles)	Agricultural Areas (sqmi)	Critical Facilities (#)
1	Bowie	920.10	398.39	2,657	1,546	4,529	402	313.6	48.31	19	406.92	3,055	1,809	5,272	417	336.0	48.63	22
2	Camp	202.66	53.40	256	124	301	60	29.9	0.56	4	55.90	276	131	314	64	31.6	0.61	4
3	Cass	956.77	274.93	573	302	917	263	159.5	1.34	12	276.04	583	307	921	263	160.8	1.35	12
4	Cooke	111.18	25.22	34	20	26	20	12.7	3.06	0	27.23	38	22	30	20	13.9	3.46	0
5	Delta	277.13	96.16	120	59	82	73	41.5	22.90	2	108.19	127	62	87	74	48.6	27.55	2
6	Fannin	853.20	227.07	1,077	709	1,328	290	170.3	58.60	18	243.03	1,256	806	1,575	300	190.5	63.87	20
7	Franklin	293.47	79.20	455	341	535	61	38.6	2.46	1	87.55	555	422	713	62	40.4	2.82	1
8	Grayson	633.94	161.17	2,569	1,511	4,360	206	180.7	16.15	23	169.29	2,924	1,810	5,376	209	210.2	17.49	23
9	Gregg	28.44	5.88	58	56	76	14	3.6	0.03	0	5.91	58	56	76	15	3.8	0.03	0
10	Harrison	532.16	151.52	897	740	1,254	116	96.6	0.40	6	152.77	917	756	1,294	116	99.0	0.41	6
11	Hopkins	543.36	162.66	702	381	907	201	148.6	13.49	5	163.77	710	383	940	201	150.5	13.66	5
12	Hunt	235.01	65.51	411	282	941	220	77.2	6.62	3	66.50	432	298	1,123	220	78.9	6.89	3
13	Lamar	931.80	283.21	1,644	1,013	2,670	290	221.8	66.90	33	291.77	1,904	1,152	3,016	295	239.8	68.42	33
14	Marion	418.82	127.71	313	163	360	36	48.0	0.21	4	148.50	390	193	460	38	55.8	0.32	4
15	Morris	256.93	73.83	234	102	232	43	38.4	0.62	6	77.05	265	119	268	44	40.7	0.66	6
16	Panola	0.41	0.04	0	0	0	0	0.0	0.00	0	0.04	0	0	0	0	0.0	0.00	0
17	Red River	1,055.00	359.94	391	138	336	208	156.7	37.57	5	378.96	441	150	380	210	170.1	39.05	5
18	Titus	425.48	149.78	596	315	1,182	175	87.1	2.45	9	150.80	634	333	1,262	175	91.2	2.47	10
19	Upshur	427.79	113.79	425	250	677	183	90.8	0.96	10	114.31	432	255	688	183	92.2	0.96	10
20	Wood	56.77	11.40	26	17	10	21	8.9	0.12	0	11.44	26	17	10	21	8.9	0.13	0
	Totals		**2,821**	**13,438**	**8,069**	**20,723**	**2,882**	**1,924**	**283**	**160**	**2,936**	**15,023**	**9,081**	**23,805**	**2,927**	**2,063**	**299**	**166**
		9,160.39																

Notes:

*Population based on Night population values

#	County	Area in Flood Planning Region (sq mi)	1% Annual Chance Flood Risk[1]								0.2% Annual Chance Flood Risk[1]							
			Area in Floodplain (sq mi)	Number of Structures in Floodplain[2]	Residential Structures in Floodplain[2]	Population[2]	Roadway Stream Crossings (#)	Roadways Segments (miles)	Agricultural Areas (sqmi)	Critical Facilities (#)	Area in Floodplain (sq mi)	Number of Structures in Floodplain[2]	Residential Structures in Floodplain[2]	Population[2]	Roadway Stream Crossings (#)	Roadways Segments (miles)	Agricultural Areas (sqmi)	Critical Facilities (#)
1	Bowie	920.10	406.92	3055	1809	5272	417	336.03	48.63	22	441.80	4826	3019	9159	448	452.33	49.86	28
2	Camp	202.66	55.90	276	131	314	64	31.64	0.61	4	64.83	575	268	818	92	51.74	0.75	4
3	Cass	956.77	276.04	583	307	921	263	160.76	1.35	12	312.09	918	522	1468	283	221.63	1.66	13
4	Cooke	111.18	27.23	38	22	30	20	13.90	3.46	0	31.55	60	30	50	24	21.78	3.55	0
5	Delta	277.13	108.19	127	62	87	74	48.62	27.55	2	116.81	241	135	241	91	86.77	30.07	2
6	Fannin	853.20	243.03	1256	806	1575	300	190.47	63.87	20	275.98	1741	1128	2374	362	293.36	70.94	22
7	Franklin	293.47	87.55	555	422	713	62	40.45	2.82	1	100.92	825	595	1109	82	73.88	3.22	3
8	Grayson	633.94	169.29	2924	1810	5376	209	210.15	17.49	23	192.53	4410	3008	9353	231	307.22	19.72	31
9	Gregg	28.44	5.91	58	56	76	15	3.80	0.03	0	7.03	120	109	182	21	7.13	0.04	0
10	Harrison	532.16	152.77	917	756	1294	116	99.04	0.41	6	176.26	1237	1030	1825	123	147.55	0.49	6
11	Hopkins	543.36	163.77	710	383	940	201	150.52	13.66	5	185.58	1300	764	2226	214	211.23	15.20	7
12	Hunt	235.01	66.50	432	298	1123	220	78.88	6.89	3	74.40	737	522	1995	282	120.06	8.14	4
13	Lamar	931.80	291.77	1904	1152	3016	295	239.85	68.42	33	326.09	2892	1721	4509	333	343.15	74.95	40
14	Marion	418.82	148.50	390	193	460	38	55.82	0.32	4	165.25	544	264	697	46	81.68	0.38	6
15	Morris	256.93	77.05	265	119	268	44	40.67	0.66	6	88.26	467	220	519	66	65.73	0.80	8
16	Panola	0.41	0.04	0	0	0	0	0.00	0.00	0	0.05	0	0	0	0	0.05	0.00	0
17	Red River	1,055.00	378.96	441	150	380	210	170.09	39.05	5	423.63	768	277	713	274	250.01	41.10	10
18	Titus	425.48	150.80	634	333	1262	175	91.15	2.47	10	169.69	1147	688	2343	185	139.40	2.89	14
19	Upshur	427.79	114.31	432	255	688	183	92.15	0.96	10	131.97	751	475	1306	190	121.36	1.10	10
20	Wood	56.77	11.44	26	17	10	21	8.89	0.13	0	13.97	65	46	48	24	13.78	0.16	0
	Totals	**9,160.39**	**2,936**	**15,023**	**9,081**	**23,805**	**2,927**	**2,063**	**299**	**166**	**3,299**	**23,624**	**14,821**	**40,935**	**3,371**	**3,010**	**325**	**208**

Notes:

*Population based on Night population values

Attachment 3

Task 4C – Geodatabase

This March 7, 2022 Technical Memorandum Addendum submittal for the Lower Red-Sulphur-Cypress Basin incudes the following geodatabases named:

- FPR02_GIS_Data_03072022.gdb,
- FPR02_Addl_TechMemoData03072022.gdb
- 02_RFP_ExhibitC_Table3_5.xlsx

The geodatabases are populated with the layers and tables below:

Item Name	Description	Feature Class Name	Data Format Polygon/Line/ Point/GDB Table
Existing Flood Hazard	Perform existing condition flood hazard analyses to determine the location and magnitude of both 1.0% annual chance and 0.2% annual chance flood events	ExFldHazard	Polygon
Flood Mapping Gaps	Gaps in inundation boundary mapping	Fld_Map_Gaps	Polygon
Existing Exposure	Gaps in inundation boundary mapping Develop high-level, region-wide, and largely GIS-based existing condition flood exposure analyses using the information identified in the flood hazard analysis to identify who and what might be harmed within the region for, at a minimum, both 1.0% annual chance and 0.2% annual chance flood events	ExFldExpPol	Polygon
	Develop high-level, region-wide, and largely GIS-based existing condition flood exposure analyses using the information identified in the flood hazard analysis to identify who and what might be harmed within the region for, at a minimum, both 1.0% annual chance and 0.2% annual chance flood events	ExFldExpLn	Polyline

Item Name	Description	Feature Class Name	Data Format Polygon/Line/ Point/GDB Table
	Develop high-level, region-wide, and largely GIS-based existing condition flood exposure analyses using the information identified in the flood hazard analysis to identify who and what might be harmed within the region for, at a minimum, both 1.0% annual chance and 0.2% annual chance flood events	ExFldExpPt	Point
	Combines the Exposure Poly, Line, and Point data into a single master layer, also includes Vulnerability data	ExFldExpAll	Point
Future Flood Hazard	Perform future condition flood hazard analyses to determine the location and magnitude of both 1.0% annual chance and 0.2% annual chance flood events	FutFldHazard	Polygon
Future Exposure	Perform future condition flood exposure analyses using the information identified in the flood hazard analysis to identify who and what might be harmed within the region for, at a minimum, both 1.0% annual chance and 0.2% annual chance flood events	FutFldExpPol	Polygon
	Perform future condition flood exposure analyses using the information identified in the flood hazard analysis to identify who and what might be harmed within the region for, at a minimum, both 1.0% annual chance and 0.2% annual chance flood events	FutFldExpLn	Polyline
	Perform future condition flood exposure analyses using the information identified in the flood hazard analysis to identify who and what might be harmed within the region	FutFldExpPt	Point

Item Name	Description	Feature Class Name	Data Format Polygon/Line/ Point/GDB Table
	for, at a minimum, both 1.0% annual chance and 0.2% annual chance flood events		
	Combines the Exposure Poly, Line, and Point data into a single master layer, also includes Vulnerability data	FutFldExpAll	Point
Existing H&H Models (Addl_TechMemoData.gdb)	Shows boundaries of where existing hydrologic and hydraulic models needed to evaluate FMSs and FMPs are available	Exis_HH_Models	Polygon
Flood Prone Areas (Addl_TechMemoData.gdb)	Known, reported flood prone areas, from public input process	Reported_FloodProneAreas	Polygon