Final Report: User's Guide for the Cumulative Effects of Recommended Strategies Tool (TWDB CERST)

Texas Water Development Board Contract #2100012470

By
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Bill Thaman, PE

Spencer Schnier, PhD, PE
Courtney Corso, PE
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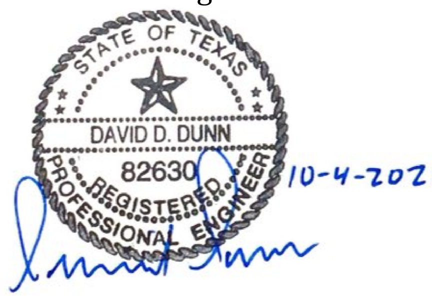
Engineering Seal

This report documents the work of the following Licensed Professional Engineers:



David D. Dunn, PE
HDR Engineering, Inc.

Project manager, technical lead for developing overall approach and final report preparation.

Bill Thaman, PE
HDR Engineering, Inc.

Technical lead for all programming of the Cumulative Effects of Recommended Strategies Tool. Prepared sections of the User's Guide related to use of the tool.

Spencer Schneir, PhD, PE
Freese and Nichols, Inc.

Technical lead for developing all water availability model simulations and summary of results for the Brazos Basin demonstration. Assisted in the development of proposed metrics for assessing the effects of water management strategies on streamflows.

October 4, 2021

Jennifer J. Walker, PE, D.WRE, ENV SP, CFM
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Developed summary of environmental flow standards in Texas. Assisted in the development of proposed metrics for assessing the effects of water management strategies on streamflows. Assisted in summarizing results of the water availability model simulations using draft versions of the Cumulative Effects of Recommended Strategies Tool.

Table of Contents

Figures

Tables

Appendix

List of Acronyms

acft	acre-feet
acft/mo	acre-feet per month
ASR	aquifer storage and recovery
BRA	Brazos River Authority
cfs	cubic feet per second
e-flows	environmental flows
GAM	groundwater availability model
MAG	modeled available groundwater
mgd	million gallons per day
RWPG	regional water planning group
SB3	Senate Bill 3
TCEQ	Texas Commission on Environmental Quality
TWDB	Texas Water Development Board
TWDB CERST	TWDB Cumulative Effects of Recommended Strategies Tool
WAM	water availability model
WRAP	Water Rights Analysis Package

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1. Introduction

During the development of a regional water plan, each regional water planning group (RWPG) is required to prepare *Chapter 6. Impacts of Regional Water Plan and Consistency with Protection of Resources* in alignment with the guiding principles described in Texas Administrative Code §358.3(8) for State Water Plan development. Regional water planning groups utilize a variety of methods to assess the cumulative effects of water management strategies on streamflows. Based on these various approaches and the overall objective of the Texas Water Development Board (TWDB) to standardize the approach for these assessments in the regional water plans, the TWDB contracted with the consulting team of HDR Engineering, Inc., Freese and Nichols, Inc. and Watearth, Inc. to develop a methodology generally applicable to each regional water plan.

This project included four primary tasks:

1. Identify a set of metrics and develop a generalized assessment methodology that is applicable to most regional water planning areas. This methodology must also consider environmental flow standards (e-flows) when e-flows are adopted for a river basin.
2. Develop a tool that will facilitate the analysis for use by RWPGs and their technical consultants.
3. Prepare a demonstration evaluation for a river basin that includes strategies recommended in multiple regional water plans.
4. Develop a Users' Guide for the tool that:
   a. Presents the generalized assessment methodology (Section 2).
   b. Presents the assessment tool and describes its application (Sections 3, 4, and 5).
   c. Demonstrates the methodology and the use of the assessment tool (Section 6).

This User's Guide presents the recommended method for assessing the cumulative effects of recommended water management strategies on streamflows and describes the TWDB Cumulative Effects of Recommended Strategies Tool (TWDB CERST). A demonstration assessment for the strategies recommended in the Brazos River Basin in the 2021 Region O, Brazos G, and Region H Plans is presented.

2. Cumulative effects assessment methodology for Chapter 6 of a regional water plan

This proposed methodology and a prioritized list of metrics were presented and discussed during a workshop held between the study contractors and TWDB staff on December 18, 2020. Interim memorandums were prepared and delivered to TWDB staff for input and a follow-up meeting was held on January 22, 2021 to confirm the methodology.

This methodology and the associated recommended metrics were used to develop the TWDB CERST and to prepare an example assessment in the Brazos River Basin.

Many RWPGs have a limited number of strategies anticipated to affect surface streamflows, and RWPGs who determine that the recommended methodology is not applicable should coordinate with TWDB staff as they develop methodologies applicable to their unique situations.

A stepwise approach for RWPG consideration of cumulative impacts analysis of recommended water management strategies follows:

1. Identify locations of interest.

   The RWPG should determine the locations of interest for evaluating the effects of recommended strategies. Consideration should be given to locations downstream of significant water management strategies and sites where the cumulative impacts of multiple strategies might be measured. The following are suggested locations for consideration.

   a. Sites at which the Texas Commission on Environmental Quality (TCEQ) has adopted environmental flows standards (e-flows) (Texas Water Code §11.0235, hereafter referred to as "SB3 e-flows standards" or "SB3").
   b. Basin outlets (bay and estuary inflows) or points where the main stems of rivers cross a state boundary, such as the Canadian, Red, Cypress, and Sulphur Basins.
   c. Locations adjacent to or within stream segments identified by the RWPG as having unique ecological value.
   d. Locations where habitat assessments have been completed pursuant to the Texas Instream Flow Program or the SB3 Environmental Flows Process (including Adaptive Management studies).
   e. Other locations of interest to the RWPG, such as long-term gage sites.

2. Identify Baseline flow condition.

   The Baseline flow condition should be selected to address the following question:

   > "*In the absence of the water management strategies recommended in the regional water plan, what would be the flows in the basin(s) given existing water management programs and water rights adjudications?*".

   The Baseline flow condition is different from what might be considered as "current" flow conditions, because the intent is to evaluate the effects of the water management strategies recommended in the regional water plans. The Baseline flow condition should include full utilization of current water rights, even if those rights are currently not being fully utilized.

   Three general alternatives are identified that are appropriate to select from as a Baseline condition. Modifications from these alternatives may be made at each RWPG's discretion as appropriate to their region and the management of water supplies therein.

   Alternative 1. For purposes of evaluating the cumulative effects of the strategies recommended in a regional water plan, the Baseline case is considered to be **the TCEQ Water Availability Model (WAM) or model approved by TWDB for RWPG use in determining current supplies**. For evaluating all strategies recommended through the final planning decade, the model reflecting conditions in the final planning decade (reservoir sedimentation, return flows, etc.) should be used. This WAM will include full utilization of water rights, but with reservoirs typically modeled at sedimentation conditions expected in the final planning decade. Note that RWPGs may have an approved variance to include some level of return flows in the current supply evaluations, and these should be included in the model. Also note that increased usage of existing water rights does not constitute a change since the regional plans assume full utilization of existing water rights as a current supply condition.

Alternative 1 is the generally recommended approach.

Alternative 2. For purposes of evaluating the cumulative effects of the strategies recommended in a regional water plan, the Baseline case is considered to be **the WAM Run 3 with full utilization of water rights**. Increased usage of existing water rights does not constitute a change since the regional plans assume full utilization of existing water rights as a current supply condition.

Alternative 3. For purposes of evaluating the cumulative effects of the strategies recommended in a regional water plan, the Baseline case is considered to be **the WAM Run 3 with full utilization of water rights, modified to include some level of projected return flows**. Return flows should be incorporated basin-wide and not just where reuse projects are anticipated.

Other items a RWPG should consider when selecting a Baseline condition include:

- Subordination, *e.g.*, upper/lower basin subordination in the Colorado River Basin
- System operation of existing water rights
- Impacts of historical groundwater development on flows
- Historical return flows
- Interstate and international compact issues – Rio Grande, Canadian, Red, and Sabine Basins

3. Identify and incorporate strategies that affect streamflows.

   Incorporate all strategies into the WAM to be developed by the final planning decade that will significantly affect streamflows. RWPGs may also consider additional, interim decades to demonstrate the effects of plan development over time if the RWPG desires and subject to TWDB allocated funding. If this is done, then reservoir sedimentation conditions and/or return flows should be modified to reflect the targeted decadal conditions.

   For specific strategies that are anticipated to affect streamflow, the following additional guidance is offered:

   a. New surface water rights

      Strategies requiring new or amended surface water rights authorizing new appropriations should be included in the applicable WAM in a manner that reproduces, to the extent possible, the configuration and operation of the recommended water management strategy when supplies available to that strategy were determined. Assigned priority dates should match the planned sequence of implementation. If two recommended strategies interact with each other, those interactions should be reflected in the WAM modeling. Water management strategies to evaluate in the analysis include:

      - New reservoirs,

- New run-of-river diversions,
- Amended water rights (increases in storage and/or diversion amounts), and
- Interbasin transfer projects transferring water into or out of the subject basin.

b. Reuse strategies

Because RWPGs have the flexibility to define the most-relevant Baseline condition as described above, inclusion of reuse strategies will be at the discretion of each RWPG based on its formulation of a Baseline flow condition. The RWPG is expected to clearly document how return flows are determined and how they are used in the modeling.

Reuse strategies should be incorporated in the WAM only if the Baseline condition includes full projected levels of return flows. Without the inclusion of return flows in the Baseline model, reuse projects would not be expected to have an impact on modeled streamflows because they are not reflected in the Baseline condition. If the projected return flows incorporated in the existing supply model are already adjusted to reflect some level of future reuse, the RWPG should use appropriate judgment to adjust those return flows further to reflect future conditions.[1]

1. Indirect Reuse

Under Baseline conditions, senior water rights will utilize return flows prior to diversion by a recommended indirect reuse project unless the indirect reuse project is modeled at a priority senior to existing rights. Because many indirect reuse projects are facilitated through bed-and-banks authorizations, such authorizations are often considered to be "outside" the priority system. In such cases, the indirect reuse strategy can be modeled senior to all existing rights, but care must be taken that the upstream discharges modeled are sufficient in all months to supply the indirect reuse amounts such that downstream senior water rights are not impacted.

Exceptions apply to return flows originating from in-basin surface water diversions – diversions of which might not be outside the priority system. When flows available to a bed-and-banks authorization are subject to senior water rights, modeling and interpretation of the impacts of reuse strategies should be made with caution because, under most Baseline conditions, senior water rights will utilize return flows prior to diversions by the indirect reuse project and the full authorized diversion amount may not be available to the recommended strategy during periods of low flow.

In all cases, the modeling used to incorporate indirect reuse of return flows should be consistent with the regulatory framework for indirect reuse projects.

2. Direct Reuse

Direct reuse strategies can be evaluated by reducing the quantity of return flows discharged in the model that includes the recommended water management

[1] When considering bed and banks authorizations for groundwater-based effluent, care must be exercised to accurately portray the adverse effects of production of this same groundwater on springflow and streamflow as well as Baseline and future water available to affected surface water right holders.

strategies (the "With WMSs" model).

c. Groundwater Development

Although most WAMs do not acknowledge the interactions of groundwater and surface water, development of groundwater to the extent allowed by the Modeled Available Groundwater (MAG) estimates likely will have some impact on fluxes between surface water and groundwater systems. In these cases where appropriate, these interactions can be incorporated using results of Groundwater Availability Models (GAMs) or other modeling to establish a set of flow changes due to groundwater development. Such incorporation is essential in basins that have major springs (*e.g.*, Guadalupe, San Antonio, etc.). Changes in streamflows due to groundwater development should reflect only those strategies utilizing groundwater in excess of current supplies so as to not overestimate the impact of groundwater development strategies on streamflows. This may necessitate additional GAM modeling to differentiate flow changes due to utilization of MAG volumes as current supplies from utilization of MAG volumes used for recommended strategies.

The level of impact of groundwater development on surface water flows varies widely across river basins and aquifer systems. Often, flow changes estimated from groundwater modeling are little more than adjustment factors to achieve mass balances within a groundwater model and are difficult to measure and define in natural systems. RWPGs should incorporate streamflow changes into the modeling as appropriate for the hydrologic conditions in each basin.

4. Run WAM and extract regulated flows.

For purposes of evaluating the effects of recommended water management strategies the WAM Run 3 (full utilization of water rights) should be used, modified as necessary to reflect appropriate levels of return flows and other water management practices in the planning area and river basin, per hydrologic variances approved by the TWDB. The same WAM used to evaluate current supplies should be employed in the Chapter 6 Cumulative Effects analysis. TWDB CERST will extract regulated flows from any output file generated by the Water Rights Analysis Package (WRAP)[2] and is designed to compare the following[3]:

- Baseline regulated flows – regulated flows with no water management strategies, and

[2] Some RWPGs may wish to utilize Run 8 (current conditions) as a Baseline, with comparison to a Run 8 model with recommended strategies. This is not recommended because it will not provide an accurate depiction of streamflows reflecting existing water right adjudication. The strategies recommended in the regional water plan are those projects necessary <u>after</u> assuming full utilization of existing water rights, *i.e.*, Run 3, not the partial utilization of water rights reflected in Run 8. However, a comparison of flows using Run 8 as a Baseline may be reasonable for evaluating the cumulative impacts of strategies to be developed during near-term planning decades.

[3] Naturalized flows. Some RWPGs may elect to compare Baseline and With-WMSs regulated flows to naturalized flows. <u>Any comparison of regulated flows to naturalized flows should be clearly identified as illustrating the cumulative effects of historical and future water resource management in the basin and not solely the cumulative effects of the strategies recommended in the regional water plan.</u>

- Regulated flows with recommended water management strategies implemented by the final planning decade.[4]

Regulated flow is the total flow passing a given control point location after all water rights have appropriated the flows to which they are entitled.

5. Compile statistical and graphical summaries.

An array of graphical, tabular, and statistical comparisons can be used to assess the cumulative effects of the water management strategies recommended in a regional water plan. Most will form comparisons of regulated flows resulting from WAM simulations of the Baseline and With WMSs conditions. These can encompass three general forms:

- Direct comparisons of the regulated flows by comparing various flow statistics in a graphical or tabular format,
- Comparison of the Baseline and With WMSs regulated flows to TCEQ SB3 e-flow standards, focusing on how the frequencies at which the standards are exceeded differ between the two sets of regulated flows, and
- Comparison of the effects of changes in the regulated flows on specific environmental metrics such as weighted useable habitat area.

The following metrics are facilitated directly by TWDB CERST to assist RWPGs with assessing the effects of the recommended water management strategies. Other metrics not included here may be utilized at the discretion of each individual RWPG.

a. Direct comparison of Baseline and With WMSs regulated flows through graphical and tabular representations.

   - Monthly median comparison – bar chart comparison of median January flows, median February flows, etc. These graphs provide a direct comparison between "average" flows of the Baseline and With WMSs conditions.
   - Tabular flow quantile comparisons of monthly, seasonal, and annual flows. These graphs allow for a direct comparison of flows having specific frequencies of exceedance.
   - Frequency plot comparisons. These graphs allow a comparison between overall flow frequency, both high and low exceedance probabilities.
   - Plots of Baseline monthly flows against With WMSs monthly flows compared to a line of equality. These plots allow, on a monthly basis, to discern if differences between Baseline and With WMSs flow conditions are limited to specific months and monthly flow volumes.

b. Comparison of Baseline and With WMSs regulated flows to e-flow standards adopted by TCEQ. These comparisons provide for a general understanding of the magnitude of flows output by the WAM compared to the e-flows standards.

   1. Frequency at which seasonal subsistence flow thresholds are exceeded
      - Baseline

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[4] RWPGs may want to utilize earlier decades in addition to the final planning decade to demonstrate the effects of plan implementation over time.

- With WMSs

2. Frequency at which seasonal base flow thresholds are exceeded
   - Baseline
   - With WMSs

   The e-flow standards adopted by TCEQ are based on daily-mean discharges. In contrast, the WAMs used by the RWPGs operate using monthly flows. Nevertheless, subsistence and base instream flow standards are incorporated into the WAMs as instream flow requirements by simple unit conversions from cubic feet per second (cfs) to acre-feet per month (acft/mo) accounting for the number of days in each month.

   RWPGs should be aware of the limitations inherent in comparing daily-flow based e-flow standards with monthly regulated flows computed by the WAMs. While low-flow months may at times be reasonably compared to subsistence or base flow targets, simply having a monthly flow volume greater than 28, 30, or 31 times the daily standard is insufficient to demonstrate that the daily standard was exceeded each day of the month. RWPGs should note that simply because the monthly regulated flows from a WAM analysis exceed a monthly total of daily e-flow requirements does not imply that the e-flows standard are always attained.

3. Number of seasonal and/or annual high-flow pulse volumes exceeding the thresholds[5]
   - Baseline
   - With WMSs

   Because high flow pulse flow thresholds in the environmental flow standards are based on daily mean flows, WAM regulated monthly flows are not directly comparable. To address this issue, TWDB CERST multiplies the pulse volume standards by the number of days in a month divided by the pulse duration standard in days, to compare with the resulting Baseline and With WMSs monthly regulated flows.

   Flood pulses are graphed by TWDB CERST as a time series scatter plot of high-flow pulses with different symbols for Baseline and With WMSs conditions but limiting the plots to include only monthly flows exceeding the smallest pulse volume standard, *i.e.*, low-flows are excluded from the graphs. Seasonal high-flow pulse volumes are superimposed to provide a visual comparison of the results in a temporal fashion.

The resulting values for Baseline and With WMSs conditions for Subsistence, Base, and high flow pulses should be summarized in tabular form for a quantitative evaluation of the cumulative effects of the recommended water management strategies.

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[5] Care must be exercised in any basin in which pulse volumes were specified as something other than the central tendency values from relations between high-flow pulse flow rate and pulse volume. For example, the standards adopted in the Nueces River Basin are based on the upper bound durations.

c. Comparison of Baseline and With WMSs regulated flows to aquatic habitat metrics (where information is available)[6]

   Curves of percent of maximum of weighted usable habitat area versus discharge have been developed for several locations in the Brazos, Guadalupe-San Antonio, and Nueces River Basins, but these types of data have not been developed for other basins. Specific exceedance-frequency flows can be plotted on these curves to demonstrate the potential differences the Baseline and With WMSs flow regimes might have on habitat area at these locations. WAM regulated flows would be utilized from the nearest control point location in the model. Suggested quantiles to compare are the 75th and 95th percentile flows of the Baseline and With WMSs conditions against these curves, for locations where the curves are available.

d. Bay and estuary inflows

   - Compare Baseline and With WMSs regulated flows at the basin outlet.

     TWDB CERST has the capability to provide the above graphs and statistical summaries if the regulated flows at the basin outlet are included in the WAM output file.

   - Compare to adopted bay and estuary inflow targets in the adopted environmental flow standards.

     Due to the widely varied nature of the adopted bay and estuary inflow targets, and the fact that several bay systems accept flows from multiple river basins, the capability of comparing basin outlet regulated flows to adopted bay and estuary inflow targets is not included in TWDB CERST. However, TWDB CERST does tabulate monthly flows within an Excel spreadsheet worksheet to facilitate an RWPG-generated comparison.

6. Prepare the text for the section of Chapter 6 summarizing the approach used to develop the Baseline and With WMSs conditions, and interpreting the results with regard to the cumulative effects of the recommended water management strategies on streamflows and bay and estuary inflows at desired locations and, where reference data are available, habitat metrics.

   The WAM models generate a large amount of data and TWDB CERST is a convenient tool for summarizing WAM results in accessible graphical and tabular formats. TWDB CERST can be used to produce a large number of graphs and statistical tables which are useful in interpreting the differences between Baseline and With WMSs conditions. However, RWPGs are encouraged to be selective when incorporating specific graphs and tables into the Chapter 6 cumulative effects analysis so that the reader is not overwhelmed with the volume of data presented. For example, during development of the Brazos Basin demonstration study, 11 basin locations were identified for evaluation and TWDB CERST generated 55 individual graphics and 22 statistics tables. That would be an inappropriate number of graphs and tables to include in Chapter 6 or an appendix. Simply said, just because TWDB CERST has generated a graph or table

[6] Note that the relationship between discharge and weighted usable habitat area likely will change over time at any specific location as a river adjusts its planform in response to various hydrologic stresses.

doesn't dictate that it must be included in the Chapter 6 report or an appendix of the regional water plan.

3. TWDB CERST structure and setup

The purpose of the TWDB CERST is to assist RWPGs in assessing the cumulative effects of strategies recommended in the regional water plans.

The TWDB CERST is a Microsoft Excel application that creates graphical and statistical comparisons of regulated streamflows from the output of any two WAM runs. To assess the cumulative effects of recommended strategies in the regional water plans, the two WAM runs that will be compared are the Baseline run and With WMSs run described in Section 2.

The TWDB CERST has the following features:

1. Extracts regulated flows for user-defined control points from any two WAM output files (*e.g.*, Baseline model and With WMSs model).
2. Creates the following regulated flow comparison plots for each user-defined control point:
    - Exceedance Frequency
        - Log-Probability scale – all data
        - Linear-Linear scale – 75% exceedance probability flows and smaller
    - Monthly median (e-flow requirements are plotted for applicable control points)
    - Monthly flow (With WMSs) versus Monthly Flow (Baseline)
    - Regulated flows that exceed environmental pulse flow requirements
3. Compares statistics in tabular form for each user-defined control point:
    - Monthly, Seasonal, and Annual exceedance frequencies
    - Percentage of months where subsistence and base flow environmental requirements are exceeded

TWDB CERST can be used for any basin, regardless of whether the basin has e-flow requirements. For basins with e-flow requirements, the requirements are stored within the tool and can be adjusted by the user. For basins without adopted e-flows, the user can input flow ranges of interest for comparison to regulated flows in exceedance probability plots. For monthly median plots, if e-flows do not exist the plot will be generated but will only compare Baseline and With WMSs flows only.

3.1 Installation

The CERST tool is comprised of a custom macro-enabled Excel workbook (*e.g.*, CERST_v1.0.xlsm) and a folder named **dist** which contains the tool's executable and dependency files. The tool's files are available from TWDB as a .zip compressed file.

The installation steps are as follows:

1. Download CERST.zip from twdb.texas.gov
2. Unzip to a folder that **does not have spaces in the path** (*e.g.*, c:/users/<your_user_name>/documents/twdb_cerst)

a. The CERST tool (combination of Excel file and **dist** folder) can be installed in multiple locations – in fact this is recommended if you are evaluating multiple basins or scenarios since all output is written to the installation folder of the tool being executed.

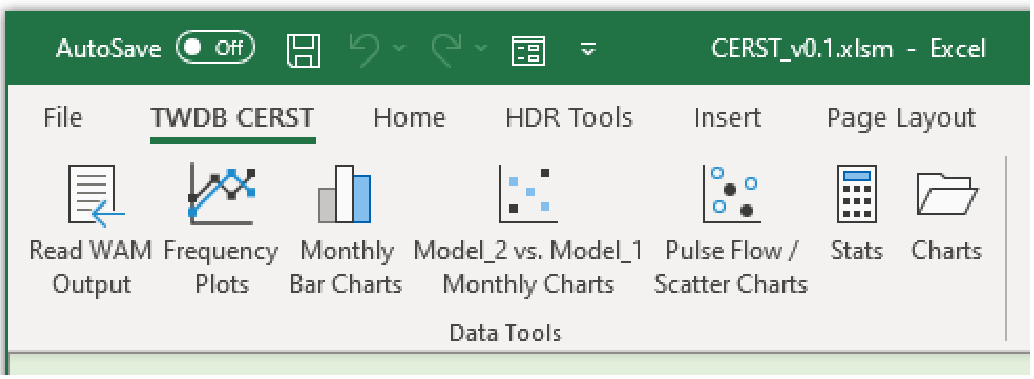
b. The Excel file must always be stored in the same directory as the **dist** folder – separating them will cause the tool to fail.

c. The only requirement of the installation folder is that the full path NOT contain spaces. This could preclude, for example, installing in a Microsoft OneDrive shared folder since the path often contains spaces.

The CERST tool will access WAM output files (.out) – these files can be stored anywhere, but it's recommended that they be stored in the installation directory for convenience. This will ensure that all input (WAM .out files) and output (plot files in .png format, and .csv files) are kept together in the same directory.

3.2 TWDB CERST Excel ribbon

TWDB CERST includes an Excel ribbon tab called **TWDB CERST**. The tab is located on the left side of the ribbon between the "File" and "Home" tabs as shown below.



The **TWDB CERST** ribbon includes seven clickable buttons, each of which initiates a process and produces output. Output is either a collection of plots (saved as .png image files), or tabular output written to the **Stats_Table1** and **Stats_Table2** worksheets. Details of the individual buttons and their output is discussed in Section 4.

3.3 TWDB CERST worksheets

This section describes the purpose of each of the tool's worksheets and how the user interacts with them. The names of the tabs are:

Settings
CP_List
Status
WAM_MODEL_1
WAM_MODEL_2
Stats_Table1
Stats_Table2
SB3-EFS-BASIN (one each for Brazos_SanJacintoBrazos, Nueces, etc.)

3.3.1 *Settings worksheet*

The settings worksheet contains user-selected settings that define the e-flows to be used in plots and statistics, and for text input of Model_1 and Model_2 labels. Suggested labels for Model_1 and Model_2 are "Baseline" and "With-WMS".

The **SELECT BASIN** setting controls which e-flows worksheet is used in the comparison plots and tables. For example, if "Brazos_SanJacintoBrazos" is selected, the e-flows used in the comparisons will come from the worksheet **SB3-EFS-Brazos_SanJacintoBrazos.** The **SELECT HYDROLOGIC CONDITION** and **SELECT PULSE FLOW TYPE** choices are filtered on the basin selected and are used to define which hydrologic conditions are used in the monthly median plots and statistics, and which pulse flow requirements are used in the pulse flow scatter charts.

The Model_1 and Model_2 label inputs, as shown in Figure 3-1, are used in the plot legends and the statistics output.

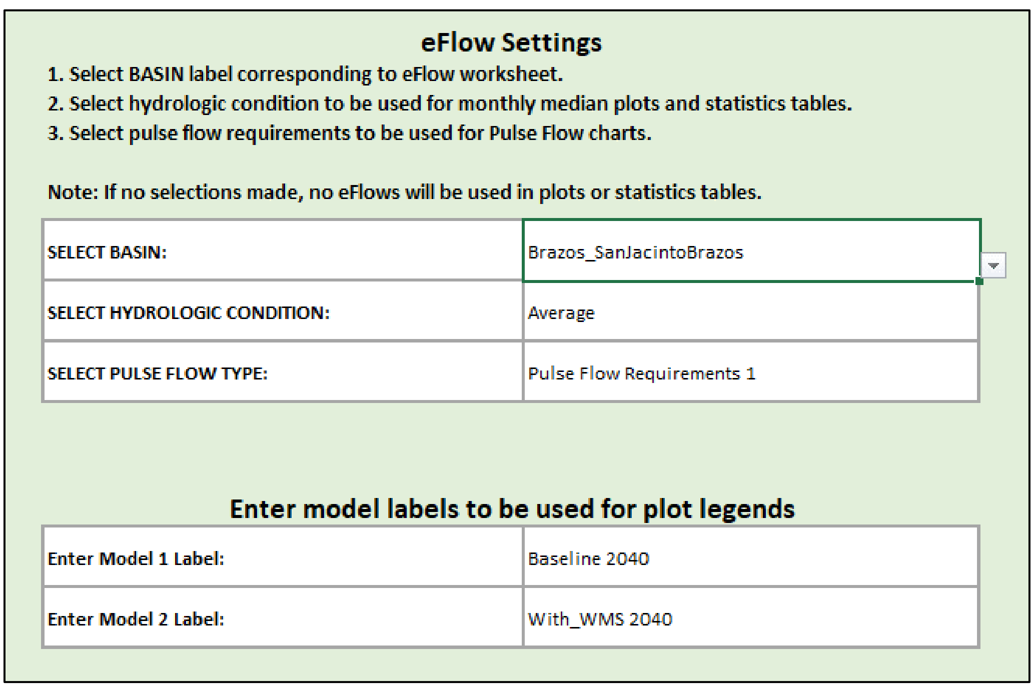


Figure 3-1. User input information on the Settings worksheet.

3.3.2 *CP_List worksheet*

The CP_List worksheet includes a user-defined table of control points for the basin selected in the Settings worksheet. The columns are defined in Table 3-1. An example is shown in Figure 3-2. The list of control points must start in row 2 and not contain any blank rows.

Table 3-1. User-inputted control point information.

Column Name	Description
Control Point ID	Identifier of any control point in selected WAM output. This must be an exact match.
Control Point Name	Descriptive name of the control point. If the control point has e-flows, this name must have an exact match in the basin's eFlow table. If the name doesn't match, the e-flows will not be used in the assessment.
eFlow 1 Low (cfs)	The lower value for a specific flow requirement (*e.g.*, subsistence) in units of cfs. The descriptive label for the associated flow requirement is entered in the **eFlow 1 Label** column.
eFlow 2 High (cfs)	The higher value for a specific flow requirement (*e.g.*, subsistence) in units of cfs. The descriptive label for the associated flow requirement is entered in **eFlow 1 Label** column.
eFlow 1 Label	The descriptive label for the values in the **eFlow 1 Low (cfs)** and **eFlow 1 High (cfs)** columns.
eFlow 2 Low (cfs)	The lower value for a second specific flow requirement (*e.g.*, Base Flow) in units of cfs. The descriptive label for this flow requirement is entered in the **eFlow 2 Label** column.
eFlow 2 High (cfs)	The higher value for a second specific flow requirement (*e.g.*, Base Flow) in units of cfs. The descriptive label for this flow requirement is entered in the **eFlow 2 Label** column.
eFlow 2 Label	The descriptive label for the values in the **eFlow 2 Low (cfs)** and **eFlow 2 High (cfs)** columns.

The eFlow requirements entered in the **CP_LIST** worksheet do not have to correspond to adopted environmental flow requirements for the specfied locations. The flows entered in the **CP_LIST** worksheet are used only when plotting exceedance frequency plots. The user is provided the opportunity to input any set of flows to compare with modeled flows on the frequency plots. Typically, these flows will correspond to adopted eflows, but can be any flow levels of interest to the user.

	A	B	C	D	E	F	G	H
1	Control Point ID	Control Point Name	eFlow 1 Low (cfs)	eFlow 1 High (cfs)	eFlow 1 Label	eFlow 2 Low (cfs)	eFlow 2 High (cfs)	eFlow 2 Label
2	SFAS06	Salt Fork Brazos River near Aspermont	1	2	Subsistence Flow	2.5	4	Base Flow (Dry)
3	DMAS09	Double Mountain Fork Brazos River near Aspermont	1	2	Subsistence Flow	3	6	Base Flow (Dry)
4	BRSE11	Brazos River at Seymour	1	5	Subsistence Flow	4	10	Base Flow (Dry)
5	CFNU16	Clear Fork Brazos River at Nugent	1	2	Subsistence Flow	2	4	Base Flow (Dry)
6	BRSB23	Brazos River near South Bend	1	2	Subsistence Flow	16	24	Base Flow (Dry)
7	BRPP27	Brazos River near Palo Pinto						
8	NBCL36	North Bosque River near Clifton	1	2	Subsistence Flow	3	6	Base Flow (Dry)
9	LEGT47	Leon River at Gatesville	1	2	Subsistence Flow	4	6	Base Flow (Dry)
10	LAKE50	Lampasas River near Kempner	10	10	Subsistence Flow	16	20	Base Flow (Dry)
11	LRLR53	Little River near Little River	55	60	Subsistence Flow	84	100	Base Flow (Dry)
12	LRCA58	Little River near Cameron	32	35	Subsistence Flow	97	110	Base Flow (Dry)
13	NAEA66	Navasota River near Easterly	1	2	Subsistence Flow	3	6	Base Flow (Dry)
14	BRHE68	Brazos River near Hempstead	510	550	Subsistence Flow	950	1000	Base Flow (Dry)
15	BRRI70	Brazos River at Richmond	550	575	Subsistence Flow	930	975	Base Flow (Dry)
16	BRRO72	Brazos River near Rosharon	430	450	Subsistence Flow	930	975	Base Flow (Dry)
17	524201	CP 524201 NO EFLOWS EXAMPLE ONLY	1	2	Subsistence Flow	9	7	Base Flow (Dry)
18	BRGM73	BRGM73 NO EFLOWS	1	2	Subsistence Flow	1	4	Base Flow (Dry)
19								

Figure 3-2. Example control point input on CP_LIST worksheet.

3.3.3 *Status worksheet*

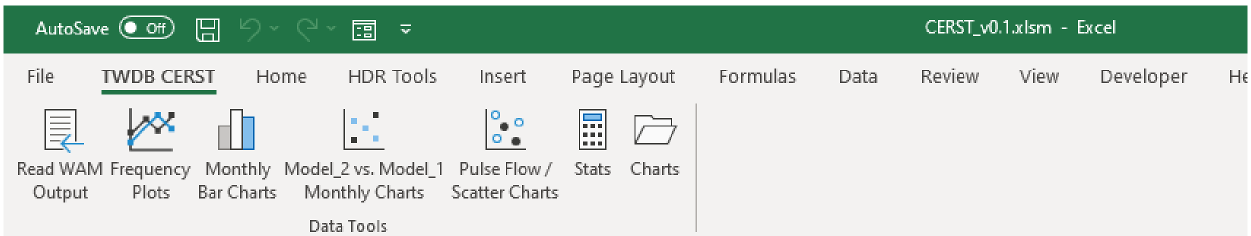
The Status worksheet, shown in Figure 3-3, is a read-only worksheet displaying the run-time status of the functions executed from the **TWDB CERST** ribbon.

Figure 3-3. Status worksheet.

3.3.4 *WAM_MODEL_1 and WAM_MODEL_2*

The WAM_Model_1 and WAM_Model_2 tabs are read-only worksheets containing regulated flows extracted from the WAM output files. A common example would be models representing Baseline and With WMSs cases, respectively. Data are generated by running the **Read WAM Output** function in the **TWDB CERST** ribbon. An example output is shown in Figure 3-4.

The **Date** column displays the month and year, and the subsequent columns display monthly regulated flows for each control point in the user-defined **CP_List** worksheet that matches a control point identifier in the selected WAM output file. The output is included in these two worksheets to allow the user the ability to verify the data or perform independent assessments of the regulated flows not supported by TWDB CERST.



	A	B	C	D	E	F	G	H	I	J	K	L
1	Date	DMAS09	SFAS06	524201.00	BRSE11	CFNU16	BRSB23	BRPP27	NBCL36	LEGT47	LAKE50	LRLR53
2	Jan-40	27.96	8.60	0.00	0.00	25019.87	8765.53	5279.75	104.00	420.89	486.57	912.12
3	Feb-40	782.50	43.73	848.02	869.40	1030.81	8126.92	2858.62	113.00	720.89	1303.97	505.65
4	Mar-40	0.00	3.22	0.00	0.00	656.62	0.00	6236.97	39.00	491.15	586.39	685.75
5	Apr-40	1761.88	4873.80	6574.73	5283.33	965.78	14269.85	35365.14	4648.64	11553.57	4420.81	5917.62
6	May-40	4089.81	3063.76	7456.49	6926.05	1960.81	75761.31	32875.71	1416.40	3345.60	2776.14	1885.96
7	Jun-40	8939.68	8326.08	21533.36	24183.21	2487.12	163330.16	214639.50	22293.62	46015.34	20448.18	112563.41
8	Jul-40	237.85	166.98	3552.92	7072.84	2534.80	28204.00	16986.89	250.32	15345.68	15339.97	53167.48
9	Aug-40	25768.77	39284.38	75652.18	76416.38	19651.10	164672.56	173946.59	796.78	1878.27	1153.47	1791.14
10	Sep-40	10009.93	1723.96	16925.00	22344.28	1918.56	41700.14	24733.05	225.00	842.02	499.65	725.70
11	Oct-40	0.04	145.11	96.33	3.53	1911.73	894.21	32674.62	0.00	1970.78	1786.64	8865.95
12	Nov-40	4772.66	9141.17	16400.32	16703.02	626.97	40082.27	9957.69	45492.23	68049.59	49784.39	216002.83
13	Dec-40	64.53	436.77	1469.11	2627.75	377.15	10939.75	35440.21	43168.84	85531.98	58861.45	350813.44
14	Jan-41	9.99	14.90	165.91	322.11	345.72	2171.48	5218.87	14911.47	32761.06	29923.12	144594.38

Figure 3-4. Example WAM regulated flows in the WAM_Model_1 and WAM_Model_2 tabs.

3.3.5 *Stats_Table1 and Stats_Table2*

The Stats_Table1 and Stats_Table 2 are read-only worksheets containing output generated by running the **Stats** function in the **TWDB CERST** ribbon.

Stats_Table1 contains tables for each control point with exceedance frequencies summarized on a monthly, seasonal, and annual basis.

Stats_Table2 contains tables for each control point with e-flows. Each table contains a comparison of monthly statistics for the percentage of time subsistence and base flow (dry and average conditions) e-flow requirements are equaled or exceeded.

3.3.6 *EFlow worksheets by basin*

Each basin with e-flow requirements adopted by TCEQ has a worksheet named "SB3_EFS-" followed by the basin name. The basin names match the names used in the basin dropdown list on the Settings worksheet. *e.g.*, if "Brazos_SanJacintoBrazos" is the selected basin in the Settings worksheet, the e-flows from the worksheet "SB3-EFS-Brazos_SanJacintoBrazos" will be used in the comparisons.

The EFlow_ worksheets are editable, so the user can customize control point names, edit values, or enter new e-flow information. Since the worksheets are editable, the user has the responsibility for maintaining the original structure. There are two tables within each EFlow worksheet: the first (columns A:S) define the e-flows for that basin; the second (columns U:V) define the seasons by month. Table 3-2 provides a definition of the columns.

Table 3-2. Descriptions of columns included in EFlow worksheets for each basin.

Column Name	Description
e-flows (columns A:S)	
BASIN	Basin name.
CP NAME	Control Point name. This name will appear on the generated plots. If its data will be used in comparisons, this name must be matched by an entry in the CP_List worksheet.
MONTH	Numerical month value (1-12). There must be twelve months for each hydrologic condition.
SEASON	Season the month is in – any combination of Winter, Spring, Summer, or Fall. These labels are used in the generated plots and statistics tables.
CONDITION	Hydrologic Condition: typical values include Dry, Average, Wet, and Severe. Some basins do not specify a hydrologic condition, in which case use "Average" in this table.
SUBSISTENCE_CFS	Subsistence Flow (units of cfs) applicable to the month, season, and condition.
BASE_CFS	Base Flow (units of cfs) applicable to the month, season, and condition.
PULSE FLOW REQUIREMENTS # VOLUME (AF)	Pulse Volumes (units of acre-feet [acft]) for six (6) sets of requirements, applicable to the month, season, and hydrologic condition.
PULSE FLOW REQUIREMENTS # DURATION (DAYS)	Pulse Duration (units of days) for six (6) sets of requirements, applicable to Pulse Volume.

4. TWDB CERST execution and outputs

This section describes the execution of each button in the **TWDB CERST** ribbon and the expected outputs for each.

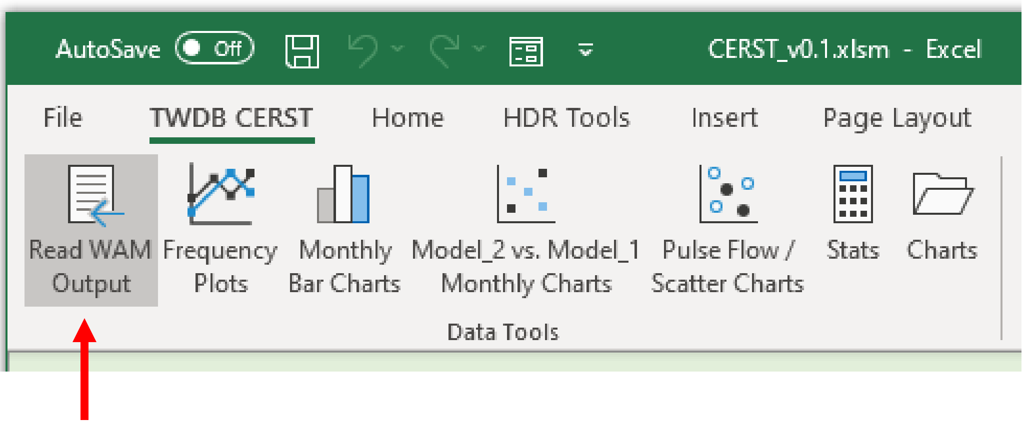
4.1 Read WAM Output

The **Read WAM Output** function extracts the regulated flows from WAM output for each control point listed in the **CP_List** worksheet. The user must select Model_1 and Model_2 WAM output files. The requirements for successful execution are as follows:

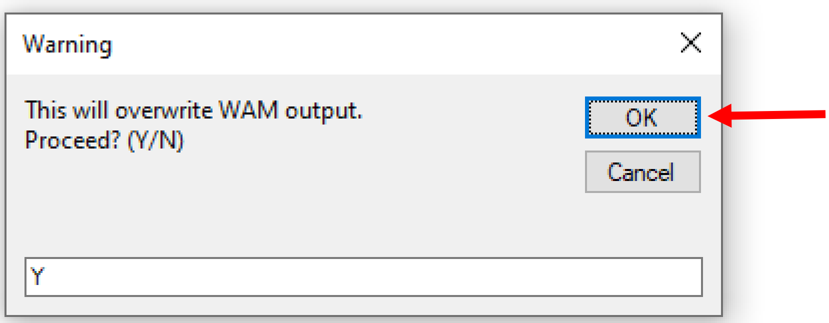
- The selected Model_1 and Model_2 output files are different files, and
- Both output files are valid WAM files.

The steps for execution and expected results are outlined below.

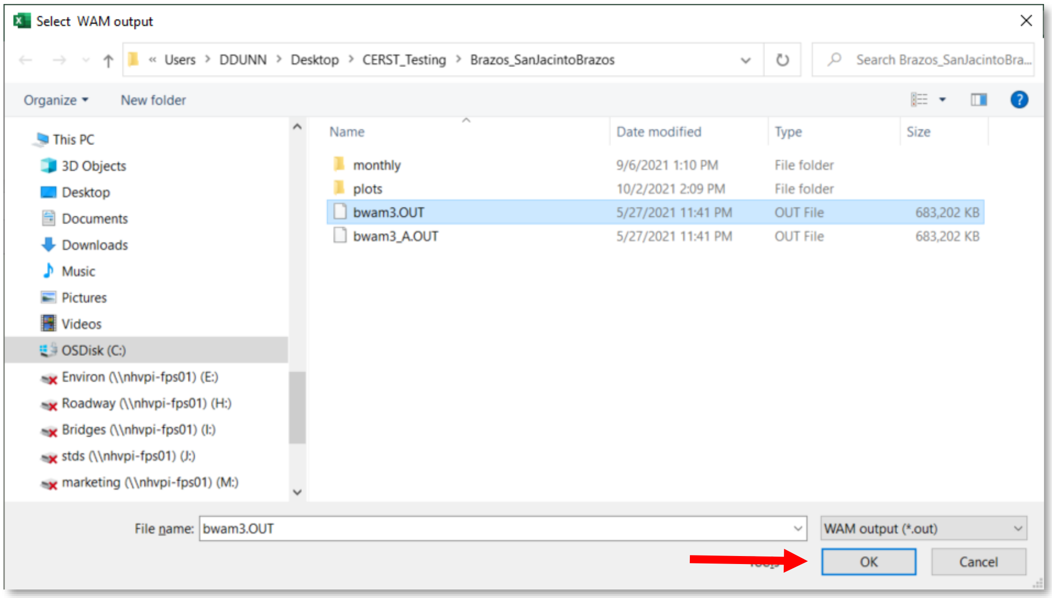
1. Click the **Read WAM Output** button.



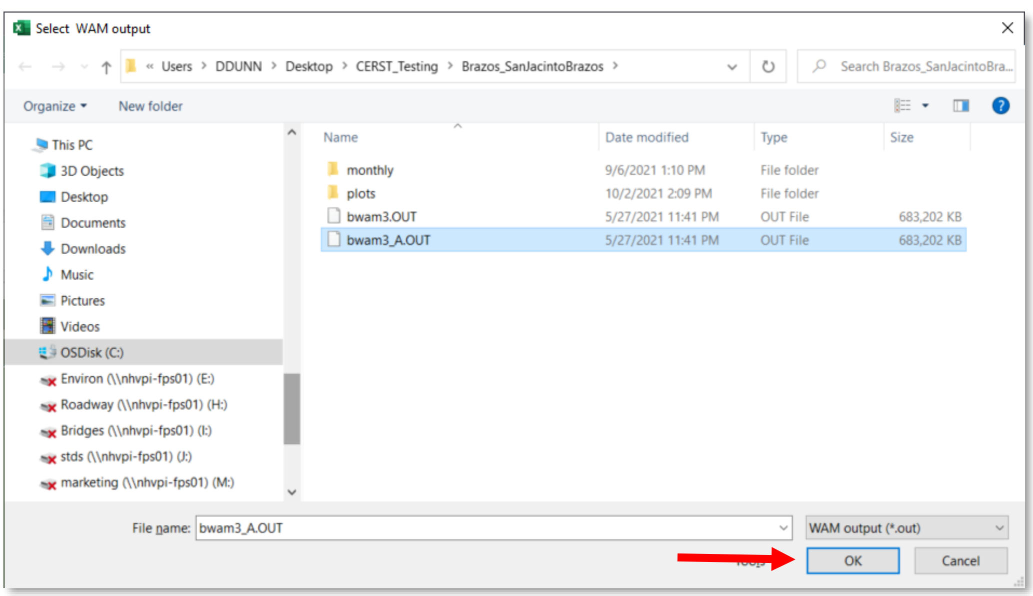
2. Click the **OK** button (click **Cancel** to cancel function execution).



3. Select Model_1 WAM output file and click the **OK** button (click the **Cancel** button to cancel output selection).



4. Select Model_2 WAM output file and click the **OK** button. Click **Cancel** to cancel output selection. If cancel is selected for the WAM output file, the entire function execution is canceled for both files.



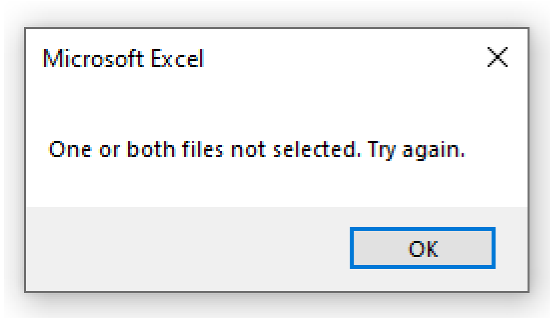
If both files are selected, the selected files are different files, and both files are valid WAM output files, then:

5. Regulated flows for user-specified control points in the **CP_List** worksheet are output to the **WAM_MODEL_1** and **WAM_MODEL_2** worksheets. If a control point in the **CP_List** worksheet is not valid, a message is displayed in the **Status** worksheet, but function

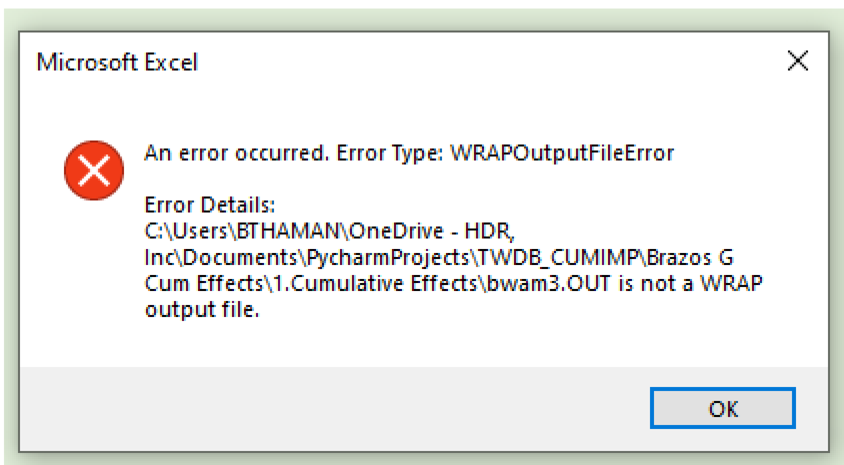
execution is not interrupted.

6. Two .csv files containing the same contents as the **WAM_MODEL_1** and **WAM_MODEL_2** worksheets are written to the directory containing the Model_2 WAM output file.
7. Monthly .csv files are written to the directory containing the Model_2 WAM output file in a subdirectory named "monthly". These files are used for the plotting functions and should not be deleted or edited.

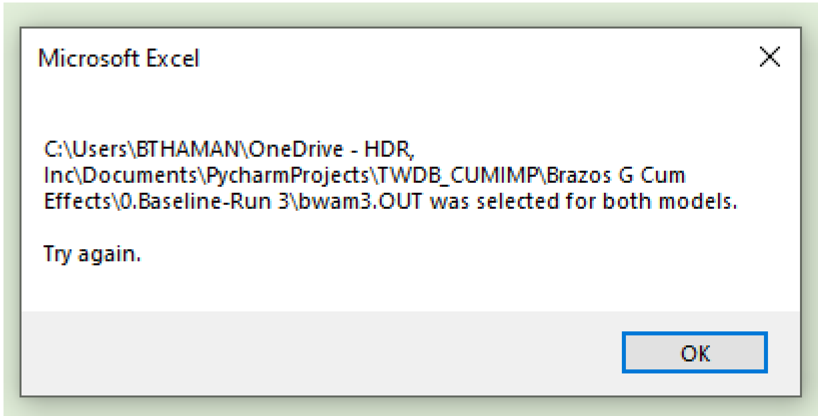
If one or both output files are not selected, the following message is displayed, and execution is canceled.



If either output file is not a valid WAM output file, an error message is displayed, and execution is canceled.

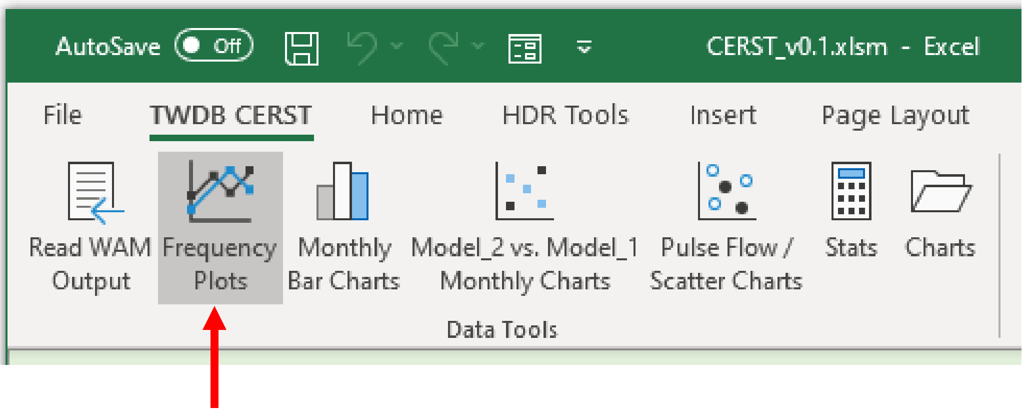


If an output file was selected twice by mistake, the following error message is displayed, and execution is canceled.



4.2 Frequency Plots

The **Frequency Plots** function creates plots of regulated flow exceedance frequencies for each control point. Two types of plots are generated and saved as .png image files in the same directory as the With-WMS (Model 2) WAM output file, in a subdirectory named "plots".



The first type of plot shows monthly WAM data on a log-probability scale. A sample plot is shown below in Figure 4-1. Each plot also includes colored bands: one for values between EFlow 1 Low and EFlow 1 High, and one for values between EFlow 2 Low and EFlow 2 High from the **CP_List** worksheet, if the values are specified. The values are converted from units of cfs to acft/mo.

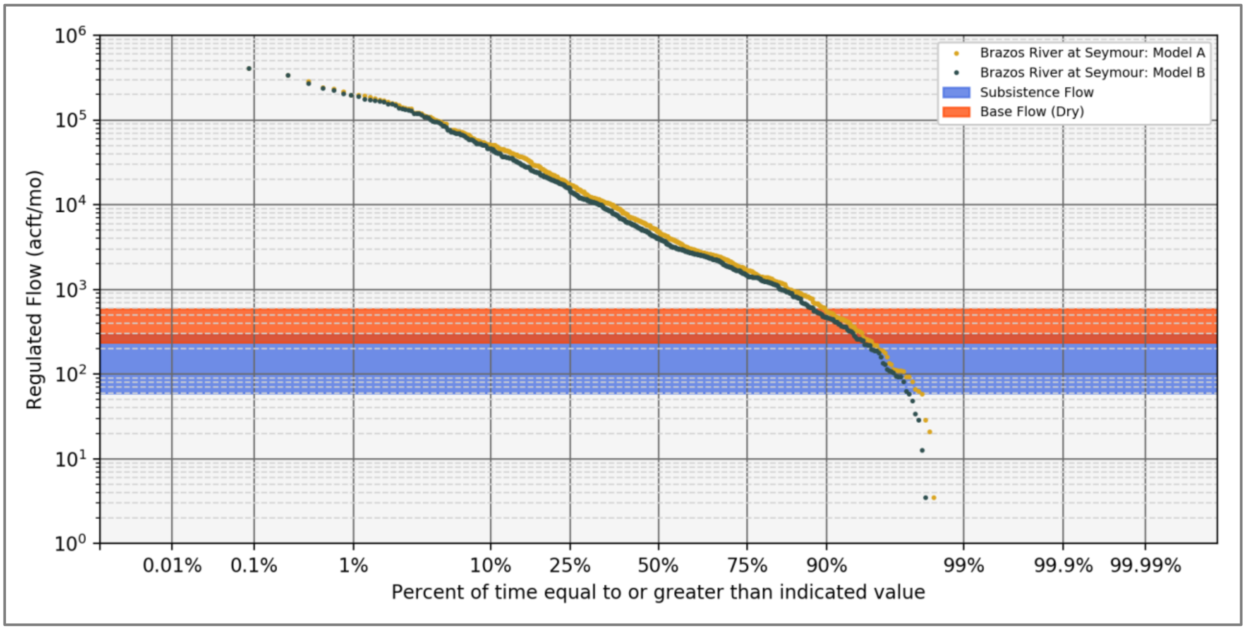


Figure 4-1. Example log-probability frequency plot.

The second type of frequency plot shows values for exceedance probabilities of 75% and greater, on a linear arithmetic scale. A sample plot is shown in Figure 4-2. Each plot also includes the EFlow bands from values on the **CP_LIST** worksheet.

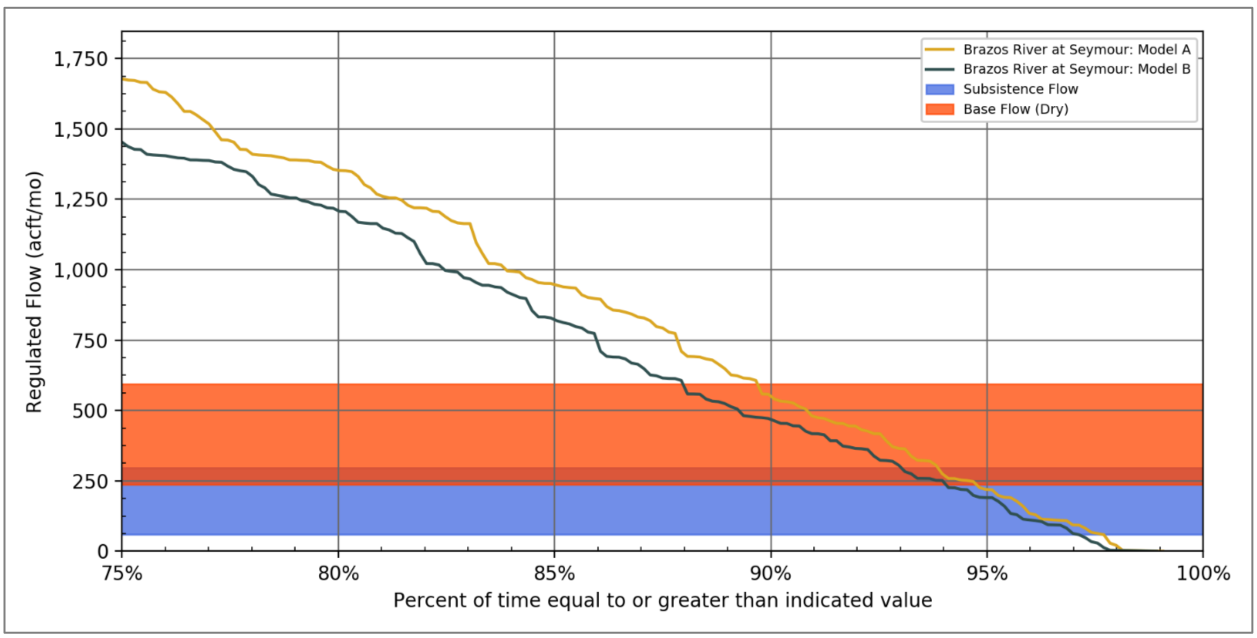
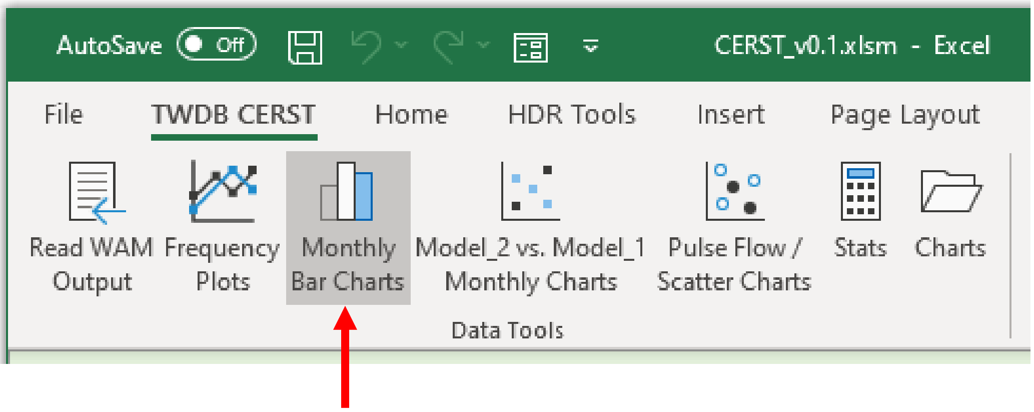


Figure 4-2. Example arithmetic frequency plot.

4.3 Monthly Bar Charts

The **Monthly Bar Charts** function creates plots of monthly medians, along with e-flow requirements (if applicable) for each control point. Plots are saved as .png image files in the same directory as the With WMSs WAM output file, in a subdirectory named "plots".



A sample plot is shown in Figure 4-3. Plots of TCEQ adopted SB3 base and subsistence e-flows are plotted behind the bars if they are available. All available hydrologic conditions are plotted for the base flows and the subsistence flows for the hydrologic condition specified on the Settings worksheet are also plotted.

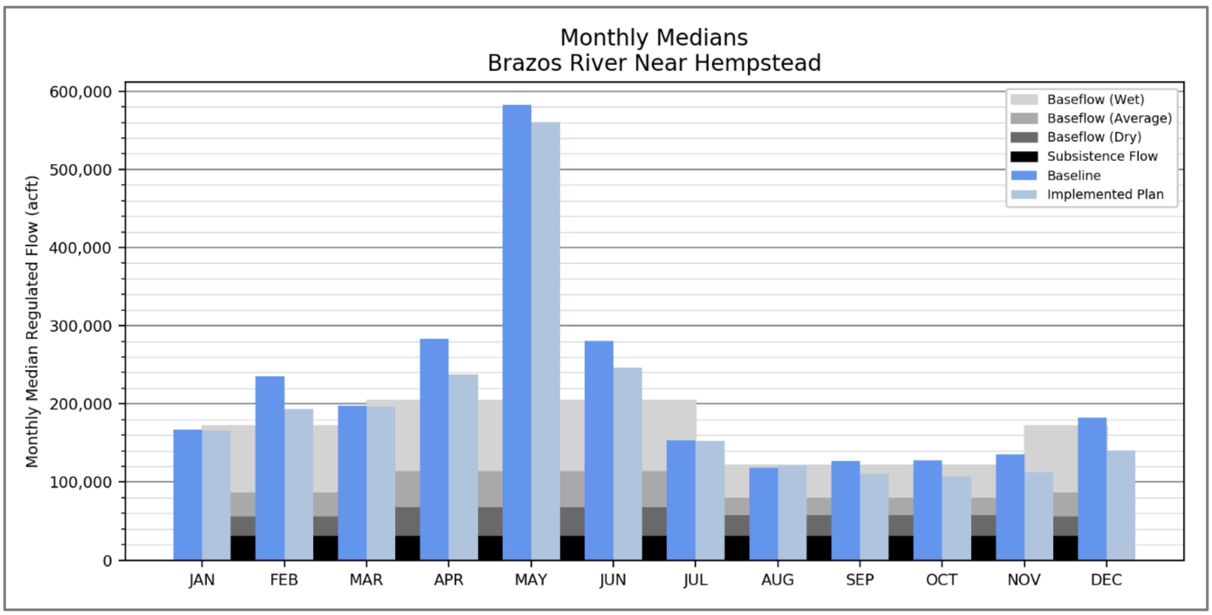
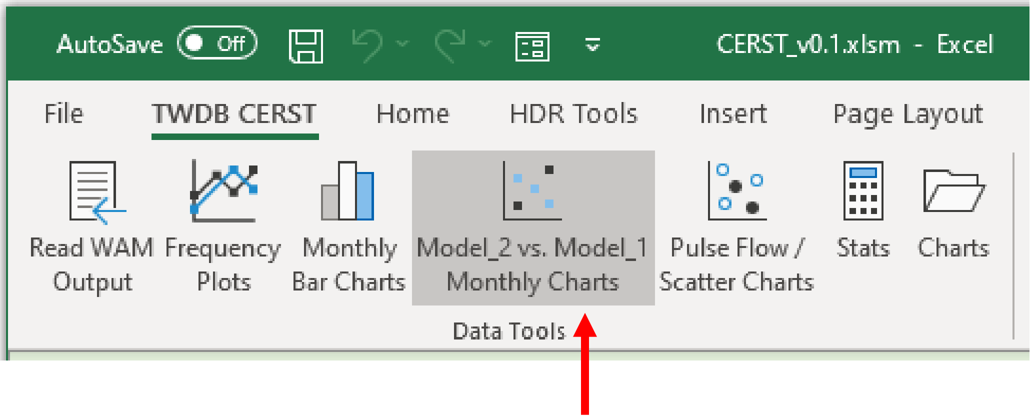


Figure 4-3. Example monthly median plot.

4.4 Model_2 vs. Model_1 Monthly Charts

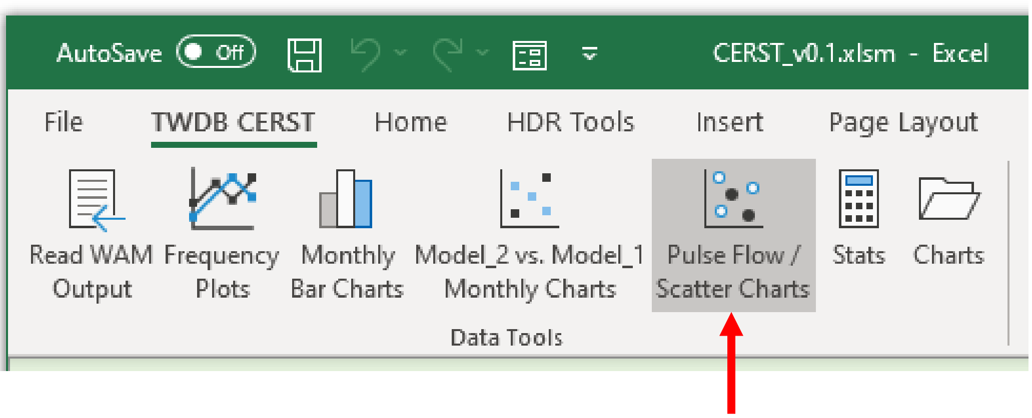
The **Model_2 vs. Model_1 Monthly Charts** function creates a collection of 12 monthly subplots for each control point specified on the **CP_LIST** worksheet – with each subplot showing Model_2 (*e.g.*, With WMSs) versus Model_1 (*e.g.*, Baseline) regulated flows as scatter plots. Plots are saved as .png image files in the same directory as the Model_2 WAM output file, in a subdirectory named "plots".



A sample plot is shown in Figure 4-4. On each subplot, a line of equivalency is plotted as a solid dark gray line. Points falling on the line of equivalency indicate the With WMSs flow is equal to the Baseline flow. Points to the right of the line of equivalency indicate the Baseline flow is greater than With WMSs flow. Points to the left indicate the With WMSs flow is greater than the Baseline flow.

4.5 Pulse Flow / Scatter Charts

The **Pulse Flow / Scatter Charts** function creates a plot for each control point showing monthly regulated flow scatter points against pulse flow requirements for the entire period of record. Plots are saved as .png image files in the same directory as the Model_2 WAM output file, in a subdirectory named "plots". If a control point does not have e-flows specified within the TWDB CERST workbook, no plot will be generated.



A sample plot is shown below in Figure 4-5. Only flows that exceed the minimum pulse flow requirements are plotted. An inset text box is shown on each plot that indicates the number of monthly flows exceeding the pulse flow requirements for the Model_1 and Model_2 cases.

The pulse flow requirements plotted are specified in the **Settings** worksheet.

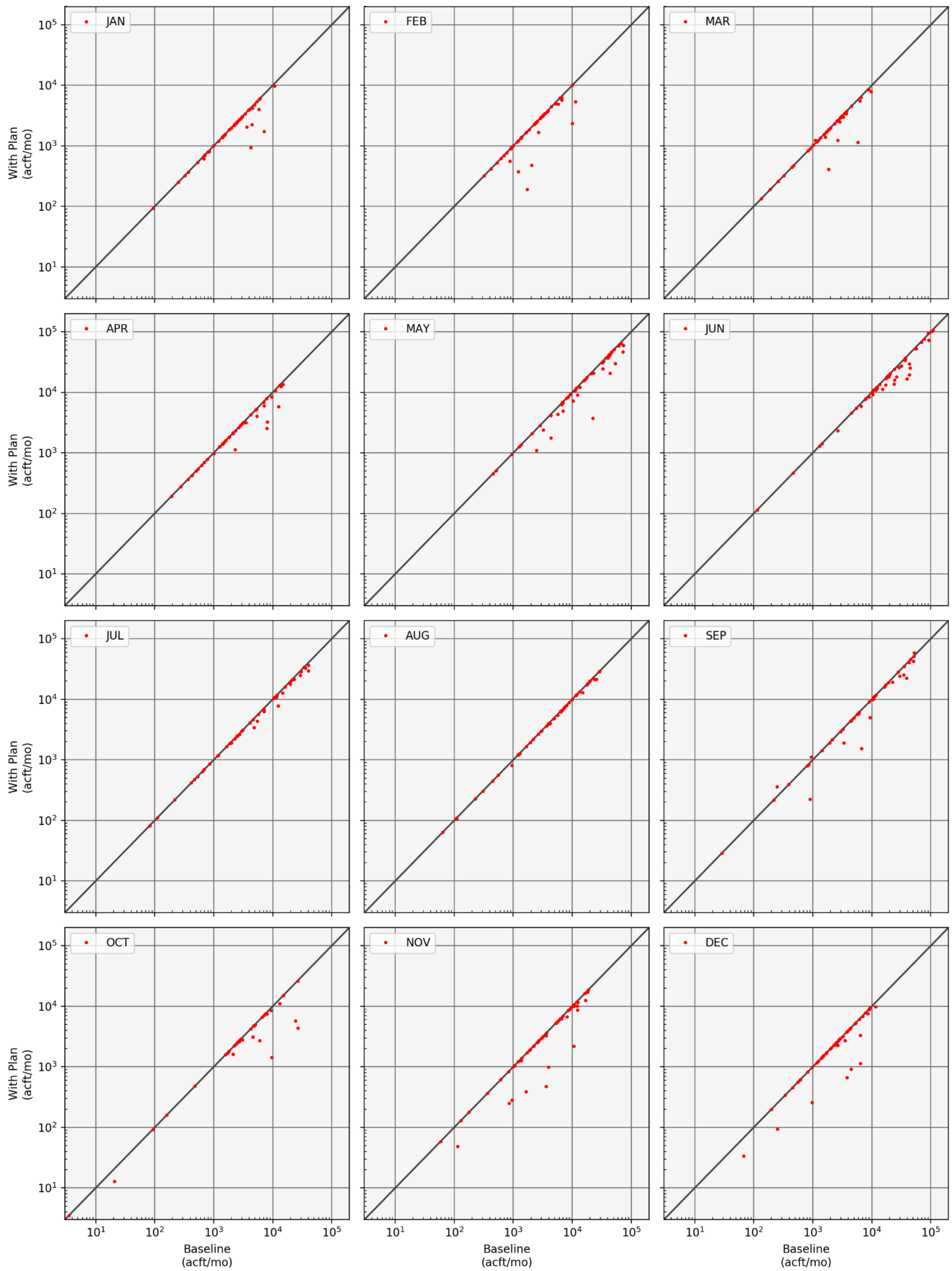


Figure 4-4. Example regulated flows scatter plot.

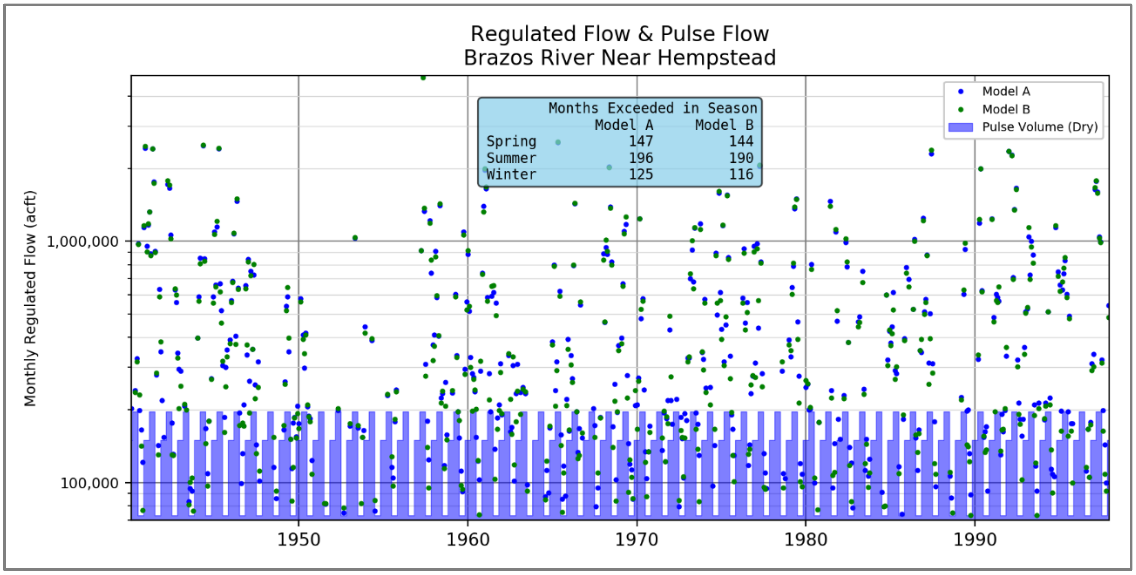
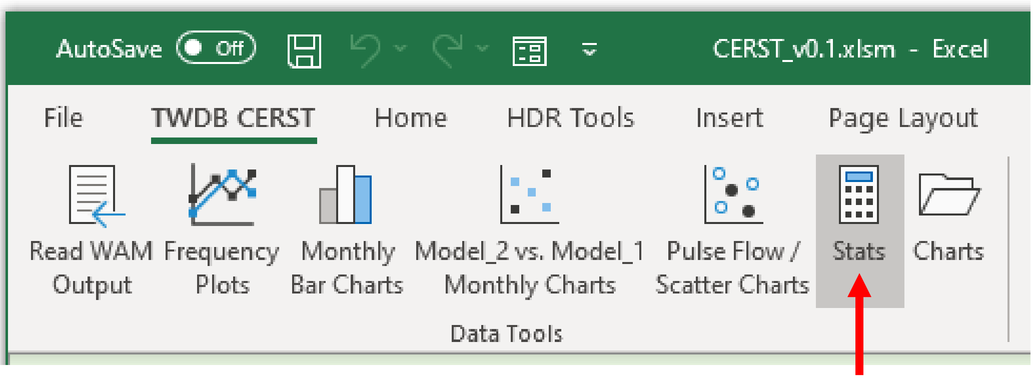


Figure 4-5. Example pulse flow / scatter plot.

4.6 Stats

The **Stats** function creates two types of statistical tables for each control point specified in **CP_List**. Output is written to the **Stats_Table1 and Stats_Table2** worksheets.



An example of the first stats output table (**Stats_Table1** worksheet) is shown in Figure 4-6. This table contains 95%, 75%, 50%, 25%, and 5% exceedance frequencies by month, season, and annually[7].

[7] A 95% exceedance frequency means that 95% of the flows equal or exceed that value.

Double Mountain Fork Brazos River Near Aspermont

Period	Baseline Model - Exceedance Frequency					WMSs Model - Exceedance Frequency				
	95%	75%	50%	25%	5%	95%	75%	50%	25%	5%
Jan	0	110	357	1,058	3,286	0	110	357	1,058	3,286
Feb	0	185	526	1,153	7,256	0	185	526	1,153	7,256
Mar	0	141	456	1,310	7,591	0	141	456	1,310	7,591
Apr	18	293	952	4,488	16,444	18	293	952	4,488	16,444
May	337	2,571	6,091	24,526	74,834	337	2,571	6,170	24,526	74,834
Jun	545	4,115	8,275	19,543	58,064	545	4,115	8,275	19,543	58,064
Jul	122	566	2,645	10,941	42,306	122	566	2,645	10,941	42,306
Aug	36	992	2,386	8,749	25,692	36	992	2,386	8,749	25,692
Sep	2	647	5,742	11,408	56,975	2	647	5,742	11,491	60,247
Oct	0	386	1,407	11,553	53,245	0	386	1,407	11,553	53,210
Nov	7	117	883	2,711	8,446	7	117	883	2,711	8,446
Dec	7	114	588	1,458	5,918	7	114	588	1,458	5,918
Winter	385	1,626	3,924	7,827	20,252	385	1,626	3,924	7,827	20,252
Spring	5,318	12,279	24,909	48,185	106,266	5,318	12,279	24,909	48,185	106,308
Summer	2,711	14,296	27,262	50,868	164,023	2,711	14,296	27,262	53,315	164,026
Annual	17,224	43,853	67,896	102,681	189,244	17,235	43,962	68,679	109,692	189,244

Figure 4-6. Example Stats_Table1 output table.

An example of the second stats output table (**Stats_Table2**) is shown in Figure 4-7. This table shows the percentage of months, for each model, where the regulated flow exceeds subsistence and base flow targets. Dry and Average conditions baseflow comparisons are made if these targets are available for the basin of interest. If only one base flow condition is available, that condition will be shown in the table.

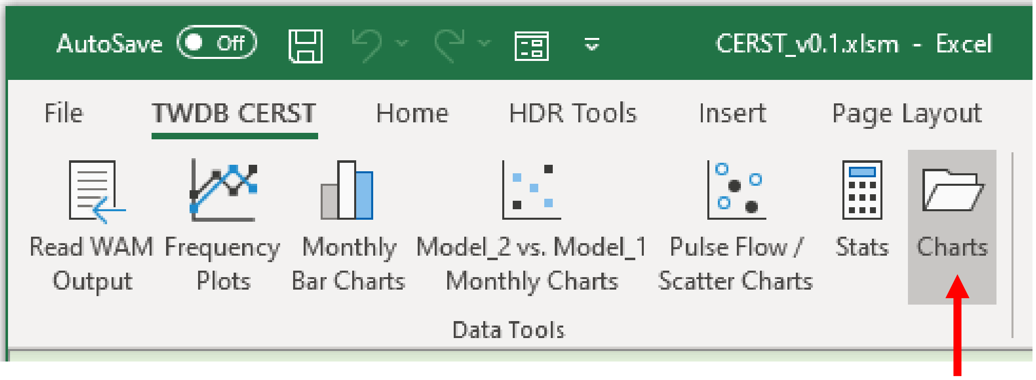
Double Mountain Fork Brazos River Near Aspermont

Month	SUBSISTENCE FLOWS				BASE FLOWS - DRY CONDITIONS				BASE FLOWS - AVERAGE CONDITIONS			
	Flow (acft/mo)	Model A % Time Met	Model B %Time Met	Delta %	Flow (acft/mo)	Model A % Time Met	Model B %Time Met	Delta %	Flow (acft/mo)	Model A % Time Met	Model B %Time Met	Delta %
Jan	61	77.6%	77.6%	0.0%	61	77.6%	77.6%	0.0%	246	60.3%	60.3%	0.0%
Feb	56	86.2%	86.2%	0.0%	56	86.2%	86.2%	0.0%	222	72.4%	72.4%	0.0%
Mar	61	81.0%	81.0%	0.0%	61	81.0%	81.0%	0.0%	184	65.5%	65.5%	0.0%
Apr	60	91.4%	91.4%	0.0%	60	91.4%	91.4%	0.0%	179	82.8%	82.8%	0.0%
May	61	100.0%	100.0%	0.0%	61	100.0%	100.0%	0.0%	184	100.0%	100.0%	0.0%
Jun	60	100.0%	100.0%	0.0%	60	100.0%	100.0%	0.0%	179	98.3%	98.3%	0.0%
Jul	61	96.6%	96.6%	0.0%	61	96.6%	96.6%	0.0%	123	94.8%	94.8%	0.0%
Aug	61	93.1%	93.1%	0.0%	61	93.1%	93.1%	0.0%	123	91.4%	91.4%	0.0%
Sep	60	87.9%	91.4%	3.4%	60	87.9%	91.4%	3.4%	119	87.9%	89.7%	1.7%
Oct	61	89.7%	89.7%	0.0%	61	89.7%	89.7%	0.0%	123	82.8%	82.8%	0.0%
Nov	60	87.9%	87.9%	0.0%	60	87.9%	87.9%	0.0%	238	70.7%	70.7%	0.0%
Dec	61	81.0%	81.0%	0.0%	61	81.0%	81.0%	0.0%	246	62.1%	62.1%	0.0%

Figure 4-7. Example Stats_Table2 output table.

4.7 Charts

When the user clicks the **Charts** function, shown below, the last saved location is opened in File Explorer, showing the charts that were generated at the last saved location.



The location of the plots folder is set to the location of the Model_2 WAM output file when the user runs the **Read WAM Output** function.

5. Errors, warnings, and troubleshooting

This section describes anticipated warning errors that can be handled while not impacting TWDB CERST application processing (*i.e.* does not result in the application crashing). In these cases the application will either display an error pop-up window, write an error message to the **Status** worksheet, or both. In all of these situations the reason for the error is known and steps can be taken to eliminate the error. The following sections discuss common sources of error, the functionality affected, and how they can be corrected.

5.1 Missing or incorrect control point information

The following table (Table 5-1) lists potential errors due to missing/incorrect control point information, the functionality affected, and the solution to correct the error.

Table 5-1. Potential errors in control point information.

Error Description	Functionality Affected	Solution
Blank Control Point list	All	Add at least one control point, run Read WAM Output to populate data.
Blank Control Point ID between two non-null IDs in CP_LIST worksheet.	All	Add control point id and re-run.
Blank Control Point Name anywhere there is a non-null Control Point ID	All	Add control point name and re-run.
Control Point ID doesn't exist in one or both models.	- Data not extracted for bad CP ID. - Plots not created for bad CP ID. - Stats not created for bad CP ID.	- Correct Control Point ID. - Re-run Read WAM Output. - Re-run plots/stats.

5.2 Missing Monthly WAM Data

When the WAM output is read from the .out files, 24 monthly data files (12 for each model) are written to a subdirectory of the directory where the Model_2 output file is located. The name of the subdirectory is "monthly". Errors will occur if any of these data are deleted or moved, the files renamed, or the directory deleted/moved/renamed. Table 5-2 lists potential errors associated with missing WAM data, functionality affected, and the solutions to correct the error.

Table 5-2. Potential errors – missing WAM data.

Error Description	Functionality Affected	Solution
MISSING FILE (missing or renamed file or directory)	- Monthly Bar Charts not created. - Plan versus Baseline Charts not created. - Stats not created.	- Re-run Read WAM Output. - Re-run affected plots/stats.

5.3 Incorrect or modified installation configuration

The TWDB CERST and the **dist** sub-directory must be in the same base directory. If they are not in the same directory, if the **dist** sub-directory was renamed, or if any of the files within the **dist** sub-directory were deleted or renamed, the application will fail. Files in the **dist** sub-directory should never be touched, so the most common mistake would be running the workbook functions from directory that does not contain the **dist** subdirectory Table 5-3 lists potential errors associated with installation configuration, functionality affected, and the solutions.

Table 5-3. Potential errors – incorrect or modified installation configuration.

Error Description	Functionality Affected	Solution
file path is not valid (where *file path* is *<path of Excel workbook>* \dist\cumimptools\cumimptools.exe)	All	Check that workbook is in same base directory as the dist sub-folder. If in same base directory, it is recommended that the application files be re-installed.
Failed to execute script… error message box (Typically caused by missing or corrupted files in the "dist" sub-directory)	All	Re-install application files.

6. Brazos River Basin demonstration study

This section describes the hydrologic effects on streamflows in the Brazos River Basin for recommended WMS presented in the 2021 Region O, Brazos G, and Region H Regional Water Plans. It is organized into a methodology section and a synthesis of results section. It is included in this User's Guide as an example for RWPGs to consider when developing the Impacts of Regional Water Plan and Consistency with Protection of Resources (Chapter 6) for a regional water plan utilizing the methodology described in Section 2 and in support of guiding principles described in Texas Administrative Code §358.3(8) for State Water Plan development.

6.1 Methodology

The Brazos River Basin WAM, modified for regional water planning purposes to determine existing supplies (Brazos G WAM), was used to quantify the cumulative effects on Brazos River Basin streamflows due to the implementation of surface water strategies recommended in the following three regional water plans through the year 2070:

- 2021 Region O Water Plan
- 2021 Brazos G Water Plan
- 2021 Region H Water Plan

The Brazos G Supply WAM, which was approved by the TWDB with hydrologic variances from Run 3, was used as the baseline model for all scenarios. Minor changes were made so that the model would run in the January 2021 version of WRAP. These model changes were made to the *.dat file and are shown in Figure 6-1[8]. The baseline model includes return flows as they were modeled in the 2021 Brazos G Regional Water Plan to develop estimated water supplies.

The Brazos G WAM assumptions include:

- return flows from wastewater treatment plants permitted for at least 1 million gallons per day of annual discharge;
- as-permitted diversions;
- Brazos River Authority (BRA) System Operations Permit;
- e-flow standards adopted by the TCEQ; and
- sediment conditions depending on the decade of analysis.

The decade in which a recommended WMS is scheduled to come online depends on the strategies and projected local and regional needs. The cumulative effects of recommended WMSs on streamflows in the Brazos Basin were analyzed for two future decades:

- 2040 – includes all recommended surface water strategies scheduled to come online by 2040.
- 2070 – includes all recommended surface water strategies scheduled to come online by 2070.

[8] This information would not normally be included in Chapter 6 of a regional water plan, but is included here for completeness.

```
----------------------------Change 1 -----------------------------------------------------------------
**JD    76    1940       1      -1      -1              5              -1
JD    76    1940       1       0       0              5              -1      15
** FNI change to allow more than 12 records on SVSA
----------------------------Change 2 -----------------------------------------------------------------
** (FNI switch order of use_drop1 and use_drop1_prev to prevent fatal error in Jan 2021 version
of WRAP)
WRBRGM73                       1    8                                  use_drop1  SYSTEM  SYSOPS
TO     13            SET                                    gbpk_gt_max    CONT
TO     13            ADD                                 use_drop1_prev
**     Set to 1 if using 1950s operation scheme
WRBRGM73      1.0  XMONTH      1    8                             use_drop1_prev  SYSTEM  SYSOPS
TO    -13            LIM      0.9                              use_drop1    CONT
TO     13            MUL                                    gbpk_lt_max    CONT
TO     13            MUL                                    rest_lt_max
****    Combine so that this will be greater than 0 when using 1950s drought operating scheme
**WRBRGM73                       1    8                                  use_drop1  SYSTEM
SYSOPS
**TO     13            SET                                    gbpk_gt_max    CONT
**TO     13            ADD                                 use_drop1_prev
**
** (FNI switch order of use_drop2 and use_drop2_prev to prevent fatal error in Jan 2021 version
of WRAP)
WRBRGM73                       1    8                                  use_drop2  SYSTEM  SYSOPS
TO     13            SET                                    start_dr2    CONT
TO     13            ADD                                 use_drop2_prev
WRBRGM73      1.0  XMONTH      1    8                             use_drop2_prev  SYSTEM  SYSOPS
TO    -13            LIM      0.9                              use_drop2    CONT
TO     13            MUL                                    gbpk_lt_max    CONT
TO     13            MUL                                    rest_lt_max
**WRBRGM73                       1    8                                  use_drop2  SYSTEM
SYSOPS
**TO     13            SET                                    start_dr2    CONT
**TO     13            ADD                                 use_drop2_prev
**
----------------------------Change 3 -----------------------------------------------------------------
** FNI change - extend SVSA record for LKWACO (straight line out from last 2 points) to prevent
fatal error in Jan 2021 version of WRAP
**SVLKWACO      0.    216.    371.    804.   1693.   3670.  14027.  28969.  52594.  78971.
144850. 186767.
**SA            0.     26.     39.    110.    174.   1003.   2407.   3567.   4449.   5290.
7169.   8190.
SVLKWACO      0.    216.    371.    804.   1693.   3670.  14027.  28969.  52594.  78971. 144850.
186767. 200000.
SA            0.     26.     39.    110.    174.   1003.   2407.   3567.   4449.   5290.   7169.
8190.   8512.
----------------------------Change 4 (2070 only) -----------------------------------------------------
** FNI change - extend SVSA record for ALCOAL (straight line out from last 2 points) to prevent
fatal error in Jan 2021 version of WRAP
**SVALCOAL      0.     62.    200.    400.   2953.   4944.   7777.   8961.  10146.  10739.
11233.  14378.
**SA            0.      5.     30.     74.    315.    450.    586.    641.    696.    723.
752.    880.
SVALCOAL      0.     62.    200.    400.   2953.   4944.   7777.   8961.  10146.  10739.  11233.
14378.  20000.
SA            0.      5.     30.     74.    315.    450.    586.    641.    696.    723.    752.
880.   1109.
```

Figure 6-1. Changes to .DAT file to run in January 2021 release of WRAP.

Cumulative effects were assessed in two planning decades, 2040 and 2070, but this approach could be applied for any selected planning decade to assess the impacts of regional water plans. At a minimum, it is expected that the cumulative effects analysis include all strategies recommended through the last planning decade (2070 in the 2021 plans).

The cumulative effects of the strategies can be quantified by comparing conditions prior to implementation of the plan (Baseline) to conditions with the recommended WMS plan in place (With WMSs). The Brazos G WAM without any of the recommended future water management strategies in place was used to simulate streamflow under baseline conditions. The conditions With WMSs in place start with the baseline Brazos G WAM and add the recommended water management strategies that could measurably affect streamflows. Modeling scenarios included a Baseline model and an 'With WMSs' model for each of two planning decades investigated, 2040 and 2070 (Table 6-1). Water management strategies from all three regions were included in a single 'With WMSs' model to reflect the cumulative impact on the basin for all recommended WMSs located in the Brazos Basin.

Table 6-1. Modeling scenarios to assess impacts of surface water strategies.

Scenario name	Modeled water management strategies	Year of reservoir area-capacity curves	Year of reservoir storage capacities	Year of return flows
Baseline_2040	None	2020*	2040	2040
WMS_2040	2020, 2030, and 2040 relevant recommended strategies	2020*	2040	2040
Baseline_2070	None	2070*	2070	2070
WMS_2070	All relevant recommended strategies (2020 – 2070), See Table 6-2	2070*	2070	2070

**Area-capacity curves were not developed for 2040 conditions.*

The recommended WMSs listed in Table 6-2 were incorporated into the With WMSs model for comparing with the Baseline. For this assessment, only recommended WMS affecting surface water were modeled. Recommended strategies not included in the cumulative effects analysis are not expected to significantly impact streamflow. The locations of the recommended water management strategies evaluated using the TWDB CERST are shown in Figure 6-2.

Table 6-2. Recommended water management strategies included in the cumulative effects analysis.

Recommended water management strategy	Year implemented	Regional water planning area
Belton-Stillhouse Pipeline	2030	G
Lake Granger ASR	2030	G
Lake Granger Augmentation	2030	G
Lake Creek Reservoir	2030	G
Turkey Peak Reservoir (Lake Palo Pinto Expansion)	2030	G
Cedar Ridge Reservoir	2030	G
Groesbeck Off-Channel Reservoir	2030	G

Coryell County Off-Channel Reservoir	2030	G
Throckmorton Reservoir	2030	G
Manvel Mustang Bayou Reservoir	2030	H
Jim Bertram Lake 7	2040	O
Lake Georgetown ASR	2040	G
Allens Creek Reservoir	2040	H
Lake Whitney Reallocation	2050	G
Lake Aquilla Reallocation	2060	G

Strategies that use permitted water supplies were not reflected in the 'With WMSs' scenarios because the associated water rights for these strategies are already reflected in the Baseline WAM. BRA System Operations, Brushy Creek Reservoir, and Bosque County Regional Project (Clifton Reservoir Enlargement) are already permitted and included in the Brazos G WAM. So, although these projects are recommended water management strategies in the 2021 Plans, they are already included in the baseline conditions runs. The proposed Allens Creek Reservoir has also already been permitted but is <u>not</u> included in the baseline run. The Manvel Mustang Bayou Reservoir WMS is located in the San Jacinto-Brazos Coastal Basin and does not impact flows in the Brazos River Basin, and for this reason is not included in either Baseline or With WMSs models.

The WRAP software is used to execute the WAM. Within the WRAP input files, water right records were revised or added to the .DAT files to model the recommended WMSs presented in Table 6-2. Some strategies also required creation of new control points in the WAM, which required updates to both the .DAT and .DIS input files. No changes were made to the .EVA, .FLO, or .HIS input files. The .EVA, .FLO, and .HIS files represent a period of hydrology from 1940 through 2015 and were adapted from a recent drought study conducted by the BRA. Flows from 1998-2015 should be considered "semi-naturalized" because they only include adjustments for reservoirs with over 10,000 acft of permitted storage, diversions from water rights permitted for more than 1,000 acft per year, and return flows from wastewater treatment plants permitted for more the 2 million gallons per day. These are the same hydrology input files used to determine supplies in the 2021 Region O, Brazos G, and Region H Plans. Changes for each With WMSs model are described below.

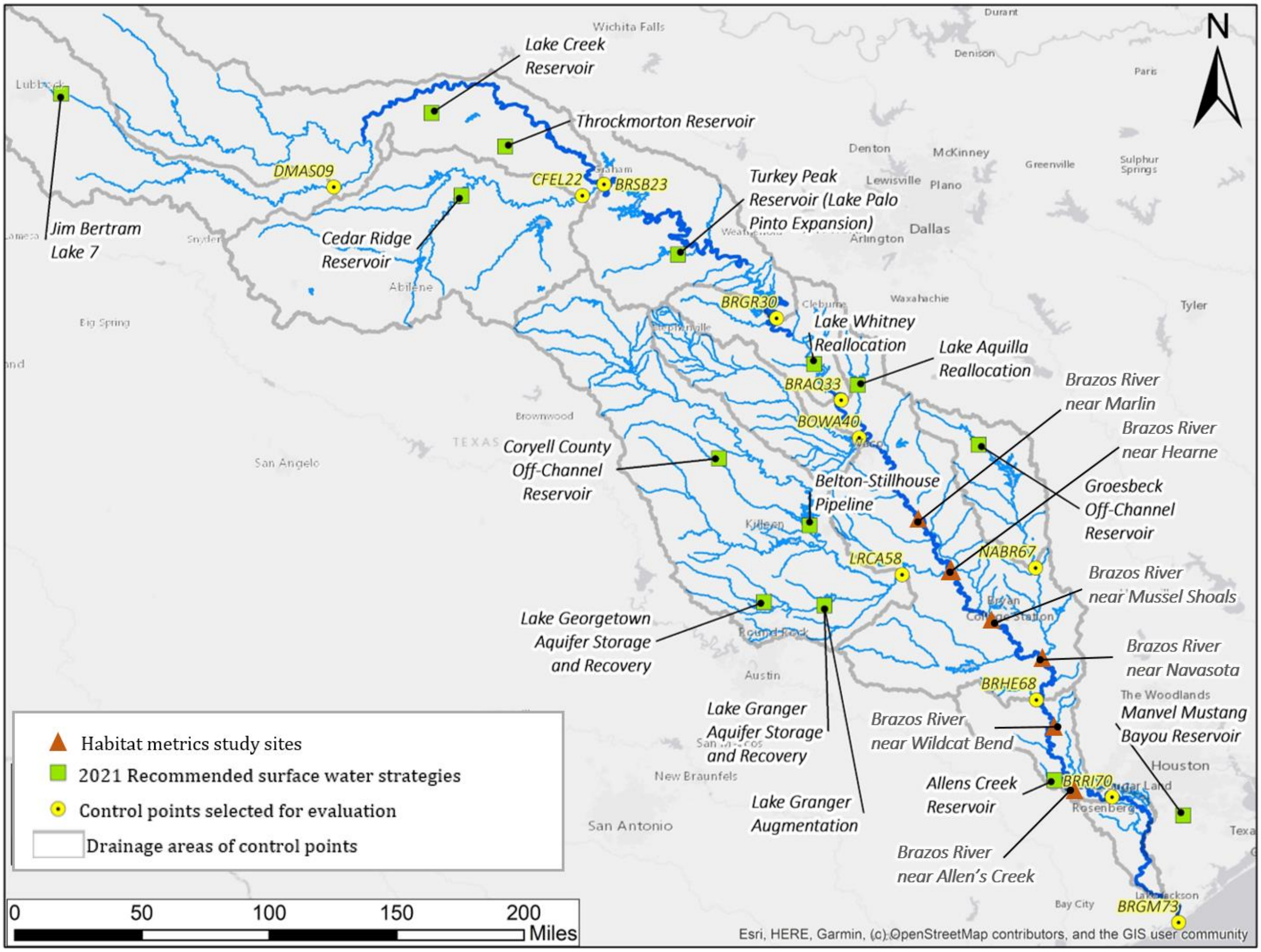


Figure 6-2. Locations of recommended water management strategies and evaluation control points.

6.1.1 *2040 Implemented Plan*

The .DIS file was updated to account for new control points for the following strategies because they each represent a new water right, reservoir, or diversion location and are not included in the WAM maintained by TCEQ. Letters in parentheses indicate the sponsor region of each WMS.

- Jim Bertram Lake 7 (O)
- Lake Creek Reservoir (G)
- Throckmorton Reservoir (G)
- Cedar Ridge Reservoir (G)
- Coryell County Off-Channel Reservoir (G)
- Groesbeck Off-Channel Reservoir (G)
- Manvel Mustang Bayou Reservoir (H)

The .DAT file was updated to reflect new control points, new water rights, water right amendments, and operational changes (*e.g.* reallocation of flood and/or hydropower storage) that would be required to implement the recommended WMS. Changes also included new or revised area-capacity curves for new reservoirs and reservoir expansion projects. Changes were made based on WAM records that had been developed to model the yield of individual strategies.

6.1.2 *2070 Implemented Plan*

All changes made to model 2020 through 2040 strategies in the WMS_2040 model were maintained in the WMS_2070 model.

The .DAT file was further updated to reflect the two surface water strategies in the Brazos Basin that were recommended for implementation later than 2040: Lake Whitney Reallocation and Lake Aquilla Reallocation.

No additional control points were added for 2050 through 2070 strategies, so no further changes were made to the .DIS file.

6.1.3 *Locations to evaluate cumulative effects*

The cumulative effects of the 2021 Plans on streamflows were evaluated at the eleven locations listed in Table 6-3, and shown in Figure 6-2. Regulated flow is the total flow passing a given control point location after all water rights have appropriated the flows to which they are entitled. The cumulative effects on regulated streamflow of implementing the strategies listed in Table 6-2 were evaluated by comparing streamflow statistics for the Baseline condition to those from the With WMSs condition at the locations listed in Table 6-3.

Table 6-3. Locations for evaluating the effects of recommended strategies on streamflow and inflows to the Brazos River Estuary.

Control point	Description	Regional water planning area
DMAS09	DMF Brazos River near Aspermont	G
CFEL22	Clear Fork Brazos River at Eliasville	G
BRSB23	Brazos River near South Bend	G
BRGR30	Brazos River near Glen Rose	G
BRAQ33	Brazos River near Aquilla	G
BOWA40	Bosque River near Waco	G
LRCA58	Little River near Cameron	G
NRBR67	Navasota River near Bryan	G
BRHE68	Brazos River near Hempstead	H
BRRI70	Brazos River at Richmond	H
BRGM73	Brazos River at Gulf of Mexico	H

Primarily surface water strategies were modeled in this assessment, and some strategies such as aquifer storage and recovery (ASR) which may impact streamflow from a supply source perspective. While it is possible that some groundwater projects may impact surface water availability where surface water-and groundwater interact, those interactions would be difficult to represent in the WAM modeling framework and may require more advanced earth systems modeling to assess. Reuse strategies were also excluded from this analysis. Although the Brazos Basin is modeled with return flows in the regional water plans for Regions O, G, and H, surface water strategies in the RWPs are typically assessed using Run 3 WAMs, which exclude return flows. Additionally, although the Brazos G WAM does include return flows, those return flows are already adjusted (reduced) to account for potential reuse projects.

6.2 Cumulative effects on streamflows of water management strategies recommended in the Brazos River Basin

6.2.1 *Effects on monthly regulated flows*

Most locations exhibit lower median monthly flows with the implementation of the 2021 Plans compared to the baseline condition. This is due primarily to the increased diversions, reservoir storage and evaporative losses associated with the recommended strategies. The locations of control gages is shown in Figure 6-2 to support the discussion below related to cumulative effects of recommended WMS on monthly regulated flows.

The Double Mountain Fork of the Brazos River near Aspermont (DMAS09) control point is the only location investigated where implementation of the 2021 Plans would not decrease the median monthly streamflow relative to the baseline conditions, as shown in Figure 6-3. The only recommended WMS affecting surface water upstream of DMAS09 is Jim Bertram Lake 7 near Lubbock.

At the Clear Fork of the Brazos River at Eliasville (CFEL22) location, the median monthly streamflow would decrease in every month compared to the baseline conditions in both the 2040 and 2070 decades, as shown in Figure 6-4. These reductions are the result of the implementation of the Cedar Ridge Reservoir. The largest change in terms of magnitude would occur in June, while the largest change in terms of percentage would occur in March.

The Brazos River near South Bend (BRSB23) location also shows median monthly streamflow decreasing in every month compared to baseline conditions in both the 2040 and 2070 decades, as shown in Figure 6-5. These reductions are the result of the implementation of the Cedar Ridge, Lake Creek and Throckmorton Reservoirs upstream. The largest percent decreases would occur between March and April in both 2040 and 2070, while the largest absolute decreases would occur between May and June. The streamflow frequency plots in Figure 6-6 show that the overall change to the flow regime would be minor.

The Brazos River near Glen Rose (BRGR30) location shows median monthly streamflow decreasing in every month (except January under 2040 conditions) relative to baseline conditions in both the 2040 and 2070 decades (Figure 6-7). This gage on the main stem of the Brazos River reflects the same impacts from recommended strategies upstream of BRSB23, plus the addition of Turkey Peak Dam (also known as Lake Palo Pinto Enlargement). The scatterplots showing the baseline scenario on the x-axis and the 'With Plan' scenario on the y-axis for 2040 conditions and 2070 conditions show marked changes in flow for individual months due to the implementation of WMSs, with some flows decreasing but others increasing in a given month of the simulation. Figure 6-8 illustrates this for 2070 conditions. In the 2040 decade, the largest decrease in median monthly flows in terms of magnitude would occur in June, while the largest percentage decrease would occur in November. In the 2070 decade, the largest absolute decrease in median monthly flows and the largest percent decrease would both occur in August. The flow frequency curves shown in Figure 6-9 indicate that the highest 25 percent of flows will change little, while lower flows are expected to decrease.

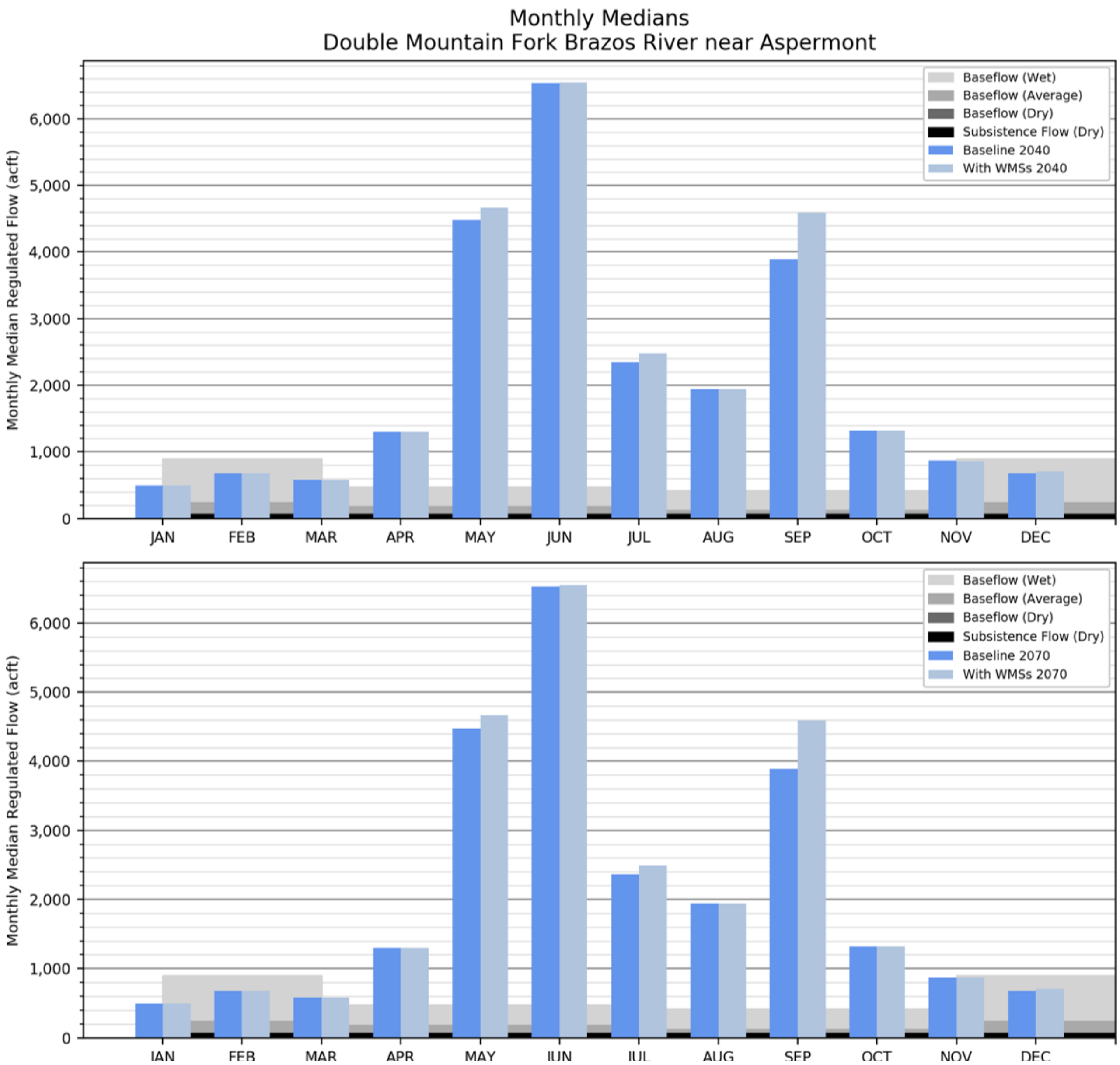


Figure 6-3. Monthly median flows at the Double Mountain Fork of the Brazos River near Aspermont for Year 2040 and Year 2070 conditions for Baseline and With WMSs models.

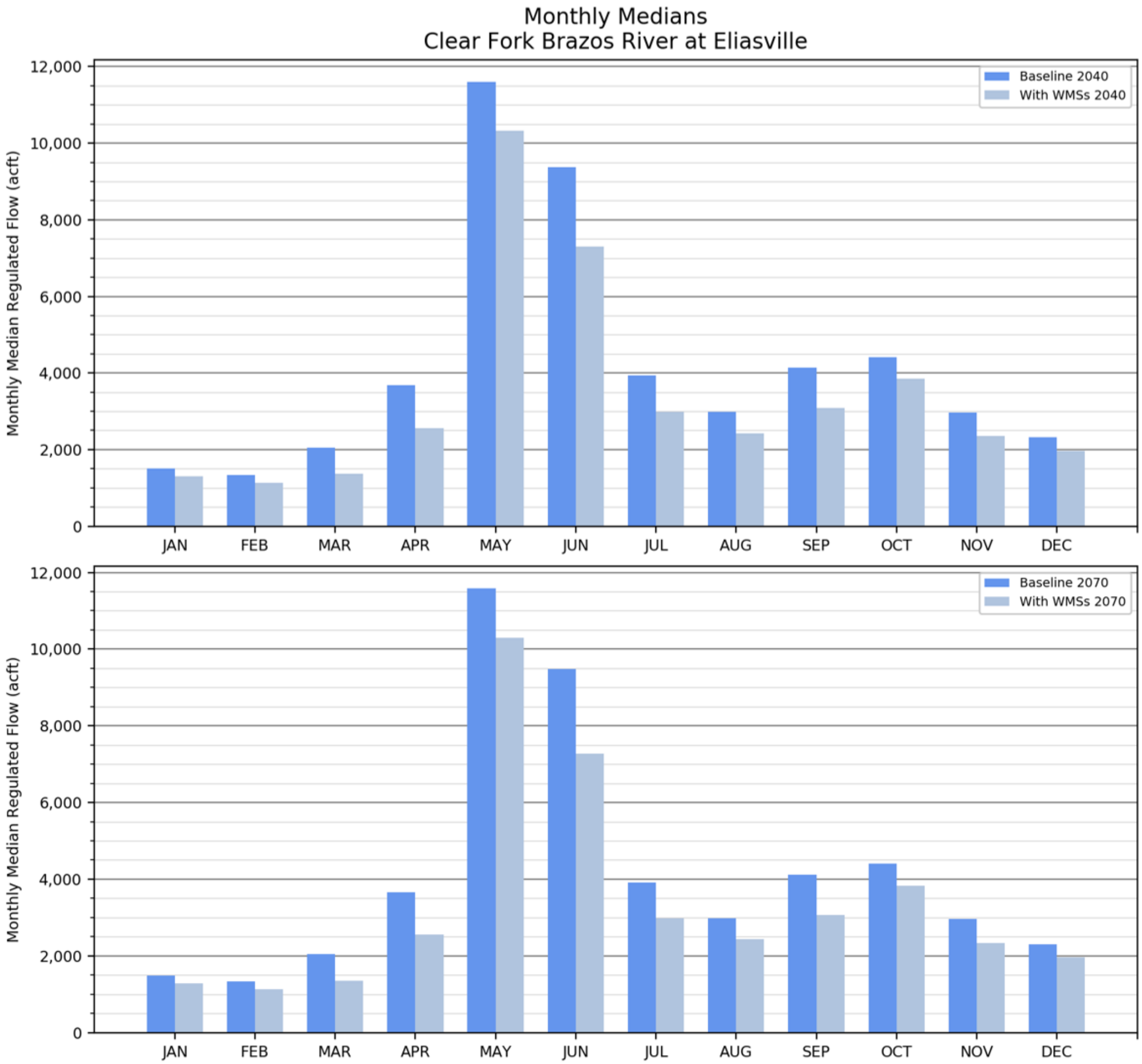


Figure 6-4 Monthly median flows at the Clear Fork of the Brazos River at Eliasville) for Year 2040 and Year 2070 conditions for Baseline and With WMSs models.

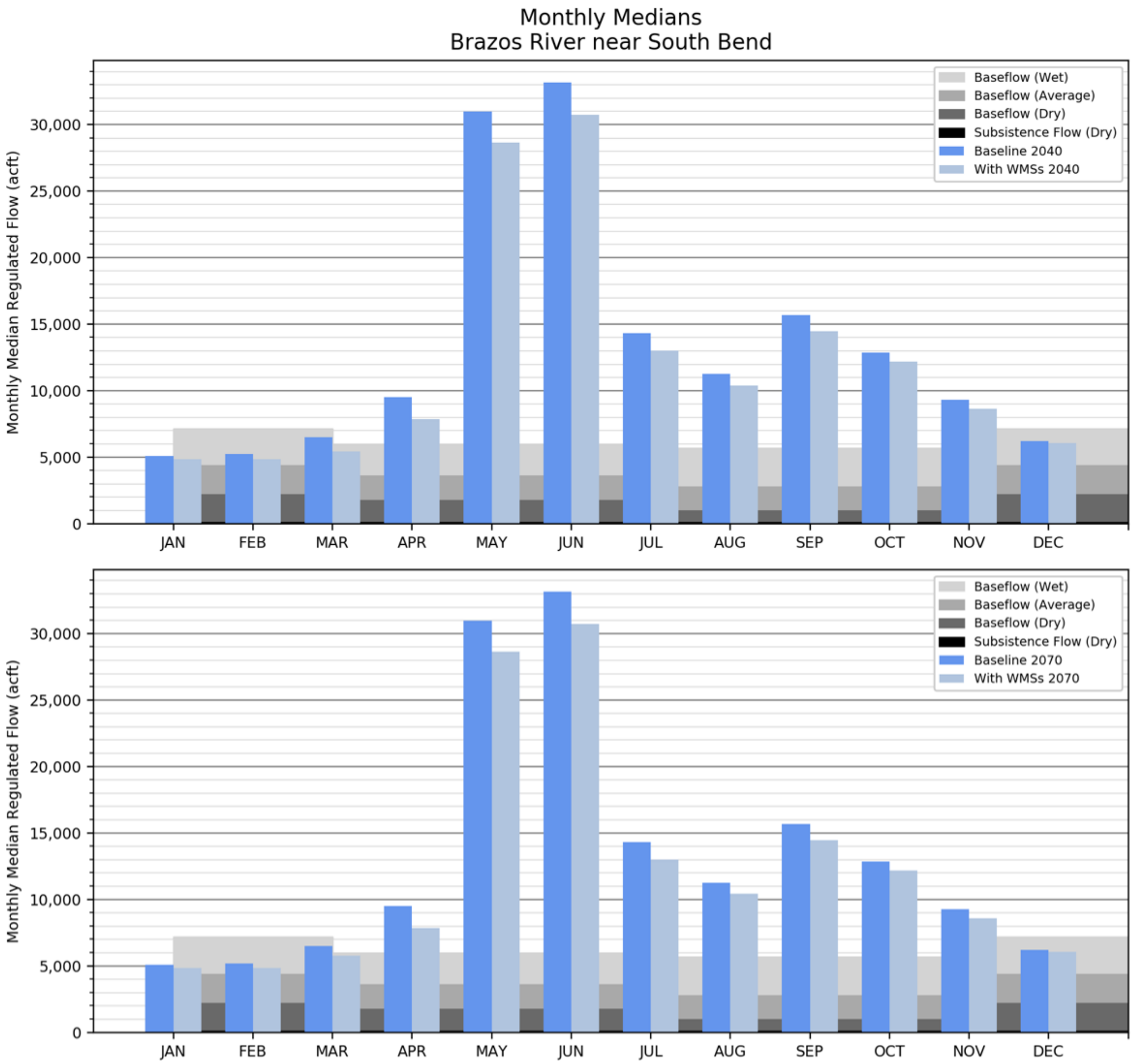


Figure 6-5. Monthly median flows at the Brazos River near South Bend for Year 2040 and Year 2070 conditions for Baseline and With WMSs models.

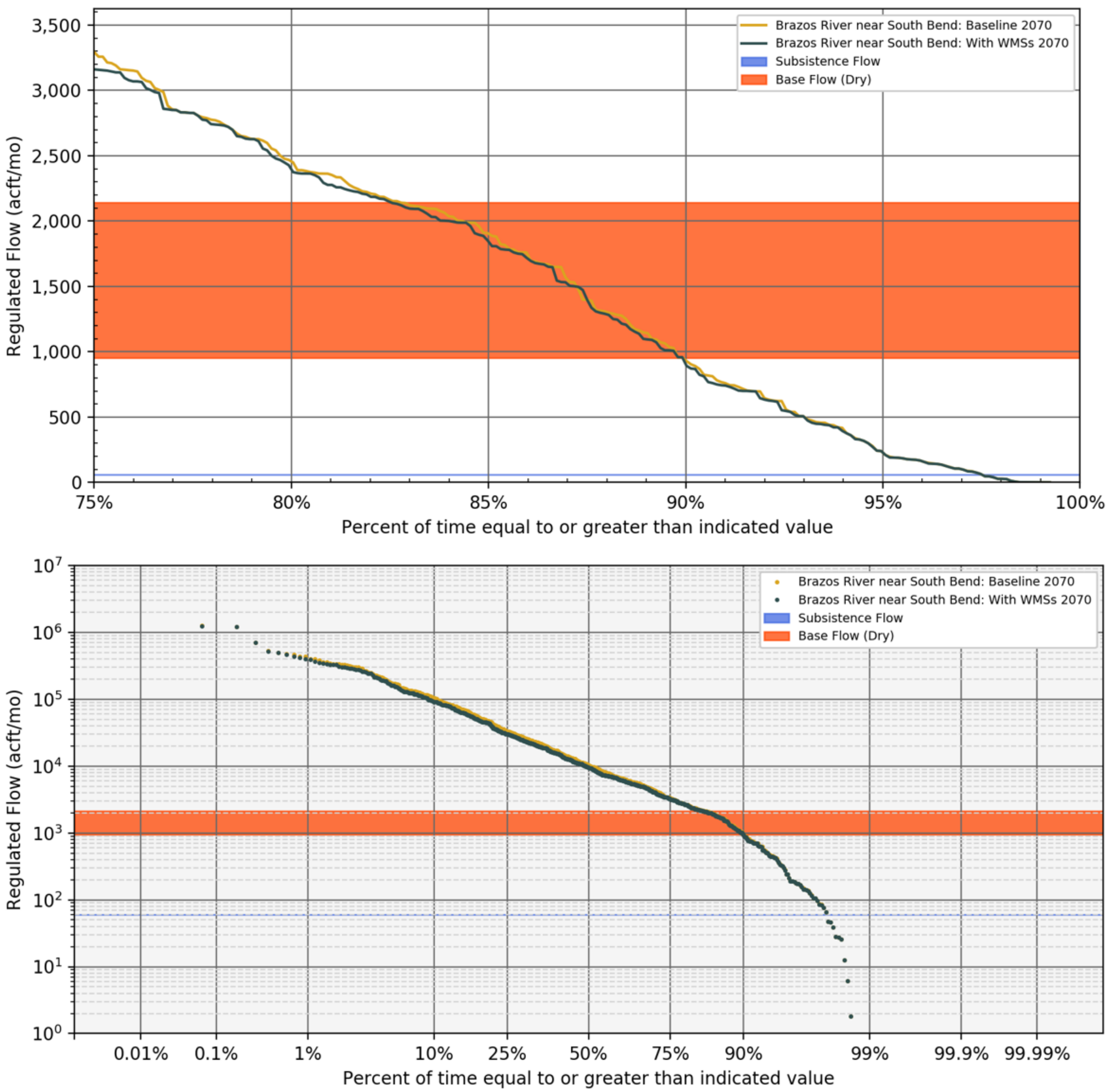


Figure 6-6. Exceedance frequencies of flows at the Brazos River at South Bend for Year 2070 conditions for Baseline and With WMSs models.

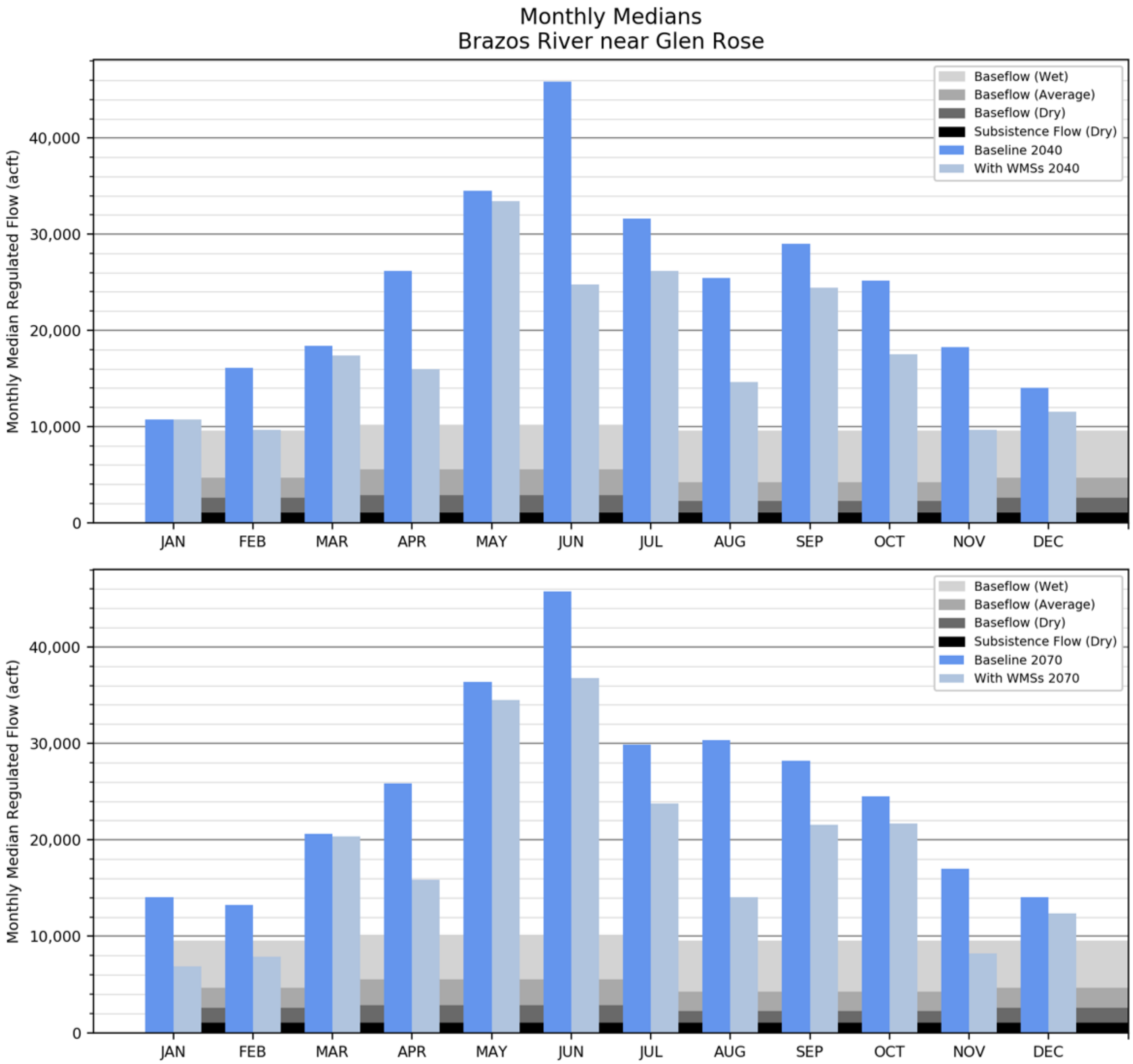


Figure 6-7. Monthly median flows at the Brazos River near Glen Rose for Year 2040 and Year 2070 conditions for Baseline and With WMSs models.

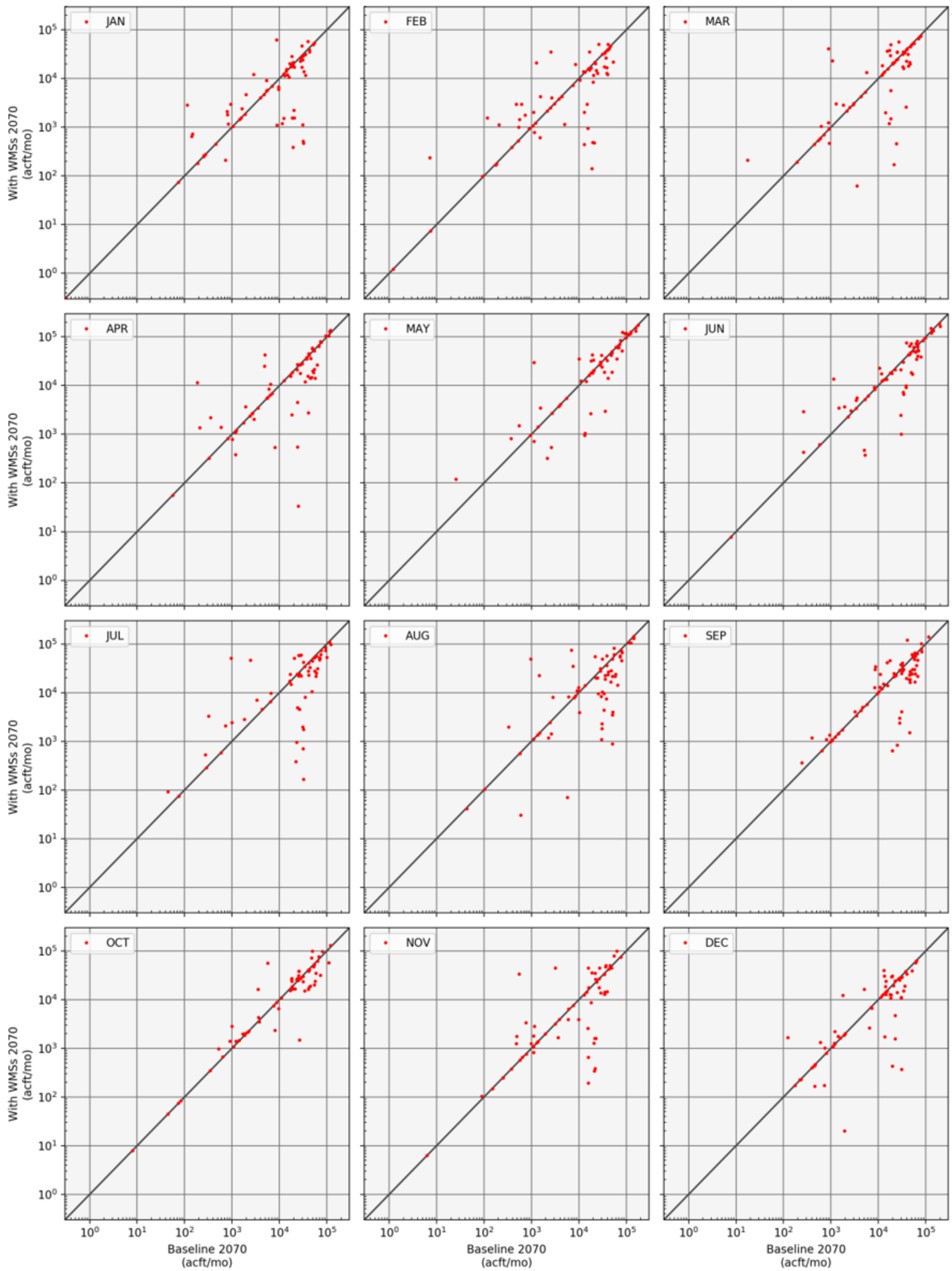


Figure 6-8. Monthly flows, Baseline versus With WMSs at the Brazos River near Glen Rose for Year 2070 conditions.

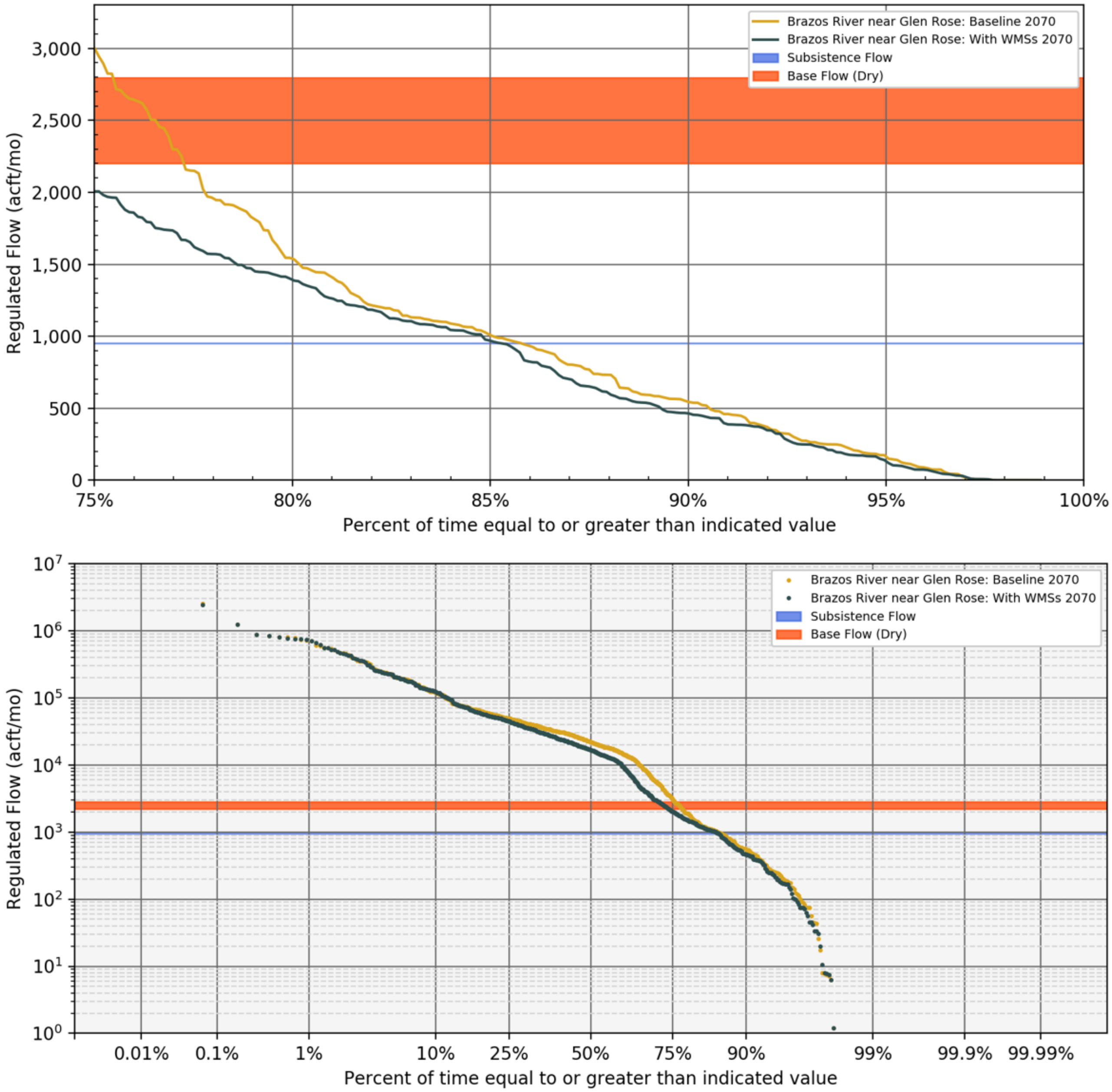


Figure 6-9. Exceedance frequencies of flows at the Brazos River near Glen Rose for Year 2070 conditions for Baseline and With WMSs models.

The Brazos River near Aquilla (BRAQ33) location shows decreases in median streamflow for nine of the twelve months by 2040 (Figure 6-10). The range of differences at this location by 2040 is a 38 percent decrease in February to a 4 percent increase in March. As seen in Figure 6-11, the recommended WMSs upstream of BRAQ33 are not expected to greatly alter the frequency of high and low flows by 2040. However, as shown by Figure 6-12, all flow quantiles including monthly median flow are expected to decrease substantially by 2070 after the implementation of the Lake Whitney reallocation strategy in 2050 and the Lake Aquilla reallocation strategy in 2060.

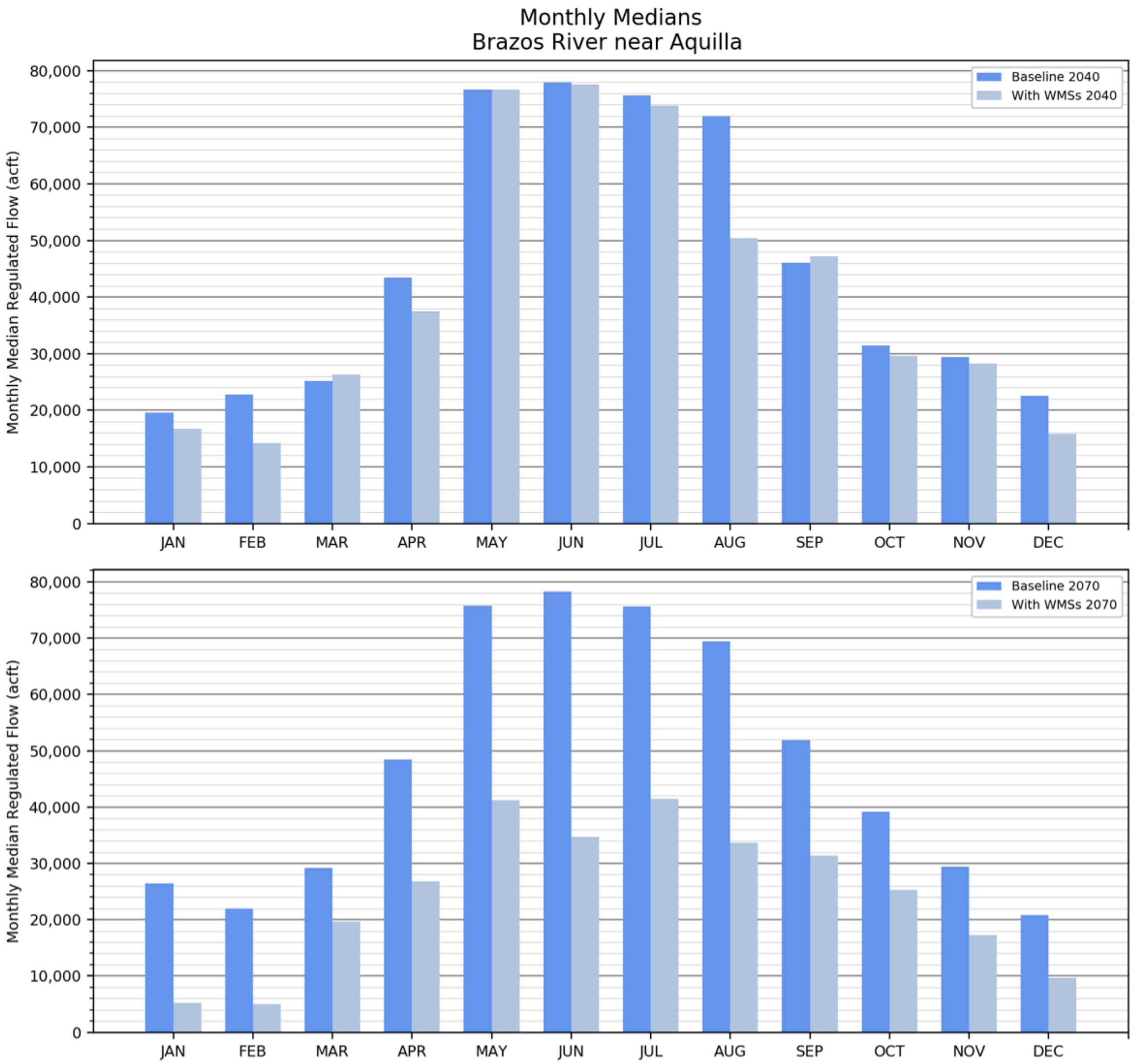


Figure 6-10. Monthly median flows at the Brazos River near Aquilla for Year 2040 and Year 2070 conditions for Baseline and With WMSs models.

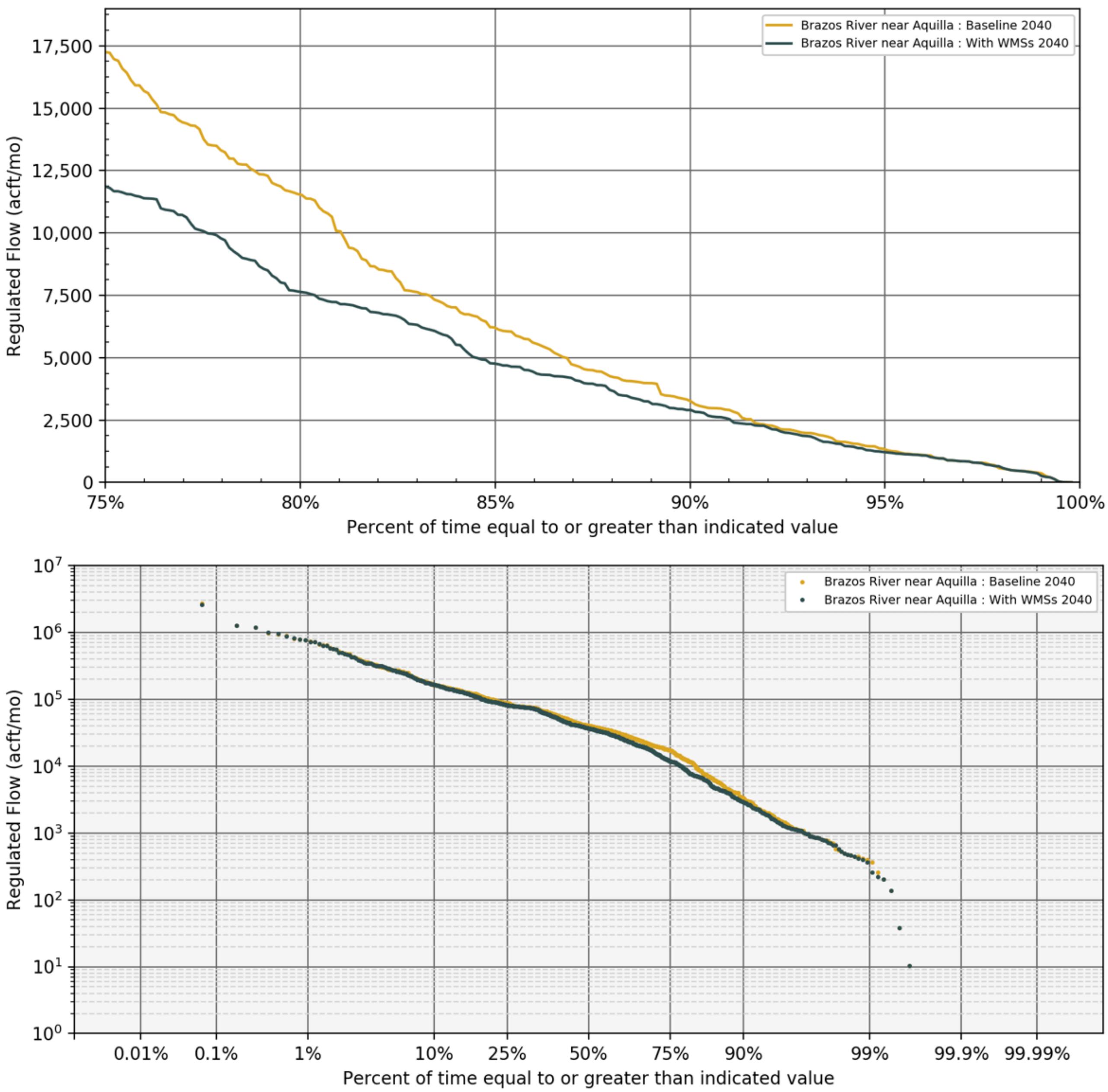


Figure 6-11. Exceedance frequencies of flows at the Brazos River near Aquilla for Year 2040 conditions for Baseline and With WMSs models.

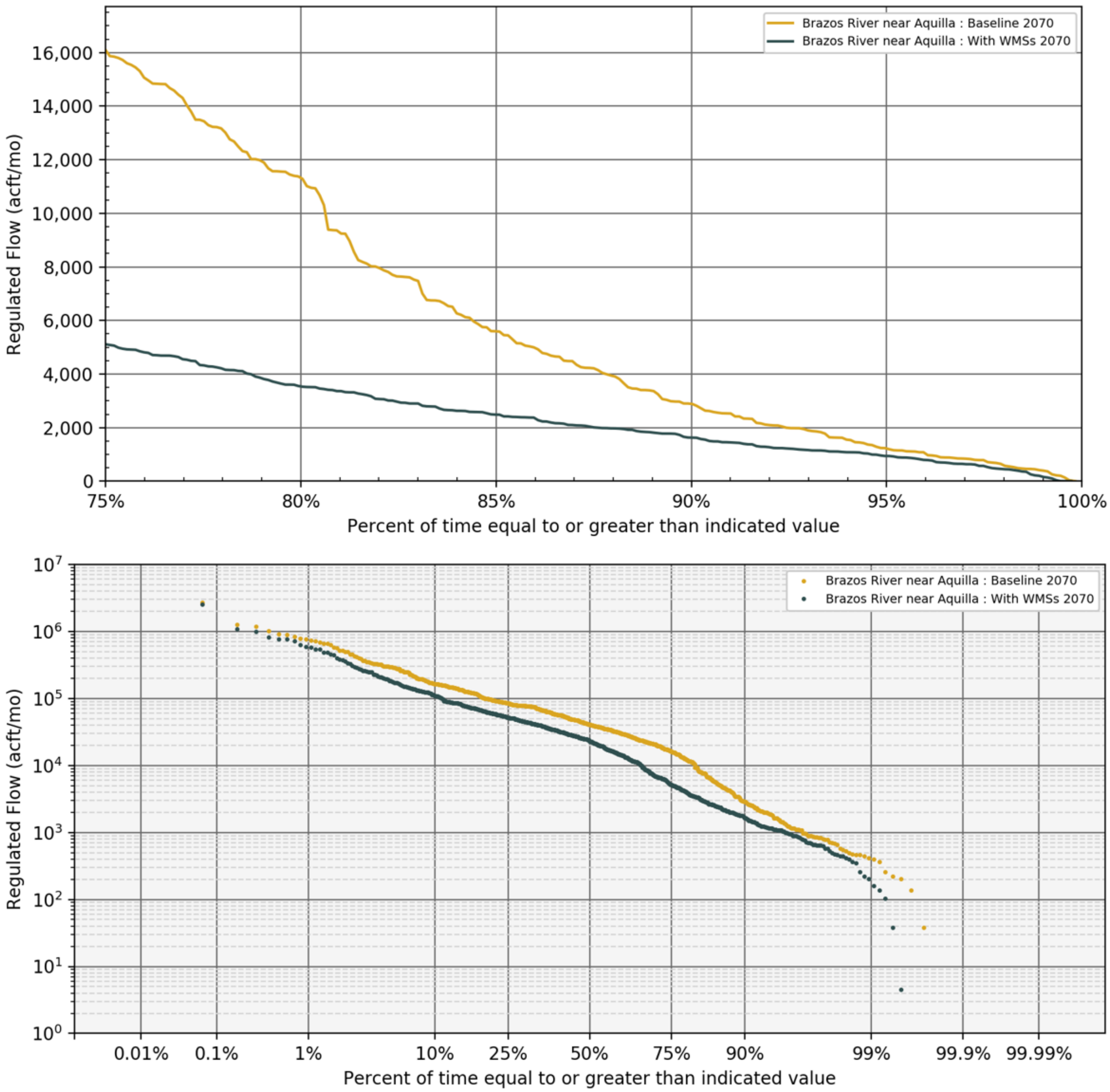
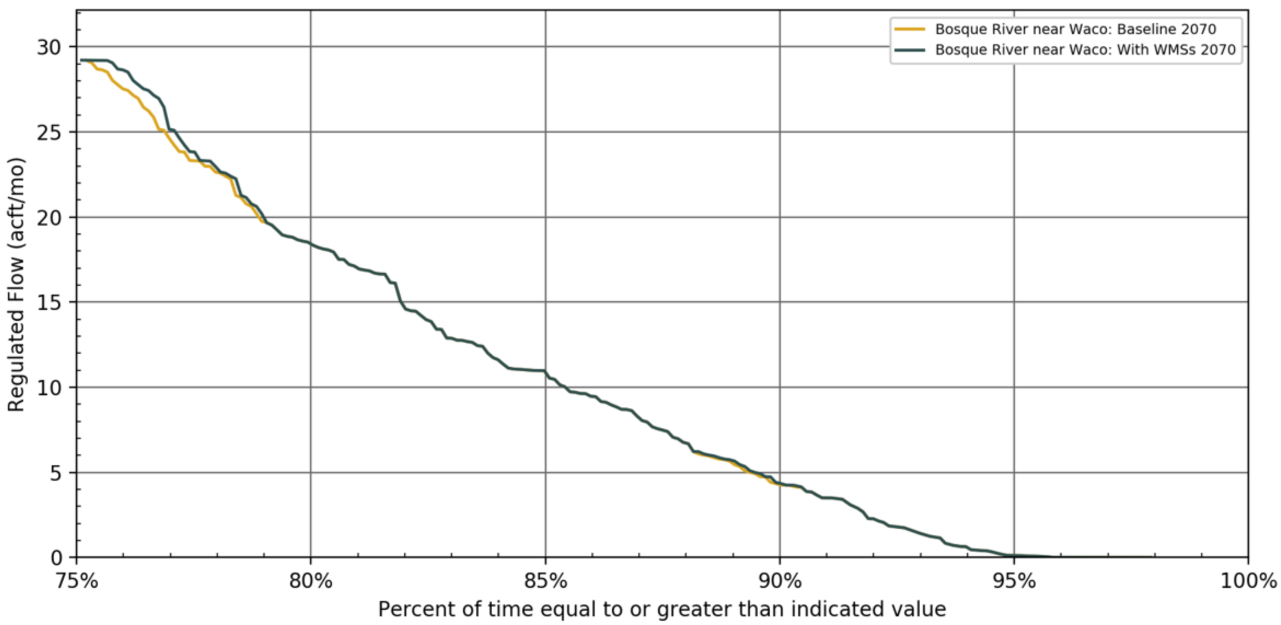


Figure 6-12. Exceedance frequencies of flows at the Brazos River near Aquilla for Year 2070 conditions for Baseline and With WMSs models.

The Bosque River near Waco (BOWA40) location gages a relatively small watershed compared to the other locations investigated in this analysis. Changes in streamflow associated with this location are relatively minor, as can be seen in the flow frequency curves for 2070 conditions in Figure 6-13.



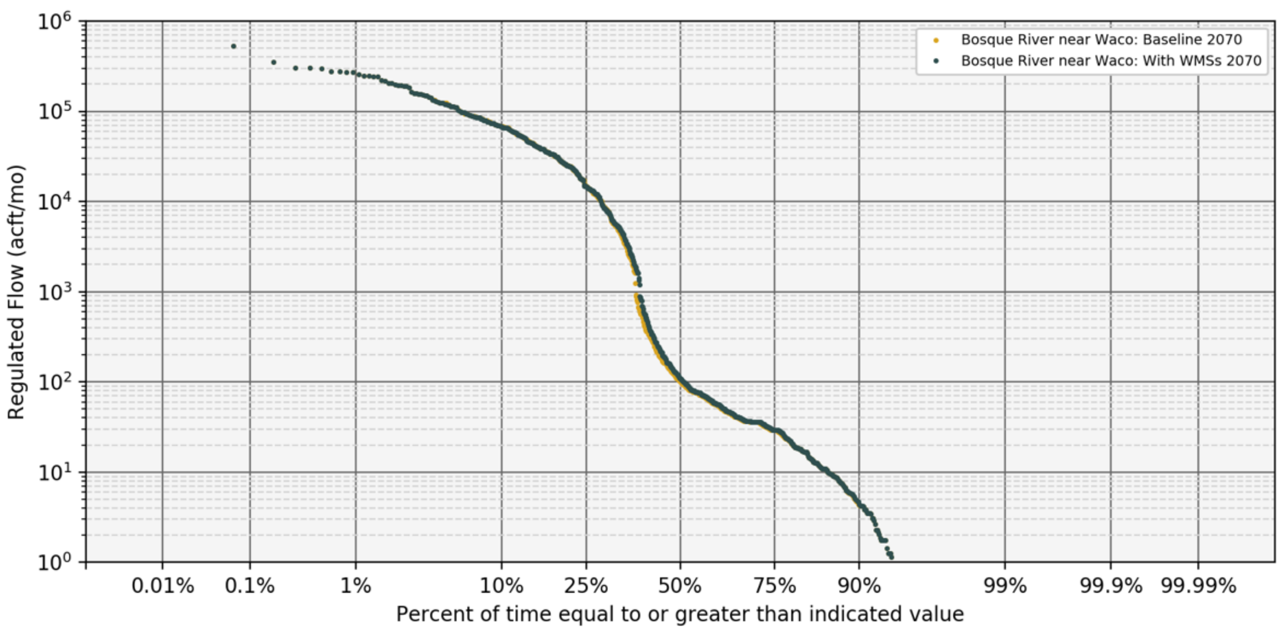


Figure 6-13. Exceedance frequencies of flows at the Bosque River near Waco for Year 2070 conditions for Baseline and With WMSs models.

Regulated flows at the Little River near Cameron (LRCA58) location reflect changes from water management strategies recommended within the Little River watershed, specifically Lake Granger ASR, Lake Granger Augmentation, and Lake Georgetown ASR. The scatterplots for 2040 conditions and 2070 conditions shown in Figure 6-14 are generally similar between the two scenarios, with a few months with much lower flow due to the implementation of the recommended strategies. Those few months with differences tend to occur during periods of moderate flow. While monthly median flows exhibit increases in April for both 2040 and 2070 conditions (Figure 6-15) and decreases in the other months, the overall flow regime is largely unchanged as indicated by the 2070-conditions flow frequency curves in Figure 6-16.

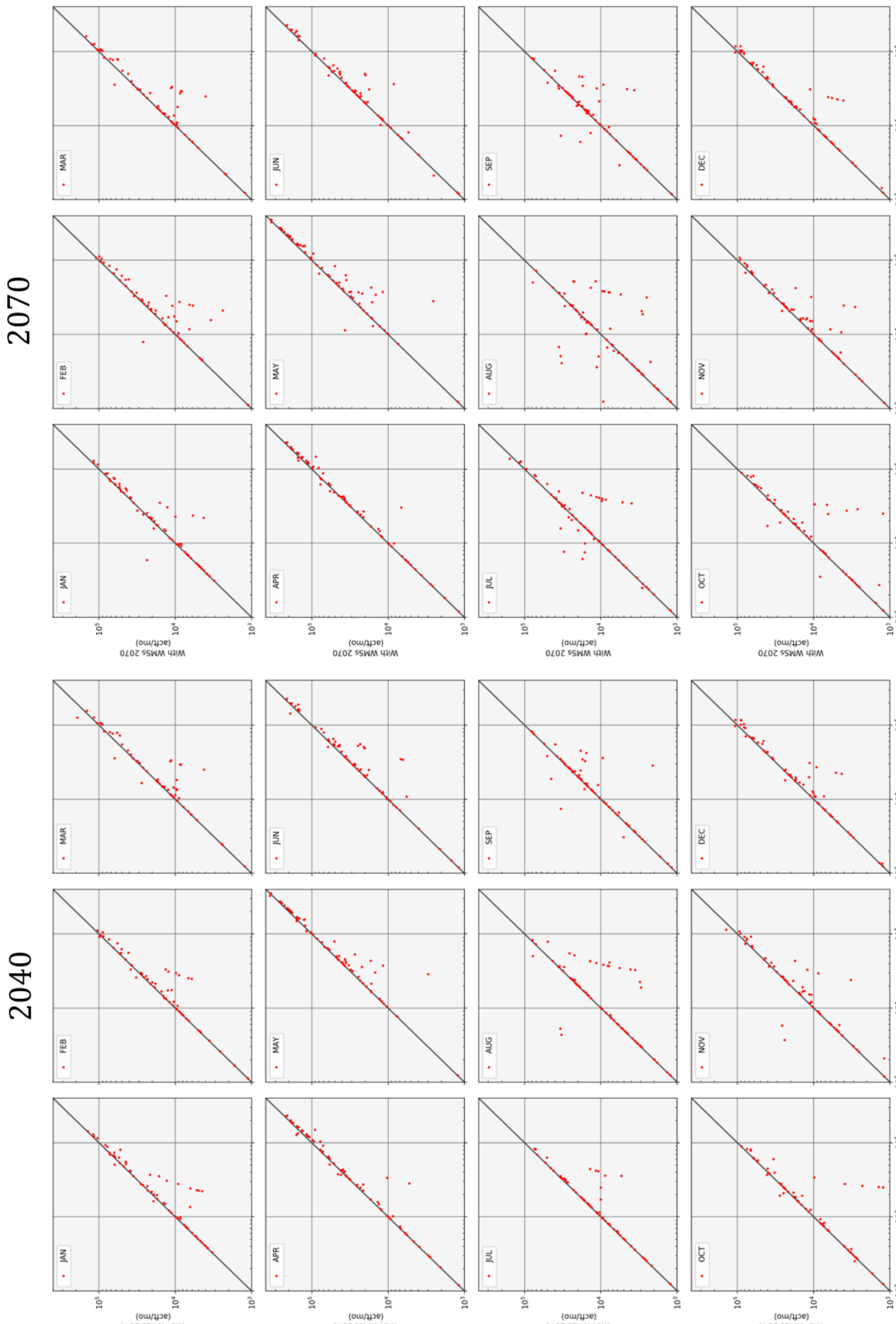


Figure 6-14. Monthly flows, Baseline versus With WMSs at the Little River near Cameron for Year 2040 and Year 2070 conditions.

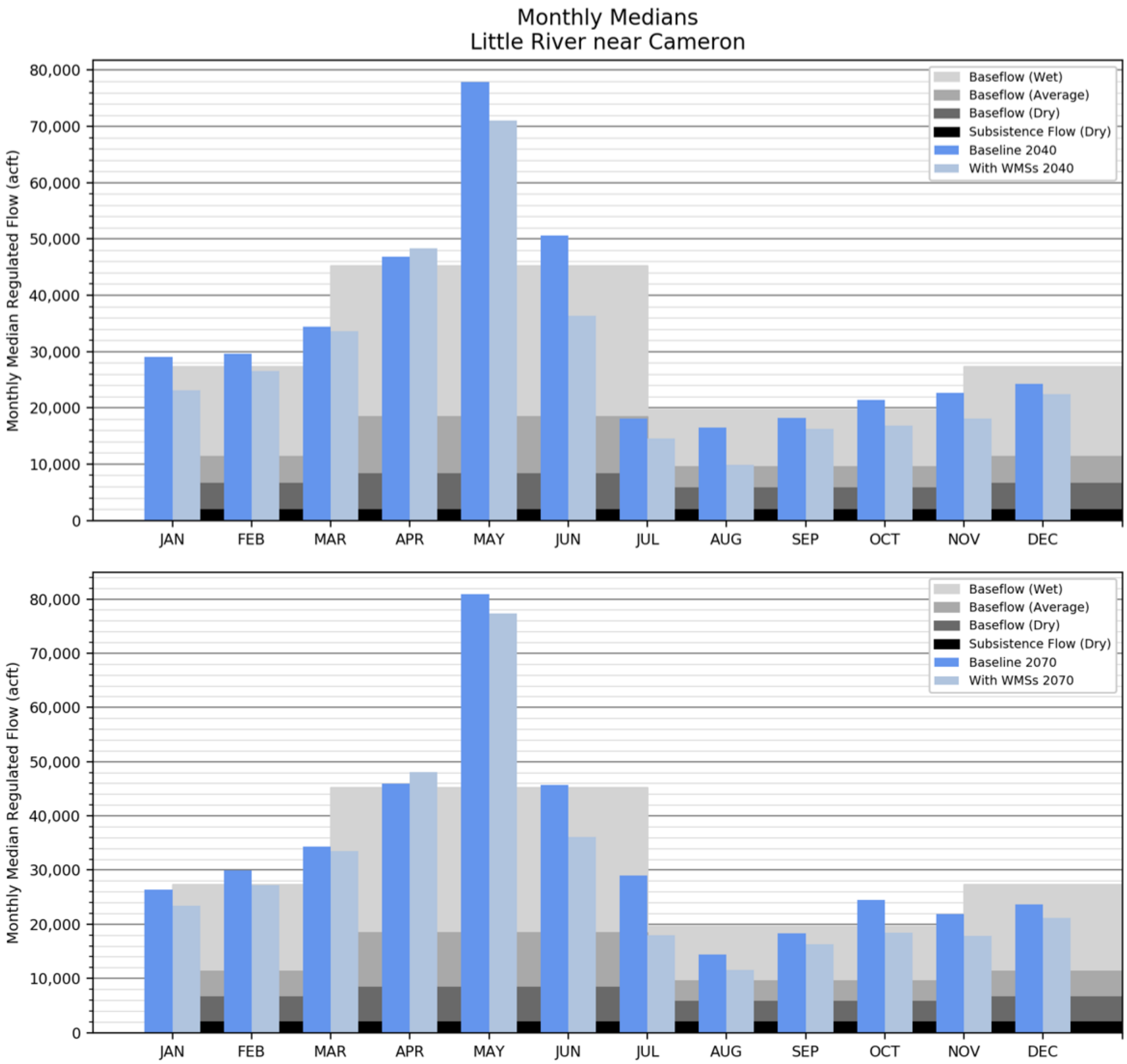


Figure 6-15. Monthly median flows at the Little River near Cameron for Year 2040 and Year 2070 conditions for Baseline and With WMSs models.

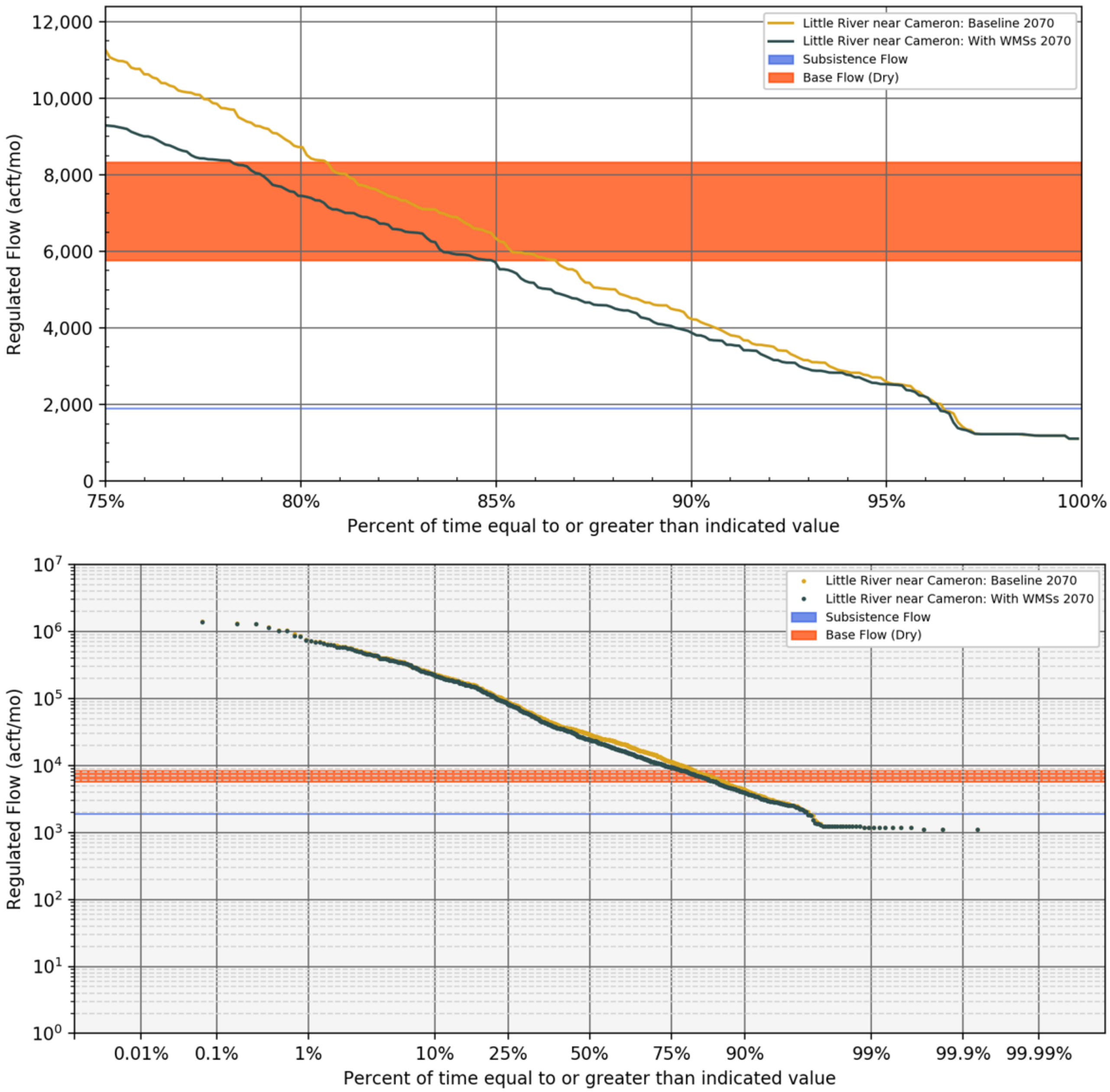


Figure 6-16. Exceedance frequencies of flows at the Little River near Cameron for Year 2070 conditions for Baseline and With WMSs models.

The Navasota River near Bryan (NABR67) location measures streamflow in the Navasota River watershed, a tributary to the Brazos River. The only recommended WMS affecting surface water upstream of NABR67 is the Groesbeck Off-Channel Reservoir, which is scheduled to be implemented by 2030. The scatterplots for 2040 and 2070 conditions in Figure 6-17 indicate changes in flow for individual months due to the implementation of the plans, with some flows decreasing but others increasing in a given month of the simulation. By 2040, median monthly flows are expected to increase slightly in 3 months (February, August, and September) and decrease the other months as shown in Figure 6-18. By 2070, decreases in monthly median flows are expected in all months except August. The flow frequency curves in Figure 6-19 indicate that low flows (*i.e.*, flows exceeded more than 95 percent of the time) are expected to increase considerably.

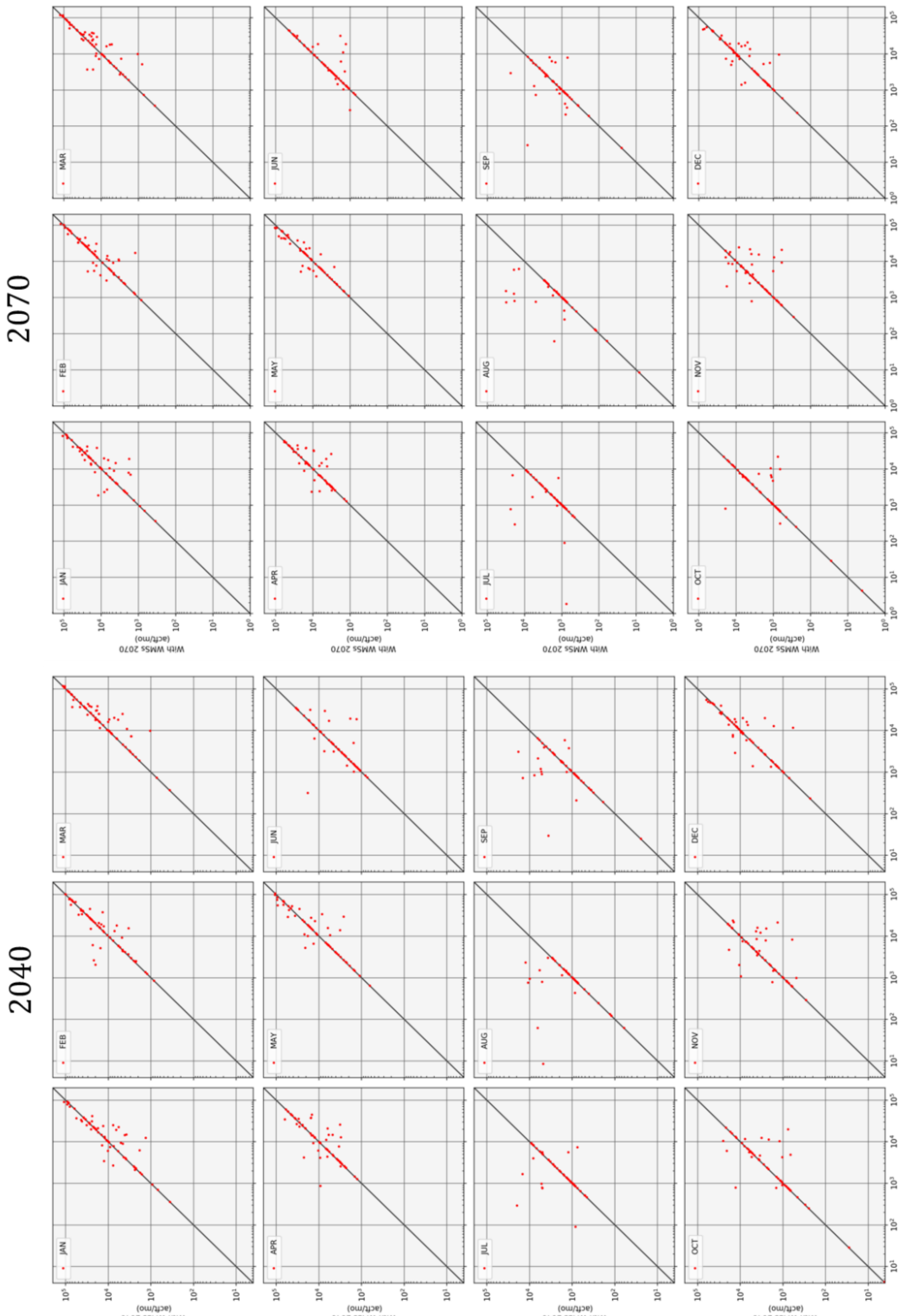


Figure 6-17. Monthly flows, Baseline versus With WMSs at the Navasota River near Bryan for Year 2040 and Year 2070 conditions.

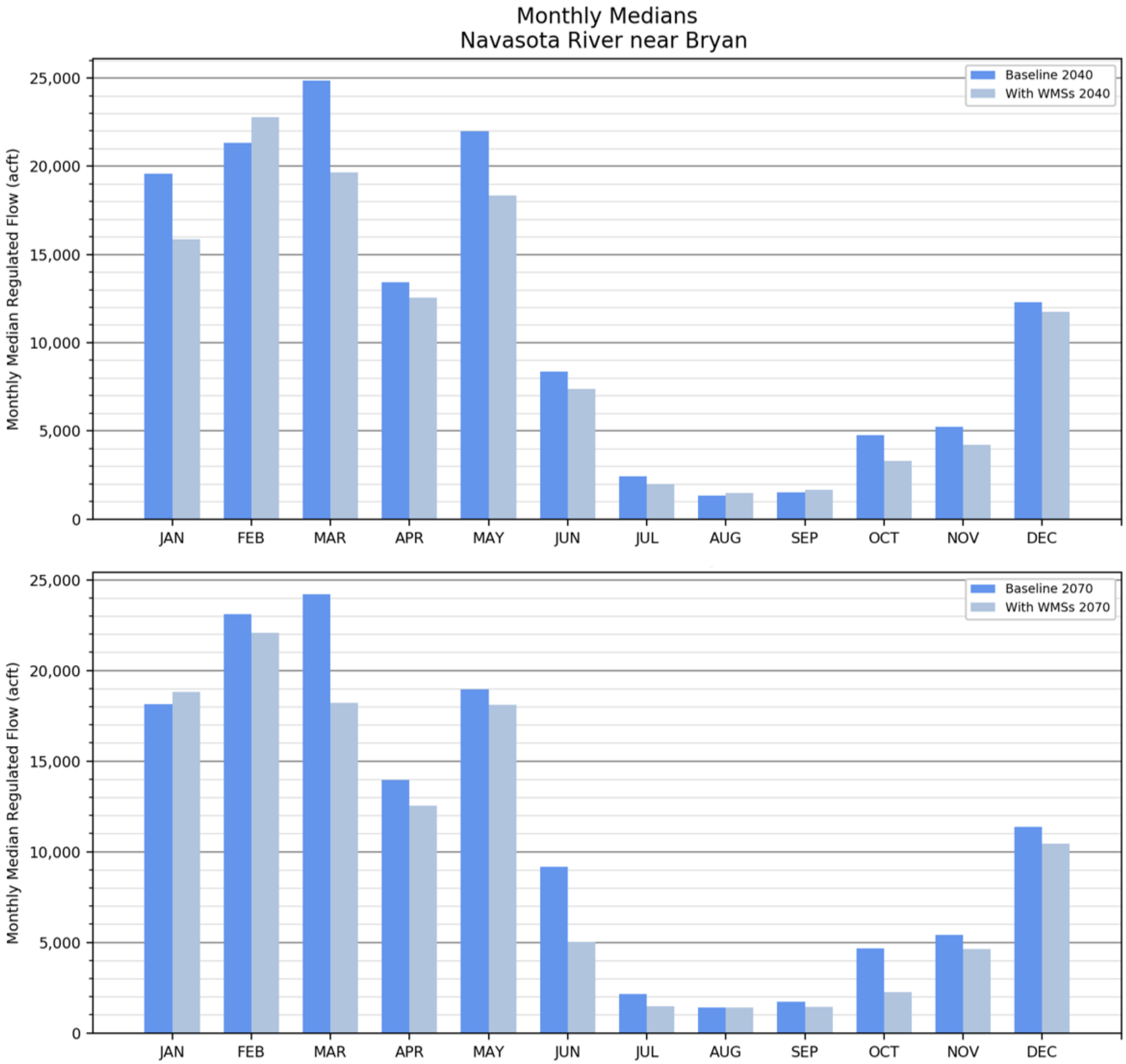


Figure 6-18. Monthly median flows at the Navasota River near Bryan for Year 2040 and Year 2070 conditions for Baseline and With WMSs models.

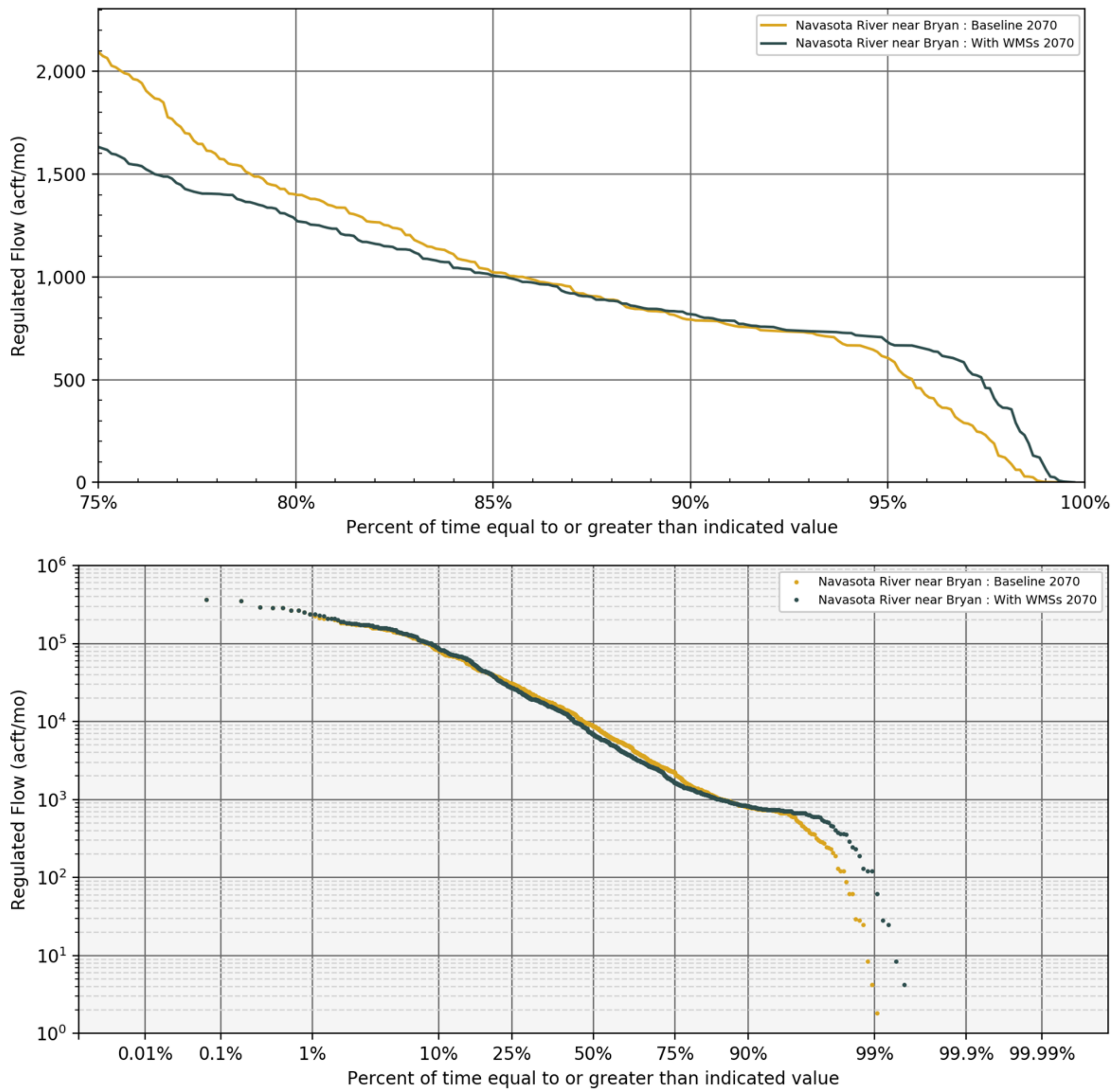


Figure 6-19. Exceedance frequencies of flows at the Navasota River near Bryan for Year 2070 conditions for Baseline and With WMSs models.

The three most downstream locations (Brazos River near Hempstead (BRHE68), Brazos River at Richmond (BRRI70), and Brazos River at the Gulf of Mexico (BRGM73)) are located on the main stem of the Brazos River and the changes in streamflow at these locations show similar patterns. These three points are located in the lower basin and are downstream of all recommended water management strategies, except the Manvel Supply Expansion project which is located in the adjacent coastal basin. These locations have the potential to be impacted by the implementation of any of the recommended strategies upstream. New reservoir and diversion projects will tend to reduce streamflow at these locations, while alterations in BRA System Operations tends to increase streamflows as releases from upstream reservoirs pass these locations to satisfy demands at downstream locations.

Monthly median streamflows will decrease at Hempstead during nine months with decreases as much as 19 percent in 2040 (Figure 6-20). The flow frequency curves at Hempstead in Figure 6-21 indicate that the decreases impact lower flows (*i.e.*, flows exceeded more than 50 percent of the time) under 2070 conditions. However, very low flows (*i.e.*, flows exceeded more than 99 percent of the time) are expected to increase at Hempstead.

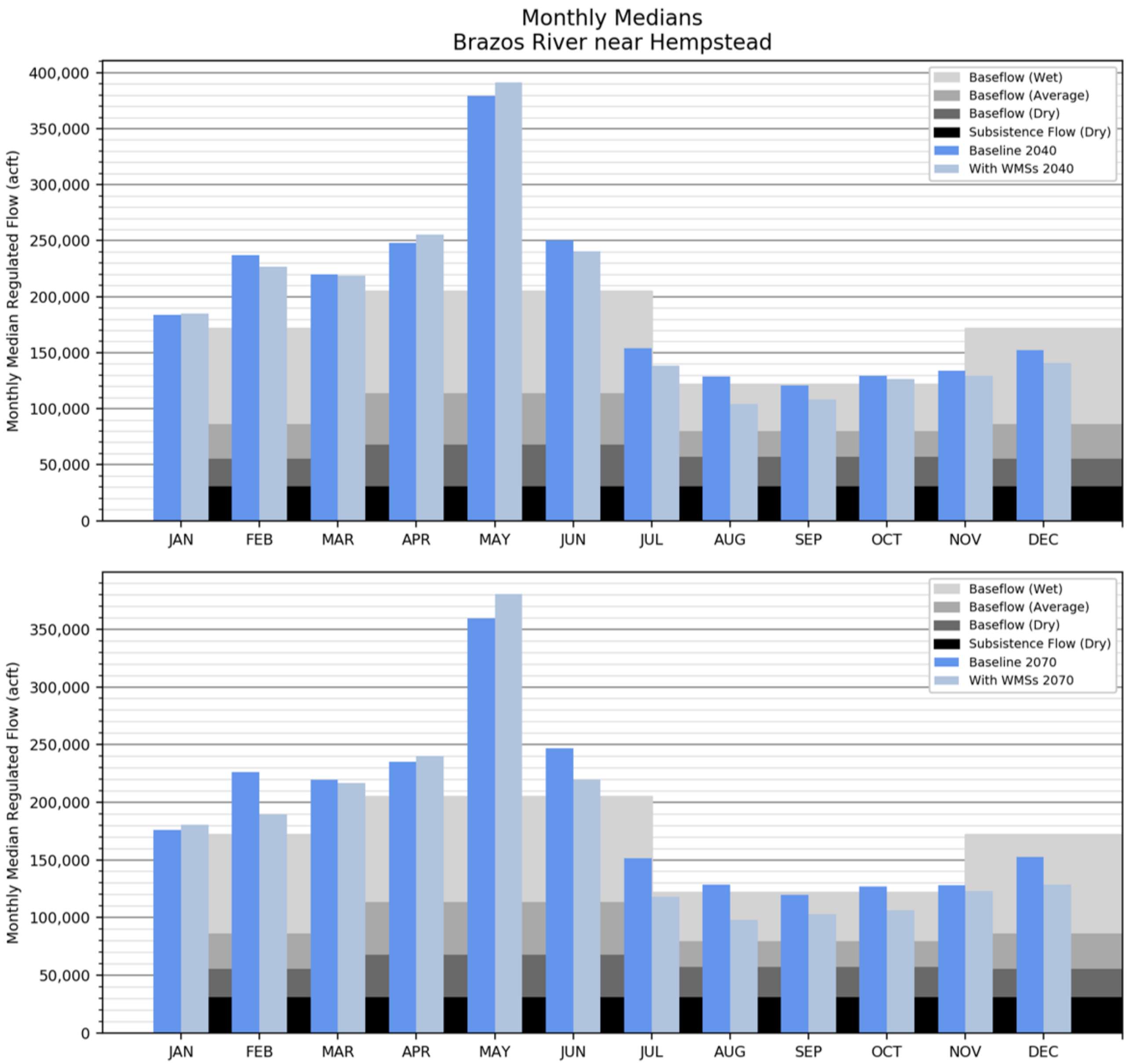


Figure 6-20. Monthly median flows at the Brazos River near Hempstead for Year 2040 and Year 2070 conditions for Baseline and With WMSs models.

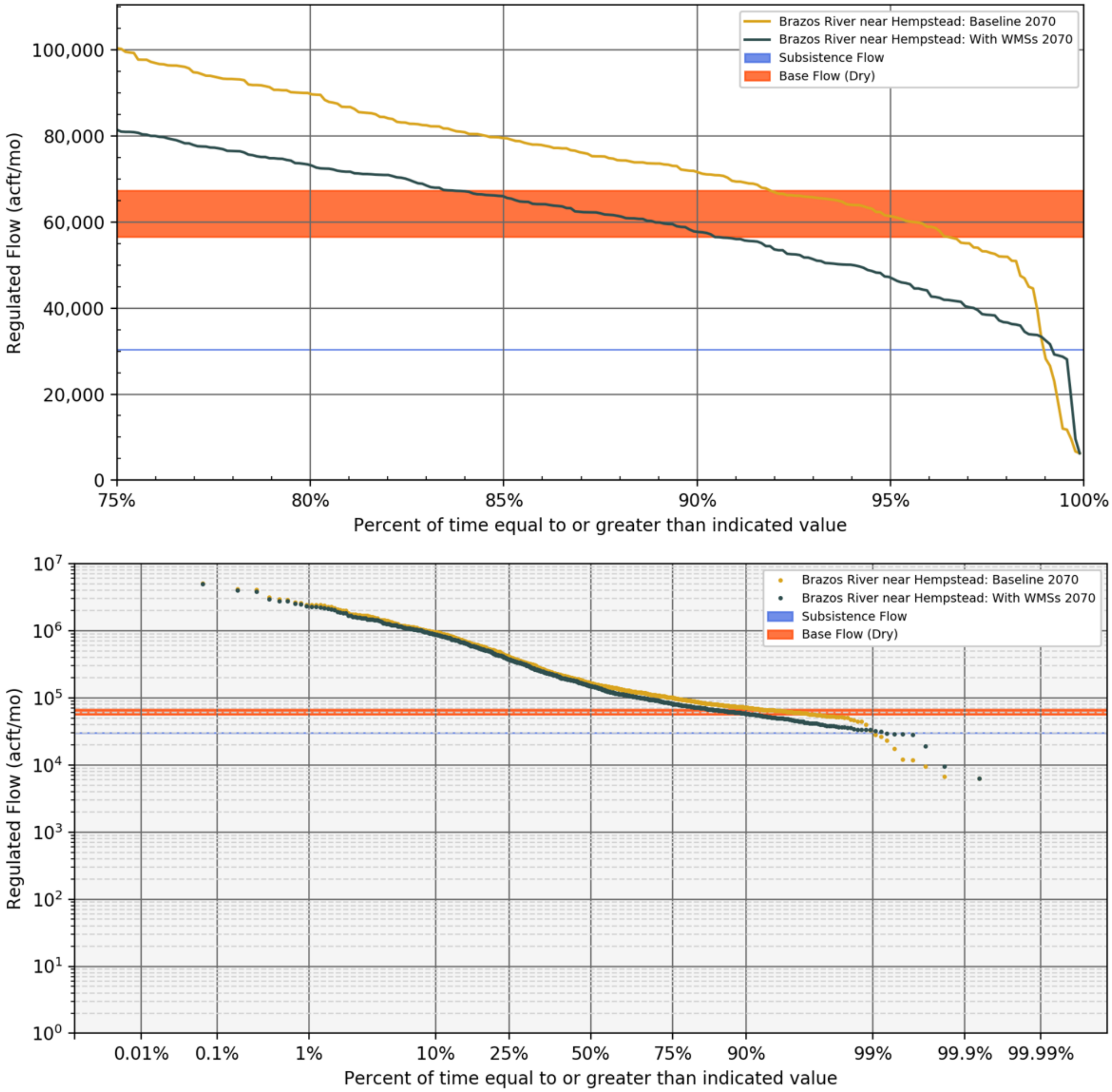


Figure 6-21. Exceedance frequencies of flows at the Brazos River near Hempstead for Year 2070 conditions for Baseline and With WMSs models.

Median flows at Richmond will decrease in all 12 months between Baseline and With WMSs conditions, as shown in Figure 6-22, as well as flows greater than about the 93rd percentile. However, lower flows (94th percentile and smaller) will tend to increase (Figure 6-23) under 2070 With WMSs conditions.

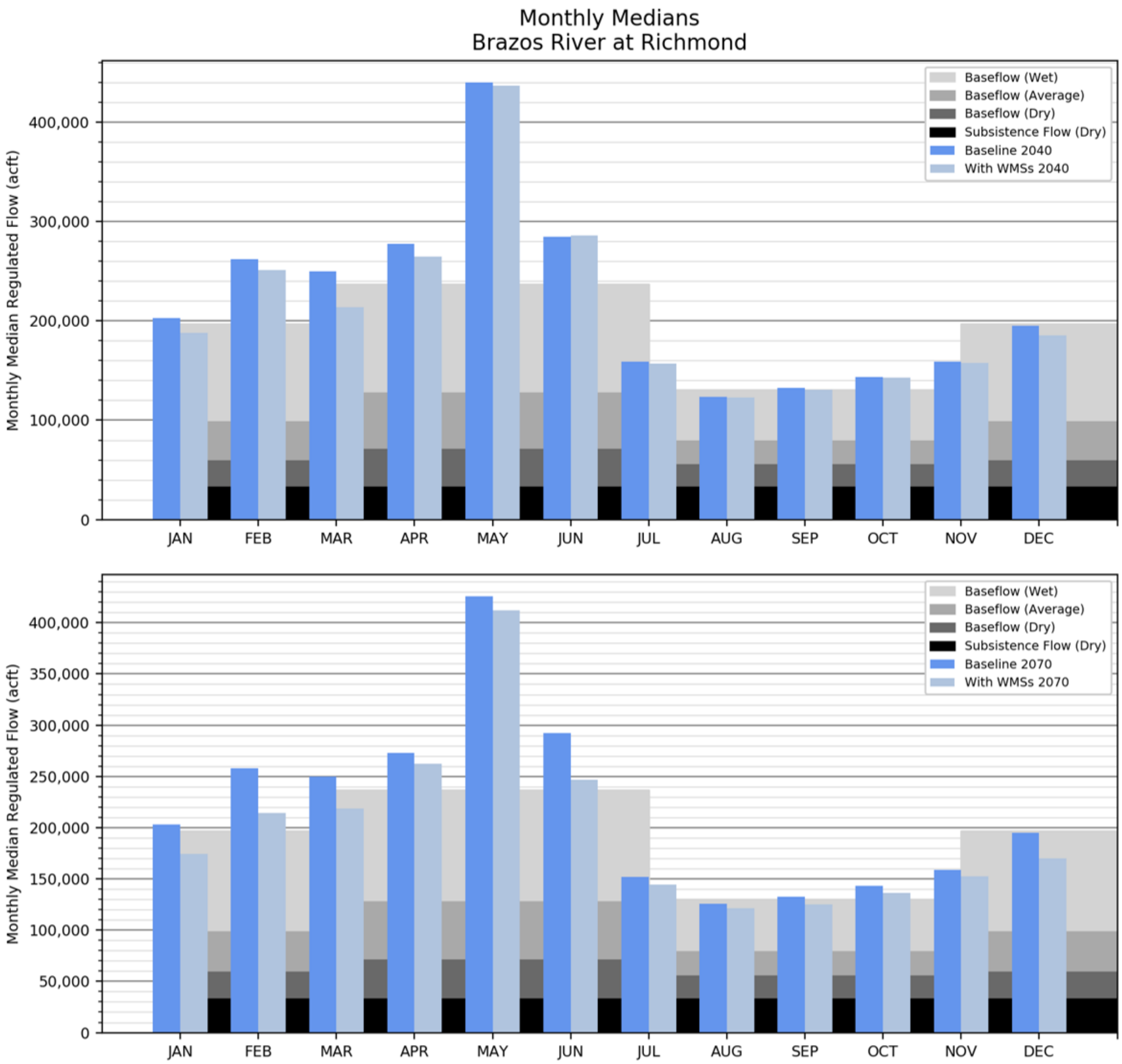


Figure 6-22. Monthly median flows at the Brazos River at Richmond for Year 2040 and Year 2070 conditions for Baseline and With WMSs models.

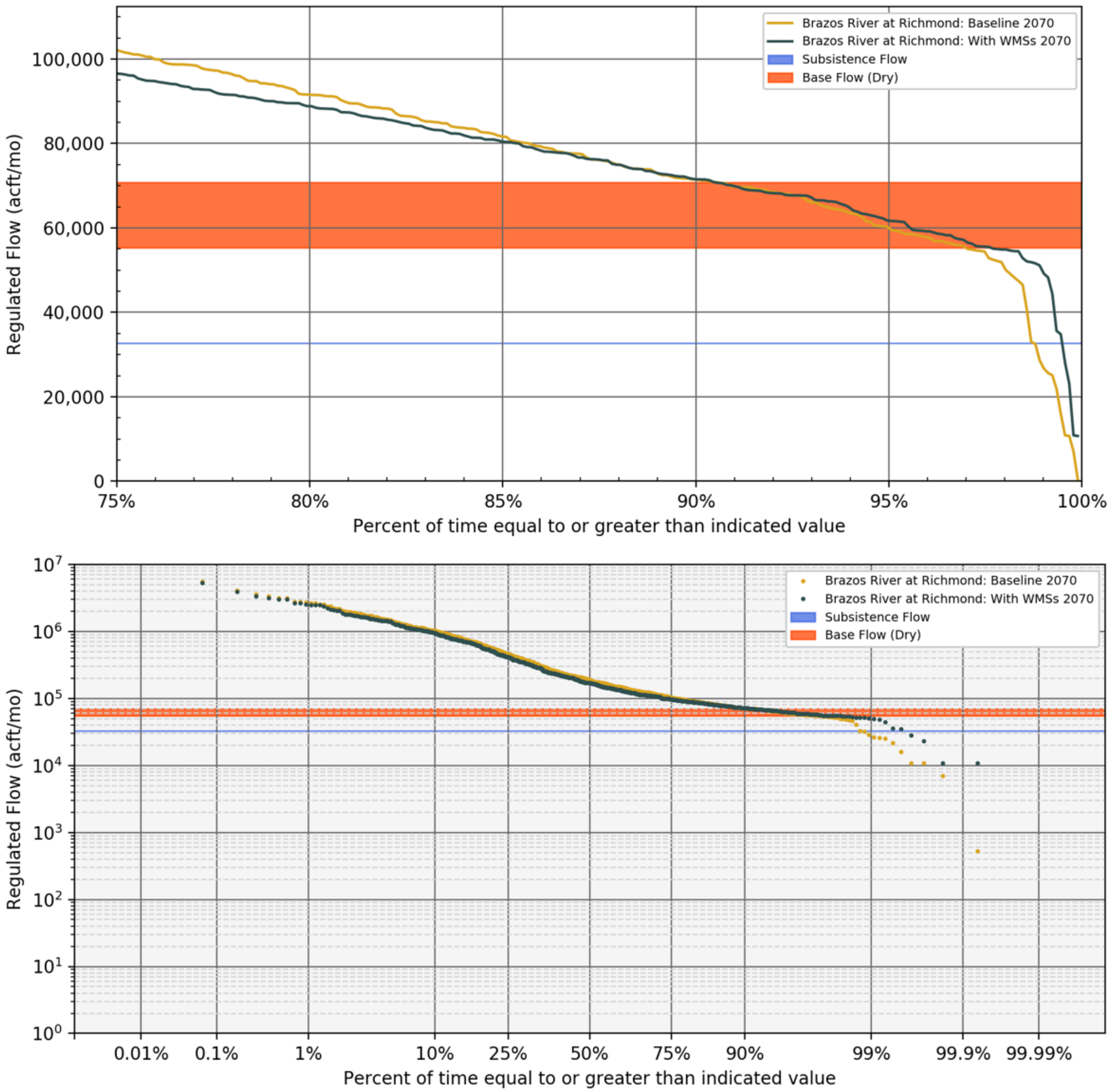


Figure 6-23. Exceedance frequencies of flows at the Brazos River at Richmond for Year 2070 conditions for Baseline and With WMSs models.

The Brazos River at the Gulf of Mexico (BRGM73) is located at the mouth of the river where it drains into the Gulf of Mexico and the Brazos Estuary. Monthly median flows from the Brazos River Basin into the Gulf of Mexico are shown in Figure 6-24. These median flows demonstrate a monthly pattern that differs greatly from the pattern of flows at Richmond. Although Richmond is upstream, flows into the Gulf are much smaller than those at Richmond. Simulated flows to the Gulf being smaller than those at Richmond is counter-intuitive; however, there are many large senior water rights between Richmond and the Gulf. Further, much of the additional yield generated by BRA System Operations is simulated as diversions at the Brazos River at Rosharon gage, which is located between Richmond and the Gulf. These factors will result in flows at Richmond being greater than those downstream flowing into the Gulf of Mexico. The reduction in regulated flows between Richmond and the Gulf of Mexico is not due to implementation of the strategies recommended in the regional water plans, but due to senior water rights utilizing their fully authorized diversions.

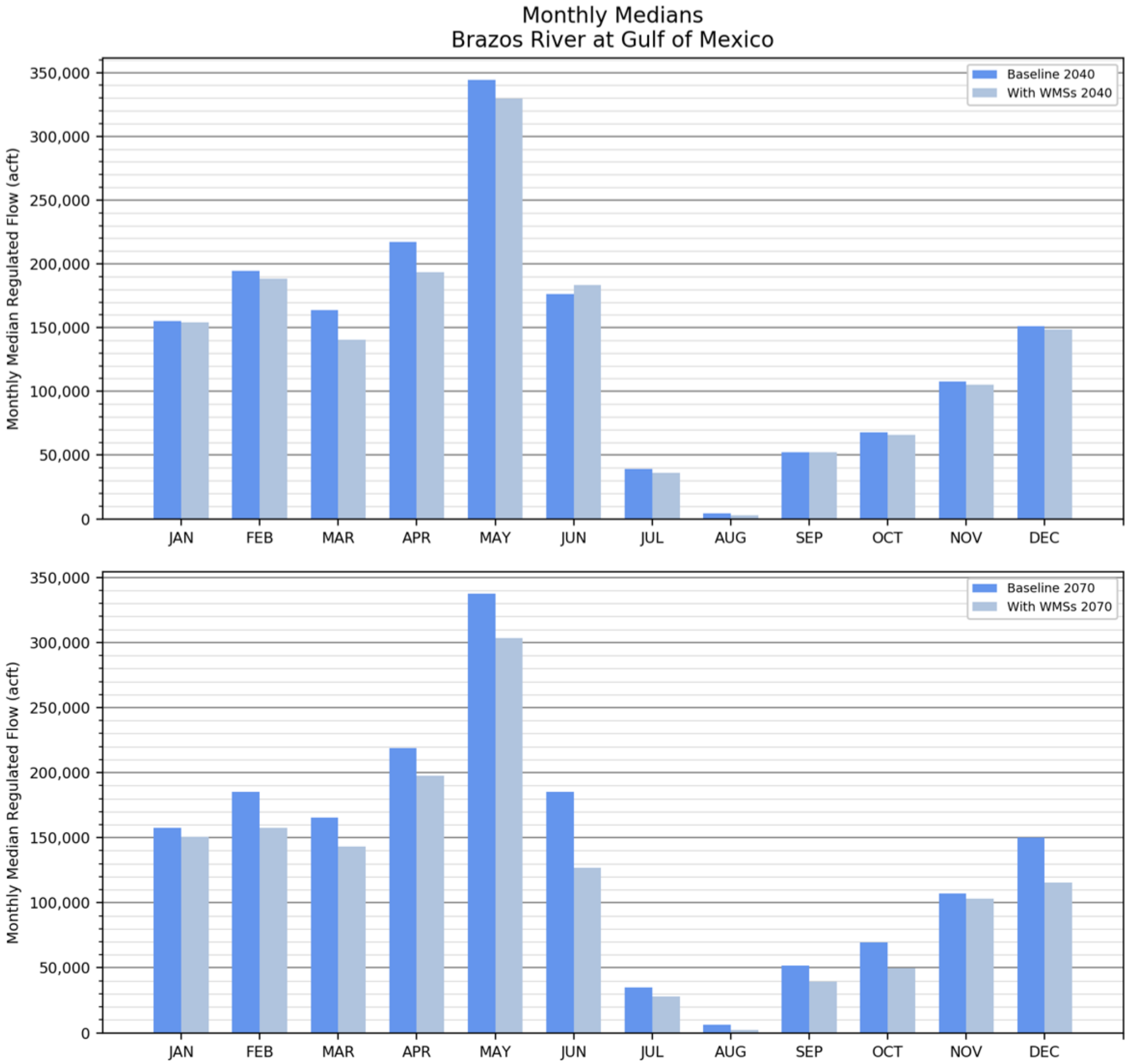


Figure 6-24. Monthly median flows at the Brazos River at the Gulf of Mexico for Year 2040 and Year 2070 conditions for Baseline and With WMSs models.

BRA System Operations operates very differently when Allens Creek Reservoir is part of the system. Allens Creek Reservoir, which is upstream of Richmond, is not included in the Baseline scenario, but is included in the With WMSs scenario. Importantly, Allens Creek Reservoir is senior to, and therefore not subject to, the TCEQ e-flow standards. This contributes to periodic decreases in monthly flows when comparing the With WMSs scenario to the Baseline scenario. Because Allens Creek Reservoir is senior to the TCEQ e-flow standards, it may affect the attainment of the TCEQ e-flows standards, but the project's complicated interaction with BRA System Operations requires a more detailed analysis than is provided here to quantify its specific effects. All other recommended water management strategies are junior to the TCEQ e-flow standards, and do not affect the attainment of environmental flow standards.

Exceedance frequency flows are tabulated in Table 6-4 and Table 6-5 for the 95th-, 75th-, 50th- (median), 25th-, and 5th-percentiles on monthly, seasonal, and annual bases for 2040 and 2070 conditions, respectively, for the eleven control points described above and listed in Table 6-3.

Table 6-4. Monthly, seasonal and annual flow frequencies, Baseline and With WMSs Year 2040 conditions (acre-feet per period) for Brazos River Basin Control Points.

Period	Baseline 2040 - exceedance frequency					With WMSs 2040 - exceedance frequency				
	95%	75%	50%	25%	5%	95%	75%	50%	25%	5%
Double Mountain Fork Brazos River near Aspermont										
Jan	0	147	493	1,291	3,392	0	147	493	1,207	3,389
Feb	0	229	675	1,395	6,210	0	229	675	1,358	6,140
Mar	0	151	577	1,727	10,615	0	151	577	1,727	10,803
Apr	29	387	1,299	4,592	17,751	29	403	1,299	4,592	18,477
May	307	2,192	4,482	14,896	67,541	307	2,192	4,670	16,131	68,244
Jun	568	2,949	6,532	19,381	58,569	568	2,949	6,546	19,647	59,099
Jul	76	535	2,349	8,755	47,598	76	550	2,480	9,429	49,161
Aug	19	643	1,946	7,746	24,508	31	683	1,946	8,375	26,488
Sep	0	437	3,886	9,852	40,783	0	437	4,590	10,158	41,519
Oct	0	352	1,318	12,509	39,494	0	352	1,321	12,497	40,834
Nov	3	226	872	2,781	7,832	3	226	863	2,747	8,154
Dec	0	125	675	1,707	5,719	0	125	706	1,693	5,697
Winter	452	1,749	4,484	8,478	22,313	452	1,748	4,479	8,322	22,283
Spring	5,325	9,702	23,832	52,217	99,947	5,325	10,066	23,981	52,805	101,702
Summer	1,208	9,809	22,947	46,994	128,715	1,208	9,880	24,254	48,634	129,818
Annual	13,576	30,124	64,403	111,777	192,292	13,144	31,098	67,462	113,811	195,777
Clear Fork Brazos River at Eliasville										
Jan	0	545	1,506	3,060	12,864	0	489	1,302	2,379	10,969
Feb	4	415	1,338	4,653	26,408	4	397	1,134	3,259	24,204
Mar	0	559	2,052	7,568	31,942	0	491	1,368	5,835	28,031
Apr	0	968	3,673	11,469	63,236	0	561	2,564	9,906	56,411
May	0	2,394	11,600	30,201	167,377	0	1,665	10,318	27,444	149,523
Jun	285	3,746	9,366	32,182	131,024	0	2,561	7,296	28,086	123,150
Jul	0	772	3,931	12,198	53,230	0	550	2,992	10,167	48,213
Aug	0	192	2,982	6,188	68,746	0	148	2,421	5,805	57,411
Sep	0	576	4,131	16,137	66,646	0	576	3,077	13,108	52,556
Oct	0	563	4,413	14,360	105,089	0	422	3,845	11,999	94,820

Period	Baseline 2040 - exceedance frequency					With WMSs 2040 - exceedance frequency				
	95%	75%	50%	25%	5%	95%	75%	50%	25%	5%
Nov	12	917	2,974	7,301	31,453	12	865	2,348	6,916	29,298
Dec	0	536	2,316	3,653	16,264	0	527	1,959	3,645	15,801
Winter	1,607	5,624	11,254	25,706	86,645	1,529	4,573	9,590	23,788	75,090
Spring	2,979	18,833	47,289	106,561	388,895	2,805	15,595	39,545	93,293	374,541
Summer	1,037	10,693	31,243	71,612	213,166	405	10,101	25,320	63,700	188,127
Annual	12,978	57,338	112,433	251,110	497,976	11,984	49,250	94,338	215,288	459,318
Brazos River near South Bend										
Jan	228	2,476	5,088	8,226	30,944	228	2,476	4,817	7,193	28,395
Feb	457	2,607	5,226	11,531	64,309	457	2,606	4,856	10,290	57,153
Mar	460	2,833	6,495	22,347	73,585	443	2,774	5,441	20,778	63,805
Apr	758	3,433	9,521	32,204	187,542	751	3,433	7,835	27,537	176,497
May	1,295	11,074	30,990	89,788	369,169	1,295	10,565	28,621	87,685	351,364
Jun	3,426	17,229	33,154	108,046	331,021	3,241	15,362	30,705	96,431	327,191
Jul	683	5,865	14,325	48,055	138,088	683	5,329	12,977	45,880	130,288
Aug	144	2,021	11,231	23,138	169,497	144	2,021	10,373	22,288	162,112
Sep	56	3,106	15,689	56,371	142,738	56	3,152	14,450	48,603	131,830
Oct	191	5,137	12,843	59,673	272,237	191	5,090	12,169	52,624	263,513
Nov	175	3,163	9,289	22,603	83,026	174	3,157	8,637	20,898	81,069
Dec	43	2,252	6,198	14,204	42,999	43	2,252	6,036	13,055	37,414
Winter	7,520	16,760	33,023	67,814	174,692	7,373	16,078	30,842	59,067	164,366
Spring	16,195	76,364	143,659	280,815	861,217	15,094	65,977	125,843	255,631	850,790
Summer	10,393	43,173	112,443	251,057	479,383	9,319	40,649	104,163	223,051	434,377
Annual	59,679	203,421	372,911	594,563	1,111,188	57,895	190,601	348,472	544,032	1,048,460
Brazos River near Glen Rose										
Jan	135	1,164	10,745	19,362	44,945	172	1,810	10,745	20,551	53,685
Feb	161	1,847	16,103	34,516	127,511	108	870	9,669	33,039	137,151
Mar	444	2,125	18,378	44,981	212,362	237	3,028	17,389	37,241	224,209
Apr	345	4,301	26,151	50,937	149,260	198	2,989	15,987	49,330	147,384
May	284	15,824	34,520	98,436	557,737	543	5,263	33,442	120,358	542,048

Period	Baseline 2040 - exceedance frequency					With WMSs 2040 - exceedance frequency				
	95%	75%	50%	25%	5%	95%	75%	50%	25%	5%
Jun	240	7,668	45,876	105,251	463,111	378	6,078	24,784	86,167	460,632
Jul	0	9,983	31,643	60,439	187,560	0	1,957	26,209	54,806	187,790
Aug	87	3,964	25,427	46,154	128,057	0	2,046	14,656	35,951	108,574
Sep	389	8,369	29,021	50,971	97,096	334	2,809	24,437	54,301	141,171
Oct	67	2,608	25,176	49,488	368,419	67	2,477	17,537	51,206	372,469
Nov	302	1,921	18,237	36,653	160,570	201	1,091	9,629	36,542	148,916
Dec	229	1,715	14,025	27,080	89,835	151	1,180	11,530	23,821	90,729
Winter	3,307	42,946	75,382	123,328	389,711	3,866	35,624	68,425	126,080	385,118
Spring	16,051	86,788	160,693	344,079	1,355,891	13,779	68,536	152,285	344,327	1,355,911
Summer	22,371	74,220	131,361	240,029	637,724	4,416	58,042	118,172	224,478	641,557
Annual	117,041	327,896	482,753	743,449	1,864,251	83,062	289,872	448,915	685,543	1,813,188
Brazos River near Aquilla										
Jan	828	4,528	19,554	37,180	91,269	616	2,868	16,712	40,449	86,769
Feb	456	4,331	22,813	44,762	165,666	471	4,257	14,218	41,328	171,039
Mar	1,349	6,777	25,166	70,794	263,046	1,349	6,700	26,264	67,169	277,560
Apr	2,707	27,537	43,490	97,296	278,735	2,563	13,286	37,532	93,963	268,926
May	2,097	26,978	76,645	168,065	578,091	2,349	24,239	76,645	180,619	573,451
Jun	11,356	43,738	77,912	153,297	569,733	8,943	30,208	77,598	143,175	567,299
Jul	19,067	41,769	75,653	116,262	188,183	11,536	38,487	73,760	92,351	189,401
Aug	6,310	28,098	72,016	106,366	185,480	6,599	26,069	50,421	106,605	169,085
Sep	3,788	27,486	46,072	86,236	154,188	5,783	21,154	47,151	82,379	160,284
Oct	376	16,753	31,490	67,271	286,638	1,443	8,995	29,625	74,009	275,683
Nov	1,056	17,366	29,417	65,303	187,559	1,056	7,764	28,312	63,204	172,320
Dec	1,084	7,297	22,566	43,368	141,875	758	3,692	15,794	45,131	129,320
Winter	18,296	77,920	124,392	245,983	580,123	16,825	66,379	113,691	208,226	563,769
Spring	67,312	153,946	275,915	556,108	1,346,779	65,168	146,114	244,008	543,640	1,340,631
Summer	58,715	158,538	251,110	393,421	772,777	57,613	140,528	230,975	368,125	730,240
Annual	269,687	484,117	767,232	1,169,920	2,434,121	264,142	436,593	699,425	1,132,786	2,436,447
Bosque River near Waco										

Period	Baseline 2040 - exceedance frequency					With WMSs 2040 - exceedance frequency				
	95%	75%	50%	25%	5%	95%	75%	50%	25%	5%
Jan	0	26	204	14,911	113,480	0	26	204	14,911	113,480
Feb	2	43	352	34,147	131,829	2	43	352	34,147	131,829
Mar	4	41	3,227	42,265	135,146	4	41	3,227	40,953	134,437
Apr	4	89	7,324	35,971	189,232	4	89	7,324	35,971	189,199
May	0	55	8,480	71,954	248,784	0	73	8,483	71,954	248,784
Jun	4	41	5,304	34,499	93,509	4	41	5,122	34,499	93,510
Jul	4	44	63	162	59,783	4	44	63	163	59,783
Aug	0	43	59	91	5,578	0	43	59	91	5,591
Sep	0	17	29	90	19,562	0	17	29	90	19,562
Oct	0	15	72	297	63,000	0	15	72	297	63,000
Nov	0	17	79	2,480	47,268	0	17	79	2,480	47,268
Dec	0	8	64	14,161	88,547	0	8	64	16,117	87,195
Winter	79	365	31,071	92,602	336,081	79	365	31,071	92,601	336,083
Spring	129	6,434	76,329	203,648	528,428	129	6,434	76,330	201,248	528,428
Summer	97	194	433	10,291	122,436	97	194	433	10,292	122,464
Annual	672	35,315	169,062	332,035	744,084	672	35,311	169,065	331,999	744,088
Little River near Cameron										
Jan	4,079	10,889	29,061	81,643	315,725	4,080	7,558	23,076	74,557	319,684
Feb	3,350	13,027	29,567	122,968	450,792	3,350	9,763	26,578	116,205	440,611
Mar	5,909	14,447	34,456	175,707	452,567	4,981	10,902	33,586	169,641	442,091
Apr	3,682	16,670	46,830	135,278	359,840	3,682	13,080	48,358	131,877	361,162
May	12,034	36,671	77,886	217,893	701,884	11,230	26,593	70,989	206,075	689,990
Jun	6,277	20,752	50,574	156,774	450,276	5,315	18,582	36,389	148,872	438,008
Jul	2,616	8,011	18,060	42,421	197,835	2,616	7,832	14,560	36,278	171,227
Aug	1,323	5,093	16,520	35,773	79,327	1,323	4,367	9,854	22,864	78,569
Sep	2,827	7,295	18,232	32,239	126,315	2,526	6,900	16,260	29,612	114,006
Oct	1,590	7,229	21,457	56,187	216,626	1,230	3,951	16,836	44,205	221,754
Nov	1,862	5,980	22,654	75,205	244,297	1,190	6,186	18,084	68,581	230,312
Dec	3,213	10,843	24,291	93,730	343,505	3,215	8,344	22,446	82,441	328,962
Winter	29,073	74,519	189,586	546,860	1,064,528	21,714	67,524	168,246	503,027	1,014,865

Period	Baseline 2040 - exceedance frequency					With WMSs 2040 - exceedance frequency				
	95%	75%	50%	25%	5%	95%	75%	50%	25%	5%
Spring	51,714	121,876	292,798	763,724	1,697,085	40,279	94,852	260,014	731,756	1,648,301
Summer	14,982	45,872	114,094	231,665	426,437	14,020	38,922	97,091	221,274	426,644
Annual	124,628	338,040	792,704	1,542,063	2,652,307	92,148	288,898	700,783	1,459,152	2,516,705
Navasota River near Bryan										
Jan	1,749	7,090	19,579	34,102	149,385	1,566	4,925	15,861	35,027	152,810
Feb	2,253	5,953	21,333	58,360	139,446	2,303	6,942	22,790	60,473	148,222
Mar	2,563	9,816	24,856	54,663	144,683	2,166	8,511	19,637	63,384	154,519
Apr	2,363	4,316	13,411	37,188	161,230	2,493	4,395	12,541	35,858	173,227
May	1,814	6,094	21,983	68,924	219,520	1,814	5,732	18,328	75,608	219,549
Jun	1,068	2,272	8,363	45,460	126,806	1,186	2,018	7,394	36,919	126,901
Jul	492	964	2,425	9,949	32,491	612	964	1,995	6,381	28,943
Aug	106	767	1,320	10,624	33,647	128	792	1,475	5,969	28,030
Sep	28	751	1,526	6,907	25,395	287	805	1,671	5,576	25,676
Oct	193	841	4,767	16,094	77,137	193	815	3,314	12,945	78,939
Nov	628	1,485	5,211	16,348	112,780	605	1,572	4,197	15,477	112,256
Dec	1,025	3,300	12,308	41,957	161,702	968	3,065	11,729	41,957	161,674
Winter	18,743	43,253	81,526	188,517	442,831	17,783	42,065	87,786	190,005	445,028
Spring	16,743	51,233	120,071	227,952	437,824	18,774	43,580	112,605	237,913	438,055
Summer	2,882	10,314	28,205	52,768	123,314	3,071	7,385	21,239	48,274	123,553
Annual	64,196	130,135	315,887	471,326	742,973	49,924	137,059	311,988	471,518	756,849
Brazos River near Hempstead										
Jan	56,397	89,163	183,734	438,488	1,087,170	51,445	77,923	184,664	429,000	1,103,349
Feb	69,444	94,312	236,797	538,709	1,279,644	50,512	83,640	226,667	543,146	1,273,718
Mar	73,248	109,185	219,886	666,305	1,310,424	46,981	99,265	218,473	664,453	1,290,551
Apr	86,743	122,639	247,753	512,987	1,316,354	62,089	106,723	255,402	521,281	1,296,722
May	106,871	198,237	379,276	1,019,068	2,467,751	99,413	167,115	391,260	1,006,529	2,461,444
Jun	96,922	146,296	250,184	722,409	1,644,468	75,835	127,250	240,758	716,981	1,658,517
Jul	76,795	113,941	153,925	212,811	847,893	57,014	97,479	138,726	213,716	837,567
Aug	63,573	90,721	128,916	179,671	266,471	44,418	70,363	104,039	171,911	263,842

Period	Baseline 2040 - exceedance frequency					With WMSs 2040 - exceedance frequency				
	95%	75%	50%	25%	5%	95%	75%	50%	25%	5%
Sep	63,703	95,508	120,945	161,143	463,000	56,739	80,646	108,233	168,513	462,132
Oct	58,442	79,529	129,182	240,744	1,084,218	40,581	67,235	126,372	245,960	1,076,632
Nov	52,765	75,934	134,151	329,198	1,207,203	40,740	68,009	129,542	326,708	1,189,821
Dec	53,124	74,480	152,050	418,942	1,287,262	42,795	72,118	140,995	382,931	1,255,806
Winter	321,241	588,126	952,553	1,807,314	3,941,090	280,034	520,892	929,422	1,792,348	3,886,510
Spring	409,650	651,804	1,661,623	3,355,471	5,615,243	357,800	591,886	1,619,523	3,318,298	5,583,540
Summer	297,767	430,012	636,586	1,041,118	1,634,133	257,733	401,268	599,463	994,200	1,590,756
Annual	1,165,313	1,882,184	3,944,477	6,032,424	10,368,769	1,079,268	1,773,966	3,843,442	5,892,658	10,187,236
Brazos River at Richmond										
Jan	59,013	105,823	202,937	534,322	1,147,105	58,996	91,223	187,867	489,486	1,119,859
Feb	69,332	108,847	262,045	569,405	1,335,221	69,332	97,046	251,437	565,777	1,324,834
Mar	74,265	125,687	249,714	718,099	1,411,812	75,083	107,876	213,801	706,975	1,351,907
Apr	83,252	123,564	277,450	548,787	1,318,535	86,309	113,131	264,804	535,989	1,300,026
May	97,683	190,573	440,185	1,067,674	2,575,051	97,588	177,991	437,185	1,024,370	2,579,674
Jun	83,929	145,685	284,716	866,143	1,808,887	83,929	128,793	285,970	849,427	1,778,715
Jul	68,703	112,075	158,850	280,229	872,982	69,072	112,392	156,760	265,185	861,777
Aug	54,916	87,362	123,778	189,177	286,059	60,525	86,616	122,750	178,605	280,384
Sep	56,974	91,833	132,406	177,971	507,132	59,497	95,654	130,678	162,607	467,455
Oct	61,803	84,588	143,298	286,648	1,146,001	64,345	82,164	143,047	267,283	1,107,081
Nov	55,107	91,632	158,921	369,670	1,227,406	55,289	89,676	157,451	358,422	1,205,300
Dec	57,050	85,347	195,037	434,347	1,420,077	57,050	83,514	185,708	434,950	1,390,243
Winter	317,368	599,219	1,154,574	1,930,989	4,342,262	302,011	580,588	1,105,470	1,905,421	4,288,429
Spring	360,163	713,124	1,880,559	3,566,853	5,891,580	359,188	661,138	1,808,683	3,519,697	5,843,528
Summer	272,686	455,004	704,444	1,082,592	1,905,404	288,549	437,648	684,338	1,034,004	1,849,004
Annual	1,192,064	2,009,605	4,298,572	6,520,392	11,386,809	1,157,398	1,954,813	4,216,792	6,404,459	11,055,298
Brazos River at Gulf of Mexico										
Jan	1	36,353	155,004	478,726	1,133,097	1	18,610	154,271	443,070	1,116,086
Feb	3	35,203	194,318	533,457	1,266,974	2	21,909	188,249	517,450	1,260,851
Mar	1	40,210	163,801	731,386	1,433,041	1	27,484	140,306	721,853	1,403,052

Period	Baseline 2040 - exceedance frequency					With WMSs 2040 - exceedance frequency				
	95%	75%	50%	25%	5%	95%	75%	50%	25%	5%
Apr	1	33,041	217,368	465,632	1,332,951	1	16,755	193,456	454,400	1,314,263
May	3,901	84,321	344,265	1,040,172	2,542,843	29	77,009	329,575	997,003	2,547,339
Jun	3	37,699	176,467	761,046	1,872,456	1	13,073	183,170	744,792	1,829,793
Jul	0	219	39,341	185,255	815,330	0	269	35,867	181,269	804,434
Aug	0	3	4,472	81,532	206,384	0	13	2,965	59,599	203,712
Sep	0	1,542	52,428	127,503	459,239	0	379	51,980	111,822	405,804
Oct	0	4,709	67,785	238,630	1,150,637	0	3,663	65,688	226,686	1,116,527
Nov	0	34,348	107,839	311,322	1,203,547	0	23,911	105,359	300,385	1,182,052
Dec	0	24,039	151,039	399,635	1,415,101	0	21,628	148,577	397,787	1,386,092
Winter	74,664	380,898	950,522	1,740,504	4,305,193	54,401	362,424	873,971	1,655,358	4,253,974
Spring	6,191	331,051	1,511,650	3,271,453	5,870,993	4,419	296,290	1,442,916	3,269,709	5,862,564
Summer	18	76,941	321,853	701,755	1,665,830	189	59,661	319,918	657,997	1,633,707
Annual	367,406	1,075,748	3,546,143	5,600,988	10,867,151	258,331	1,040,917	3,435,359	5,498,765	10,544,801

Table 6-5. Monthly, seasonal and annual flow frequencies, Baseline and With Plan Year 2070 conditions (acre-feet per period) for Brazos River Basin Control Points.

Period	Baseline 2070 - exceedance frequency					With WMSs 2070 - exceedance frequency				
	95%	75%	50%	25%	5%	95%	75%	50%	25%	5%
Double Mountain Fork Brazos River near Aspermont										
Jan	0	144	493	1,291	3,391	0	144	493	1,207	3,389
Feb	0	229	675	1,395	6,210	0	229	679	1,358	6,139
Mar	0	151	577	1,722	10,615	0	151	577	1,722	10,802
Apr	29	387	1,299	4,592	17,748	29	403	1,299	4,592	18,473
May	307	2,192	4,478	14,891	67,535	307	2,192	4,670	16,125	68,254
Jun	567	2,947	6,529	19,358	58,561	567	2,966	6,546	19,606	59,070
Jul	76	535	2,367	8,755	47,617	76	550	2,488	9,515	49,168
Aug	19	643	1,946	7,746	24,506	31	683	1,946	8,375	26,486
Sep	0	437	3,886	9,852	40,780	0	437	4,590	10,158	41,516
Oct	0	352	1,318	12,507	39,494	0	352	1,321	12,497	40,832
Nov	3	226	871	2,780	7,832	3	226	871	2,747	8,154
Dec	0	116	674	1,709	5,719	0	116	706	1,710	5,697
Winter	452	1,749	4,483	8,476	22,312	452	1,748	4,478	8,531	22,283
Spring	5,325	9,711	23,832	52,212	99,941	5,325	10,066	23,974	52,804	101,696
Summer	1,208	10,024	23,076	46,997	128,650	1,208	10,024	24,481	48,639	129,784
Annual	13,575	31,297	64,398	111,891	192,234	13,143	31,575	67,450	113,821	195,810
Clear Fork Brazos River at Eliasville										
Jan	0	532	1,493	3,047	12,849	0	476	1,289	2,366	10,955
Feb	0	403	1,326	4,642	26,446	0	385	1,123	3,248	24,243
Mar	0	548	2,041	7,557	31,975	0	480	1,357	5,823	28,020
Apr	0	954	3,659	11,417	63,191	0	548	2,551	9,893	56,366
May	0	2,379	11,585	30,119	166,103	0	1,650	10,297	27,396	149,698
Jun	270	3,731	9,475	31,951	130,988	0	2,546	7,276	28,056	122,972
Jul	0	762	3,921	12,180	53,121	0	540	2,982	10,152	48,104
Aug	0	166	2,973	6,179	68,730	0	138	2,433	5,786	57,116
Sep	0	568	4,123	16,129	65,817	0	568	3,069	13,099	51,537
Oct	0	555	4,402	14,349	105,197	0	403	3,834	11,979	94,928

Period	Baseline 2070 - exceedance frequency					With WMSs 2070 - exceedance frequency				
	95%	75%	50%	25%	5%	95%	75%	50%	25%	5%
Nov	3	900	2,965	7,292	31,379	3	856	2,339	6,906	29,224
Dec	0	527	2,306	3,644	16,442	0	518	1,955	3,635	15,866
Winter	1,568	5,574	11,212	25,634	86,513	1,497	4,528	9,554	23,712	75,117
Spring	2,951	18,797	47,222	106,628	389,420	2,766	15,541	39,490	93,230	375,369
Summer	1,022	10,653	30,970	71,573	214,251	380	10,060	25,237	63,545	188,166
Annual	12,876	57,219	112,688	252,046	497,678	11,877	49,120	94,281	215,784	459,254
Brazos River near South Bend										
Jan	168	2,464	5,077	8,194	30,925	168	2,464	4,815	7,181	26,849
Feb	450	2,597	5,175	11,518	64,348	450	2,596	4,824	10,278	57,143
Mar	460	2,830	6,485	22,337	73,663	441	2,764	5,764	20,768	63,037
Apr	745	3,421	9,507	32,218	187,486	738	3,421	7,821	28,633	176,441
May	1,295	11,061	30,977	90,003	367,988	1,295	10,552	28,610	87,901	351,446
Jun	3,412	17,215	33,143	108,031	330,457	3,238	15,349	30,729	96,780	326,935
Jul	681	5,856	14,316	48,019	138,424	681	5,322	12,968	46,106	128,961
Aug	144	2,072	11,222	23,130	170,691	144	2,072	10,430	22,280	162,083
Sep	56	3,092	15,681	56,479	142,754	56	3,138	14,442	48,632	131,448
Oct	180	5,127	12,833	59,717	272,225	180	5,080	12,159	52,698	264,525
Nov	171	3,154	9,230	22,585	82,955	169	3,148	8,578	20,905	80,998
Dec	20	2,210	6,190	14,191	43,053	21	2,204	6,069	13,043	37,740
Winter	7,487	16,709	32,985	67,775	174,422	7,340	16,020	31,196	60,660	164,097
Spring	16,155	76,331	144,314	282,394	862,945	15,064	65,933	125,834	256,507	852,324
Summer	10,369	43,138	112,364	251,433	480,449	9,286	40,613	104,824	223,666	435,070
Annual	59,548	203,260	372,780	598,614	1,110,936	57,769	190,530	348,480	545,645	1,050,254
Brazos River near Glen Rose										
Jan	134	1,611	14,056	29,668	44,895	204	1,382	6,863	20,650	54,271
Feb	111	1,196	13,258	34,751	127,536	161	1,141	7,905	23,143	137,842
Mar	516	3,420	20,584	43,773	212,127	205	2,583	20,330	41,875	222,886
Apr	296	4,528	25,854	50,894	149,065	371	2,705	15,891	42,179	148,939
May	284	12,713	36,351	115,543	558,137	487	5,103	34,485	120,343	542,620
Jun	499	10,027	45,757	90,052	463,171	463	7,159	36,763	85,699	460,694

Period	Baseline 2070 - exceedance frequency					With WMSs 2070 - exceedance frequency				
	95%	75%	50%	25%	5%	95%	75%	50%	25%	5%
Jul	0	4,271	29,869	59,740	188,911	0	2,321	23,764	53,307	192,178
Aug	87	5,970	30,338	51,260	129,451	26	2,219	14,055	49,039	111,008
Sep	763	7,721	28,193	51,535	89,920	785	3,286	21,566	36,809	125,142
Oct	67	3,231	24,497	52,148	359,987	67	2,338	21,716	42,695	379,146
Nov	249	1,134	17,020	34,963	151,014	183	1,257	8,199	43,027	147,939
Dec	229	1,369	14,038	28,187	89,756	174	1,317	12,385	25,492	90,651
Winter	3,095	42,010	76,847	127,240	389,240	4,272	34,101	67,518	118,461	387,627
Spring	9,795	89,083	164,665	343,151	1,354,964	12,135	74,599	147,493	341,452	1,357,019
Summer	13,108	81,526	130,591	245,632	636,165	8,722	70,472	115,388	219,411	619,117
Annual	100,772	315,725	480,142	736,181	1,857,428	110,997	261,272	446,389	688,766	1,822,860
Brazos River near Aquilla										
Jan	763	4,213	26,433	43,696	87,162	480	2,077	5,223	22,148	46,952
Feb	461	3,838	21,919	41,931	196,732	430	1,808	4,983	19,280	57,087
Mar	1,509	6,945	29,166	69,871	250,579	1,214	4,155	19,716	40,257	125,396
Apr	2,761	21,504	48,404	92,998	278,984	1,738	6,654	26,747	51,514	130,356
May	2,097	25,478	75,765	169,584	602,629	1,753	8,437	41,181	112,590	466,953
Jun	11,686	41,684	78,273	158,770	579,940	1,425	11,103	34,748	92,360	399,674
Jul	15,736	37,083	75,687	93,652	187,727	3,037	21,810	41,437	64,451	169,887
Aug	6,270	27,217	69,427	102,858	168,858	7,889	21,914	33,679	65,036	149,592
Sep	3,757	21,373	51,863	76,270	164,942	3,026	11,469	31,390	68,402	166,294
Oct	811	11,417	39,121	74,145	300,719	494	5,554	25,314	53,073	199,633
Nov	1,056	15,790	29,391	58,126	185,849	885	4,452	17,309	45,788	110,950
Dec	877	6,610	20,847	39,403	141,836	798	2,341	9,744	24,059	74,889
Winter	14,318	77,514	116,063	247,518	579,739	7,464	27,756	65,552	119,286	255,662
Spring	57,782	162,175	267,036	549,584	1,372,351	19,281	94,242	175,814	286,519	977,765
Summer	52,683	158,752	250,255	381,960	784,266	50,239	106,932	159,529	263,630	563,911
Annual	251,967	482,669	757,898	1,161,118	2,449,093	174,616	317,055	411,336	747,738	1,786,771
Bosque River near Waco										
Jan	0	26	204	14,826	110,422	0	26	204	14,827	110,427
Feb	2	43	352	33,872	131,769	2	43	352	33,874	131,769

Period	Baseline 2070 - exceedance frequency 95%	75%	50%	25%	5%	With WMSs 2070 - exceedance frequency 95%	75%	50%	25%	5%
Mar	4	41	4,589	43,300	134,428	4	41	4,573	41,666	134,428
Apr	4	89	8,472	35,755	189,044	4	89	8,572	35,756	189,057
May	0	87	8,334	70,042	248,605	0	55	8,354	70,042	248,607
Jun	4	41	7,083	36,625	92,808	4	48	6,898	35,414	92,808
Jul	4	36	60	150	59,541	11	36	64	731	59,543
Aug	0	36	44	95	5,376	0	36	45	112	7,546
Sep	0	17	29	90	18,720	0	17	29	99	18,721
Oct	0	15	70	312	62,257	0	15	70	312	61,750
Nov	0	17	75	3,159	47,101	0	17	79	2,818	47,100
Dec	0	8	64	15,013	87,030	0	8	64	16,214	87,024
Winter	79	365	28,381	91,781	335,195	79	365	30,789	91,734	335,200
Spring	129	12,041	75,199	200,258	527,031	125	12,257	74,258	200,040	526,601
Summer	97	169	422	9,586	121,931	97	169	564	11,831	122,133
Annual	672	34,001	167,977	330,383	743,245	578	31,364	168,099	324,705	743,287
Little River near Cameron										
Jan	3,853	9,613	26,339	78,356	309,121	3,853	8,396	23,430	74,308	319,355
Feb	4,560	14,767	29,960	124,441	450,485	3,160	10,135	27,211	120,142	440,304
Mar	5,693	14,417	34,332	175,283	452,177	4,758	10,662	33,471	164,922	441,701
Apr	3,451	16,404	45,929	140,847	360,665	3,451	13,327	48,082	133,201	360,614
May	11,274	36,412	80,890	217,480	705,317	10,960	27,847	77,279	206,398	693,418
Jun	5,917	20,583	45,642	159,885	449,792	5,061	19,286	36,078	148,261	437,993
Jul	2,454	9,751	28,946	44,098	182,863	2,493	9,578	17,916	36,263	171,112
Aug	1,349	4,512	14,366	34,574	79,389	1,666	4,438	11,539	23,521	78,204
Sep	2,859	8,783	18,352	31,665	115,049	2,930	8,775	16,263	27,522	109,891
Oct	1,470	7,273	24,460	46,652	211,871	1,230	6,450	18,414	42,859	214,557
Nov	2,047	8,672	21,907	68,827	244,021	2,047	5,993	17,799	68,381	229,933
Dec	3,029	10,119	23,606	95,446	342,106	3,029	7,284	21,199	83,373	327,504
Winter	24,621	72,418	185,593	549,848	1,062,522	20,973	67,533	172,464	505,710	1,012,416
Spring	50,181	123,264	286,908	765,217	1,692,745	39,559	98,578	253,909	730,199	1,632,034
Summer	14,313	44,811	117,217	230,411	426,138	14,416	43,149	105,058	221,793	425,440

Period	Baseline 2070 - exceedance frequency					With WMSs 2070 - exceedance frequency				
	95%	75%	50%	25%	5%	95%	75%	50%	25%	5%
Annual	122,341	333,499	794,163	1,535,739	2,647,225	91,072	296,650	700,430	1,461,660	2,515,495
Navasota River near Bryan										
Jan	1,721	5,852	18,124	37,352	149,322	1,566	4,923	18,827	34,989	151,293
Feb	2,440	7,282	23,098	56,629	140,646	2,075	6,282	22,076	63,013	140,606
Mar	2,550	8,505	24,202	57,037	148,575	1,659	7,944	18,216	64,091	157,413
Apr	2,493	4,467	13,937	38,711	162,286	2,799	4,340	12,541	35,769	173,239
May	1,814	6,006	18,968	68,856	222,241	1,814	6,369	18,096	73,843	222,314
Jun	1,068	2,430	9,159	43,170	126,745	1,065	1,834	5,024	36,755	126,782
Jul	416	959	2,149	12,389	30,813	615	964	1,479	7,187	30,033
Aug	106	736	1,386	11,682	32,769	128	787	1,400	7,001	27,928
Sep	28	802	1,720	7,840	26,376	374	833	1,450	4,240	25,375
Oct	193	782	4,674	12,370	74,084	193	766	2,271	9,664	78,731
Nov	704	1,954	5,412	16,352	112,785	605	1,572	4,613	15,678	112,261
Dec	1,025	2,841	11,359	41,950	161,665	968	2,697	10,445	42,989	161,637
Winter	17,425	43,734	83,861	189,309	444,033	17,783	44,930	88,407	189,857	444,841
Spring	16,735	49,820	111,321	234,124	436,422	17,592	41,786	119,631	237,628	437,915
Summer	2,882	9,090	25,316	55,315	123,128	3,115	5,976	21,663	51,920	128,295
Annual	58,594	140,849	318,407	469,340	742,149	48,000	138,629	315,191	470,336	747,137
Brazos River near Hempstead										
Jan	56,140	88,877	175,734	416,852	1,090,064	41,693	78,877	180,674	407,189	1,098,012
Feb	69,177	94,052	226,193	543,630	1,288,247	47,681	74,180	189,538	495,729	1,208,192
Mar	72,960	108,417	219,727	666,580	1,296,589	63,330	92,234	216,603	658,325	1,180,959
Apr	86,361	122,145	235,278	532,222	1,300,440	58,749	100,469	240,286	517,236	1,174,431
May	105,235	190,880	359,321	1,032,873	2,471,614	97,444	143,698	380,612	924,927	2,316,585
Jun	95,634	140,664	246,769	720,578	1,668,606	68,511	115,173	219,478	632,978	1,507,743
Jul	73,008	113,681	151,183	211,786	847,232	57,578	93,356	117,713	209,739	752,519
Aug	62,875	90,572	128,397	171,713	257,581	42,286	72,930	97,993	147,001	240,758
Sep	62,098	92,951	119,701	160,851	457,225	41,815	70,558	102,751	151,489	423,295
Oct	58,012	76,927	127,086	237,864	1,086,771	48,018	71,196	106,116	228,087	1,041,899
Nov	53,040	75,966	127,880	330,886	1,197,559	38,113	64,586	122,721	292,549	1,134,826

Period	Baseline 2070 - exceedance frequency					With WMSs 2070 - exceedance frequency				
	95%	75%	50%	25%	5%	95%	75%	50%	25%	5%
Dec	52,833	73,067	152,584	399,434	1,279,857	43,556	64,535	128,588	367,386	1,188,464
Winter	319,601	590,401	950,233	1,793,105	3,962,631	288,376	493,463	917,922	1,784,541	3,710,514
Spring	407,431	649,176	1,662,584	3,368,125	5,646,651	361,602	617,160	1,490,484	3,033,658	5,059,625
Summer	285,188	428,184	639,778	1,001,955	1,628,134	255,145	387,926	559,004	810,920	1,494,615
Annual	1,141,839	1,874,026	3,925,316	6,053,122	10,447,182	1,081,161	1,675,873	3,624,584	5,654,777	9,593,473
Brazos River at Richmond										
Jan	58,518	102,015	202,816	514,031	1,158,934	57,914	90,187	174,455	460,700	1,079,557
Feb	69,108	108,599	258,276	576,621	1,336,193	68,039	92,827	214,474	543,348	1,203,990
Mar	74,020	126,555	249,594	732,889	1,398,318	73,881	106,396	218,898	706,700	1,242,222
Apr	82,774	123,277	272,892	545,778	1,318,024	84,179	111,571	262,233	485,838	1,216,125
May	97,515	188,385	425,762	1,081,196	2,589,525	95,634	164,614	412,035	971,954	2,478,948
Jun	82,736	145,307	291,972	869,506	1,839,197	81,123	130,256	246,653	729,140	1,657,707
Jul	65,565	111,934	152,087	284,111	872,371	68,250	110,482	144,233	238,342	778,766
Aug	53,900	83,846	125,758	191,976	277,009	59,217	83,194	121,237	162,751	256,557
Sep	49,837	91,184	132,815	177,636	488,468	58,731	91,014	125,376	154,504	397,856
Oct	61,639	81,838	143,250	289,908	1,122,210	62,737	80,952	136,237	222,507	1,021,845
Nov	54,971	91,420	158,687	379,850	1,227,477	54,971	82,813	152,667	343,361	1,196,975
Dec	56,767	84,943	194,792	433,719	1,412,884	55,399	80,983	169,732	418,319	1,324,526
Winter	316,282	598,751	1,139,895	1,936,894	4,349,217	296,850	565,605	1,065,361	1,843,014	4,131,481
Spring	358,140	731,252	1,882,443	3,564,377	5,942,194	358,174	681,823	1,664,571	3,313,566	5,568,788
Summer	266,653	439,233	698,527	1,054,140	1,882,248	279,181	427,956	606,897	908,637	1,715,144
Annual	1,164,721	2,004,381	4,269,033	6,540,917	11,463,828	1,134,376	1,868,887	4,049,087	6,151,586	10,542,657
Brazos River at Gulf of Mexico										
Jan	1	31,368	157,705	461,553	1,137,181	1	19,019	150,522	418,279	1,060,996
Feb	3	35,152	185,203	538,518	1,275,389	2	19,015	157,650	493,464	1,130,664
Mar	1	39,983	165,618	741,085	1,422,708	1	23,668	143,195	704,599	1,287,826
Apr	1	32,974	219,095	467,632	1,338,190	1	14,067	197,688	418,785	1,203,134
May	3,996	81,964	337,546	1,053,577	2,557,174	29	65,441	303,189	921,933	2,450,133
Jun	3	37,338	185,064	764,575	1,879,767	1	13,159	126,725	634,092	1,710,329
Jul	0	8	35,078	184,605	814,961	0	24	28,074	139,081	726,223

Period	Baseline 2070 - exceedance frequency					With WMSs 2070 - exceedance frequency				
	95%	75%	50%	25%	5%	95%	75%	50%	25%	5%
Aug	0	3	6,264	76,648	189,892	0	5	2,140	47,297	177,308
Sep	0	796	51,702	127,459	432,016	0	193	39,261	88,621	388,972
Oct	0	2,459	69,413	243,259	1,127,733	0	3,968	49,693	173,204	1,035,738
Nov	0	29,526	107,095	329,117	1,203,841	0	15,696	103,253	289,093	1,174,182
Dec	0	23,955	149,927	398,452	1,408,342	0	22,013	115,747	382,242	1,323,757
Winter	74,536	378,611	937,171	1,738,769	4,268,697	54,781	352,970	865,392	1,622,148	4,059,784
Spring	6,217	339,484	1,494,574	3,274,309	5,913,702	4,862	290,511	1,323,744	2,951,357	5,583,351
Summer	18	76,305	336,940	673,456	1,643,757	100	51,361	271,102	615,435	1,477,136
Annual	366,325	1,072,730	3,523,343	5,614,388	10,944,873	258,418	968,468	3,263,571	5,211,313	10,061,494

6.2.2 *Effects on attainment of e-flows standards*

Subsistence and base flows

Several of the preceding figures demonstrate graphically for specific locations the frequency at which subsistence and base flows are exceeded. Table 6-6 and Table 6-7 present these data in tabular form for 2040 and 2070 conditions, summarizing changes in the percentage of time that specific e-flow standards are equaled or exceeded between the Baseline and With WMSs scenarios.

Pulse flows

Table 6-8 and Table 6-9 present the number of months with qualifying pulses occurring over the simulation period under 2040 and 2070 conditions, respectively. As shown in the tables, the number of potentially qualifying pulses is reduced slightly between the Baseline and With WMSs conditions, but the implemented plans are not expected to decrease the attainment of environmental flow pulse standards.

6.2.3 *Effects on aquatic habitat indices*

In 2018, the Texas Instream Flow Program completed a study titled "Instream Flow Study of the Middle and Lower Brazos River." The study report included several figures relating "weighted usable habitat area as a function of simulated discharge" for fish habitat guilds. Those study sites are shown in Figure 6-2. Figure 6-25 through Figure 6-30 compare those figures against the 75th and 95th percentile regulated flows for the Baseline and With WMSs scenarios for both 2040 and 2070 conditions. Regulated flows were extracted from the WAM for those locations using the nearest control points existing in the model.

The figures indicate that the implemented plans will tend to decrease the flows that are exceeded 75 percent of the time and the flows exceeded 95 percent of the time (low flows) relative to the Baseline condition. At some study sites, the 75th and 95th percentile flows tend to adjust to nearer the optimum streamflows under With WMSs conditions. However, the 95th percentile flows (Baseline and With WMSs) at the Brazos River near Marlin and Brazos River near Hearne sites are outside the range of the Instream Flow Study data.

Note that the Instream Flow Study results are based on daily flows, and the WAM regulated flows used in this analysis are monthly-average flows, and are not completely applicable to the Instream Flow Study. Nonetheless, the results can provide some insight into the relative effects that changes in flow from Baseline to With WMSs conditions may have on usable habitat area at these specific sites. Additionally, the relationship between discharge and weighted usable habitat area likely will change over time at any specific location as a river adjusts its planform in response to various hydrologic stresses.

6.2.4 *Summary of overall effects of the recommended water management strategies on flows in the Brazos River Basin*

The cumulative effects of implementing the water management strategies recommended in the 2021 Region O, Brazos G, and Region H Regional Water Plans will tend to decrease streamflows in most months, with occasional increases. With the implementation of water management strategies recommended in the 2021 Region O, Brazos G, and Region H

Water Plans, there are expected to be decreases in the percent of time baseflow e-flows standards are met in all months in the 2040 With WMSs and 2070 With WMSs scenarios for Baseflows – Dry Condition and Baseflows – Average Condition for the Brazos River at Glen Rose, Little River near Cameron, and the Brazos River near Hempstead. For the Brazos River at Glen Rose, the percent of time subsistence flows are met is expected to reduce in February and June through December in the 2040 With WMSs scenario. For the Brazos River at Richmond, the percent of time Baseflows – Average Conditions e-flow standards are met is expected to decrease under the 2040 With WMSs and 2070 With WMSs scenarios.

Table 6-6. Changes in percent of time subsistence and base flow e-flows are equaled or exceeded for Year 2040 conditions for Baseline and With WMSs models.

	SUBSISTENCE FLOWS				BASE FLOWS - DRY CONDITIONS				BASE FLOWS - AVERAGE CONDITIONS			
Month	Flow (acft/mo)	Baseline 2040 % Time Met	With WMSs 2040 %Time Met	Delta %	Flow (acft/mo)	Baseline 2040 % Time Met	With WMSs 2040 %Time Met	Delta %	Flow (acft/mo)	Baseline 2040 % Time Met	With WMSs 2040 %Time Met	Delta %
Double Mountain Fork Brazos River near Aspermont												
Jan	61	82.9%	82.9%	0.0%	61	82.9%	82.9%	0.0%	246	64.5%	64.5%	0.0%
Feb	56	86.8%	86.8%	0.0%	56	86.8%	86.8%	0.0%	222	76.3%	76.3%	0.0%
Mar	61	84.2%	84.2%	0.0%	61	84.2%	84.2%	0.0%	184	72.4%	72.4%	0.0%
Apr	60	93.4%	93.4%	0.0%	60	93.4%	93.4%	0.0%	179	88.2%	86.8%	-1.3%
May	61	100.0%	100.0%	0.0%	61	100.0%	100.0%	0.0%	184	96.1%	96.1%	0.0%
Jun	60	98.7%	98.7%	0.0%	60	98.7%	98.7%	0.0%	179	98.7%	98.7%	0.0%
Jul	61	94.7%	94.7%	0.0%	61	94.7%	94.7%	0.0%	123	90.8%	90.8%	0.0%
Aug	61	92.1%	92.1%	0.0%	61	92.1%	92.1%	0.0%	123	88.2%	89.5%	1.3%
Sep	60	89.5%	89.5%	0.0%	60	89.5%	89.5%	0.0%	119	86.8%	86.8%	0.0%
Oct	61	88.2%	88.2%	0.0%	61	88.2%	88.2%	0.0%	123	82.9%	82.9%	0.0%
Nov	60	86.8%	86.8%	0.0%	60	86.8%	86.8%	0.0%	238	73.7%	73.7%	0.0%
Dec	61	78.9%	78.9%	0.0%	61	78.9%	78.9%	0.0%	246	64.5%	64.5%	0.0%
Brazos River near South Bend												
Jan	61	97.4%	97.4%	0.0%	2,214	77.6%	76.3%	-1.3%	4,489	53.9%	53.9%	0.0%
Feb	56	97.4%	97.4%	0.0%	1,999	81.6%	81.6%	0.0%	4,054	57.9%	56.6%	-1.3%
Mar	61	98.7%	98.7%	0.0%	1,783	85.5%	85.5%	0.0%	3,689	68.4%	63.2%	-5.3%
Apr	60	100.0%	100.0%	0.0%	1,726	88.2%	88.2%	0.0%	3,570	73.7%	72.4%	-1.3%
May	61	98.7%	98.7%	0.0%	1,783	93.4%	92.1%	-1.3%	3,689	89.5%	89.5%	0.0%
Jun	60	98.7%	98.7%	0.0%	1,726	97.4%	97.4%	0.0%	3,570	94.7%	93.4%	-1.3%
Jul	61	100.0%	100.0%	0.0%	984	89.5%	89.5%	0.0%	2,828	78.9%	80.3%	1.3%
Aug	61	98.7%	98.7%	0.0%	984	85.5%	85.5%	0.0%	2,828	69.7%	69.7%	0.0%
Sep	60	94.7%	94.7%	0.0%	952	88.2%	88.2%	0.0%	2,737	78.9%	76.3%	-2.6%
Oct	61	98.7%	98.7%	0.0%	984	86.8%	86.8%	0.0%	2,828	80.3%	80.3%	0.0%
Nov	60	97.4%	97.4%	0.0%	2,142	81.6%	81.6%	0.0%	4,344	68.4%	67.1%	-1.3%
Dec	61	93.4%	93.4%	0.0%	2,214	76.3%	76.3%	0.0%	4,489	61.8%	61.8%	0.0%

	SUBSISTENCE FLOWS				BASE FLOWS - DRY CONDITIONS				BASE FLOWS - AVERAGE CONDITIONS			
Month	**Flow (acft/mo)**	**Baseline 2040 % Time Met**	**With WMSs 2040 %Time Met**	**Delta %**	**Flow (acft/mo)**	**Baseline 2040 % Time Met**	**With WMSs 2040 %Time Met**	**Delta %**	**Flow (acft/mo)**	**Baseline 2040 % Time Met**	**With WMSs 2040 %Time Met**	**Delta %**
Brazos River near Glen Rose												
Jan	984	78.9%	86.8%	7.9%	2,582	63.2%	67.1%	3.9%	4,735	59.2%	57.9%	-1.3%
Feb	889	84.2%	75.0%	-9.2%	2,333	71.1%	63.2%	-7.9%	4,276	67.1%	57.9%	-9.2%
Mar	984	80.3%	82.9%	2.6%	2,890	73.7%	77.6%	3.9%	5,657	67.1%	65.8%	-1.3%
Apr	952	86.8%	86.8%	0.0%	2,797	77.6%	75.0%	-2.6%	5,474	71.1%	64.5%	-6.6%
May	984	88.2%	92.1%	3.9%	2,890	84.2%	78.9%	-5.3%	5,657	81.6%	73.7%	-7.9%
Jun	952	92.1%	90.8%	-1.3%	2,797	85.5%	85.5%	0.0%	5,474	76.3%	75.0%	-1.3%
Jul	984	85.5%	76.3%	-9.2%	2,275	84.2%	72.4%	-11.8%	4,304	78.9%	69.7%	-9.2%
Aug	984	85.5%	81.6%	-3.9%	2,275	78.9%	73.7%	-5.3%	4,304	73.7%	64.5%	-9.2%
Sep	952	89.5%	86.8%	-2.6%	2,202	80.3%	76.3%	-3.9%	4,165	78.9%	69.7%	-9.2%
Oct	984	86.8%	85.5%	-1.3%	2,275	75.0%	76.3%	1.3%	4,304	72.4%	65.8%	-6.6%
Nov	952	84.2%	77.6%	-6.6%	2,499	72.4%	61.8%	-10.5%	4,582	68.4%	56.6%	-11.8%
Dec	984	81.6%	77.6%	-3.9%	2,582	67.1%	61.8%	-5.3%	4,735	65.8%	59.2%	-6.6%
Little River near Cameron												
Jan	1,968	100.0%	100.0%	0.0%	6,764	85.5%	78.9%	-6.6%	11,683	73.7%	65.8%	-7.9%
Feb	1,777	96.1%	96.1%	0.0%	6,109	89.5%	88.2%	-1.3%	10,552	80.3%	72.4%	-7.9%
Mar	1,968	98.7%	98.7%	0.0%	8,608	89.5%	86.8%	-2.6%	19,061	63.2%	57.9%	-5.3%
Apr	1,904	98.7%	98.7%	0.0%	8,331	85.5%	84.2%	-1.3%	18,446	73.7%	71.1%	-2.6%
May	1,968	98.7%	98.7%	0.0%	8,608	97.4%	96.1%	-1.3%	19,061	88.2%	81.6%	-6.6%
Jun	1,904	97.4%	97.4%	0.0%	8,331	90.8%	88.2%	-2.6%	18,446	78.9%	75.0%	-3.9%
Jul	1,968	97.4%	97.4%	0.0%	5,964	82.9%	81.6%	-1.3%	9,838	69.7%	67.1%	-2.6%
Aug	1,968	92.1%	92.1%	0.0%	5,964	69.7%	65.8%	-3.9%	9,838	59.2%	50.0%	-9.2%
Sep	1,904	96.1%	96.1%	0.0%	5,772	80.3%	78.9%	-1.3%	9,521	67.1%	65.8%	-1.3%
Oct	1,968	93.4%	89.5%	-3.9%	5,964	78.9%	72.4%	-6.6%	9,838	67.1%	59.2%	-7.9%
Nov	1,904	94.7%	93.4%	-1.3%	6,545	72.4%	73.7%	1.3%	11,306	67.1%	63.2%	-3.9%
Dec	1,968	96.1%	96.1%	0.0%	6,764	82.9%	80.3%	-2.6%	11,683	71.1%	61.8%	-9.2%

	SUBSISTENCE FLOWS				BASE FLOWS - DRY CONDITIONS				BASE FLOWS - AVERAGE CONDITIONS			
Month	Flow (acft/mo)	Baseline 2040 % Time Met	With WMSs 2040 %Time Met	Delta %	Flow (acft/mo)	Baseline 2040 % Time Met	With WMSs 2040 %Time Met	Delta %	Flow (acft/mo)	Baseline 2040 % Time Met	With WMSs 2040 %Time Met	Delta %
Brazos River near Hempstead												
Jan	31,359	98.7%	98.7%	0.0%	56,569	94.7%	92.1%	-2.6%	88,542	75.0%	68.4%	-6.6%
Feb	28,324	100.0%	100.0%	0.0%	51,094	100.0%	93.4%	-6.6%	79,974	85.5%	76.3%	-9.2%
Mar	31,359	100.0%	100.0%	0.0%	69,481	98.7%	88.2%	-10.5%	116,827	72.4%	67.1%	-5.3%
Apr	30,347	100.0%	100.0%	0.0%	67,240	100.0%	93.4%	-6.6%	113,058	78.9%	72.4%	-6.6%
May	31,359	100.0%	100.0%	0.0%	69,481	100.0%	100.0%	0.0%	116,827	90.8%	85.5%	-5.3%
Jun	30,347	100.0%	100.0%	0.0%	67,240	100.0%	97.4%	-2.6%	113,058	88.2%	77.6%	-10.5%
Jul	31,359	100.0%	100.0%	0.0%	58,413	100.0%	93.4%	-6.6%	81,779	92.1%	86.8%	-5.3%
Aug	31,359	97.4%	100.0%	2.6%	58,413	96.1%	88.2%	-7.9%	81,779	82.9%	61.8%	-21.1%
Sep	30,347	98.7%	98.7%	0.0%	56,529	96.1%	94.7%	-1.3%	79,141	84.2%	75.0%	-9.2%
Oct	31,359	96.1%	98.7%	2.6%	58,413	94.7%	84.2%	-10.5%	81,779	69.7%	67.1%	-2.6%
Nov	30,347	98.7%	100.0%	1.3%	54,744	92.1%	84.2%	-7.9%	85,686	69.7%	65.8%	-3.9%
Dec	31,359	100.0%	97.4%	-2.6%	56,569	92.1%	81.6%	-10.5%	88,542	67.1%	64.5%	-2.6%
Brazos River at Richmond												
Jan	33,818	98.7%	98.7%	0.0%	60,873	90.8%	90.8%	0.0%	101,455	75.0%	71.1%	-3.9%
Feb	30,546	100.0%	100.0%	0.0%	54,982	100.0%	100.0%	0.0%	91,637	80.3%	77.6%	-2.6%
Mar	33,818	100.0%	100.0%	0.0%	73,170	96.1%	97.4%	1.3%	131,584	69.7%	67.1%	-2.6%
Apr	32,727	100.0%	100.0%	0.0%	70,810	96.1%	97.4%	1.3%	127,339	72.4%	69.7%	-2.6%
May	33,818	100.0%	100.0%	0.0%	73,170	100.0%	100.0%	0.0%	131,584	84.2%	80.3%	-3.9%
Jun	32,727	100.0%	100.0%	0.0%	70,810	98.7%	98.7%	0.0%	127,339	81.6%	75.0%	-6.6%
Jul	33,818	100.0%	100.0%	0.0%	57,184	97.4%	98.7%	1.3%	81,779	90.8%	90.8%	0.0%
Aug	33,818	96.1%	100.0%	3.9%	57,184	93.4%	96.1%	2.6%	81,779	78.9%	78.9%	0.0%
Sep	32,727	98.7%	98.7%	0.0%	55,339	94.7%	97.4%	2.6%	79,141	85.5%	86.8%	1.3%
Oct	33,818	96.1%	98.7%	2.6%	57,184	96.1%	98.7%	2.6%	81,779	77.6%	76.3%	-1.3%
Nov	32,727	97.4%	98.7%	1.3%	58,909	89.5%	90.8%	1.3%	98,182	73.7%	69.7%	-3.9%
Dec	33,818	100.0%	100.0%	0.0%	60,873	89.5%	89.5%	0.0%	101,455	67.1%	65.8%	-1.3%

Table 6-7. Changes in percent of time subsistence and base flow e-flows are equaled or exceeded for Year 2070 conditions for Baseline and With WMSs models.

Month	SUBSISTENCE FLOWS Flow (acft/mo)	SUBSISTENCE FLOWS Baseline 2070 % Time Met	SUBSISTENCE FLOWS With WMSs 2070 %Time Met	SUBSISTENCE FLOWS Delta %	BASE FLOWS - DRY CONDITIONS Flow (acft/mo)	BASE FLOWS - DRY CONDITIONS Baseline 2070 % Time Met	BASE FLOWS - DRY CONDITIONS With WMSs 2070 %Time Met	BASE FLOWS - DRY CONDITIONS Delta %	BASE FLOWS - AVERAGE CONDITIONS Flow (acft/mo)	BASE FLOWS - AVERAGE CONDITIONS Baseline 2070 % Time Met	BASE FLOWS - AVERAGE CONDITIONS With WMSs 2070 %Time Met	BASE FLOWS - AVERAGE CONDITIONS Delta %
Double Mountain Fork Brazos River near Aspermont												
Jan	61	81.6%	81.6%	0.0%	61	81.6%	81.6%	0.0%	246	64.5%	64.5%	0.0%
Feb	56	86.8%	86.8%	0.0%	56	86.8%	86.8%	0.0%	222	76.3%	76.3%	0.0%
Mar	61	84.2%	84.2%	0.0%	61	84.2%	84.2%	0.0%	184	72.4%	72.4%	0.0%
Apr	60	93.4%	93.4%	0.0%	60	93.4%	93.4%	0.0%	179	88.2%	86.8%	-1.3%
May	61	100.0%	100.0%	0.0%	61	100.0%	100.0%	0.0%	184	96.1%	96.1%	0.0%
Jun	60	98.7%	98.7%	0.0%	60	98.7%	98.7%	0.0%	179	98.7%	98.7%	0.0%
Jul	61	94.7%	94.7%	0.0%	61	94.7%	94.7%	0.0%	123	90.8%	90.8%	0.0%
Aug	61	92.1%	92.1%	0.0%	61	92.1%	92.1%	0.0%	123	88.2%	89.5%	1.3%
Sep	60	90.8%	90.8%	0.0%	60	90.8%	90.8%	0.0%	119	86.8%	86.8%	0.0%
Oct	61	88.2%	88.2%	0.0%	61	88.2%	88.2%	0.0%	123	82.9%	82.9%	0.0%
Nov	60	85.5%	85.5%	0.0%	60	85.5%	85.5%	0.0%	238	73.7%	73.7%	0.0%
Dec	61	78.9%	78.9%	0.0%	61	78.9%	78.9%	0.0%	246	63.2%	63.2%	0.0%
Brazos River near South Bend												
Jan	61	97.4%	97.4%	0.0%	2,214	77.6%	76.3%	-1.3%	4,489	53.9%	53.9%	0.0%
Feb	56	97.4%	97.4%	0.0%	1,999	81.6%	81.6%	0.0%	4,054	57.9%	56.6%	-1.3%
Mar	61	98.7%	98.7%	0.0%	1,783	85.5%	85.5%	0.0%	3,689	68.4%	63.2%	-5.3%
Apr	60	100.0%	100.0%	0.0%	1,726	88.2%	88.2%	0.0%	3,570	73.7%	72.4%	-1.3%
May	61	98.7%	98.7%	0.0%	1,783	93.4%	92.1%	-1.3%	3,689	89.5%	89.5%	0.0%
Jun	60	98.7%	98.7%	0.0%	1,726	97.4%	97.4%	0.0%	3,570	94.7%	93.4%	-1.3%
Jul	61	100.0%	100.0%	0.0%	984	89.5%	89.5%	0.0%	2,828	78.9%	80.3%	1.3%
Aug	61	98.7%	98.7%	0.0%	984	85.5%	85.5%	0.0%	2,828	69.7%	69.7%	0.0%
Sep	60	94.7%	94.7%	0.0%	952	88.2%	88.2%	0.0%	2,737	78.9%	76.3%	-2.6%
Oct	61	98.7%	98.7%	0.0%	984	86.8%	86.8%	0.0%	2,828	80.3%	80.3%	0.0%
Nov	60	97.4%	97.4%	0.0%	2,142	81.6%	81.6%	0.0%	4,344	68.4%	67.1%	-1.3%
Dec	61	93.4%	93.4%	0.0%	2,214	76.3%	76.3%	0.0%	4,489	61.8%	61.8%	0.0%

Month	SUBSISTENCE FLOWS Flow (acft/mo)	Baseline 2070 % Time Met	With WMSs 2070 %Time Met	Delta %	BASE FLOWS - DRY CONDITIONS Flow (acft/mo)	Baseline 2070 % Time Met	With WMSs 2070 %Time Met	Delta %	BASE FLOWS - AVERAGE CONDITIONS Flow (acft/mo)	Baseline 2070 % Time Met	With WMSs 2070 %Time Met	Delta %
Brazos River near Glen Rose												
Jan	984	78.9%	81.6%	2.6%	2,582	71.1%	61.8%	-9.2%	4,735	67.1%	55.3%	-11.8%
Feb	889	80.3%	81.6%	1.3%	2,333	68.4%	64.5%	-3.9%	4,276	61.8%	53.9%	-7.9%
Mar	984	84.2%	84.2%	0.0%	2,890	77.6%	72.4%	-5.3%	5,657	69.7%	64.5%	-5.3%
Apr	952	89.5%	88.2%	-1.3%	2,797	77.6%	72.4%	-5.3%	5,474	71.1%	67.1%	-3.9%
May	984	90.8%	88.2%	-2.6%	2,890	81.6%	80.3%	-1.3%	5,657	77.6%	73.7%	-3.9%
Jun	952	93.4%	92.1%	-1.3%	2,797	86.8%	88.2%	1.3%	5,474	78.9%	78.9%	0.0%
Jul	984	81.6%	78.9%	-2.6%	2,275	78.9%	75.0%	-3.9%	4,304	73.7%	71.1%	-2.6%
Aug	984	86.8%	85.5%	-1.3%	2,275	81.6%	75.0%	-6.6%	4,304	76.3%	68.4%	-7.9%
Sep	952	92.1%	93.4%	1.3%	2,202	81.6%	77.6%	-3.9%	4,165	78.9%	71.1%	-7.9%
Oct	984	86.8%	88.2%	1.3%	2,275	75.0%	75.0%	0.0%	4,304	71.1%	71.1%	0.0%
Nov	952	81.6%	78.9%	-2.6%	2,499	69.7%	61.8%	-7.9%	4,582	64.5%	52.6%	-11.8%
Dec	984	81.6%	81.6%	0.0%	2,582	65.8%	61.8%	-3.9%	4,735	65.8%	59.2%	-6.6%
Little River near Cameron												
Jan	1,968	100.0%	100.0%	0.0%	6,764	81.6%	80.3%	-1.3%	11,683	68.4%	67.1%	-1.3%
Feb	1,777	96.1%	96.1%	0.0%	6,109	92.1%	88.2%	-3.9%	10,552	82.9%	73.7%	-9.2%
Mar	1,968	98.7%	98.7%	0.0%	8,608	89.5%	85.5%	-3.9%	19,061	65.8%	57.9%	-7.9%
Apr	1,904	97.4%	97.4%	0.0%	8,331	85.5%	84.2%	-1.3%	18,446	73.7%	72.4%	-1.3%
May	1,968	98.7%	98.7%	0.0%	8,608	97.4%	96.1%	-1.3%	19,061	86.8%	81.6%	-5.3%
Jun	1,904	97.4%	97.4%	0.0%	8,331	89.5%	89.5%	0.0%	18,446	78.9%	76.3%	-2.6%
Jul	1,968	97.4%	97.4%	0.0%	5,964	85.5%	82.9%	-2.6%	9,838	75.0%	72.4%	-2.6%
Aug	1,968	90.8%	92.1%	1.3%	5,964	67.1%	69.7%	2.6%	9,838	59.2%	53.9%	-5.3%
Sep	1,904	97.4%	97.4%	0.0%	5,772	82.9%	80.3%	-2.6%	9,521	71.1%	71.1%	0.0%
Oct	1,968	93.4%	90.8%	-2.6%	5,964	78.9%	76.3%	-2.6%	9,838	71.1%	63.2%	-7.9%
Nov	1,904	94.7%	94.7%	0.0%	6,545	78.9%	73.7%	-5.3%	11,306	69.7%	60.5%	-9.2%
Dec	1,968	96.1%	96.1%	0.0%	6,764	84.2%	78.9%	-5.3%	11,683	71.1%	61.8%	-9.2%

	SUBSISTENCE FLOWS				BASE FLOWS - DRY CONDITIONS				BASE FLOWS - AVERAGE CONDITIONS			
Month	Flow (acft/mo)	Baseline 2070 % Time Met	With WMSs 2070 %Time Met	Delta %	Flow (acft/mo)	Baseline 2070 % Time Met	With WMSs 2070 %Time Met	Delta %	Flow (acft/mo)	Baseline 2070 % Time Met	With WMSs 2070 %Time Met	Delta %
Brazos River near Hempstead												
Jan	31,359	98.7%	98.7%	0.0%	56,569	93.4%	85.5%	-7.9%	88,542	75.0%	68.4%	-6.6%
Feb	28,324	98.7%	100.0%	1.3%	51,094	98.7%	92.1%	-6.6%	79,974	85.5%	73.7%	-11.8%
Mar	31,359	100.0%	100.0%	0.0%	69,481	97.4%	89.5%	-7.9%	116,827	71.1%	65.8%	-5.3%
Apr	30,347	100.0%	100.0%	0.0%	67,240	100.0%	92.1%	-7.9%	113,058	77.6%	71.1%	-6.6%
May	31,359	100.0%	100.0%	0.0%	69,481	100.0%	100.0%	0.0%	116,827	89.5%	82.9%	-6.6%
Jun	30,347	100.0%	98.7%	-1.3%	67,240	100.0%	94.7%	-5.3%	113,058	88.2%	77.6%	-10.5%
Jul	31,359	100.0%	100.0%	0.0%	58,413	98.7%	94.7%	-3.9%	81,779	90.8%	85.5%	-5.3%
Aug	31,359	97.4%	98.7%	1.3%	58,413	96.1%	85.5%	-10.5%	81,779	82.9%	64.5%	-18.4%
Sep	30,347	98.7%	98.7%	0.0%	56,529	96.1%	86.8%	-9.2%	79,141	84.2%	67.1%	-17.1%
Oct	31,359	96.1%	98.7%	2.6%	58,413	94.7%	86.8%	-7.9%	81,779	67.1%	59.2%	-7.9%
Nov	30,347	98.7%	98.7%	0.0%	54,744	92.1%	82.9%	-9.2%	85,686	71.1%	60.5%	-10.5%
Dec	31,359	100.0%	98.7%	-1.3%	56,569	92.1%	84.2%	-7.9%	88,542	67.1%	61.8%	-5.3%
Brazos River at Richmond												
Jan	33,818	98.7%	98.7%	0.0%	60,873	90.8%	92.1%	1.3%	101,455	75.0%	67.1%	-7.9%
Feb	30,546	100.0%	100.0%	0.0%	54,982	98.7%	100.0%	1.3%	91,637	80.3%	75.0%	-5.3%
Mar	33,818	100.0%	100.0%	0.0%	73,170	96.1%	96.1%	0.0%	131,584	69.7%	65.8%	-3.9%
Apr	32,727	100.0%	100.0%	0.0%	70,810	96.1%	97.4%	1.3%	127,339	72.4%	69.7%	-2.6%
May	33,818	100.0%	100.0%	0.0%	73,170	100.0%	100.0%	0.0%	131,584	84.2%	78.9%	-5.3%
Jun	32,727	100.0%	100.0%	0.0%	70,810	97.4%	97.4%	0.0%	127,339	80.3%	76.3%	-3.9%
Jul	33,818	100.0%	100.0%	0.0%	57,184	96.1%	98.7%	2.6%	81,779	89.5%	90.8%	1.3%
Aug	33,818	96.1%	100.0%	3.9%	57,184	93.4%	96.1%	2.6%	81,779	77.6%	75.0%	-2.6%
Sep	32,727	97.4%	98.7%	1.3%	55,339	93.4%	96.1%	2.6%	79,141	84.2%	85.5%	1.3%
Oct	33,818	96.1%	98.7%	2.6%	57,184	96.1%	97.4%	1.3%	81,779	75.0%	73.7%	-1.3%
Nov	32,727	97.4%	98.7%	1.3%	58,909	89.5%	90.8%	1.3%	98,182	72.4%	64.5%	-7.9%
Dec	33,818	100.0%	100.0%	0.0%	60,873	89.5%	88.2%	-1.3%	101,455	67.1%	64.5%	-2.6%

Table 6-8. Number of months with qualifying pulse flows for Year 2040 conditions for Baseline and With WMSs models.

Season	Baseline	With WMSs
Double Mountain Fork Brazos River near Aspermont		
Spring	129	131
Summer	135	135
Winter	0	0
Brazos River near South Bend		
Spring	146	135
Summer	159	154
Winter	0	0
Brazos River near Glen Rose		
Spring	118	105
Summer	147	116
Winter	115	96
Little River near Cameron		
Spring	140	134
Summer	181	156
Winter	156	141
Brazos River near Hempstead		
Spring	189	185
Summer	271	238
Winter	163	162
Brazos River at Richmond		
Spring	187	181
Summer	252	252
Winter	173	167

Table 6-9. Number of months with qualifying pulse flows for Year 2070 conditions for Baseline and With WMSs models.

Season	Baseline	With WMSs
Double Mountain Fork Brazos River near Aspermont		
Spring	129	131
Summer	135	135
Winter	0	0
Brazos River near South Bend		
Spring	146	135
Summer	159	154
Winter	0	0
Brazos River near Glen Rose		
Spring	119	104
Summer	146	112
Winter	115	94
Little River near Cameron		
Spring	139	134
Summer	189	169
Winter	149	142
Brazos River near Hempstead		
Spring	187	183
Summer	268	232
Winter	163	157
Brazos River at Richmond		
Spring	187	177
Summer	247	246
Winter	172	163

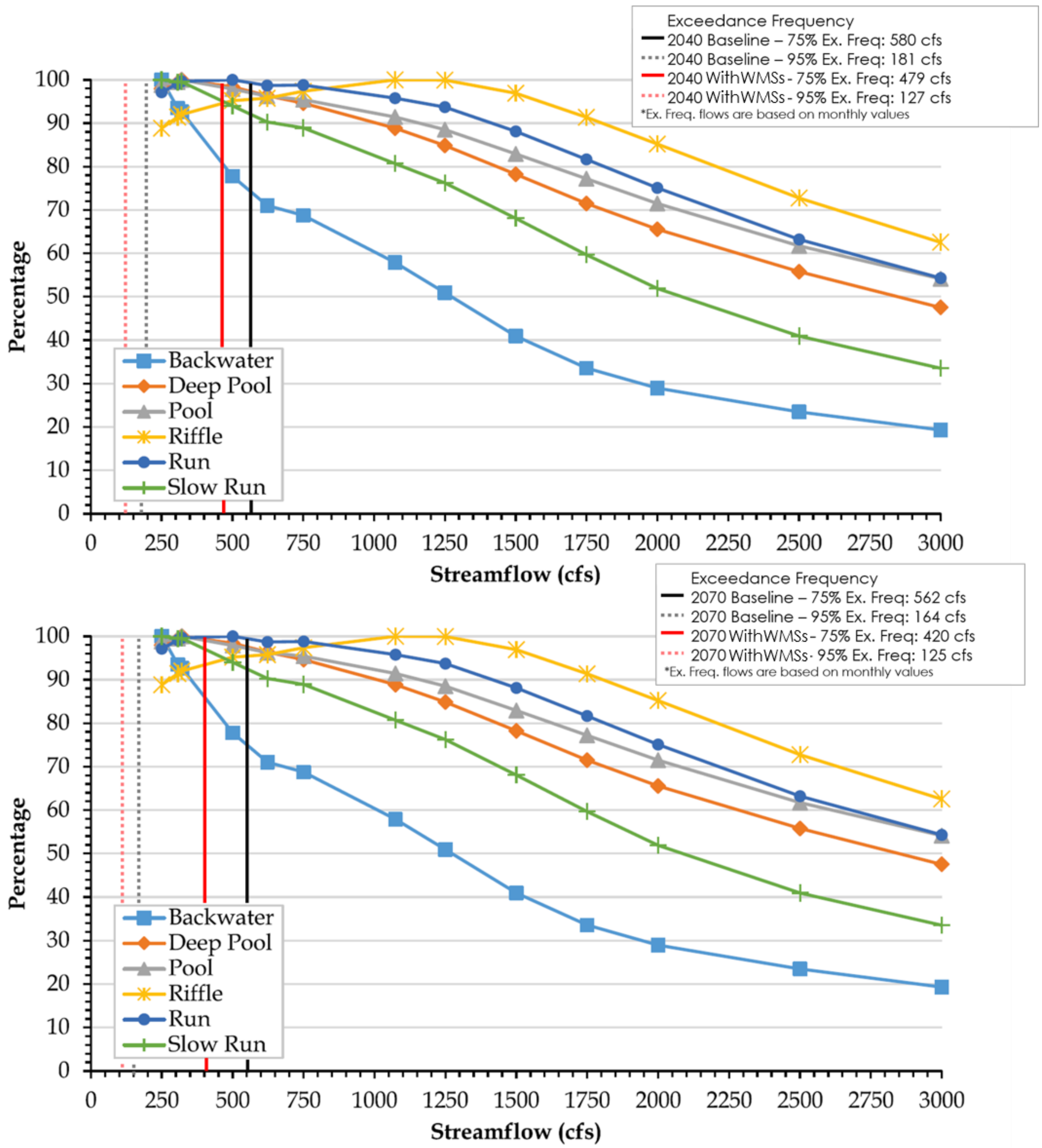


Figure 6-25. Regulated flows compared to usable habitat area, Brazos River near Marlin for Year 2040 and Year 2070 conditions for Baseline and With WMSs models (figure source: 2018 Instream Flow Study).

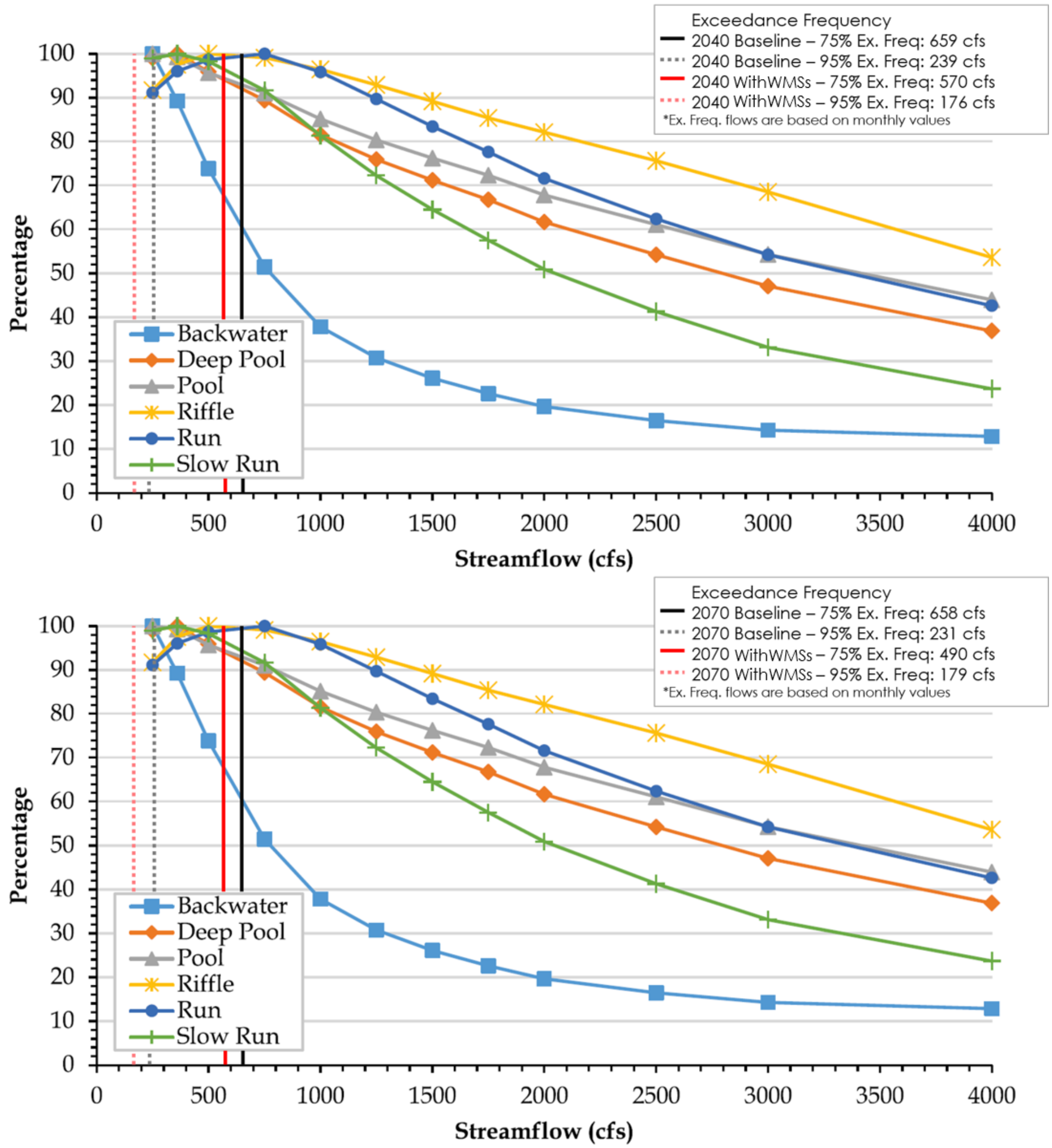


Figure 6-26. Regulated flows compared to usable habitat area, Brazos River near Hearn for Year 2040 and Year 2070 conditions for Baseline and With WMSs models (figure source: 2018 Instream Flow Study).

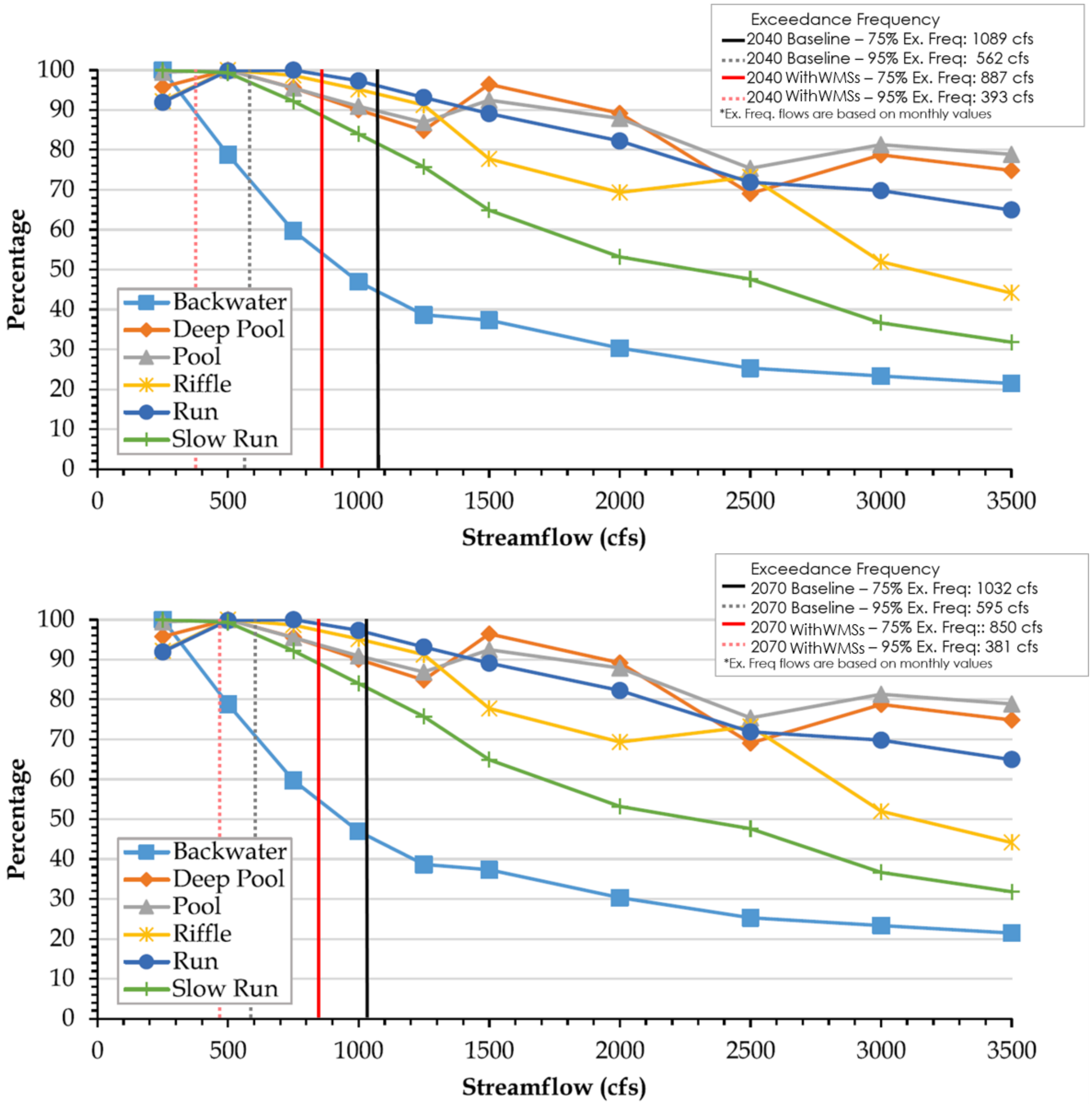


Figure 6-27. Regulated flows compared to usable habitat area, Brazos River near Mussel Shoals for Year 2040 and Year 2070 conditions for Baseline and With WMSs models (figure source: 2018 Instream Flow Study).

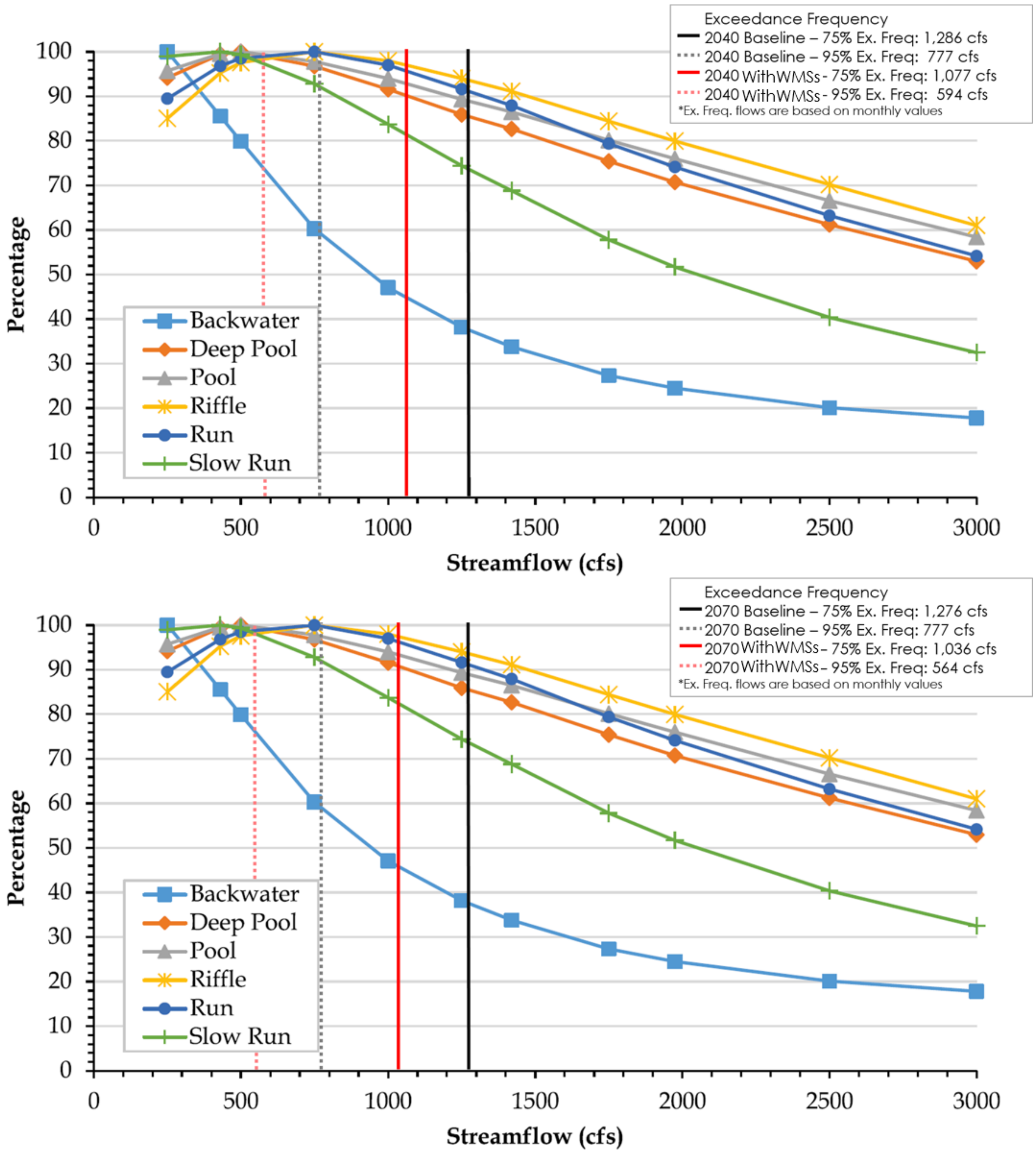


Figure 6-28. Regulated flows compared to usable habitat area, Brazos River near Navasota for Year 2040 and Year 2070 conditions for Baseline and With WMSs models (figure source: 2018 Instream Flow Study).

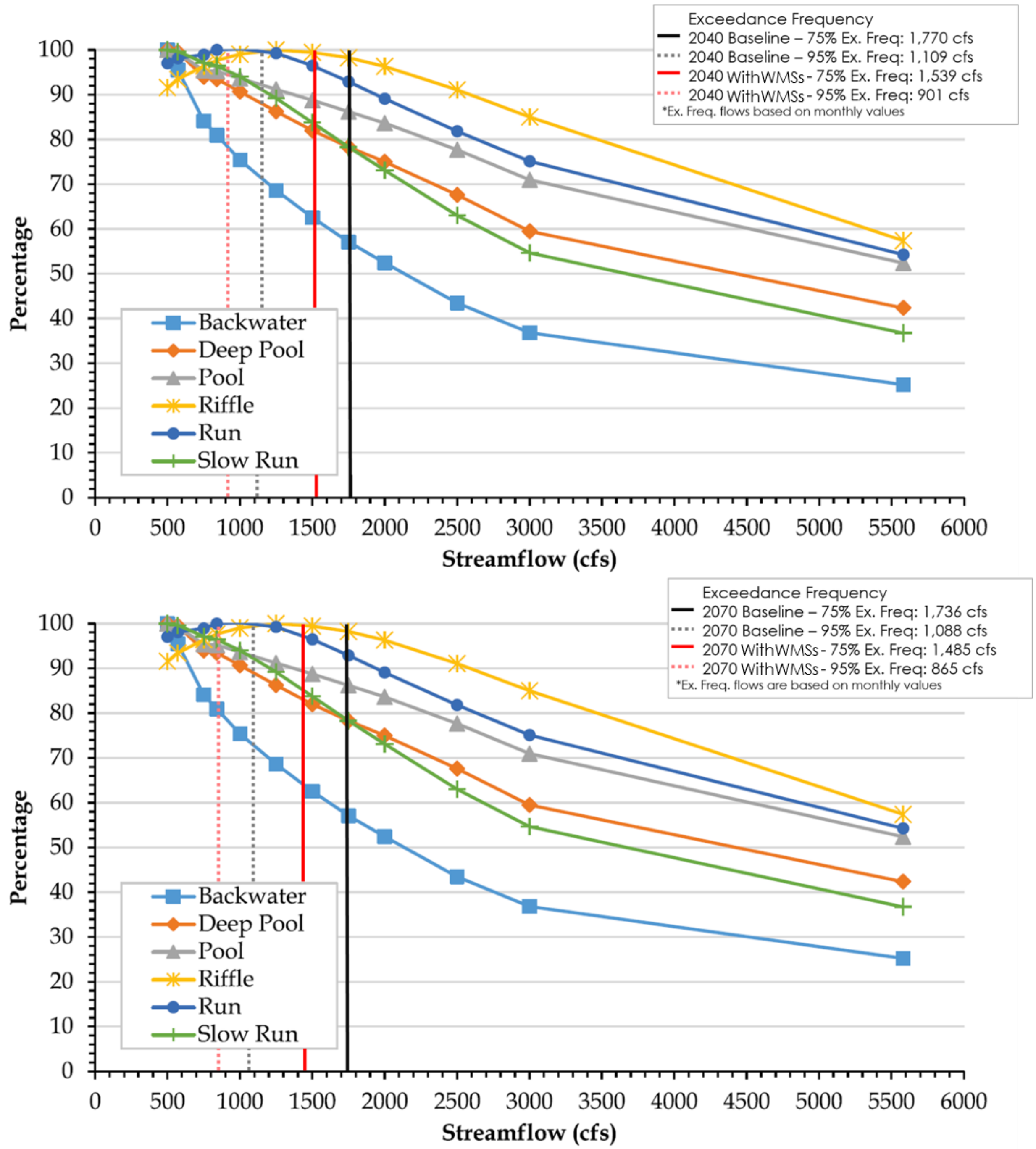


Figure 6-29. Regulated flows compared to usable habitat area, Brazos River near Wildcat Bend for Year 2040 and Year 2070 conditions for Baseline and With WMSs models (figure source: 2018 Instream Flow Study).

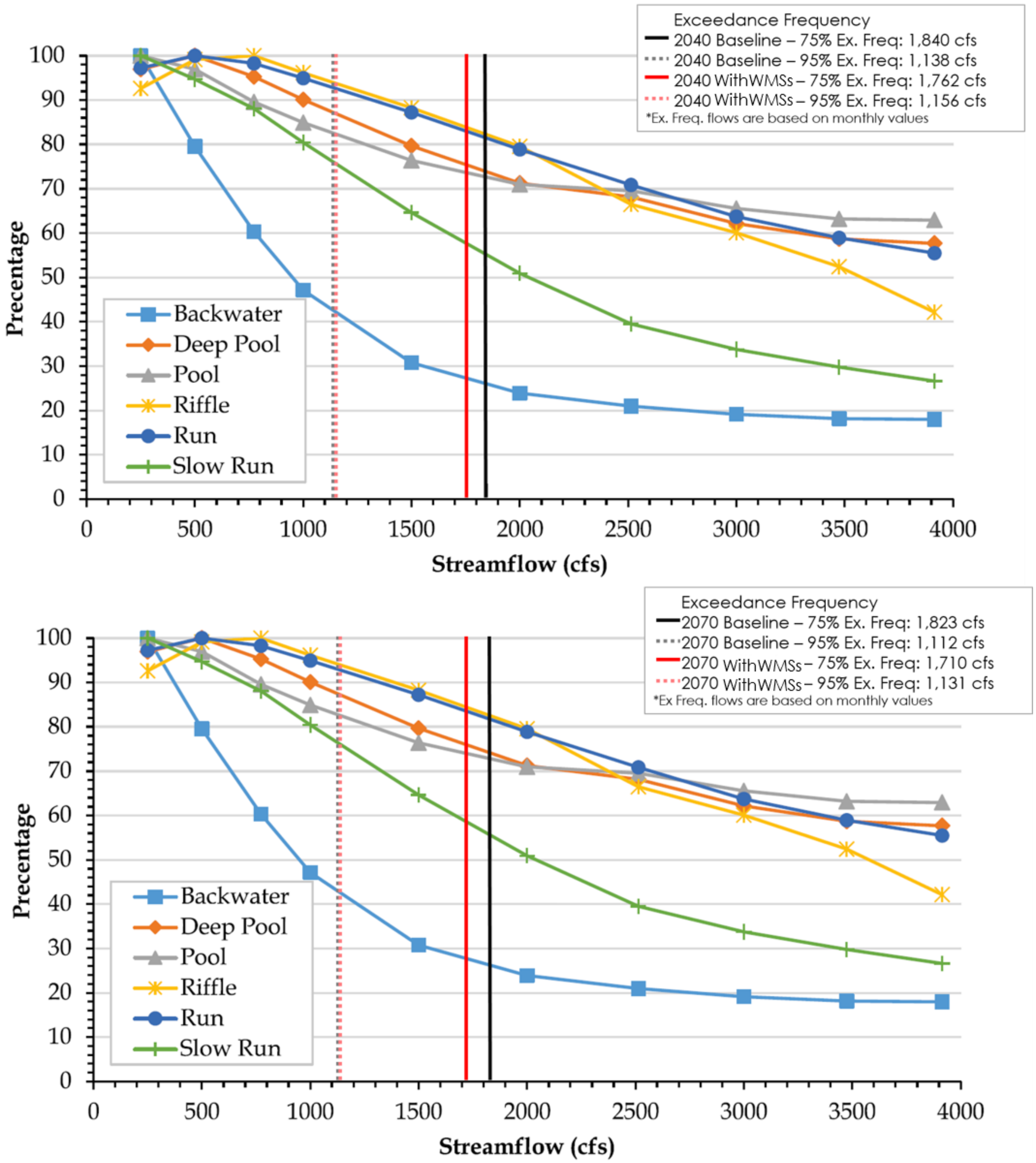


Figure 6-30. Regulated flows compared to usable habitat area, Brazos River near Allen's Creek for Year 2040 and Year 2070 conditions for Baseline and With WMSs models (figure source: 2018 Instream Flow Study).

Appendix – TWDB Comments Received on the Draft User's Guide and Responses

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REQUIRED CHANGES

General Draft Final Report Comments:

1. Page 1:

Current wording: Many RWPGs have a limited number of strategies anticipated to effect surface streamflows, and RWPGs who determine that the recommended methodology is not applicable should coordinate with TWDB staff as they develop methodologies applicable to their unique situations.

Requested wording: Many RWPGs have a limited number of strategies anticipated to affect surface streamflow, and RWPGs who determine that the recommended methodology is not applicable should coordinate with TWDB staff as they develop methodologies applicable to their unique situations.

Response: The misspelling has been corrected.

2. Refer to the Texas Water Code § 11.0235 instead of "SB3" on first introduction of environmental flow standards.

For example, page 2:

Current wording: "Sites at which the Texas Commission on Environmental Quality (TCEQ) has adopted Senate Bill 3 (SB3) e-flows standards."

Requested wording: "Sites at which the Texas Commission on Environmental Quality (TCEQ) has adopted e-flows standards (Texas Water Code § 11.0235, hereafter referred to as "SB3 e-flows standards" or "SB3")."

Response: The suggested wording has been incorporated.

3. Italicize "i.e."

Response: All occurrences of "*i.e.*" have been italicized.

4. Keep captions together with figures and tables. See Table 3-2 and Figure 6-8.

Response: The formatting has been corrected.

5. Spell out "vs" when used in the body of the text as "versus".

Response: "Vs" has been replaced with "versus", except in instances where "vs" is used within a variable or tab name.

6. Spell out ASR on first use.

Response: Aquifer storage and recovery is spelled out and "ASR" is defined on first use.

Specific Draft Final Report Comments:

1. Page 2, Alternative 1: Consider bolding the text that differentiates between alternative 1 and 2.

Response: The text has been bolded to differentiate between alternatives 1, 2, and 3.

2. Page 3, Item 3a:

   Current wording: Strategies requiring new or amended surface water rights authorizing new appropriations should be included in the applicable WAM as similarly as possible to the configuration and operation of the recommended water management strategy when supplies available to that strategy were determined.

   Requested wording: Strategies requiring new or amended surface water rights authorizing new appropriations should be included in the applicable WAM in a manner that reproduces, to the extent possible, the configuration and operation of the recommended water management strategy when supplies available to that strategy were determined.

Response: The requested wording has been added.

3. Page 6, Item 5: Consider discussing the type of graphs and why those were selected display the data.

Response: Additional text has been added to the section discussing the rationale for specific types of graphs.

4. Page 10, Section 3.2.2, CP list: Please include a screen shot of a sample table of control points in the CERST User's Guide.

Response: *Figure 3-2. Example control point input on CP_LIST worksheet.* has been added.

5. Page 15, Step 1: Move the arrow up so it does not block the word "ok" in step 2.

Response: The figure has been adjusted.

6. Page 33, Section 6.2.1:

   Current wording: The locations of control gages is shown in Figure 6-2 to support the discussion below related to cumulative impacts of recommended WMS on monthly regulated flows.

   Requested wording: The locations of control gages are shown in Figure 6-2 to support the discussion below related to cumulative effects of recommended WMS on monthly regulated flows.

Response: "Impacts" has been changed to "effects" as requested.

7. Page 55, discussion on Allens Creek: Please include a statement on whether Allens Creek coming online affects the attainment of e-flow standards at Richmond.

Response: The model runs employed do not provide sufficient information to determine the effects of a specific recommended water management strategy. In order to determine the specific effects of Allens Creek Reservoir coming online, model simulations would be required that incorporate, alternatively, "all recommended strategies" and "all recommended strategies less Allens Creek Reservoir." Furthermore, an evaluation based solely on monthly flows might be misleading when attempting to determine if a specific project affects the attainment of e-flows standards that are based on daily flows.

The following text has been added to the discussion surrounding the seniority of Allens Creek Reservoir compared to the TCEQ e-flows standards.

> "Because Allens Creek Reservoir is senior to the TCEQ e-flow standards, it may affect the attainment of the TCEQ e-flows standards, but the project's complicated interaction with BRA System Operations requires a more detailed analysis than is provided here to quantify its specific effects."

8. Page 72, Section 6.2.4:

Please replace:

- Overall, none of the locations in the Brazos River Basin are expected to experience significantly different streamflows with implementation of the water management strategies that are recommended in the 2021 Region O, Brazos G, and Region H Regional Water Plans.

With the following:

- With the implementation of water management strategies recommended in the 2021 Region O, Brazos G, and Region H Water, there are expected to be decreases in the percent of time base flow e-flows standards are met in all months in the 2040 With Plan and 2070 With Plan conditions for Baseflows – Dry Condition and Baseflows - Average Condition for the Brazos River at Glen Rose, Little River near Cameron, and the Brazos River near Hempstead. For the Brazos River at Glen Rose, the percent of time subsistence flow are met is expected to reduce in February and June through December in the 2040 With Plan condition. For the Brazos River at Richmond, Baseflows – Average Conditions, the percent of time baseflow e-flow standards are met in the Baseflows- Average Condition is expected to decrease under the 2040 With Plan and 2070 With Plan conditions.

Response: The following text was added, which is the requested text with some minor edits:

"With the implementation of water management strategies recommended in the 2021 Region O, Brazos G, and Region H Water, there are expected to be decreases in the percent of time baseflow e-flows standards are met in all months in the 2040 With WMSs and 2070 With WMSs scenarios for Baseflows – Dry Condition and Baseflows – Average Condition for the Brazos River at Glen Rose, Little River near Cameron, and the Brazos River near Hempstead. For the Brazos River at Glen Rose, the percent of time subsistence flows are met is expected to reduce in February and June through December in the 2040 With WMSs scenario. For the Brazos River at Richmond, the percent of time Baseflows – Average Conditions e-flow standards are met is expected to decrease under the 2040 With WMSs and 2070 With WMSs scenarios."

SUGGESTED CHANGES

Specific Draft Final Report Comments:

1. Consider changing "With WMSs yyyy" to be "with WMSs yyyy", because the baseline model is also a planning model. (Note, this comment is for the CERST excel tool).

Response: The requested change has been incorporated into the report text and the CERST tool.

2. Consider changing sheet name "EFlow-Brazos" to be "SB3-EFS-Brazos", where EFS refers to Environmental Flow Standards.

Response: The requested change has been incorporated into the report text and the CERST tool.