Evaluation of “With Project” Base Conditions Report

(Part II Deliverable B-2.5.1b)

KCOL Surface Water Supply Availability Study

(Contract No. 4600000933-WO01)

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AFET	Alternative Formulation/Evaluation Tool
ASCII	American Standard Code for Information Exchange
C&SF	Central and Southern Florida
cfs	cubic feet per second
DEM	Digital Elevation Model
DHI	Danish Hydraulic Institute
ECFT	East Central Florida Transient
GIS	Geographic Information System
HESM	Hydrologic and Environmental Systems Modeling
ICA	Irrigation Command Area
ICU	Intermediate Confining Unit
KBMOS	Kissimmee Basin Modeling and Operations Study
KCOL	Kissimmee Chain of Lakes
KRRP	Kissimmee River Restoration Project
KUB	Kissimmee Upper Basin
LKB	Lower Kissimmee Basin
MAE	Mean Absolute Error
ME	Mean Error
MG	Million Gallons
PET	Potential Evapotranspiration
PWS	Public Water Supply
RET	Reference Evapotranspiration
RMSE	Root Mean Squared Error
SAS	Surficial Aquifer System
SFWMD	South Florida Water Management District
SJRWMD	St. Johns River Water Management District
SWFWMD	Southwest Florida Water Management District
UFAS	Upper Floridan Aquifer System
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey

1 INTRODUCTION

This document describes the results and the drivers of the "with project" base condition run. This base condition run was defined for use in the evaluation of Kissimmee Basin Modeling and Operations Study (KBMOS) alternative plans, development of the "with project" target and reservation timeseries for the Kissimmee Basin water reservation and the evaluation of proposed surface water supply withdrawals made under the selected plan for the KBMOS. The "with project" base condition model incorporated Alternative Formulation/Evaluation Tool (AFET) model improvements associated with the recalibration effort (Earth Tech 2008a) and the Kissimmee River Floodplain Hydraulic Model (Earth Tech 2008b), including use of a new reference evapotranspiration (RET) data set produced by the South Florida Water Management District (SFWMD) (SFWMD 2008). The recalibrated model is referred to as the AFET-W. The "with project" base condition run was executed using the SFWMD accepted version of the AFET-W.

Base conditions are the results from a calibrated model simulation that used a fixed set of conditions over a defined period of record. Base conditions are used to predict basin response under those conditions. The base conditions defined and used for the "with project" base conditions combine the existing hydrologic conditions of the watershed (land use, water use) with the future hydraulic conditions (infrastructure, operations, etc.). These two components were augmented by climate drivers and other boundary conditions that were held constant throughout the study. The following sections describe the components of the "with project" base condition definition in detail, along with the following:

- Definition of the period of simulation (1965 to 2005)
- Climate drivers (RET and rainfall)
- Boundary conditions
  - Tailwater timeseries for the S-65E Structure
  - Lateral and horizontal groundwater boundary conditions
- Hydrologic conditions of the basin (land use, water use)
  - Year 2000 Land Use/Cover
  - Existing Legal Uses of Water
- Hydraulic conditions of the basin (operations, infrastructure, etc.)
  - Complete restoration of the Kissimmee River including Kissimmee River Headwaters Revitalization Project

1.1 Overview of AFET and AFET-W Calibration Efforts

The AFET was a fully integrated model that coupled the formulation tool (MIKE 11) with a watershed model that included overland and groundwater flow (MIKE SHE) that was developed for application as part of the KBMOS. The development and calibration of the AFET was documented in the "Alternative Formulation Evaluation Tool Model

Documentation and Calibration Report" (Earth Tech 2007a). Peer Review of the development and proposed application of the AFET was completed in June 2008. The Peer Review Panel recommended that new RET data be used to calibrate the model. This work was completed and was documented in the Draft Calibration AFET-W Calibration Report (Earth Tech 2008a). The main differences between the AFET-W and the AFET were that the AFET-W was calibrated with an improved set of RET data (differences between RET data sets will be detailed later in the document) and the AFET-W was also calibrated to match the behavior of observation wells in the Floridan Aquifer, while the AFET used a qualitative approach based on seasonal potentiometric maps.

Both the AFET and the AFET-W were run in two stages. The first stage involved the running of a 3-layer model that included the Upper Floridan Aquifer System (UFAS), the Intermediate Confining Unit (ICU) and the Surficial Aquifer System (SAS), in addition to the surface water network. This model has a 3,000 foot grid cell size. Fluxes between the UFAS and the ICU were extracted from this model run (a.k.a. the 3K model) and used as boundary conditions for a more detailed model that only included one layer in the groundwater portion (SAS). The one-layer model has a finer grid (1,000 feet). The one-layer model is known as the 1K model. Results from the 1K model were used to evaluate stages and flow in the Kissimmee Basin. The calibration of the AFET and the AFET-W followed the same approach, where successive model runs were made for the 3K and 1K models to refine the model parameters to achieve the calibration targets. (Earth Tech 2007a and Earth Tech 2008a)

The original calibration of the AFET used the following periods:

- Model Calibration - 2001 through 2004
- Model Verification - 1994 through 1998
- Storm Event Verification - 2004 Hurricane Season (August 1 – October 15, 2004)

The AFET-W calibration process focused only on model calibration and simulated the verification period of record minus the year 1994 (1995 – 1998). This period was chosen for its overlap with the SFWMD East Central Florida Transient (ECFT) MODFLOW model. During calibration, qualitative assessments of groundwater responses were made between the two models to determine reasonableness of fit between observed and predicted and between the AFET and ECFT models.

Groundwater calibration criteria used during the AFET-W calibration were also modified. The original AFET calibration used a qualitative comparison with seasonal potentiometric maps to calibrate the UFAS. The AFET-W calibration used UFAS observation wells. The AFET used the qualitative comparison because most of the observation wells did not have data during the AFET calibration period (2001-2004). The AFET-W calibration criteria were:

<u>Calibration Criteria</u>

- Surface Network
  - Stages*
    - Root mean squared error (RMSE) ≤ 2.5

        - R ≥0.5
    - Flow*
        - CE ≤15 percent
        - R ≥ 0.84
- Groundwater (both SAS and UFAS)
    - Heads
        - For primary wells, the mean error (ME) and the mean absolute error (MAE) should be less than or equal to ± 2.5 feet for 50 percent of the wells.
        - For primary wells, the ME and MAE should be less than or equal to ± 5.0 feet for 80 percent of the wells.
        - For primary wells, the RMSE should be less than or equal to ± 5.0 feet for 80 percent of the wells.
        - The overall ME should be within ± 1.0 feet and should approach zero.
        - R ≥ 0.5

*: For surface water calibration, only stations listed in the AFET documentation as "high" priority were used in the calibration refinement – (Earth Tech 2008a).

2 DESCRIPTION OF THE “WITH PROJECT” BASE CONDITIONS

2.1 “With Project” Base Conditions

Generally, basin conditions affect the basin’s hydrologic and hydraulic responses to rainfall events. Examples of these basin conditions include land use that affects rainfall-runoff relationships, basin storage and wetlands, water use that affects low flows, aquifer recharge and surface (lakes, wetlands, canals) and groundwater water levels, physical infrastructure changes such as the Kissimmee River Restoration Project (KRRP) and its various completion phases and operational changes that affect the timing and distribution of water in the basin.

While these key basin conditions were in a state of flux and change over time, the establishment of base conditions required that they be static (frozen) over the simulation period. This approach is common practice in planning studies and essential to isolate the hydrologic and hydraulic impacts of any proposed changes. The objective was to assess the range of hydrologic and hydraulic responses if the basin experienced the same long-term rainfall patterns witnessed in the past, while basin conditions remain static. Basin conditions can then be modified (i.e. new operating criteria, a different withdrawal scenario, etc.) and the model can be run using the same rainfall record to evaluate the basin’s response (as represented by a set of evaluation performance measures) to the new set of conditions.

The combination of these key conditions into simulations also required careful consideration. The “with project” base conditions combine some current watershed conditions (i.e. land use and water use) with other future features (i.e. future infrastructure and operations). The “future” features included in the “with project” base conditions were related with the implementation of the KRRP and the Kissimmee River Revitalization Project in the Kissimmee Basin.

This section divides the description of the “with project” base conditions into three parts. The first part describes the model setup (i.e. period of simulation, model used, etc.). The second part describes the model drivers portion of the base conditions and the third part describes the components of the base conditions that were a function of the description of the watershed.

2.1.1 Model Setup

The “with project” base condition model was run for 41 calendar years, including 1965 through 2005. The model used to run the “with project” base conditions was the recently calibrated AFET-W, whose calibration was documented in the Draft AFET-W Calibration Report (Earth Tech 2008a).

2.1.1.1 Downstream Boundary Conditions (S-65E-TW)

The modeling tool used a timeseries of tailwater stages at the S-65E Structure as the downstream boundary conditions. During the entire alternative plan selection process, a single timeseries was used. The United States Army Corps of Engineers (USACE) Lake

Okeechobee Regulation Schedule Study was selected to be used as boundary conditions in the KBMOS. The criteria used for this selection is presented in Earth Tech 2007b.

2.1.1.2 Groundwater Boundary Conditions

The "with project" base conditions were run in two stages. The first stage was the 3-layer, 3,000 foot grid size model (a.k.a. the 3K model). This model used a repeating annual pattern of lateral boundary conditions obtained from United States Geological Survey (USGS) seasonal potentiometric maps for the UFAS (included in Figure 2-1 and Figure 2-2) and no flow boundaries for the SAS. The second stage, the 1-layer, 1,000 foot grid size, used boundary conditions extracted from the 3K model and no boundary flows for the SAS.

There were four sets of boundary conditions, including the lateral flow boundary conditions along the SAS, the lateral flow boundary conditions for the UFAS, the vertical flow boundary conditions at the bottom of the UFAS for the 3-layered configuration of the AFET-W and the vertical flow boundary conditions of the SAS for the 1-layered configuration of the AFET-W. These sets were defined as follows:

- Lateral flow for the SAS - A no flux boundary was used in the "with project" base conditions as it was the case during the calibration of the AFET-W. The base condition evaluation should not use a set of boundary conditions that is different from the one used in the calibration.
- Lateral flow in the UFAS - A variable-head boundary condition was used in the "with project" base conditions. This variable head was obtained from the USGS available potentiometric maps similar to the maps shown in Figure 2-1 and Figure 2-2. Since these maps were seasonal, linear interpolation was used to obtain daily values.
- Vertical flow boundary conditions at the bottom of the SAS throughout the model domain were needed for the 1-layered configuration of the AFET-W. These boundary conditions were extracted from the 3-layer results. Extracted values corresponded to daily heads at each cell grid (3,000 foot grid cell).
- Vertical flow boundary conditions at the bottom of the UFAS throughout the model domain were needed for the 3-layered configuration of the AFET-W. A no flux condition was assumed for both the calibration and the "with project" base condition simulation.

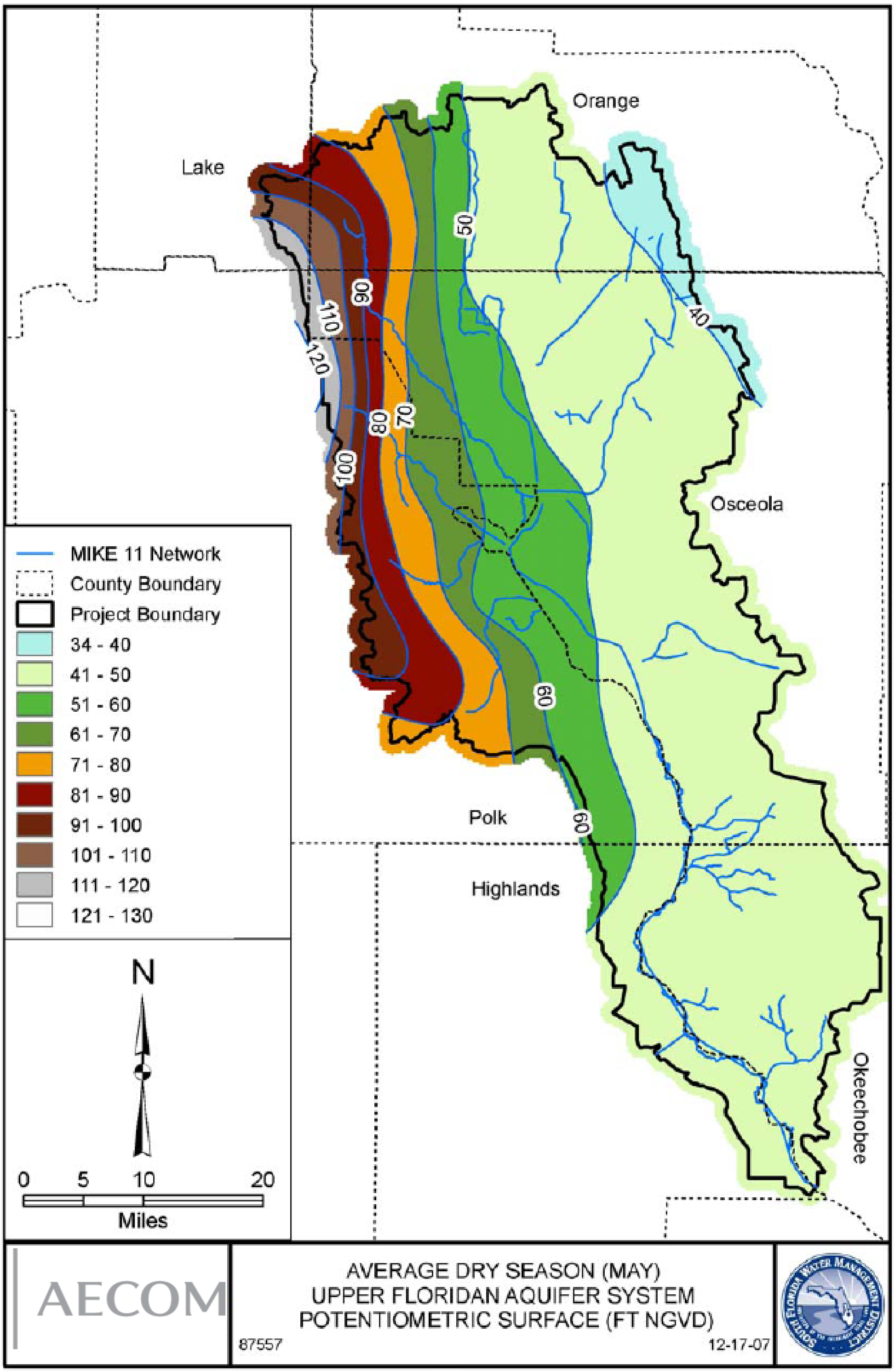

Figure 2-1: Average Dry Season (May) UFAS Potentiometric Surface Used to Extract Lateral Boundary Conditions (USGS)

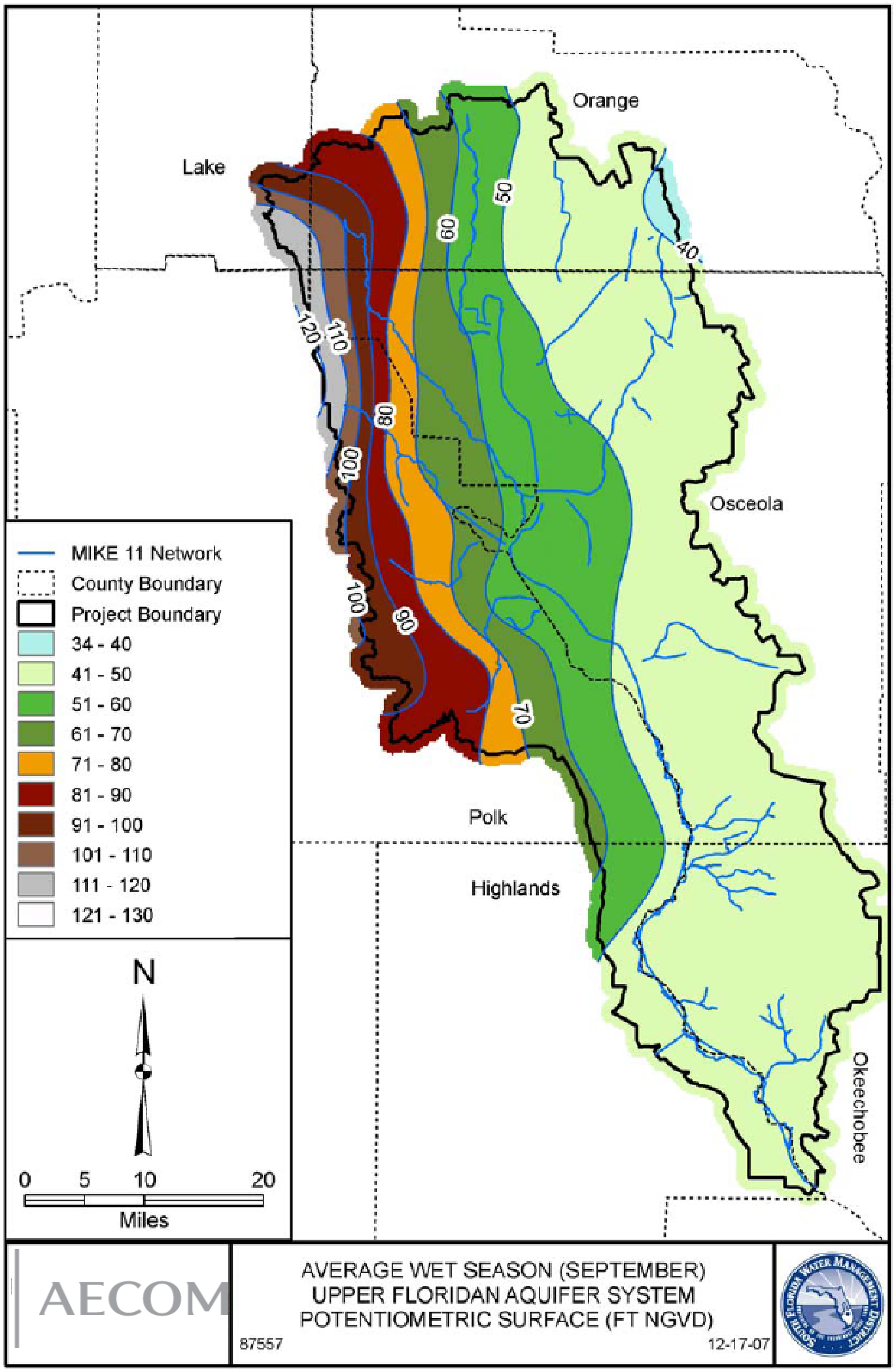

Figure 2-2: Average Wet Season (September) UFAS Potentiometric Surface Used to Extract Lateral Boundary Conditions. (USGS)

2.1.2 Model Drivers

2.1.2.1 Historic Rainfall (1965 – 2005)

The model used spatially varied rainfall data obtained from a 2-mile square grid matrix provided by Hydrologic and Environmental Systems Modeling (HESM) – SFWMD for the 1965 to 2005 period. This period included a wide variety of wet and dry years (Figure 2-3), as well as years where extreme conditions were observed (1994 and 2000). Figure 2-4 shows a frequency analysis of the rainfall being used to drive the study modeling tools. This figure shows that the annual rainfall during the simulation period was evenly distributed around the mean. This distribution was similar to the normal distribution, also included in the figure. This indicated that the selected period of simulation encompassed the range of climatic conditions required to achieve a fair evaluation of alternatives.

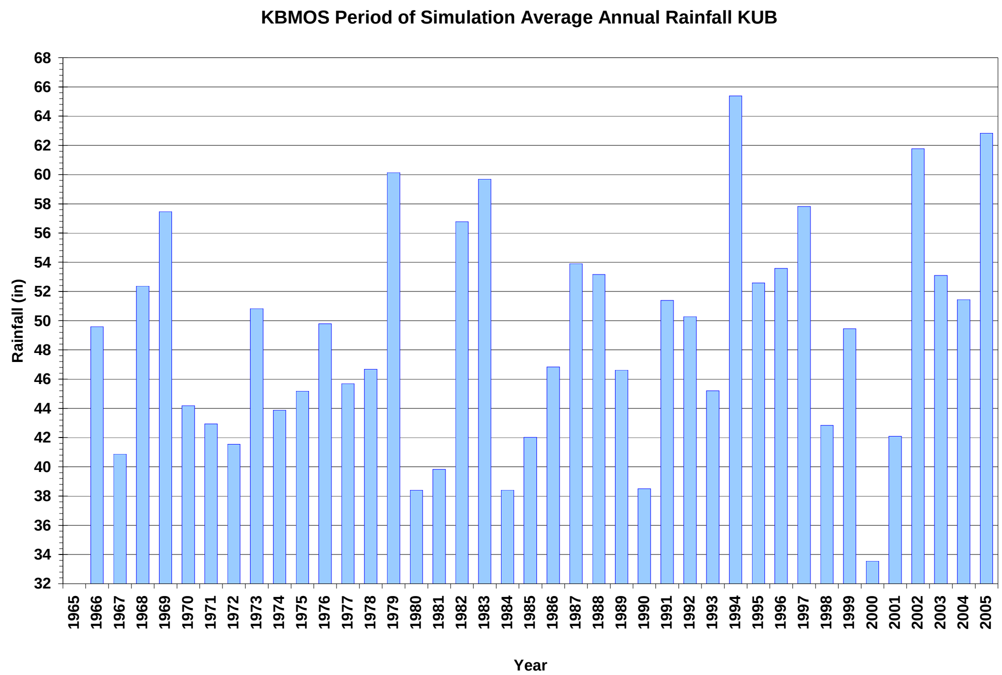

Figure 2-3: Annual Rainfall During the "With Project" Base Conditions

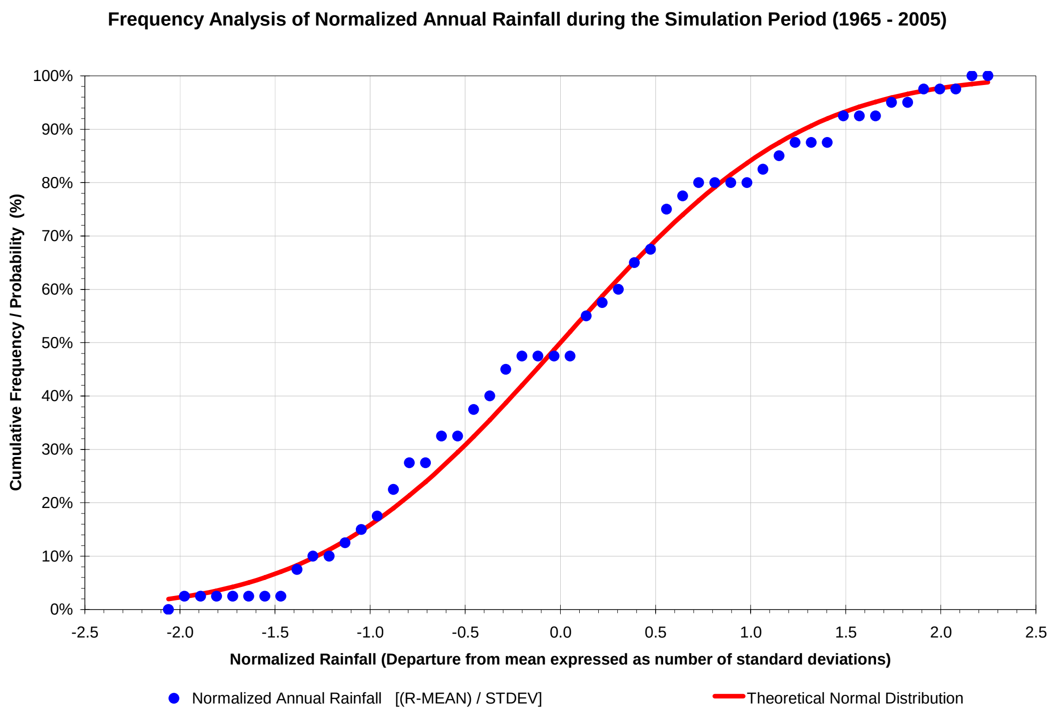

Figure 2-4: Frequency of Normalized Annual Rainfall Kissimmee Basin 1965-2005

2.1.2.2 RET

Revision Two of the RET (1965 – 2005) data set was used in the "with project" base conditions as described in Appendix A. Data were provided by HESM – SFWMD.

2.1.3 Watershed Description

Post-Phase 1 watershed conditions represented the Kissimmee Basin for the "with project" base conditions. An overview of changes in the Kissimmee Basin through recent history was presented in the Phase I Kissimmee Basin Assessment Report (Earth Tech 2005: Section 1). By 1999, the Kissimmee Upper Basin (KUB) was (and still is) the most heavily populated and intensively developed part of the Kissimmee Basin.

The total surface area of the managed lakes at normal water surface elevation, in the KUB, was approximately 10 percent of the total area of the KUB (USACE 1996). The Lower Kissimmee Basin (LKB) included the channelized and partially restored Kissimmee River and extended approximately 56 miles from the outlet at Lake Kissimmee to Lake Okeechobee. The final eight mile portion of the canal, known as Government Cut, was constructed as part of the Lake Okeechobee Levee Project and had an open water connection to Lake Okeechobee. It was hydraulically separated from the LKB by the S-65E Structure and was not considered to be part of the Kissimmee Basin.

2.1.3.1 Current Land Use (2000)

Watershed hydrologic conditions in the AFET models (both the AFET and the AFET-W) were represented by the land use layer used to drive them. Land use was probably one of the watershed components that had experienced the most changes during the previous decades. Over the past twenty years, the northern portion of Osceola County, above Lake Cypress (in the KUB), had become increasingly urbanized. Development related to Orlando’s vacation attractions was a major factor in the over sixty percent population increase in Osceola County from 1990 to 2000 (Earth Tech 2005). Citrus in the KUB, located mainly north of Lake Cypress, was the primary existing and projected water user in the Kissimmee Basin. Agriculture remains a significant land use in the Kissimmee Basin and was the primary land use activity in the LKB, being dominated by extensive beef cattle production and dairy activities. Yet, the citrus industry was shifting southward due to a series of severe freezes that occurred in the 1980s and sugar cane was becoming a significant crop in Highlands County (Earth Tech 2005: Section 1.3). The land use spatial distribution presented during 1999 was captured by the SFWMD 2000 Kissimmee Basin Land Use Layer. This layer was used to describe the watershed hydrologic conditions for the “with project” base conditions. The “with project” base conditions used the current land use, which was the same land use used for the calibration of the AFET and the AFET-W. This land use coverage was consistent with current Kissimmee Basin water supply planning efforts. A summary of the current land use is presented in Table 2-1.

Table 2-1: Summary of Year 2000 (Current) Kissimmee Basin Land Use to be used in the "With Project" Base Conditions

Land Use Category *	Land Use Code Range	Number of Parcels	Acres	Percentage of Total Parcels
Residential	**1009 – 1390**	**11,112**	**612,873**	**4.80**
Commercial	**1400 – 1490**	**3,394**	**66,636**	**1.47**
Industrial	**1500 – 1660**	**1,182**	**236,461**	**0.51**
Institutional	**1700 – 1760**	**1,556**	**32,989**	**0.67**
Recreational	**1800 – 1890**	**1,144**	**43,134**	**0.49**
Open Land	**1900 – 1940**	**726**	**65,122**	**0.31**
Agricultural	**2100 – 2610**	**15,711**	**2,389,817**	**6.79**
Upland Non-Forested	**3100 – 3300**	**14,489**	**618,967**	**6.26**
Upland Forests	**4100 – 4430**	**22,571**	**1,056,544**	**9.76**
Water	**5000 – 5600**	**23,767**	**1,139,389**	**10.28**
Wetlands	**6100 – 6530**	**132,178**	**1,842,261**	**57.15**
Barren Land	**7100 – 7430**	**1,775**	**53,047**	**0.77**
Transportation	**8100 – 8191**	**473**	**63,837**	**0.20**
Communication and Utilities	**8200 – 8390**	**1,194**	**24,463**	**0.52**
Other	**9000**	**1**	**43**	**0.00**

2.1.3.2 Status of the KRRP Infrastructure

In addition to the features of the KRRP already in place, the following future infrastructure were included in the model:

- Demolition of the S-65C Structure
- U-shaped weir and downstream berm (Figure 2-5)
- Phase II and IV, as defined in Bousquin et al. 2005
- Future Conditions Digital Elevation Model (DEM) (berms, removal of levees, etc.)

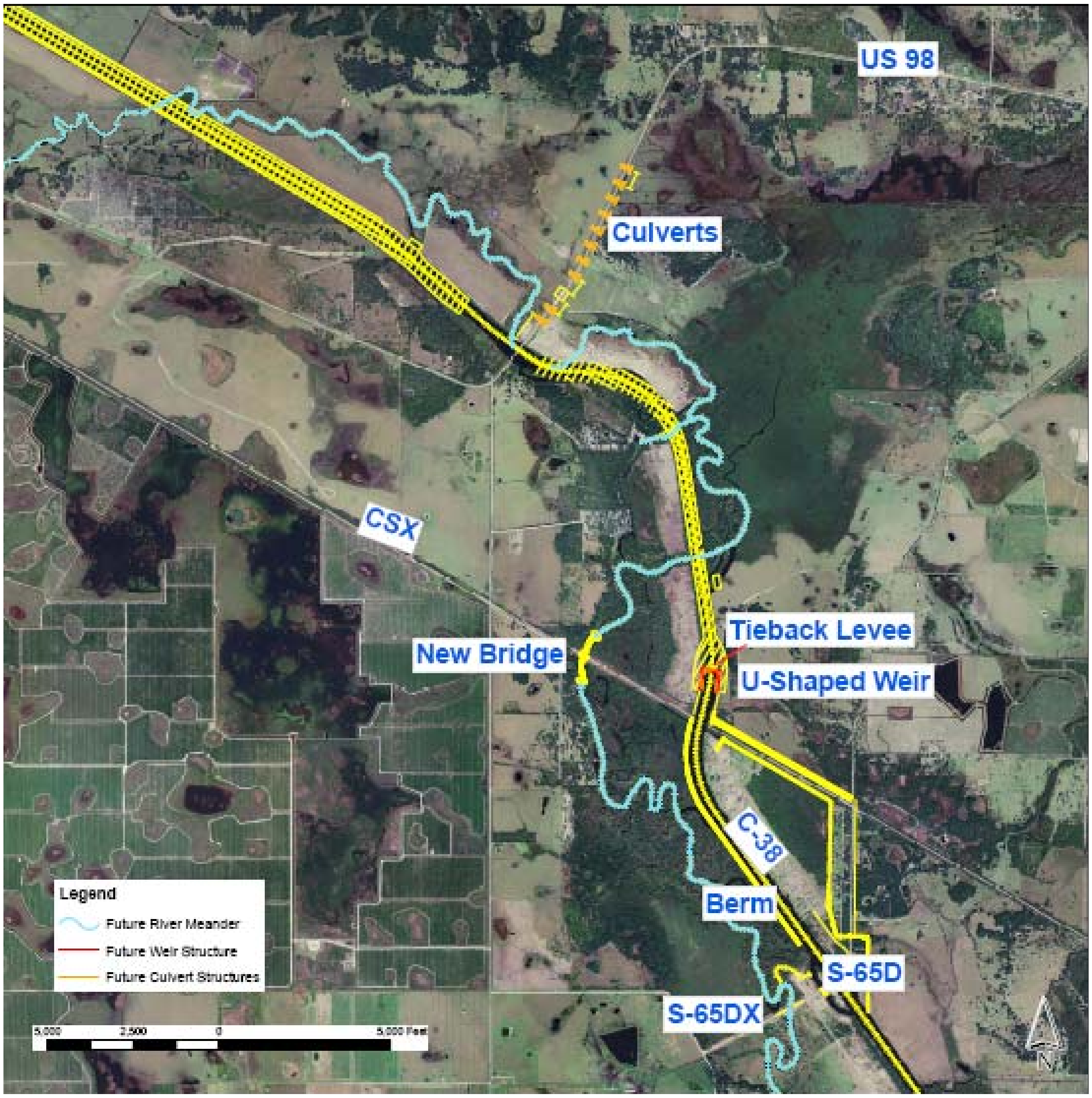

Figure 2-5: KRRP Features in Pool D

2.1.3.3 Water Use

- **Public Water Supply (PWS)**

The "with project" base conditions included the ***Existing Legal Users*** or the Existing Permitted Surface Water and Groundwater Uses. These permits were extracted from the SFWMD Permit Database and included Large General and Individual Permits. The methodology used to prepare the PWS data sets used in the "with project" base condition model was described in the "Technical Approach to Create the Existing Legal Users database included in the "with project" base condition model Technical Memorandum" (Earth Tech 2008c). The appendices of the referenced technical memorandum include all of the databases used in the process.

PWS wells in the model domain were represented in AFET-W by pumping wells. Water pumped from the PWS wells was extracted from the specified screen interval and removed from the model. The primary source of water in the Kissimmee Basin was the Floridan Aquifer System. There were virtually no wells that withdrew water from the SAS.

PWS data from the water use permit and well shapefiles, recently developed by the SFWMD, were reviewed and used as the primary source of data to define the characteristics of each well. Data currently in the version or "Revision 1" of the KBMOS current base conditions were used for the other two districts with jurisdiction within the Kissimmee Basin. The water use permit and well shapefiles from each district were merged together and clipped to the model domain. These shapefiles were joined based on permit numbers and a data file containing the necessary information for each well that were created and imported into the MIKE SHE well database.

The current withdrawal conditions (permitted maximum allocation by 2008 for the SFWMD jurisdiction) were held constant during the 41 years of the "with project" base condition simulation.

- **Irrigated Areas**

A similar approach was used for the irrigated areas where the ***Existing Legal Users*** were maintained under the "with project" base conditions. Irrigation in AFET-W was handled through Irrigation Command Areas (ICA). These ICAs in MIKE SHE were used to define unique spatially distributed areas in the model where irrigation was applied. Irrigation sources and rates were defined for each ICA. Furthermore, multiple prioritized sources were defined for each ICA. Irrigation applications were simulated for each MIKE SHE cell in an ICA. The Irrigation Command Module tracked soil moisture, determined irrigation demands and supplied the demand from sources described in the model. Therefore the agricultural water use is estimated based on crop Evapotranspiration and water availability but capped to the maximum capacity specified in the irrigation permits of each area.

The ICAs in the "with project" base were based on water use permit areas from the SFWMD. Water use permit areas and the locations of surface water pumps and groundwater wells were obtained from each water management district. Irrigated areas and associated sources in the model domain were identified and unique integer grid codes were defined for each of the identified ICAs based on permit numbers. Only existing permits with corresponding permit areas and abstraction information were included in the irrigation setup. ICAs correspond to Citrus, Truck Crops, Golf Courses, Low Urban Density, Medium Urban Density and High Urban Density land use classifications defined in the model. The methodology used to prepare the irrigated areas data sets used in the "with project" base condition model was described in detail in the "Technical Approach to Create the Existing Legal Users Database Included in the "With Project" Base Condition Model Technical Memorandum" (Earth Tech 2008c). The appendices of the referenced technical memorandum include all of the databases used in the process.

2.1.3.4 Operations

Operations of Central and Southern Florida (C&SF) structures included:

- Operating criteria set for the S-65 Structure by the Kissimmee Headwaters Revitalization Project - Figure 2-6
- Interim schedule proposed in KBMOS for the S-65D Structure to avoid steep hydraulic gradients in upstream crossings - Figure 2-7 (Earth Tech 2007)
- Current regulation schedules in all other structures (Figure 2-8 through Figure 2-13)

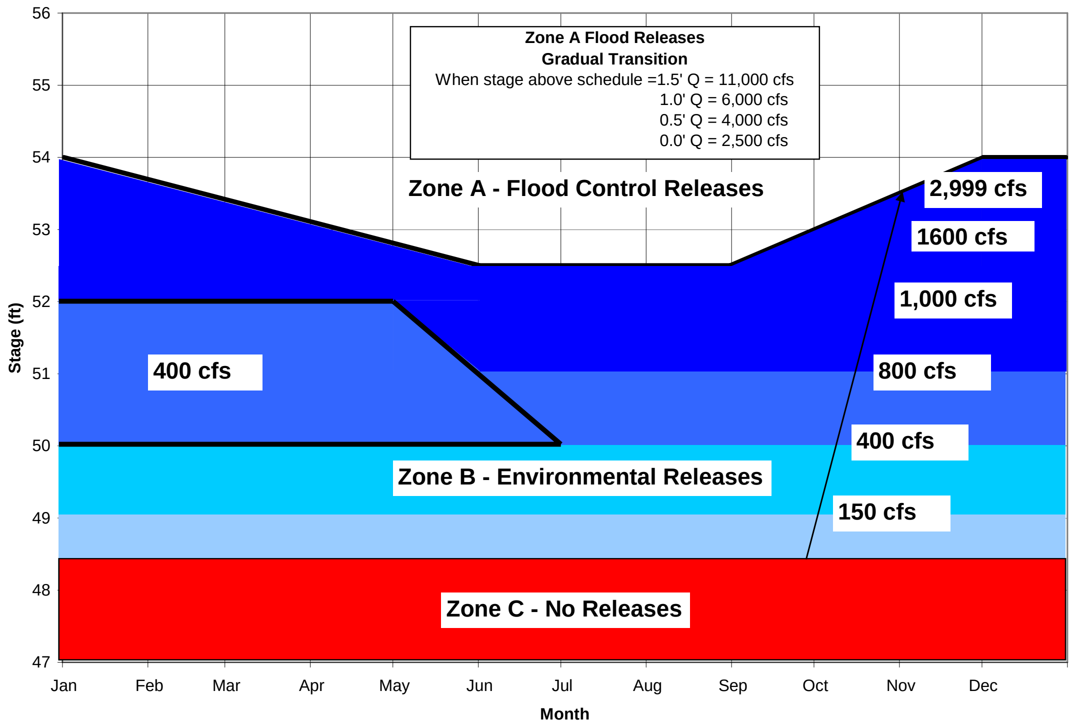

Figure 2-6: Operating Criteria for S-65 Structure "With Project" Base Condition

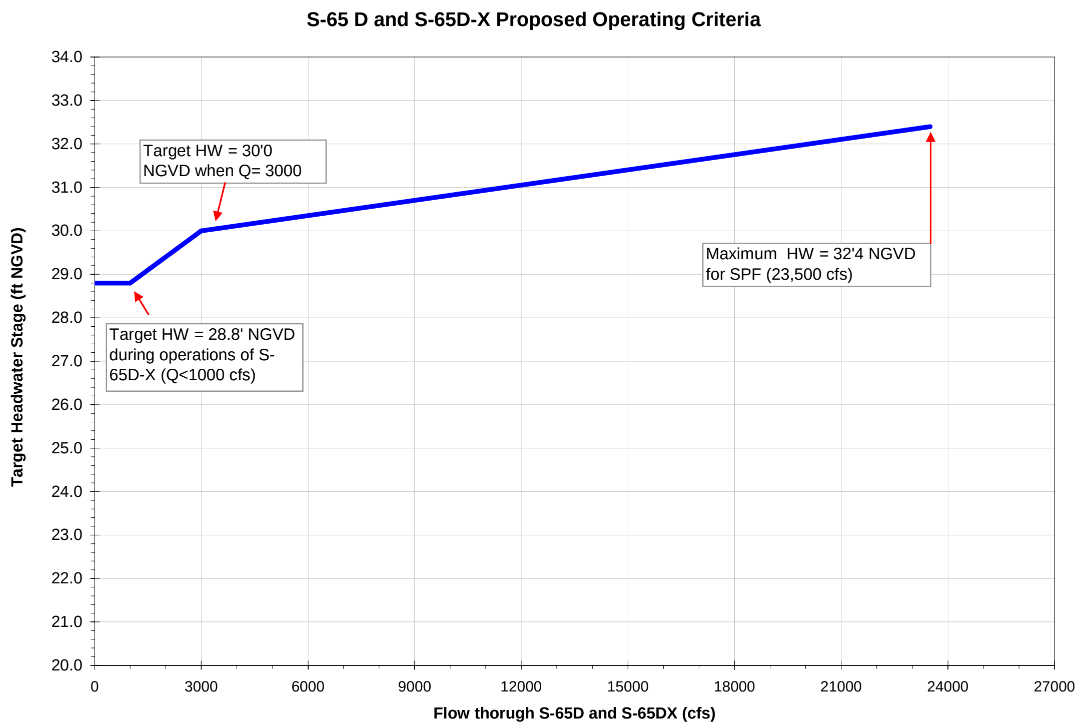

Figure 2-7: Operating Criteria for S-65D Structure "With Project" Base Condition

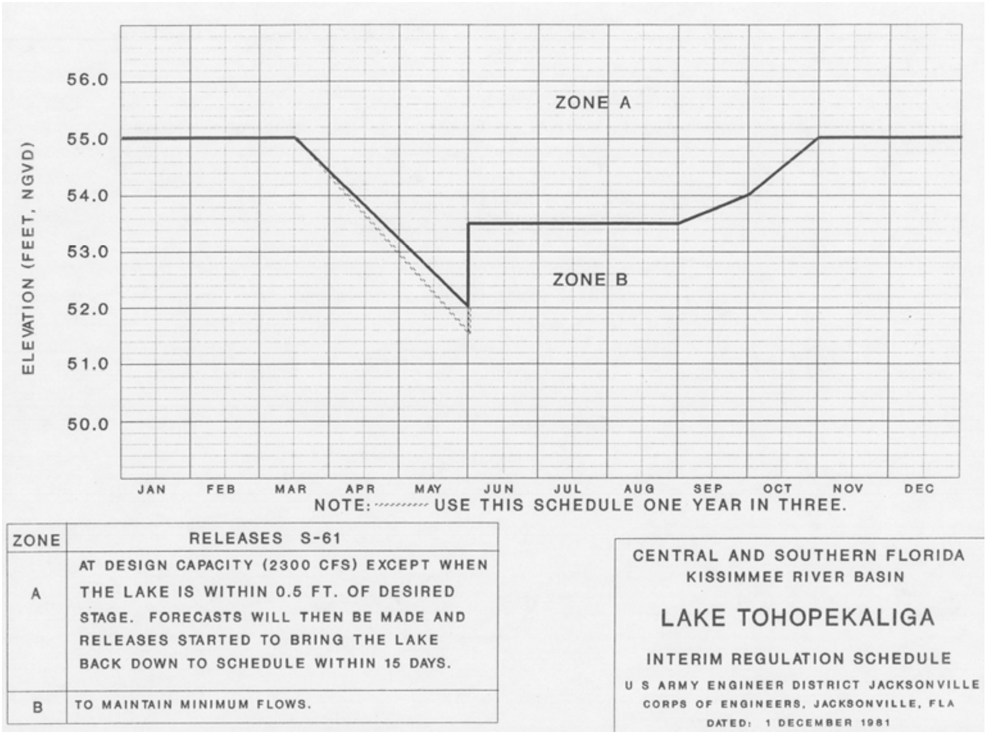

Figure 2-8: Operating Criteria for S-61 Structure "With Project" Base Condition

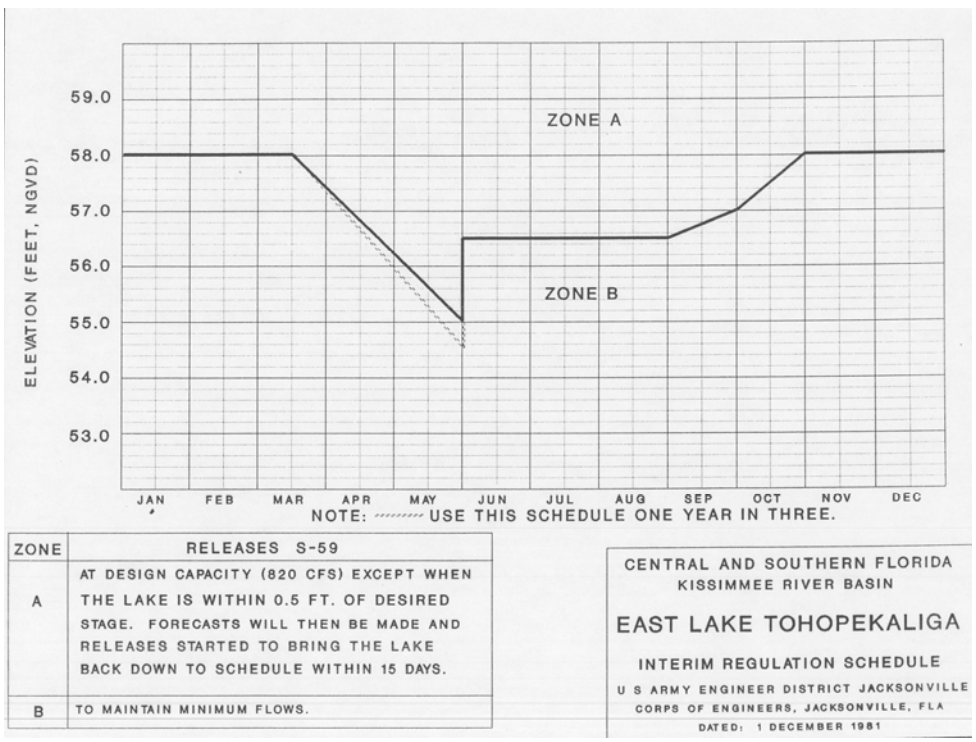

Figure 2-9: Operating Criteria for S-59 Structure "With Project" Base Condition

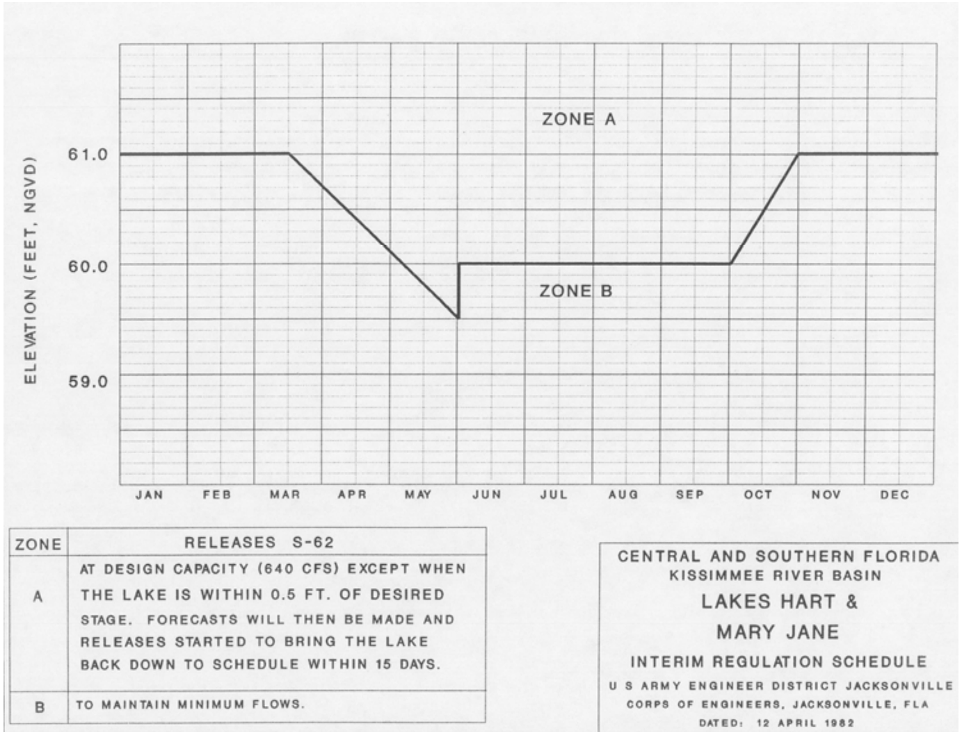

Figure 2-10: Operating Criteria for S-62 Structure "With Project" Base Condition

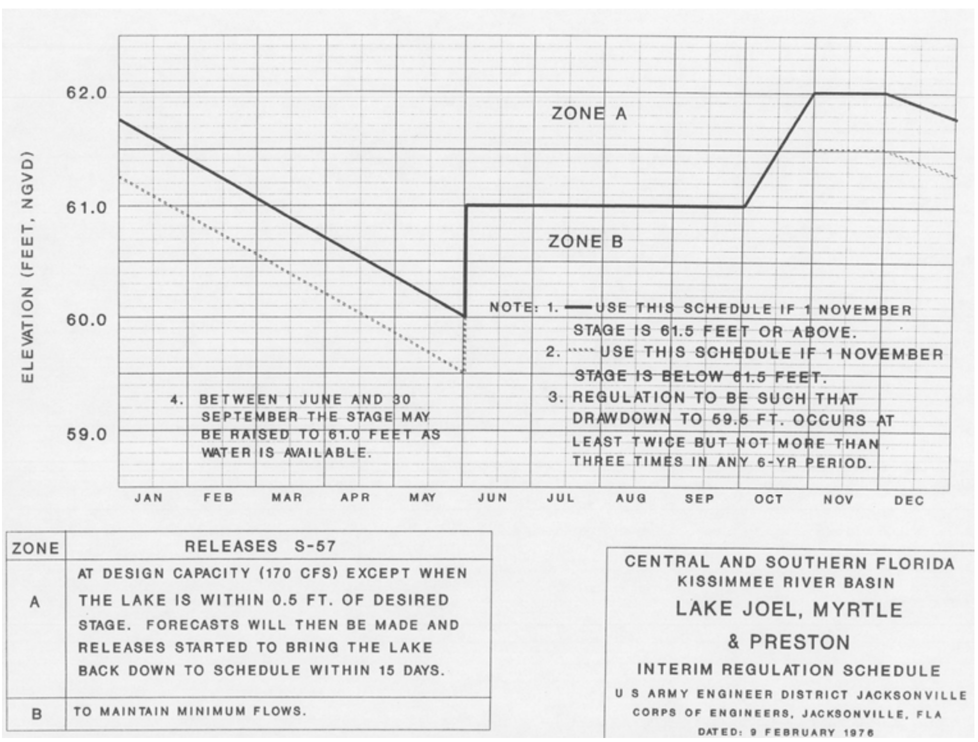

Figure 2-11 : Operating Criteria for S-57 Structure "With Project" Base Condition

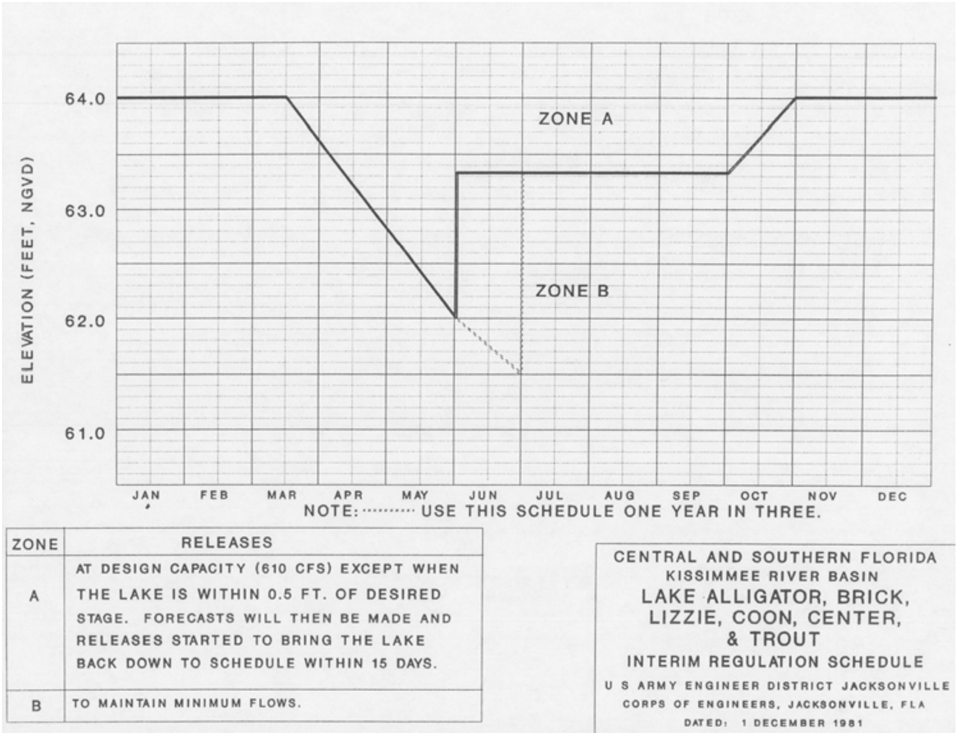

Figure 2-12: Operating Criteria for S-60 Structure "With Project" Base Condition

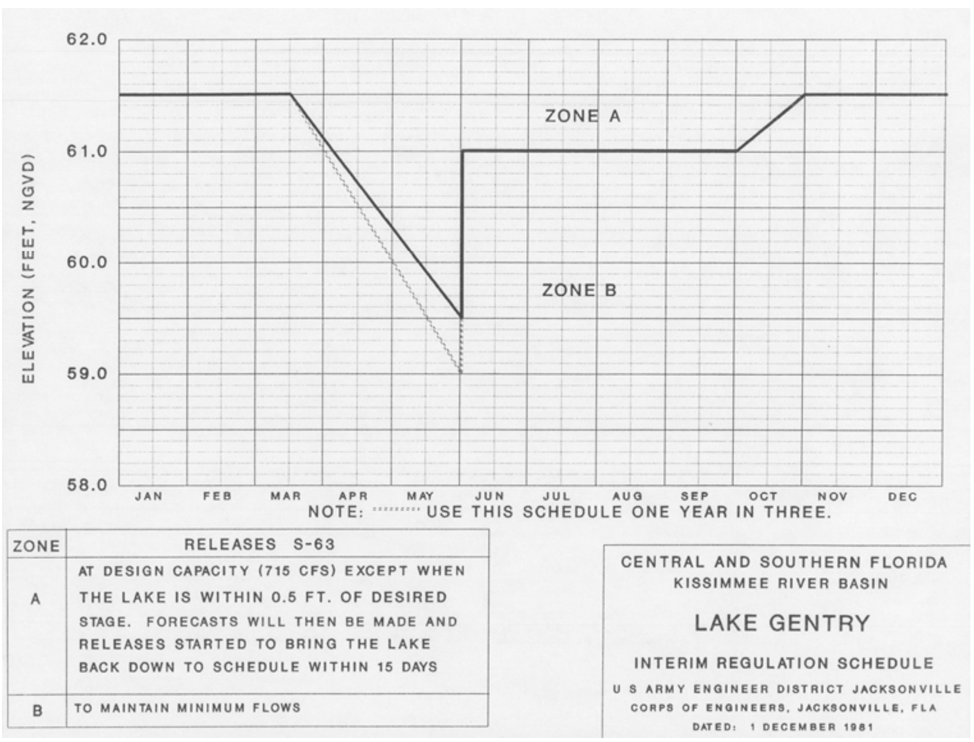

Figure 2-13: Operating Criteria for S-63 (S-63A) Structure "With Project" Base Condition

3 DEVELOPMENT OF THE "WITH PROJECT" BASE CONDITION MODEL

The "with project" base condition AFET-W model was developed from the KBMOS MIKE SHE/MIKE 11 models developed and calibrated earlier in the study. A number of modifications were made to the calibrated AFET-W model to develop the "with project" base condition model that represents the base conditions described in the previous sections. The modifications made to the calibrated AFET-W are described in detail in this section.

3.1 Rainfall and RET

Figure 3-1 shows the spatial distribution of the average rainfall used to drive the "with project" base condition model. Rainfall grids were provided by the SFWMD in American Standard Code for Information Exchange (ASCII) format and converted to a Danish Hydraulic Institute (DHI) dfs2 format to be used as input in the model.

The revised RET was provided by the SFWMD as a separate time series for individual cells throughout the model domain. This file was used to create a dfs2 file that contained a spatially varied time series for each of the 1,000 x 1,000 foot grids of the model domain. The maximum and mean RET for the model domain is shown in Figure 3-2 and Figure 3-3. Appendix A has a summary of the RET data used in the "with project" base condition model and the effect of this parameter on the results of the previous KBMOS base condition runs.

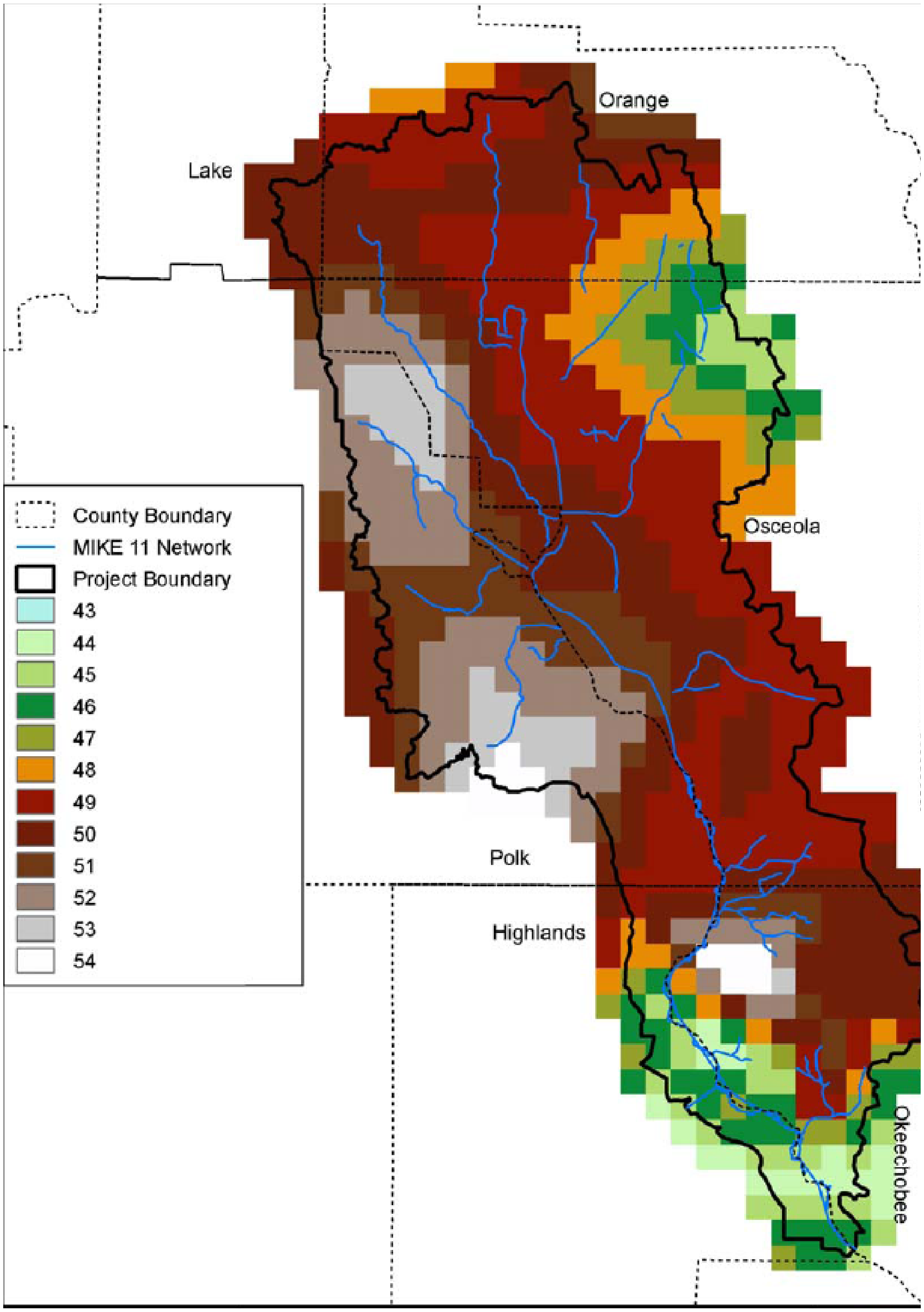

Figure 3-1: Spatially-Distributed Average Annual Rainfall in the Kissimmee Basin from 1965 through 2005

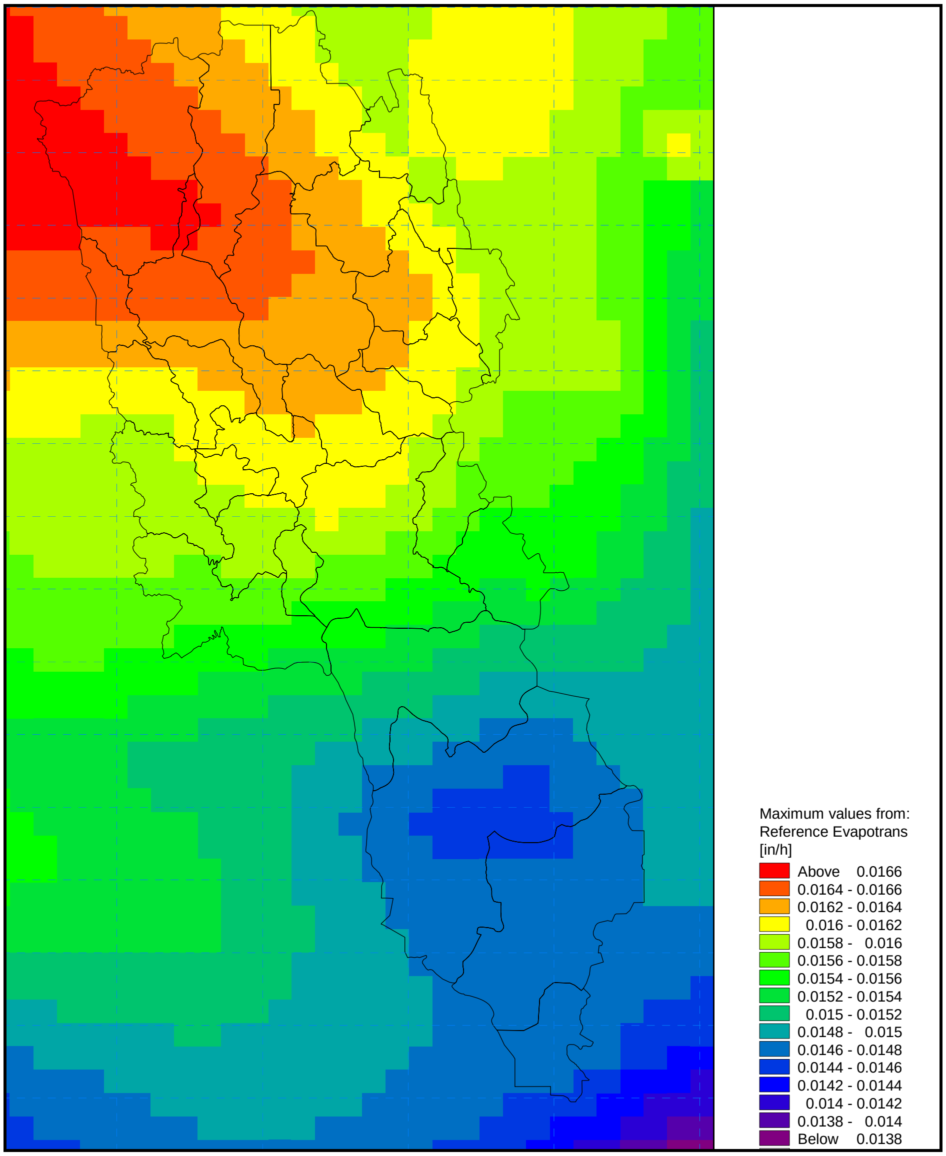

Figure 3-2: Spatially-Distributed Maximum RET in the Kissimmee Basin from 1965 through 2005

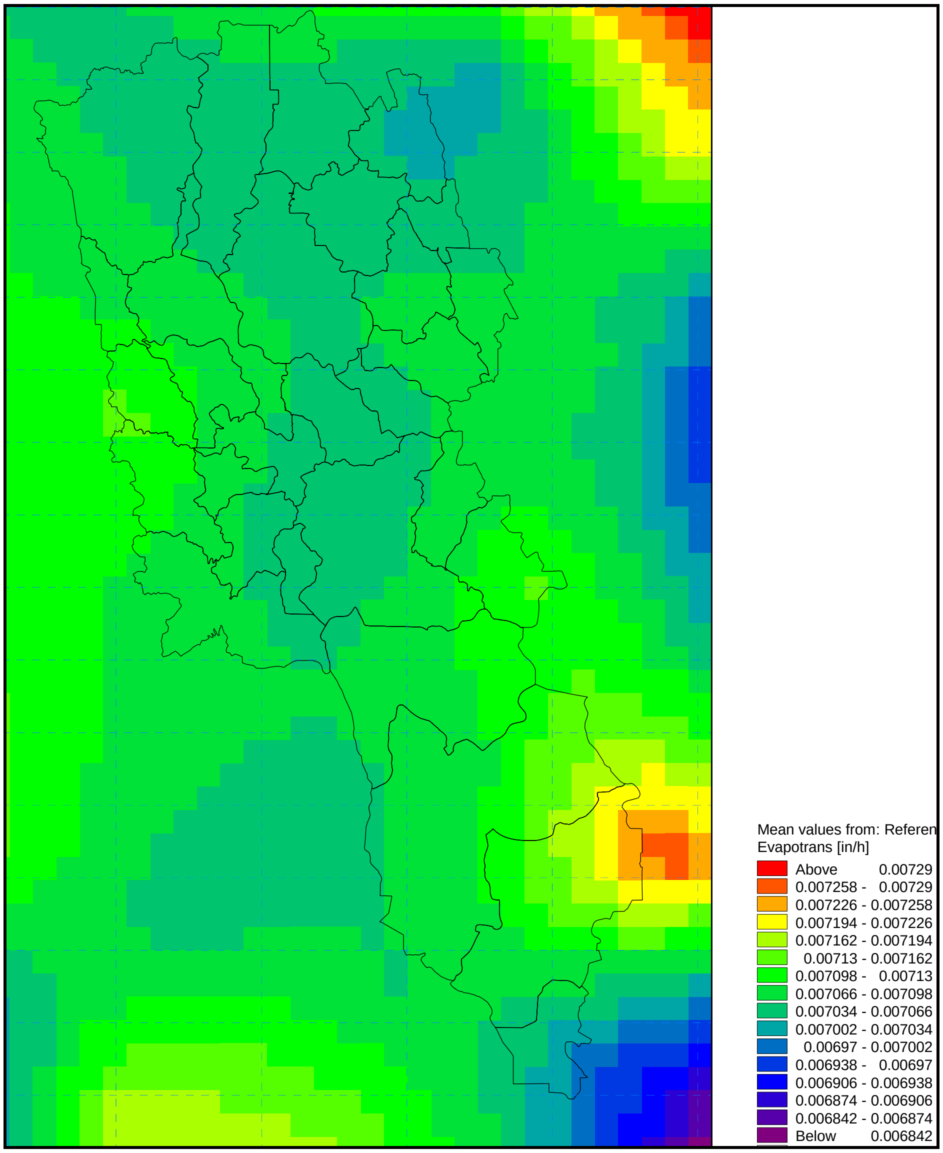

Figure 3-3: Spatially-Distributed Average RET in the Kissimmee Basin from 1965 through 2005

3.2 Future Operating Conditions

Operating conditions for the S-65 and S-65D Structures used in the "with project" base condition model correspond to the future operating conditions, described in detail below.

3.2.1 The S-65 Structure (Headwater Revitalization Operating Criteria)

The MIKE 11 structure operation of S-65 Structure gates in the "with project" base condition model was based on the headwater revitalization schedule of the S-65 Structure, which is shown in Figure 2-6. The control logic for the S-65 Structure had been coded to meet the target flows for each zone based on the headwater stage. The documentation of the code used to simulate the operations of the headwaters revitalization schedule in the S-65 Structure and its results was presented in the KBMOS Evaluation of Base Conditions Report (Earth Tech 2008). The reader is referred to that document for additional details on the operation of the C&SF structures in the AFET-W.

3.2.2 S-65D Structure Proposed Interim Operating Criteria

The MIKE 11 structure operation of S-65D Structure gates in the "with project" base condition model was based on the KBMOS Draft Operating Criteria for Modeling S-65D Future Conditions Memorandum (Earth Tech 2007). The revised S-65D Structure operations for the "with project" base condition model must be able to handle the larger volume of Pool B-C-D after the removal of the S-65C Structure and also meet the goals of the Kissimmee River Revitalization Project. Furthermore, the existing operational criteria for the S-65D Structure caused steep gradients to form at the CSX Railroad and US-98 bridges and culverts, located upstream of the structure. To reduce these steep gradients, future operational criteria maintain headwater stages at the S-65D Structure at a higher elevation (minimum of 28.8 feet) than the currently maintained elevation (26.8 feet). The proposed future base condition design flow-headwater stage relation at the S-65D Structure is shown in Figure 2-7**Error! Reference source not found.**. For flows less than 1,000 cubic feet per second (cfs), the S-65D Structure, in the C-38 Canal, was closed and the S-65DX Structure (a culvert that was considered part of the S-65D Structure group), in the restored portion of the Kissimmee River, will operate when headwater stages exceed 28.8 feet to maintain the stages, as shown in Figure 2-7. For flows larger than 1,000 cfs, S-65D Structure gates operate to maintain the stages shown in Figure 2-7. In the case of severe flooding, when the S-65D Structure was fully opened and headwater stages still exceeded 28.8 feet, the S-65DX2 Structure could be operated to allow additional flow from the restored portion of the river to the C-38 Canal. The documentation of the code used to simulate the operations of the proposed interim operating criteria of the S-65D Structure and its results was presented in the KBMOS Evaluation of Base Conditions Report (Earth Tech 2008). The reader is referred to that document for additional details on the operation of the C&SF structures in the AFET-W.

3.3 Land Use

The "with project" base condition model used the same land use distribution used by the AFET-W calibrated model (Earth Tech 2008a), as shown in Figure 3-4.

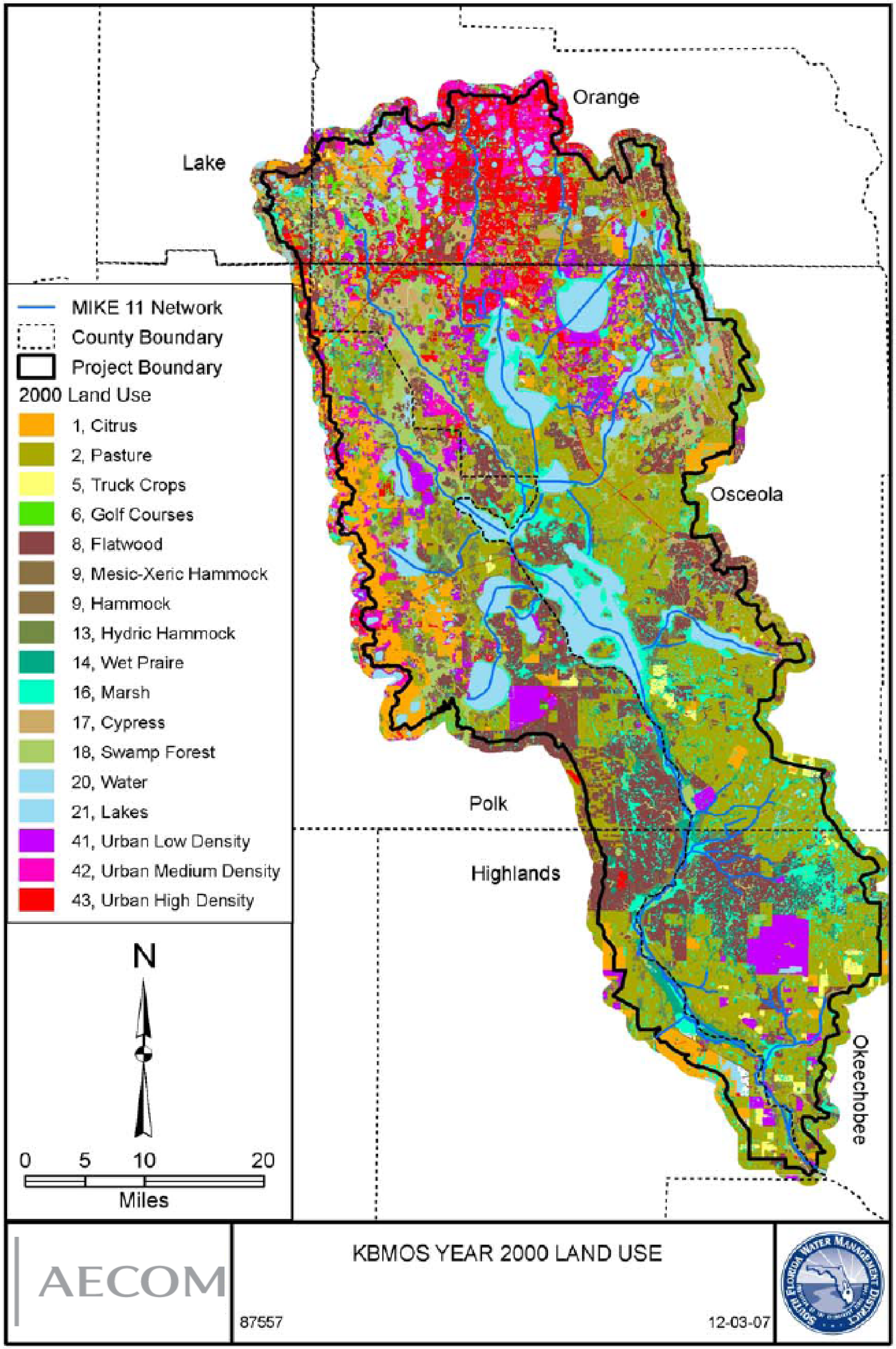

Figure 3-4: Current Land Use Data (Year 2000)

3.4 Water use data sets

Irrigation uses and potable water use in the Kissimmee Basin used in the "with project" base conditions reflect the existing legal user. The process followed to query the SFWMD permit database to extract the information that was finally used in the model was documented in a technical memorandum, dated November 26, 2008, titled "Technical Approach to Create the Existing Legal Users Database Included in the "With Project" Base Condition Model" (Earth Tech 2008c).

3.4.1 PWS

PWS withdrawals used in the "with project" base conditions in AFET-W were permitted allocations. The maximum allocation was used. This allocation was distributed using observed monthly patterns. The following paragraphs describe the process used to extract the information used in the model.

The SFWMD initiated the data acquisition effort to document existing legal users of water within the Kissimmee Basin of the SFWMD, as it related to establishing a water reservation for the Kissimmee River and upstream surface water bodies. Data were acquired from the SFWMD's Regulatory Database and the pumpage files from the SFWMD's ECFT Model, whose boundaries incorporate a portion of the SFWMD's Kissimmee Basin. Data from both sources were compiled in the KissSept08-summaryFINAL.xls spreadsheet (see Attachment A of the aforementioned memorandum) and included details such as permit number, use classification, source, location and annual allocation. It was determined that a monthly distribution of that allocation needed to be estimated based on historical usage. Monthly distribution percentages were calculated from actual pumpage from the most current two to three years for each permit number for PWS, where actual data were available (Kissimmee_pws_multiplierByPermit.xls in Attachment B of the aforementioned memorandum) and percentage distribution averages for each county were developed to be used where there were gaps in the data (Kissimmee_pws-multiplier-average.xls in Attachment C also in the memorandum).

Collectively, the above mentioned data served as the source file for the SFWMD and were augmented with information extracted from information previously compiled during the development of the KBMOS base condition models and documented in the Evaluation of Base Conditions Report (Earth Tech 2008). The KBMOS base condition models were used to obtain well and water allocation rates for areas outside of the boundary of the SFWMD but within the Kissimmee River basin model area. They therefore included water use information for locations within the jurisdiction of the St. Johns River Water Management District (SJRWMD) and Southwest Florida Water Management District (SWFWMD). Collectively, data for 2149 facilities were obtained and a comprehensive database that included such detail as Well Identification Number, Location, Water Allocation (monthly and daily), Permit Number, Water Usage, Well Screen Elevation and Water Source was developed.

The process of reviewing and screening the SFWMD data involved the following steps and procedures:

1. 1878 facilities contained in the SFWMD Permit Inventory were reviewed and plotted on Geographic Information System (GIS) maps to verify whether they were located within the limits of the Kissimmee Basin. Facilities outside of the basin boundary were eliminated.
2. The 1878 facilities included both "withdrawal" and "non-withdrawal" structures. 273 facilities were identified as being "non-withdrawal" structures such as pumps and/or culverts and were deleted from the database. The other 1605 "withdrawal" structures, which were essentially wells, were maintained in the database for future analysis.
3. The 1605 withdrawal structures (wells) were placed in groups with identical permit identification numbers. A total of 352 groups (by permit ID) were identified. It is important to note the SFWMD had originally provided a list of 417 water use permits but only provided well information for approximately 84 percent of those permits. As such, there was no available well information for 65 permits.
4. The maximum water allocation for each of the water use permits was divided equally between the total number of wells served under that permit. This facilitated the determination of the maximum annual water allocation per well (MG/Yr/Well). For example, a water use permit that had an annual maximum allocation of 100 MG/Yr and served ten wells was given per well assignment of 10 MG/yr/well.
5. The withdrawal structures (wells) were then placed into two broad categories of "irrigation" and "non-irrigation" wells. The "non irrigation" designation was applied to PWS users and industrial users (IND) and the "irrigation" designation for irrigation wells (IRR), agriculture (AGR), livestock (LIV) and reclamation usage. This categorization produced 242 "non irrigation" (See Attachment D) and 1363 "irrigation" structures (See Attachment E). Below is a table summarizing the breakdown of usage within each category.

	Facility Code	**"Non –irrigation" Usage**	**"Irrigation" Usage**
PWS Wells	PWS	190	
Industrial Wells	IND	52	
Irrigation Wells	IRR		1058
Agricultural Well	AGR		129
Livestock Wells	LIV		97
Reclamation	N/A		3
Other	BTL, DOM, FRZ,DAI		41
Not Available			35
Total		242	1363

6. With the annual water allocations for the well determined, the monthly demand for the non-irrigation wells were calculated using the monthly multiplier prescribed specifically for each water use permit. In cases where this information was lacking, the average county monthly demand multiplier was used.

To complement the information in the SFWMD database and to include information from area outside of the SFWMD jurisdiction, but within the Kissimmee Basin, the information previously included in the KBMOS future base condition model was used, the following procedures were used:

1. The KBMOS base condition model data were plotted in GIS to ensure that there was no duplication of the well information already included in the SFWMD Permit Inventory. 37 "non-irrigation" wells were identified that fell outside of the SFWMD but within the SJRWMD and SWFWMD.
2. The model files also provided current well user information and daily water demand/ withdrawal for the years 1965 through to 2005. They were incorporated into the database with the SFWMD information.

Figure 3-5 summarizes the total PWS (existing legal users) used in the "with project" base condition model.

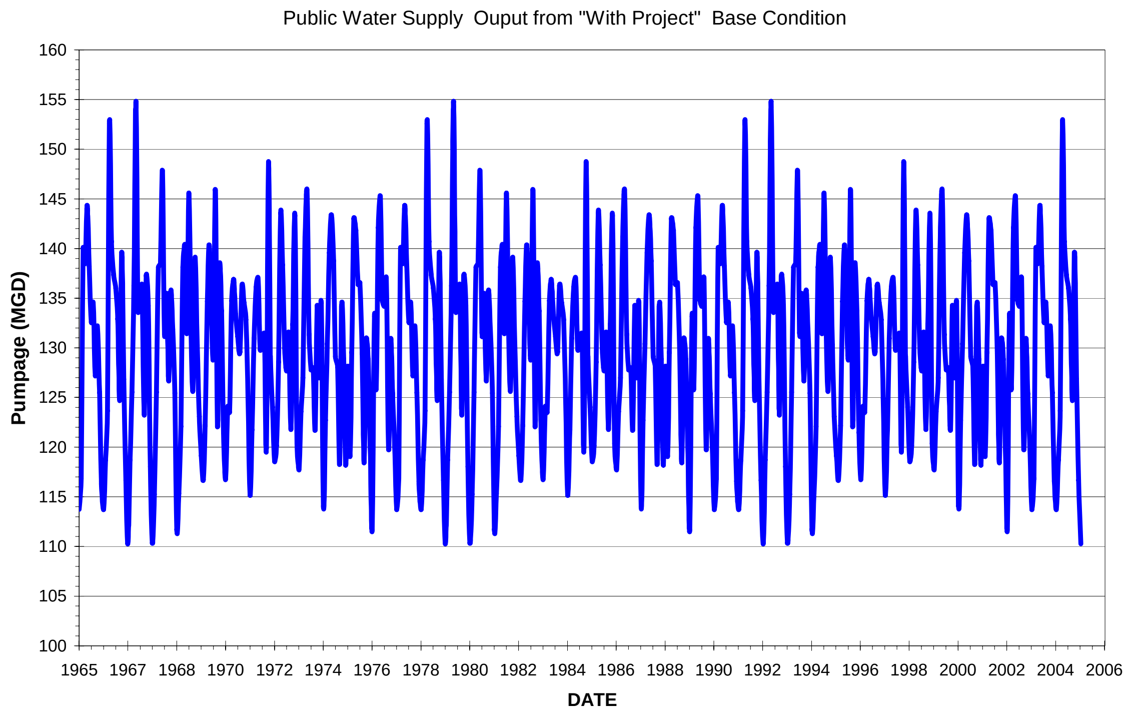

Figure 3-5: PWS Pumpage (Existing Legal Users) in the "With Project" Base Condition

3.4.2 Agricultural Uses (ICAs)

As mentioned in Section 2, the existing irrigated command areas raster data set was updated from the KBMOS base condition model with the locations of the permitted irrigated areas received from the SFWMD. However, the shapefile provided only the locations of permitted areas within the SFWMD's political boundary. The two data sets were merged in ArcGIS 9.2 to develop a single data set to represent the entire Kissimmee Basin. The steps taken to accomplish this can be found in the "Technical Approach to Create the Existing Legal Users database included in the "With Project" Base Condition Model Technical Memorandum (Earth Tech 2008c).

To remain consistent with the existing well location raster data set in the base condition model, the well locations shapefile was conditioned to follow the same format. The current format of the well location in the model is one well per permitted area. The allocations of the wells were spatially linked to the permitted irrigated areas in the model. Following this format, a point shapefile was created that contained the centroid of the permitted irrigated areas within the SFWMD boundary. The centroid served as the location of the total allocation aggregated from multiple wells for each permitted area. This location, along with the total allocation, was spatially linked in the base condition model after it was converted into a raster and then imported into the model.

Irrigation withdrawals were meant to cope with the deficit in evapotranspiration. RET is first met by the moisture of the soil in the unsaturated zone. This is done by reducing the RET based on leaf area index and crop coefficients. The leaf area index is a function of the interception storage capacity of the vegetation, which must be filled before stem flow to the ground surface takes place. The leaf area index characterizes the vegetation type and its stage of development. The tables, based on land use, for the leaf area index and crop coefficients used are specified in the AFET-W Calibration Report. Once the ET is calculated, it is compared with the amount of water available in the unsaturated zone, taking into consideration the wilting point. The quantity of irrigation withdrawals is based on the difference between the ET levels and the water available in the unsaturated zone. However, the amount of water that is irrigated was capped by the maximum permitted pumping capacity obtained from the SFWMD permit database.

3.5 MIKE 11 Network

The "with project" base condition model included the fully restored conditions of the Kissimmee River. These conditions were the same conditions used and modeled in the KBMOS future condition model, whose model development was documented in the Evaluation of Base Conditions Report (Earth Tech 2008). That report described the process that was followed to construct a MIKE 11 network for the Kissimmee River and the Kissimmee Chain of Lakes (KCOL) that represented the future conditions of the river. As documented in the aforementioned report, the Manning's "n" used in the KBMOS future condition model for Pool D were extrapolated from the calibrated conditions obtained for Phase I. However, the evaluations made by the SFWMD of the future condition models concluded that the slope of the water surface profile between the S-65C and S-65D Structures for the extrapolated condition was relatively flat. This was due to the fact that the vegetation found in Phase I during the calibration period (2001-2004) did not correspond to the vegetation expected during the fully restored conditions. Therefore, the set of roughness coefficients extrapolated to Pool D were not representative of the expectations of the KRRP. For this reason, a hydraulic model of the fully restored conditions of the Kissimmee River floodplain was built as documented in the “Kissimmee River Floodplain Hydraulic Model” (Earth Tech 2008b). The purpose of the creation of the hydraulic model was to ensure an accurate representation of restoration project features and to find the right set of Manning’s “n” so that it matched the expectations of the KRRP in terms of the expected vegetation along the floodplain. The reader is referred to the aforementioned document for details on the hydraulic network and the results of the roughness tune-up exercise. The MIKE 11 network in the “with project” base condition model was updated with the MIKE 11 network obtained at the end of the mentioned task.

4 "WITH PROJECT" BASE CONDITION RESULTS

In addition to evaluation of stage and discharge data at select locations (see Figure 4-1), MIKE SHE and MIKE 11 water budgets were calculated for the "with project" base condition models. MIKE SHE water budgets were calculated for the 29 watersheds shown in Figure 4-2. Maximum lake or floodplain storage areas were used to calculate MIKE 11 water budgets and are shown in Figure 4-3.

Annual rainfall amounts for the 1965 through 2005 "with project" base condition simulation periods are shown in Figure 4-4. Actual evapotranspiration and available water calculated from the "with project" base condition model results are also shown in Figure 4-4. Annual available water was the difference between rainfall and actual evapotranspiration and represents the amount of water available for runoff and infiltration processes in a given year. Average annual rainfall, actual evapotranspiration and available water for the period from 1965 through 2005 were 49.1, 40.2 and 9.0 inches, respectively. Figure 4-5 compares the runoff values obtained with the "with project" base condition models with those values obtained with the AFET-W calibration run. This plot also includes a summary of the RET data used in the model runs. These values explain the actual evapotranspiration values seen in Figure 4-4.

Annual rainfall, RET, actual evapotranspiration and available water amounts for the "with project" base condition model are summarized in Table 4-1. Although actual evapotranspiration rates in the "with project" base condition models were different, actual evapotranspiration differences between the models were not as significant as the observed year to year differences in rainfall.

4.1 Stage and Flow Results

Results for the "with project" base condition model for key locations in both the KUB and in the LKB are included in Appendix B.

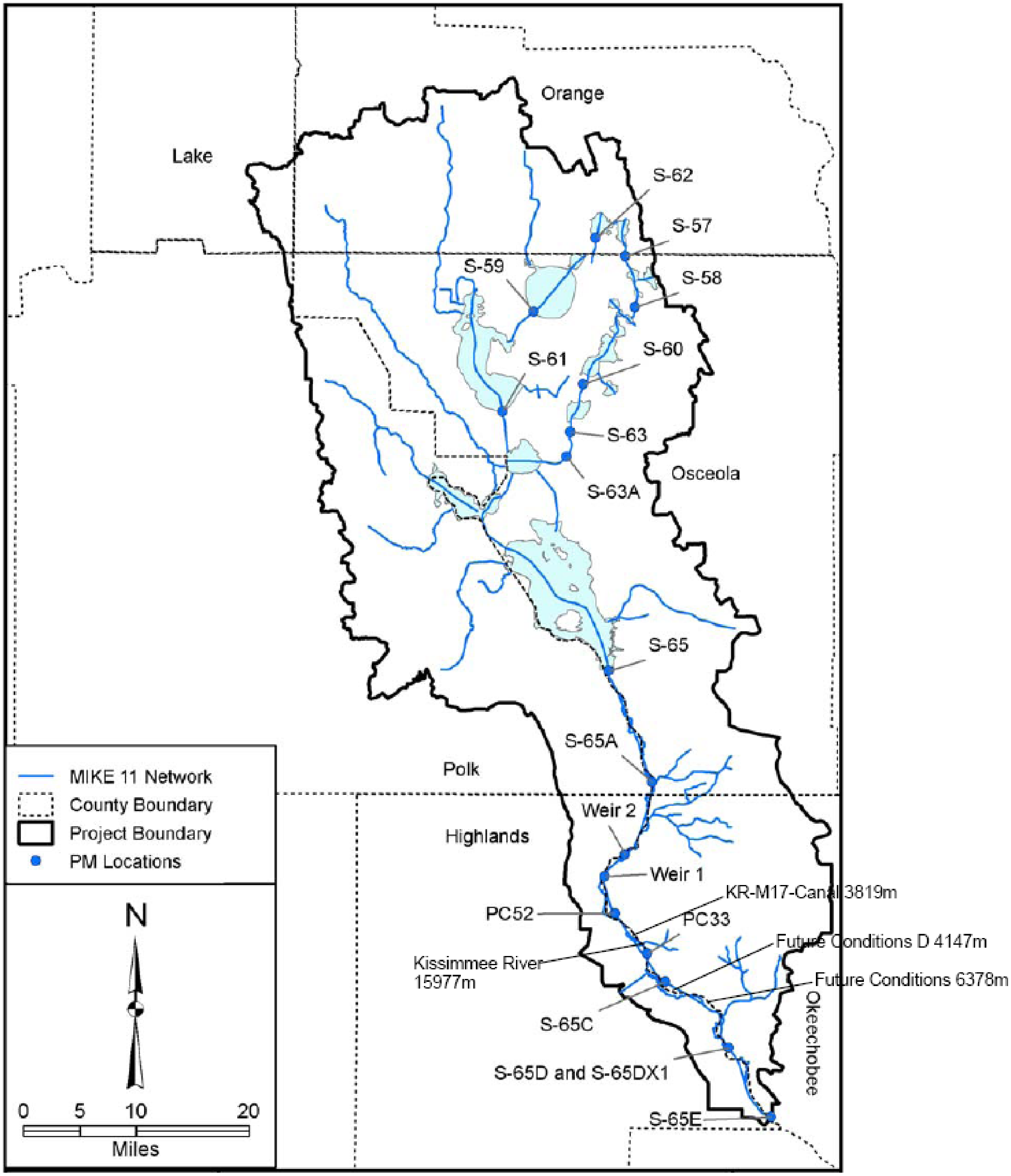

Figure 4-1: Structure and Performance Measure Locations Evaluated in the With Project Base Condition Models

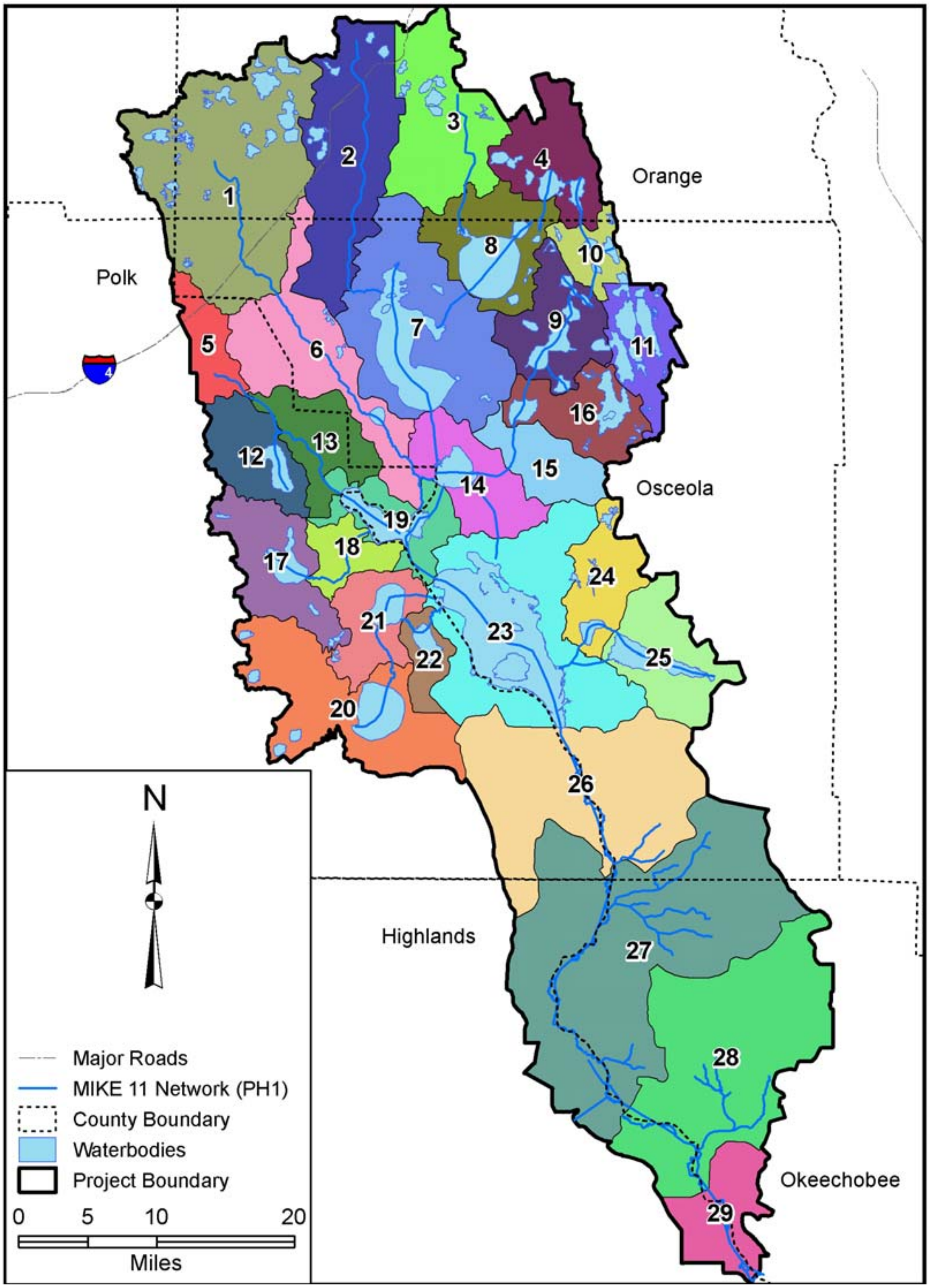

Figure 4-2: Kissimmee Basin Watersheds Used to Calculate Water Budgets for the With Project Base Condition Simulations

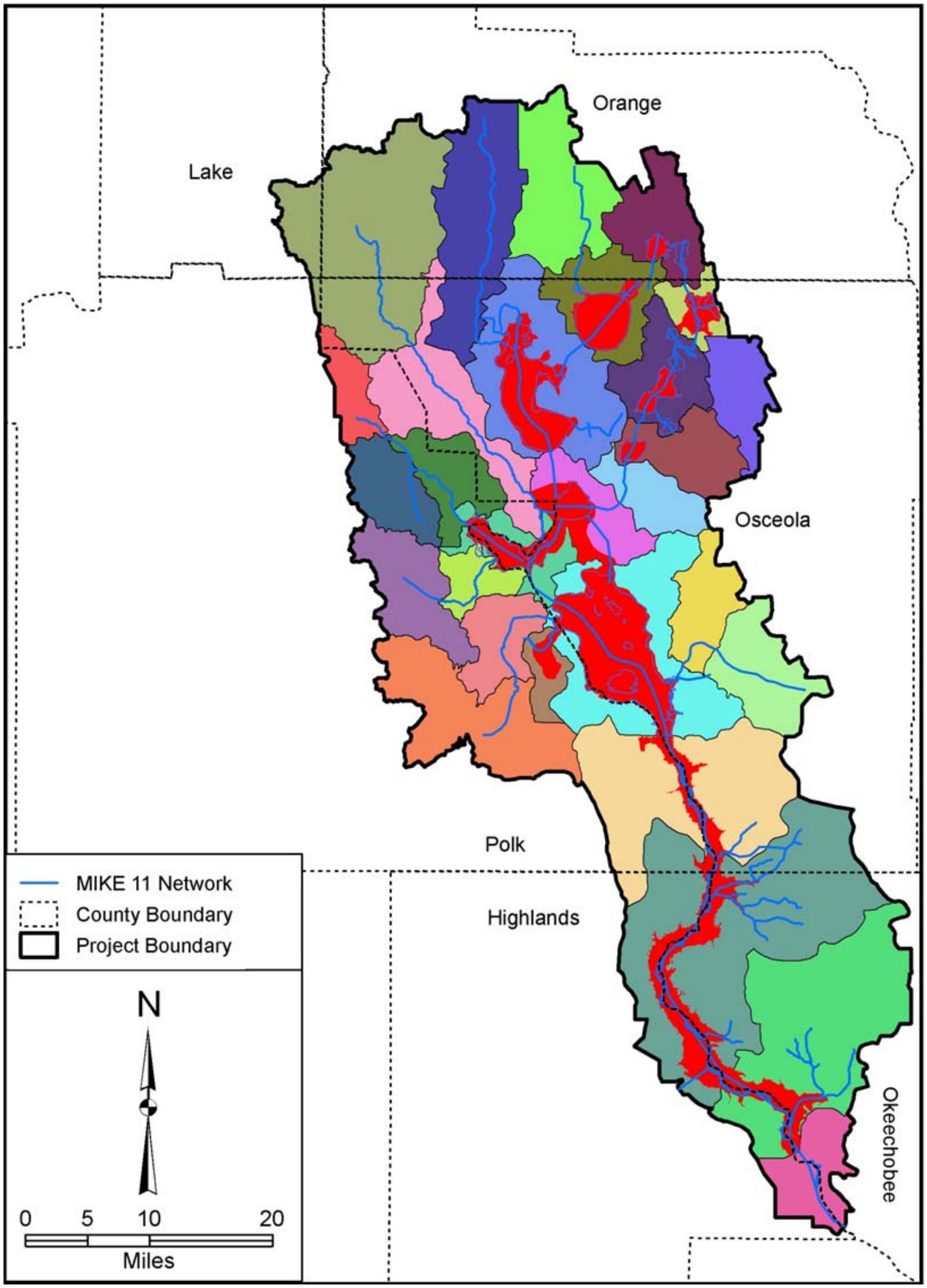

Figure 4-3: Maximum Storage Area Defined for KUB Lakes and the LKB Floodplain. Maximum Storage Areas were used to Define the Extent of Areas Used to Calculate MIKE 11 Water Budgets

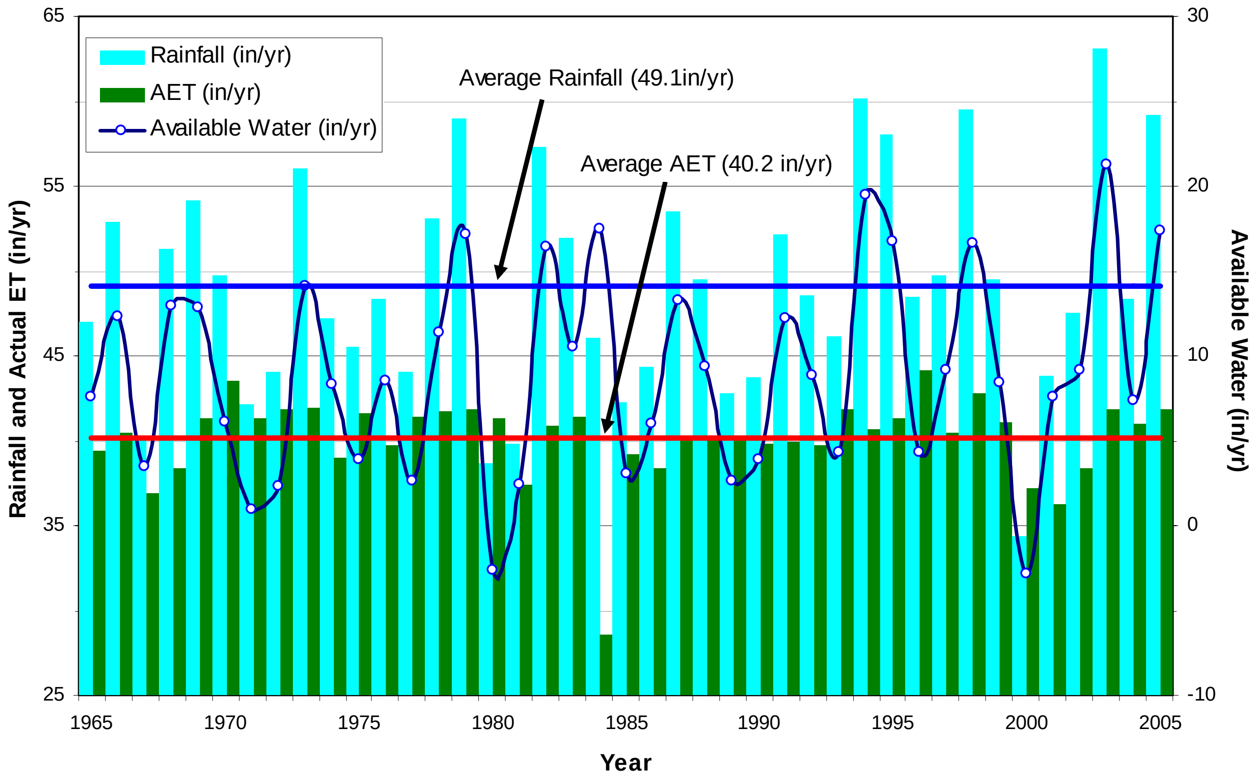

Figure 4-4: Annual Rainfall, RET, Simulated Actual Evapotranspiration and Simulated Available Water Rates (inches/year) in the Kissimmee Basin for the Period from 1965 through 2005. Simulated Actual Evapotranspiration and Available Water Data were from the With Project Base Condition Model. Available Water was calculated as the Difference between Annual Rainfall and Simulated Actual Evapotranspiration Rates

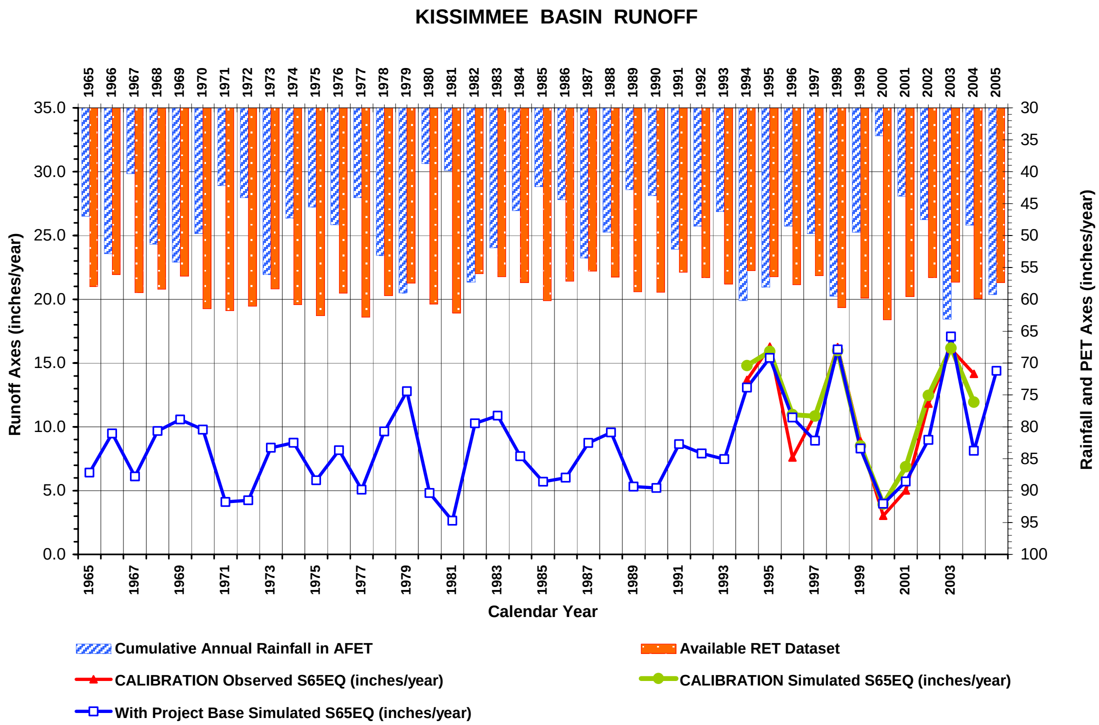

Figure 4-5: Simulated Annual Runoff for the "With Project" Base Condition Model runs as compared to the Calibration Model run annual runoff rates (inches/year). Rainfall and RET rates (inches/year) also included for reference

4.2 MIKE SHE Water Budgets

Average annual "with project" base condition MIKE SHE water budgets for the 29 watersheds, shown in Figure 4-2 for the period from 1965 through 2005, are summarized in Table 4-2.

Table 4-1: Annual Rainfall, RET, Simulated Actual Evapotranspiration and Simulated Available Water Rates (inches/year) in the Kissimmee Basin

Year	Rainfall (inches/year)	RET (inches/year)	Actual Evapotranspiration (inches/year)	Available Water (inches/year)
1965	47.01	57.99	39.40	7.61
1966	52.86	56.10	40.50	12.36
1967	40.31	58.97	36.86	3.45
1968	51.36	58.42	38.37	12.99
1969	54.17	56.38	41.33	12.84
1970	49.69	61.50	43.54	6.15
1971	42.18	61.80	41.27	0.91
1972	44.07	61.08	41.80	2.27
1973	56.10	58.36	41.99	14.11
1974	47.26	60.85	38.99	8.27
1975	45.54	62.57	41.63	3.91
1976	48.33	59.02	39.77	8.56
1977	44.05	62.79	41.45	2.60
1978	53.12	59.45	41.74	11.38
1979	59.00	57.46	41.88	17.12
1980	38.71	60.73	41.33	-2.62
1981	39.86	62.14	37.45	2.41
1982	57.29	56.00	40.88	16.41
1983	51.93	56.47	41.43	10.50
1984	46.10	57.40	28.61	17.49
1985	42.31	60.24	39.26	3.05
1986	44.37	57.17	38.35	6.02
1987	53.51	55.58	40.26	13.25
1988	49.48	56.49	40.14	9.34
1989	42.81	58.85	40.19	2.62
1990	43.73	58.89	39.82	3.91
1991	52.17	55.77	39.97	12.20
1992	48.53	56.61	39.69	8.84
1993	46.21	57.60	41.85	4.36
1994	60.20	55.48	40.69	19.51
1995	58.09	56.47	41.31	16.78
1996	48.51	57.72	44.16	4.35
1997	49.69	56.31	40.50	9.19
1998	59.51	61.29	42.84	16.67
1999	49.49	59.79	41.07	8.42
2000	34.37	63.20	37.25	-2.88
2001	43.83	59.56	36.24	7.59
2002	47.50	56.60	38.36	9.14
2003	63.11	57.32	41.89	21.22
2004	48.36	59.89	40.96	7.40
2005	59.24	57.35	41.82	17.42

4.3 Comparison of Cumulative Flow at the S-65 and S-65E Structures

Cumulative plots were prepared to compare modeled with observed flows at the S-65 and S-65E Strcutures. Figure 4-6 and Figure 4-7 show these comparisons. These figures, in addition to the comparison shown in Figure 4-5, show that the base condition modeled flows were in agreement with the recorded flows, especially in the S-65E Structure. It is important to emphasize that the watershed and operating conditions used in the "with project" base conditions differ from the watershed and operating conditions present in the basin at the time the flow record was established. Therefore, it was not the intention of the base condition simulation to match the historical record.

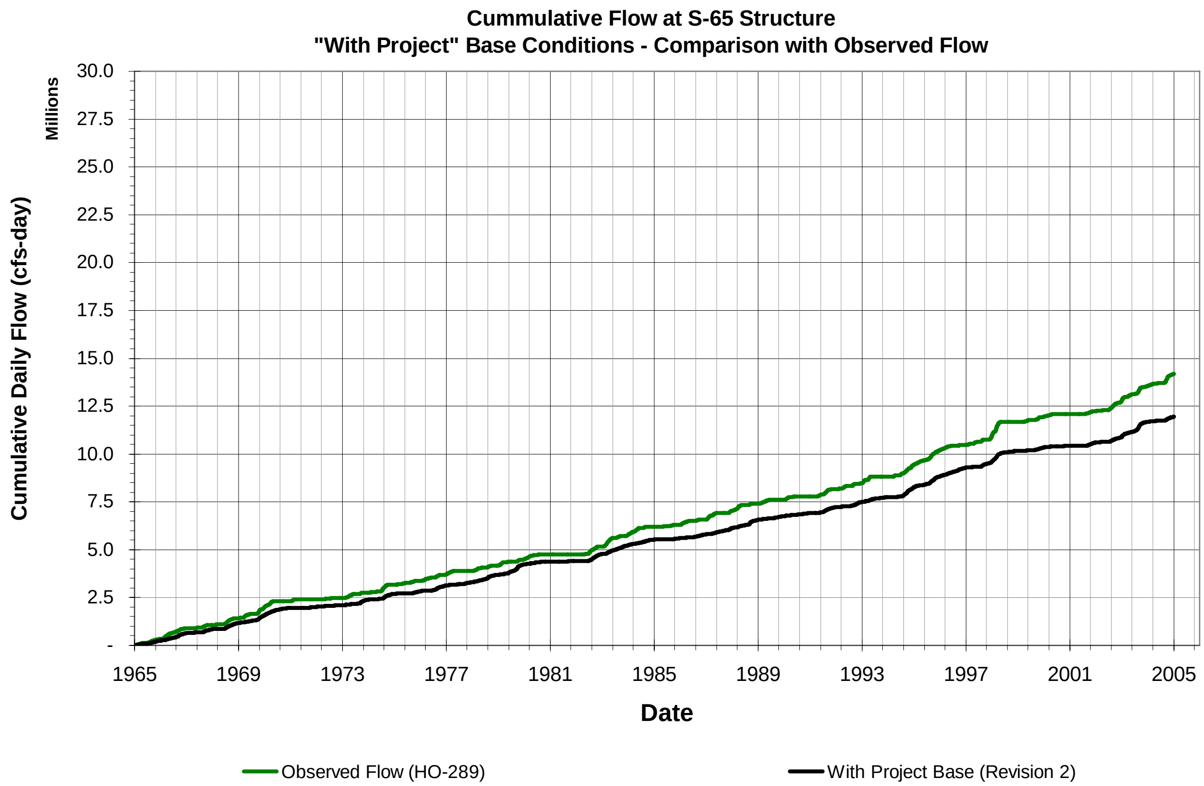

Figure 4-6: Cumulative flow at the S-65 Structure. Modeled and observed flows

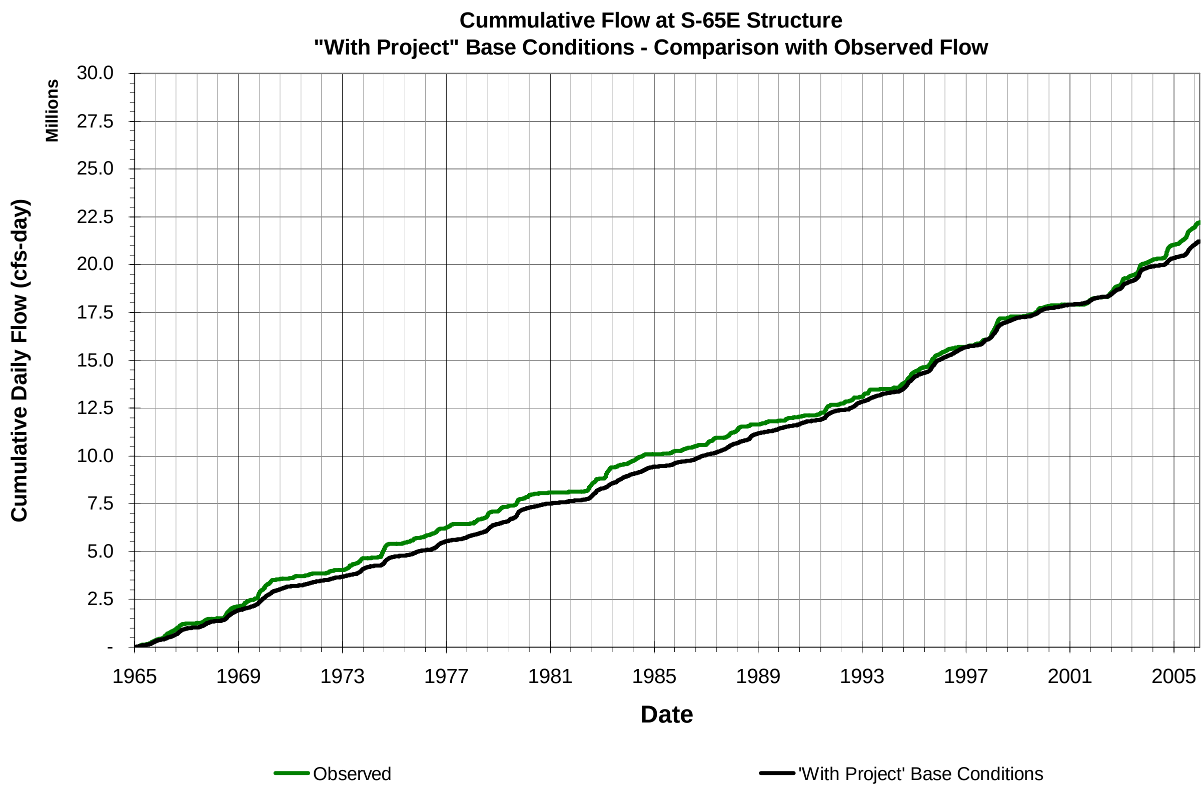

Figure 4-7: Cumulative flow at the S-65E Structure, modeled and observed flows

4.4 MIKE 11 Water Budgets – Extraction of Lateral Inflows

Lateral inflows to each lake and pool in the Kissimmee Basin were extracted from MIKE SHE/MIKE 11.

Table 4-3 includes yearly summaries of the lateral inflows in inches and Figure 4-8, Figure 4-9 and Figure 4-10 show the temporal variation of the lateral inflows for the KUB, LKB and Kissimmee Basin.

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Table 4-2: "With Project" Base Condition Water Budget for 29 Watersheds in the Kissimmee Basin

Sub-Watershed	ID	Rain (*Rai*)	Actual ET (*AET*)	Canopy-OL Storage Change *ΔOL*	Runoff (*Ro*)	OL Boundary Flows (OL_{BC})	Baseflow (*BF*)	Drainage To River (*D*)	Irrigation (*Irr*)	PWS Pump (GW_P)	Irrigation Pump (GW_I)	SZ Boundary Flow (SZ_{BC})	Subsurface Storage Change (*ΔSZ+ΔUZ*)	Total Error (*Err*)
Upper Reedy Cr.	1	49.59	38.10	0.15	1.88	0.00	0.36	6.25	0.57	0.00	0.00	-3.31	0.11	0.00
Shingle Creek	2	48.90	35.70	0.07	3.40	0.00	0.62	7.16	0.21	0.00	0.00	-2.10	0.03	0.00
Boggy Creek	3	48.78	35.61	-0.03	3.45	0.00	0.20	8.73	0.12	0.00	0.00	-0.94	-0.02	0.00
Lake Hart	4	47.42	43.09	-0.70	0.58	0.03	0.07	4.12	0.00	0.00	0.00	-0.26	-0.05	0.00
Horse Creek	5	51.74	36.79	0.89	8.17	0.03	1.75	0.00	1.22	0.00	0.00	-3.81	1.52	0.00
Lower Reedy Cr.	6	50.87	41.63	0.24	1.10	0.00	0.60	6.83	0.15	0.00	0.00	-0.36	0.26	0.00
Lake Toho	7	48.43	42.73	0.01	-1.49	0.00	0.19	6.97	0.19	0.00	0.00	-0.18	0.03	0.01
East Lake Toho	8	47.00	44.67	-0.07	-3.28	0.00	0.37	5.58	0.27	0.00	0.00	0.02	0.01	0.00
Alligator Lake	9	46.48	42.43	-1.53	-0.12	0.00	0.20	5.96	0.49	0.00	0.00	-0.04	0.00	0.00
Lake Mrytle	10	44.97	42.58	-0.88	-0.01	0.03	0.57	2.16	0.00	0.00	0.00	-0.63	-0.10	0.00
Lake Conlin	11	45.47	40.65	-0.09	0.00	0.03	0.00	4.73	0.00	0.00	0.00	-0.26	-0.10	0.00
Lake Marion	12	51.53	37.75	0.09	0.09	-0.04	0.03	9.70	0.10	0.00	0.00	-3.57	0.45	0.01
Marion Creek	13	50.91	41.60	0.14	1.13	0.03	0.51	6.68	0.05	0.00	0.00	-0.74	0.13	0.00
Lake Cypress	14	49.08	41.94	-0.91	-0.46	0.01	0.65	8.48	0.51	0.00	0.00	0.07	-0.04	0.01
S63A	15	48.48	38.42	0.00	0.25	0.01	0.22	9.71	0.66	0.00	0.00	-0.50	0.05	0.01
Lake Gentry	16	47.86	40.83	-0.26	0.26	-0.73	0.23	7.08	0.16	0.00	0.00	-0.57	0.03	0.01
Lake Pierce	17	50.71	35.10	0.26	2.05	0.02	0.00	8.17	0.21	0.00	0.00	-4.82	0.46	0.00
Catfish Creek	18	50.44	38.06	0.08	1.57	-0.01	2.01	8.80	0.49	0.00	0.00	-0.31	0.12	0.00
Lake Hatchineha	19	49.91	47.94	0.37	-3.39	-0.05	0.71	4.39	0.18	0.00	0.00	-0.12	0.01	0.00
Lk Weohyakapaka	20	51.70	38.27	0.12	0.55	0.01	0.02	10.96	0.04	0.00	0.00	-1.58	0.22	0.00
Lake Rosalie	21	51.25	42.17	0.13	0.82	0.02	0.23	6.33	0.05	0.00	0.00	-1.45	0.12	0.00
Tiger Lake	22	51.36	45.12	0.21	-1.42	-0.01	0.14	7.77	0.18	0.00	0.00	0.25	-0.02	0.00
Lake Kissimmee	23	49.95	48.32	0.15	-4.00	0.01	0.04	6.29	0.81	0.00	0.00	0.05	0.00	0.00
Lake Jackson	24	48.80	41.66	0.11	-0.84	-0.01	0.04	6.58	0.03	0.00	0.00	-1.07	0.21	0.00
Lake Marian	25	48.63	43.85	0.04	-1.84	0.00	0.01	7.59	1.03	0.00	0.00	0.06	0.07	0.00
S-65A	26	49.10	39.05	0.20	0.88	0.03	0.69	8.58	1.15	0.00	0.00	-0.56	0.25	0.00
S-65BC	27	48.41	38.02	0.18	-0.50	-0.01	0.98	9.97	0.20	0.00	0.00	0.10	0.07	0.00
S-65D	28	47.96	38.06	0.08	1.36	0.01	0.28	9.89	2.03	0.00	0.00	-0.29	0.04	0.01
S-65E	29	44.32	36.09	-0.01	-0.95	1.19	2.05	7.77	1.00	0.00	0.00	0.74	-0.06	0.01

Table 4-3: “With Project” Base Conditions Lateral inflows for the Future Base Conditions – 1965-2005, Annual

	Toho	Hart	East Toho	Myrtle	Alligator	Gentry	Kissimmee, Hatchineha and Cypress	Pool A	Pool BCD	Pool E	Kissimmee Upper Basin	Lower Kissimmee Basin	Kissimmee Basin
Drained Area (acres)	*153,040*	*34,408*	*91,750*	*13,939*	*59,430*	*29,943*	*645,793*	*103,353*	*295,353*	*29,157*	*1,028,303*	*427,863*	*1,456,166*
% of the Kissimmee Basin	*10.5%*	*2.4%*	*6.3%*	*1.0%*	*4.1%*	*2.1%*	*44.3%*	*7.1%*	*20.3%*	*2.0%*	*70.6%*	*29.4%*	*100.0%*
Water Year	**Hydrologic Yield of the area draining to the WCU (A.K.A. Lateral Inflows) per Water Year in Inches**												
1965-1966	7.5	8.2	14.1	6.8	8.7	1.1	6.6	10.7	7.6	2.5	7.4	8.0	7.6
1966-1967	6.3	7.9	11.0	4.2	3.4	0.7	5.1	8.4	10.5	14.4	5.7	10.3	7.0
1967-1968	6.3	2.5	6.9	-1.3	1.7	0.6	3.4	7.6	10.5	5.5	3.9	9.4	5.5
1968-1969	12.2	9.1	18.1	6.8	9.0	0.7	10.4	15.8	15.5	21.5	10.9	16.0	12.4
1969-1970	15.3	12.9	22.4	10.0	15.5	2.8	12.0	16.2	16.0	20.7	13.4	16.4	14.2
1970-1971	-0.4	1.1	0.2	-0.2	-1.5	0.0	2.2	5.6	9.1	3.6	1.3	7.9	3.2
1971-1972	1.2	1.6	3.3	-0.3	0.3	0.6	3.1	7.0	12.2	14.5	2.5	11.1	5.0
1972-1973	1.5	1.3	4.2	0.1	-0.4	0.4	3.4	9.8	11.3	1.4	2.7	10.3	5.0
1973-1974	5.8	1.5	6.7	-0.8	1.5	0.7	6.3	11.5	11.5	8.7	5.6	11.3	7.2
1974-1975	4.2	4.1	8.6	1.9	3.1	0.5	7.4	12.9	13.1	12.3	6.4	13.0	8.3
1975-1976	4.6	1.5	5.3	-1.5	-0.4	0.7	4.0	8.7	9.5	2.9	3.7	8.8	5.2
1976-1977	3.7	3.9	9.0	1.8	0.7	0.7	9.6	13.7	11.2	4.6	7.6	11.3	8.7
1977-1978	5.6	2.2	6.8	1.5	0.6	0.6	8.0	8.6	8.1	1.4	6.6	7.8	6.9
1978-1979	7.3	3.2	9.5	0.8	-0.1	0.7	9.1	12.4	14.0	7.2	7.8	13.1	9.3
1979-1980	10.0	5.7	11.6	-0.4	0.6	1.1	15.1	15.7	11.6	10.5	12.2	12.5	12.3
1980-1981	-3.0	0.1	-1.9	-2.4	-4.1	0.3	-0.2	4.6	8.8	1.4	-1.0	7.3	1.4
1981-1982	4.5	1.7	8.2	0.0	1.9	0.6	1.1	4.1	10.8	2.6	2.2	8.7	4.1
1982-1983	14.0	7.6	19.6	4.3	6.9	1.4	15.3	19.7	14.9	16.8	14.2	16.2	14.8
1983-1984	9.8	4.8	10.5	1.1	0.6	0.6	9.5	13.9	7.7	6.3	8.6	9.1	8.7
1984-1985	2.6	1.9	2.9	-3.1	-4.3	0.3	2.5	7.5	9.7	7.9	2.0	9.0	4.1
1985-1986	5.5	3.9	9.6	2.6	1.9	0.7	3.1	6.7	10.8	6.0	3.9	9.5	5.6
1986-1987	7.5	3.6	9.5	0.3	0.5	0.7	7.6	11.8	9.1	10.7	6.9	9.9	7.8
1987-1988	9.3	4.2	11.9	0.3	1.8	1.0	8.7	15.6	12.1	6.7	8.2	12.6	9.5
1988-1989	10.7	3.3	11.9	-0.5	0.6	0.5	8.1	9.1	6.8	2.5	7.9	7.1	7.7
1989-1990	6.8	0.7	5.6	-1.9	-1.6	0.6	3.9	5.5	8.2	2.6	3.9	7.2	4.8
1990-1991	2.6	0.7	3.4	-1.2	-1.4	0.4	2.8	5.3	11.5	7.5	2.4	9.7	4.6
1991-1992	9.6	2.1	11.5	-2.0	0.6	0.8	7.5	10.8	12.4	9.3	7.3	11.8	8.6
1992-1993	11.8	4.1	14.8	1.7	3.8	0.9	10.2	18.0	13.4	13.8	9.9	14.5	11.3
1993-1994	0.6	0.4	2.6	-0.9	-2.8	0.2	1.9	8.8	10.3	6.8	1.3	9.7	3.8
1994-1995	22.5	10.7	26.6	6.8	7.9	0.9	14.6	19.5	18.5	22.1	15.8	19.0	16.7
1995-1996	19.4	5.1	18.4	0.0	2.7	1.8	14.8	19.4	17.8	18.8	14.2	18.2	15.4
1996-1997	4.2	5.0	8.2	1.2	-0.9	1.4	6.7	9.0	10.3	6.2	5.7	9.7	6.9
1997-1998	22.4	15.8	28.9	11.9	11.6	1.2	16.4	22.2	23.8	15.7	17.6	22.9	19.2
1998-1999	-0.7	0.9	-0.2	-0.4	-3.9	0.1	0.9	9.4	16.3	5.1	0.3	13.8	4.3
1999-2000	8.1	4.0	11.1	0.9	1.2	0.7	5.3	4.8	18.1	13.2	5.7	14.5	8.3
2000-2001	0.3	-0.6	0.2	-2.2	-1.5	0.5	2.1	7.1	6.1	2.4	0.1	8.2	2.5
2001-2002	4.5	2.2	7.7	1.0	1.1	0.7	10.5	10.6	6.9	6.0	5.3	10.3	6.8
2002-2003	17.3	8.9	22.3	7.6	7.6	0.4	21.2	16.1	6.1	12.2	13.1	16.7	14.2
2003-2004	14.2	9.9	18.7	7.1	4.6	1.2	14.8	11.5	7.7	12.2	12.2	12.1	12.1
2004-2005	3.5	2.6	9.8	1.2	1.4	0.1	14.7	14.9	8.9	7.4	6.2	14.5	8.6
Average Annual	**7.5**	**4.3**	**10.2**	**1.6**	**2.0**	**0.7**	**7.7**	**11.3**	**11.5**	**8.8**	**6.8**	**11.7**	**8.2**

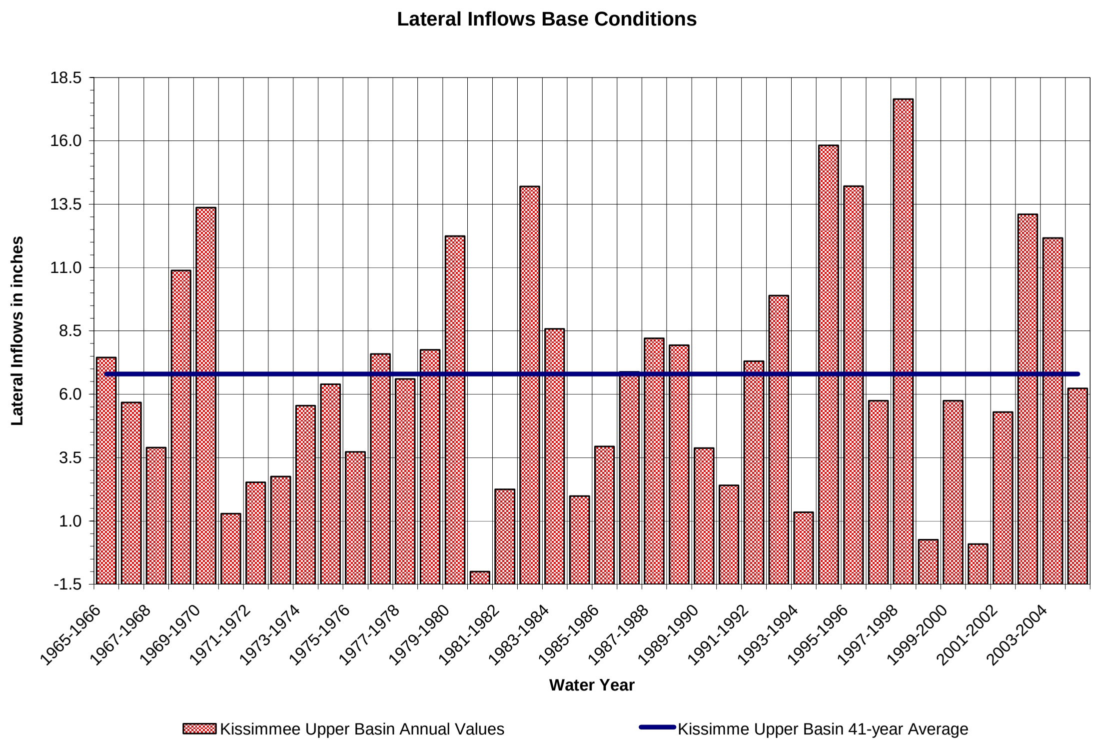


Figure 4-8: "With Project" Base Conditions – Lateral inflows for the KUB

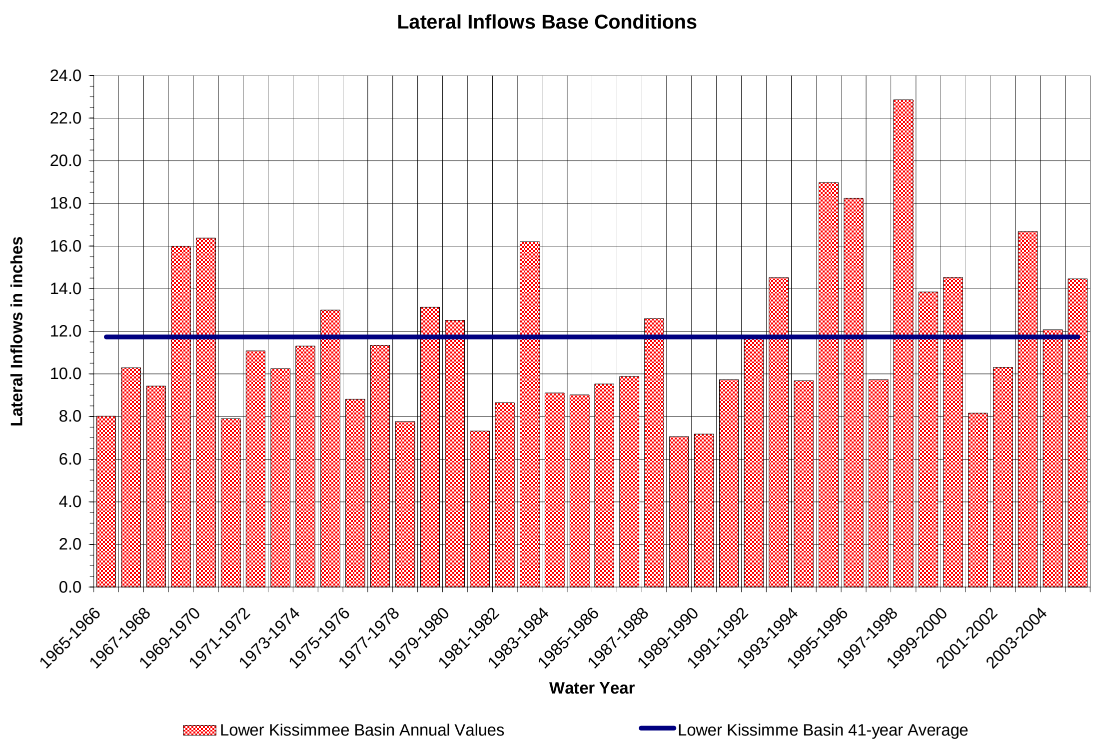


Figure 4-9: "With Project" Future Base Conditions – Lateral inflows for the LKB

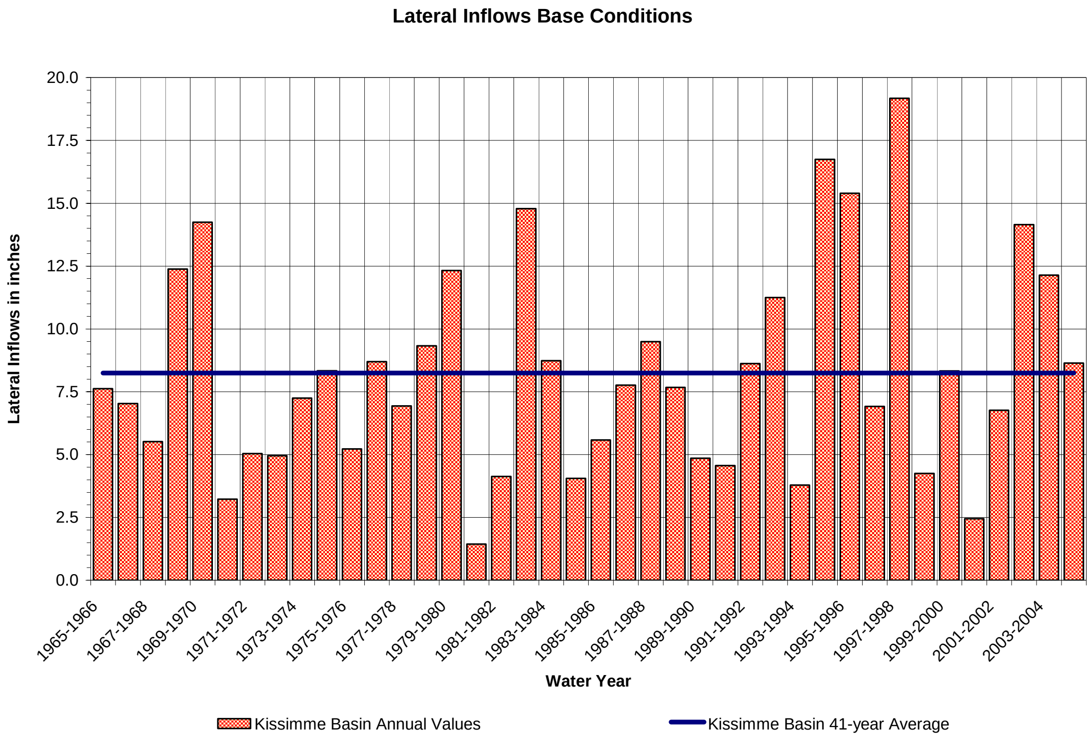


Figure 4-10: "With Project" Base Conditions – Lateral inflows for the Kissimmee Basin

Table 4-4: "With Project" Base Condition Annual Runoff from Boggy, Single and Reedy Creeks

	BOGGY CREEK	SHINGLE CREEK	REEDY CREEK
Drained Area (acres)	*52,664*	*68,383*	*170,653*
Water Year	Runoff in inches		
1965-1966	18.3	11.0	5.9
1966-1967	18.3	12.6	7.6
1967-1968	12.7	11.4	7.3
1968-1969	22.0	15.2	9.6
1969-1970	26.7	19.4	13.8
1970-1971	4.7	4.1	4.6
1971-1972	8.1	5.8	5.0
1972-1973	10.5	6.5	3.5
1973-1974	13.1	11.0	7.3
1974-1975	13.4	9.2	7.1
1975-1976	10.8	8.4	6.0
1976-1977	13.7	7.6	7.2
1977-1978	10.9	9.6	10.7
1978-1979	15.5	12.4	11.2
1979-1980	16.6	14.0	13.2
1980-1981	4.2	1.9	1.5
1981-1982	13.4	7.5	3.9
1982-1983	23.7	18.0	13.0
1983-1984	15.1	13.3	9.9
1984-1985	9.8	8.1	5.6
1985-1986	15.5	9.9	6.4
1986-1987	15.7	11.9	8.0
1987-1988	16.7	12.4	8.2
1988-1989	16.4	12.4	9.9
1989-1990	10.3	8.9	6.8
1990-1991	8.7	6.5	4.7
1991-1992	18.3	13.2	7.8
1992-1993	19.7	14.4	9.9
1993-1994	7.2	4.6	2.6
1994-1995	33.5	26.1	16.4
1995-1996	23.1	22.0	14.7
1996-1997	13.2	8.0	6.0
1997-1998	34.5	24.8	18.4
1998-1999	5.7	5.5	4.1
1999-2000	17.6	13.1	5.8
2000-2001	4.1	3.9	1.7
2001-2002	12.3	8.5	4.2
2002-2003	27.4	19.6	11.8
2003-2004	24.9	18.6	12.9
2004-2005	11.2	7.7	4.7
Average Annual	**15.4**	**11.5**	**8.0**

5 REFERENCE

Bousquin S. G., D. H. Anderson, G. E. Williams, and D. J. Colangelo, 2005. Establishing a Baseline: Pre-restoration Studies of the Channelized Kissimmee River. South Florida Water Management District, West Palm Beach, Florida.

Earth Tech, 2005. Phase I Kissimmee Basin Assessment Report - Section 1.

Earth Tech, 2007. Kissimmee Basin Hydrologic Assessment, Modeling, and Operations Planning Study, Phase II, Draft Operating Criteria for Modeling S-65D Future Conditions Memo.

Earth Tech, 2007a. Alternative Formulation Evaluation Tool Model Documentation and Calibration Report, Peer Review Copy, prepared for SFWMD.

Earth Tech, 2008. Kissimmee Basin Modeling and Operations Study KBMOS, Evaluations of Base Conditions Report.

Earth Tech, 2008a. KCOL Surface Water Supply Availability Study, Draft AFET-W Calibration Report. (Evaluation of the Surface Water Withdrawals from the Kissimmee Chain of Lakes, AFET – Calibration Approach Technical Memorandum)

Earth Tech, 2008b. Kissimmee River Floodplain Hydraulic Model.

Earth Tech, 2008c. Technical Approach to create the Existing Legal Users database included in the "With Project" base condition model.

SFWMD, 2008. Generation of the Expanded Coverage Reference Evapotranspiration Dataset for Hydrologic Modeling

USACE, 1996. KUB (Kissimmee Upper Basin)

APPENDIX A

Comparison of Previous KBMOS Base Conditions Results

1 BASE CONDITION RUNS PREVIOUSLY DEFINED IN KBMOS

KBMOS future and current base conditions are described in the Evaluation of Base Conditions Report (Earth Tech 2008b). This section analyzes the results obtained in terms of total basin runoff as compared to the available information.

1.1 Future Base Conditions

A future base condition run was defined within KBMOS. These base conditions corresponded to the fully restored Kissimmee River under a future land use scenario. The first model results obtained from these base conditions indicated a large difference in basin runoff, as compared to the total basin runoff obtained with the model run corresponding to the current base conditions. Since the rest of the model drivers are kept constant in the base conditions, these differences in basin runoff were all due to changes in land use. These results raised concerns over the assumptions made to generate the "future" land use coverage. Therefore, base conditions used for ongoing Kissimmee Basin planning efforts will only use the current land use.

1.2 Current Base Conditions

The basic description of the KBMOS current base conditions is included below:

- Current Land Use (2000):
    - Consistent with Current Kissimmee Basin Water Supply Planning Efforts
- Historic Rainfall (1965 to 2005)
    - Data derived from the 2-mile square grid data (HESM Standard)
- RET
    - Single data point RET (composite timeseries)
- Completed KRRP
    - USACE Infrastructure
- Existing Permitted Surface Water and Groundwater Uses as of August 31, 2008
    - SFWMD Permit Database
- Operations
    - Headwater Revitalization Schedule at the S-65 Structure
    - Current Regulation Schedules all other structures

Prior to the development of the "with project" base conditions, the KBMOS team ran two versions or revisions of the current base condition, as described below.

1.2.1 Base Conditions Revision Zero

The initial current base condition run included a set of RET data that consisted of a single timeseries for the entire basin (not spatially distributed) and was compiled from multiple data sources.

Figure A-1 and **Figure A-2** show comparisons of runoff and cumulative flow at the S-65 Structure for the current base condition Revision Zero. As seen in these figures, the current base condition Revision Zero is over-predicting basin runoff.

However, it is important to emphasize that data collection and management is a very complex and challenging task within the SFWMD. The SFWMD is constantly updating the timeseries of recorded flows and stages. Flow recording is particularly challenging. Flow is calculated by the SFWMD using an equation that represents the flow through the type of structures where the flow is being computed (mostly gated spillways and gated culverts). Therefore, the timeseries of flows is affected by errors associated with the data used by those equations (stages and gate openings) and by errors associated with the equations. The SFWMD has been updating the equations used to compute the flows and identifying datum issues that could be affecting the calculation of flows. As a result of these efforts, there are several timeseries or "DBKEYS" with available information. In addition to the QA/QC efforts carried out by the SFWMD, there had been several changes in the methodologies used to collect the stage information used to compute flows. Stages are currently recorded using digital devices, but in the past they had been recorded with graphical devices. Gate openings were collected manually in the past. For the main structures representing total runoff from the KUB and LKB (S-65 and S-65E, respectively) the SFWMD has been responsible for the data collection activities only after 1996. Therefore, the study team believed that recent data (1996 to present) may have had the level of accuracy sufficiently reliable to be compared to the results of the base condition simulations.

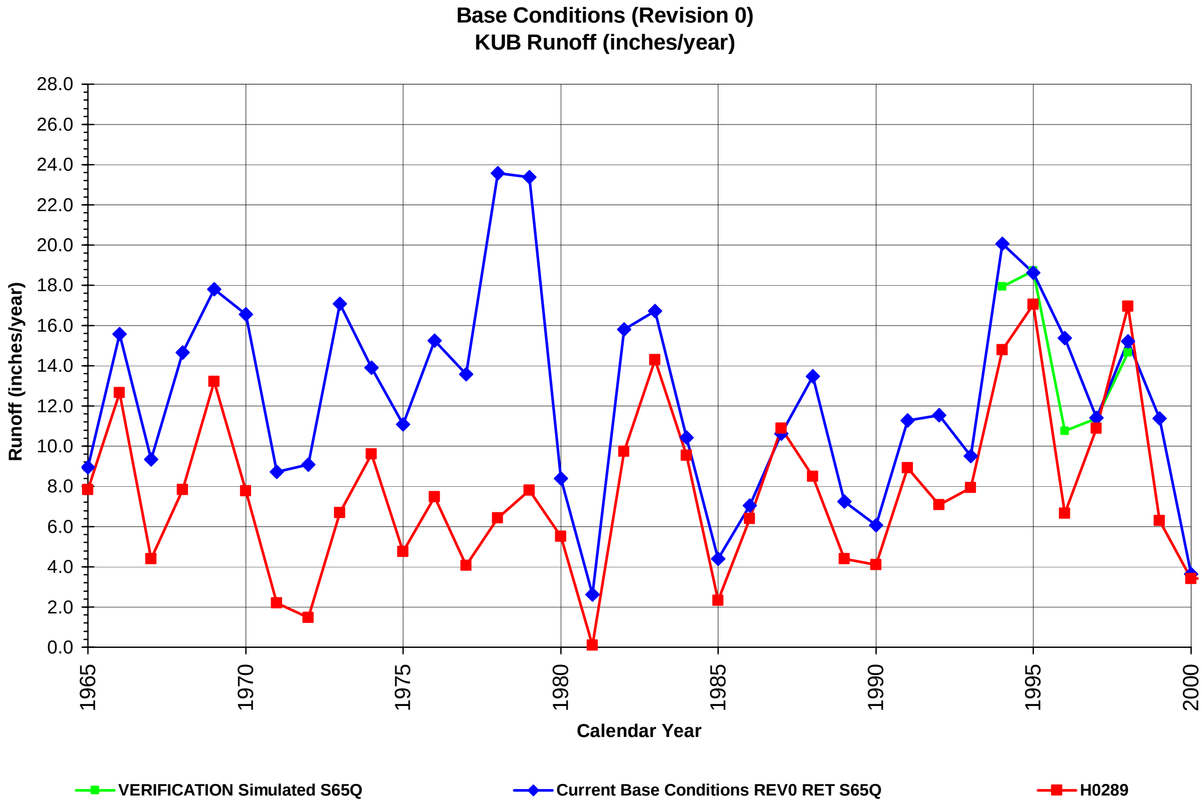


Figure A-1: Comparison of Annual Runoff at the S-65 Structure – Current Base Condition Revision Zero vs Observed Flow

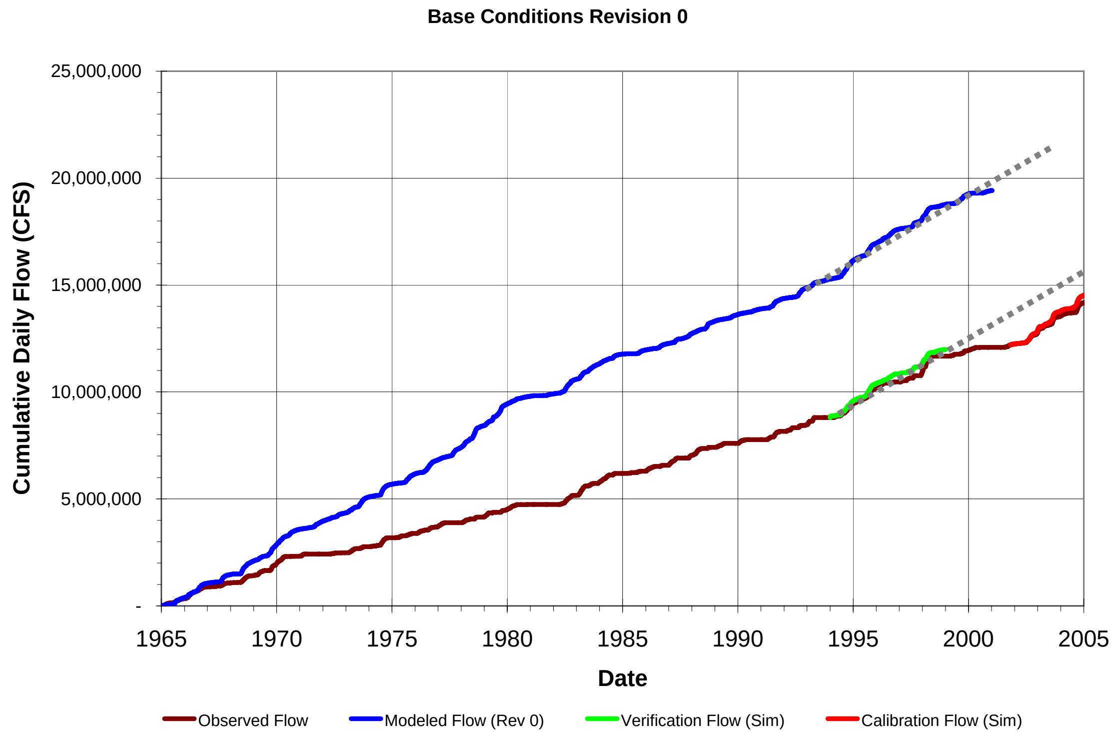


Figure A-2: Comparison of Cumulative Flow through the S-65 Structure – Current Base Condition Revision Zero vs. Observed Flow

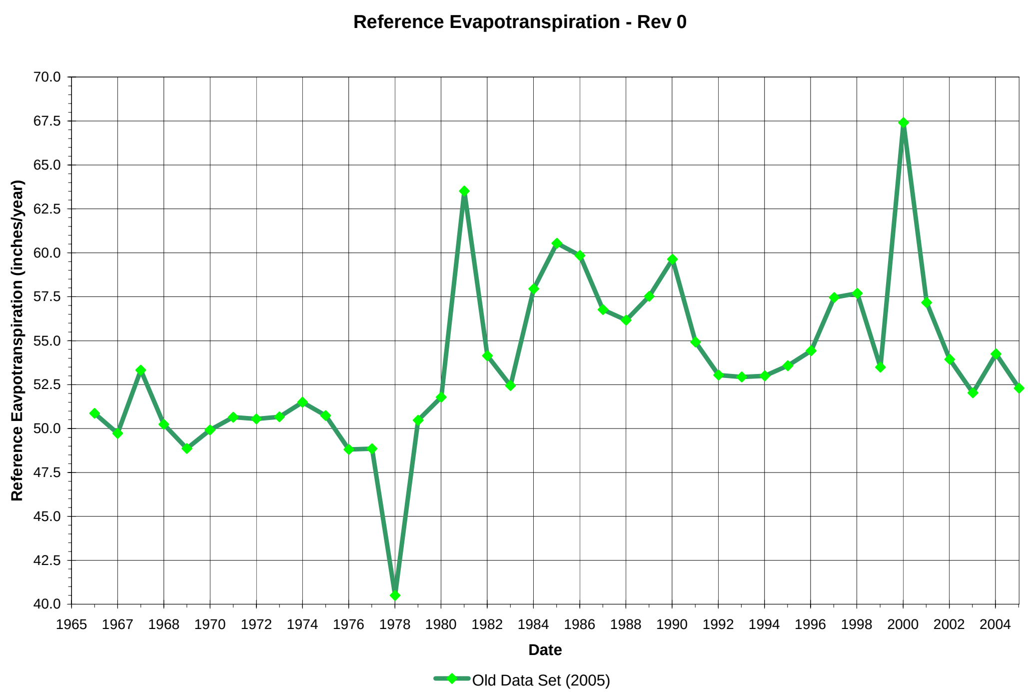


Figure A-3: Annual Summary of RET Data used in Revision Zero

The differences between modeled results and observed data cannot be explained by the lack of accuracy in the observed data. The plot included in **Figure A-3** shows that the RET values used to drive Revision Zero had a shift in their average after 1980. This shift is not explained by any climatologic phenomenon and it may be an artifact of the methodology used to calculate the RET timeseries. This shift in RET is also evident in the simulated runoff for the same time period shown in **Figure A-1**. Based in these data, the RET was identified as a potential source of a portion of the cumulative error evident in **Figure A-3**.

Since at the time Revision Zero was run there was no other data source available, it was decided to manually adjust the RET data set and re-run the current base conditions. This adjustment process created what is called "Revision One".

1.2.1.1 Revision One

As mentioned in the previous section, the RET values used in Revision Zero had annual values that were, on average, five inches per year lower in the period from 1965 to 1980 than in the period from 1980 through 2005. As is the case with the flow records, it is believed that the most recent data are more accurate than older information due to the advances in the methodologies to collect, process, transmit and store the information. For those reasons and given the lack of a better source of data, a manual adjustment was introduced to the RET data. The RET data set was adjusted with monthly multipliers that were applied to the RET timeseries (1965 to 1980). Table A-1 summarizes the adjustment factors applied to the original RET timeseries .In addition to the adjustments done to the pre-1980 data, evident outliers were removed in January and February of 2000. The annual summary of the resulting RET timeseries is depicted in **Figure A-4**.

Table A-1: Adjustment Factor Applied to the RET Data (1965 to 1980) Revision Zero

Month	Multiplier
JAN	1.16
FEB	1.18
MAR	1.08
APR	1.09
MAY	1.11
JUN	1.14
JUL	1.12
AUG	1.12
SEP	1.08
OCT	1.12
NOV	1.14
DEC	1.17

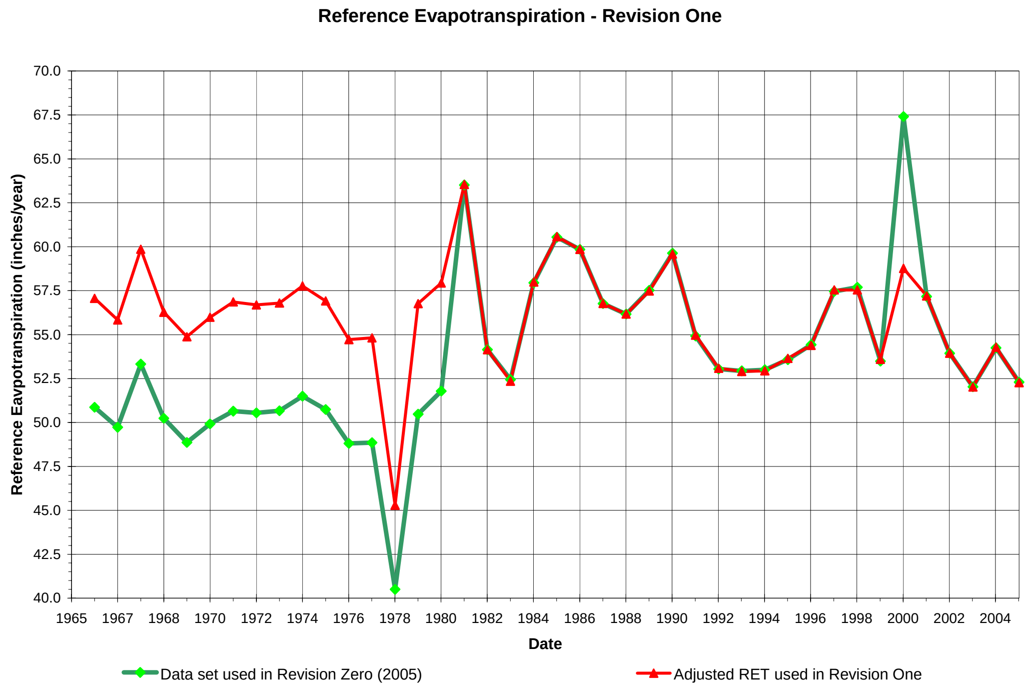


Figure A-4 : Annual Summary of RET Data used in Revisions One and Zero

This timeseries was still not the desired data set since it was a unique timeseries for the entire basin, meaning that it was not spatially distributed. The same data were being applied in the vicinity of the S-65E Structure as was being applied near Orlando. Additionally, as seen in **Figure A-4**, the adjusted timeseries still had some oddities or peaks that needed to be resolved or explained.

Figure A-5 shows the results of Revision One in terms of the KUB total runoff (inches/year) measured at the S-65 Structure. This figure shows an improvement from Revision Zero (red line). It is also evident in this figure, as pointed out before, that almost all series coincide after 1996, which is the time period with more confidence in the observed flow data. Perhaps the largest discrepancy observed in the plot is the peak discharge seen in 1978. This coincides with the "oddity" mentioned in the previous paragraph. The RET timeseries show an unusual dip in that year, when the average annual RET is almost ten inches lower than the average in the entire period.

In June 2008, the SFWMD completed the work associated with the construction of a spatially distributed data set of RET for the entire Kissimmee Basin. This newly available data set generated the need to run Revision Two, described in the following sections.

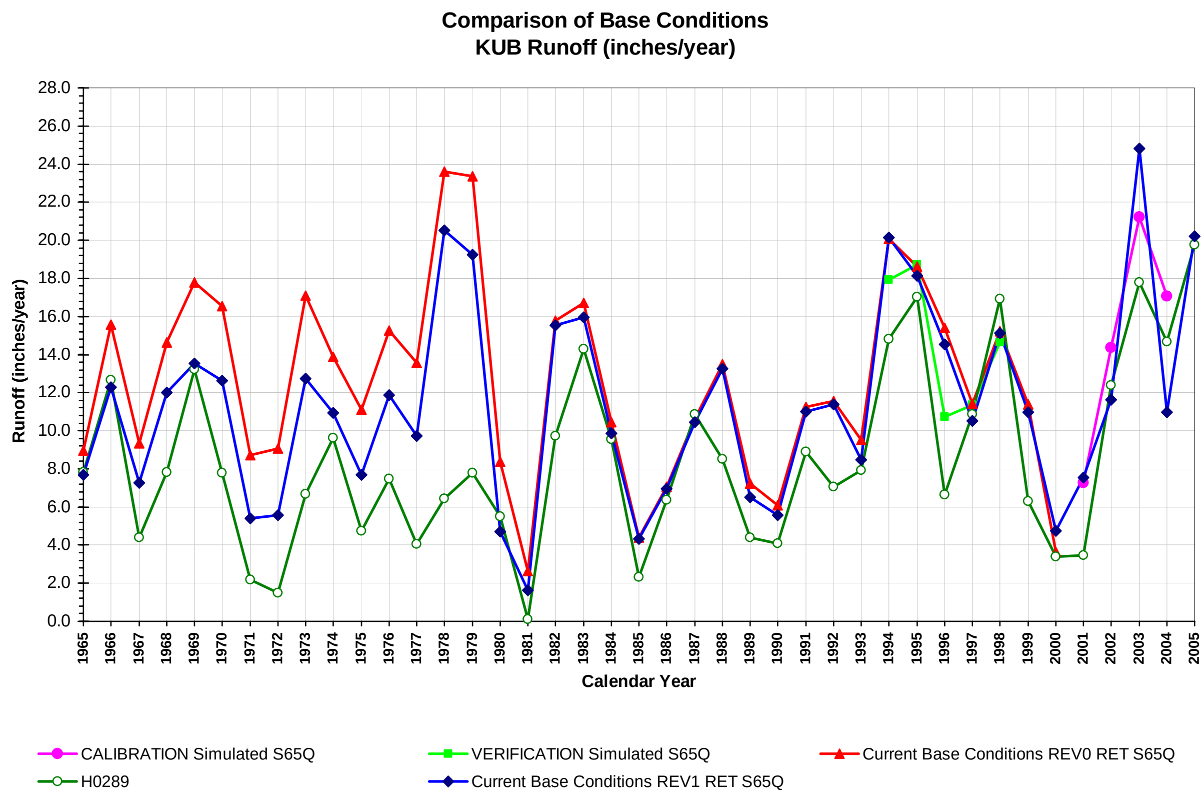


Figure A-5: Comparison of Annual Runoff at the S-65 Structure – Current Base Condition Revision One, Revision Zero and Observed Flow

1.2.1.2 Revision Two - Spatially distributed RET Data

The "with project" base conditions described later in this document used the spatially distributed RET data produced by the SFWMD. This section offers a comparison between the timeseries used in the latest revision of the base condition run within KBMOS and the newly available data.

1.2.1.2.1 Comparison of RET Daily Data

Figure A-6 shows a plot of the RET daily values for the period used in the calibration of the AFET-W. In comparing the data shown in the figure, it was noted that the revised data and original data both track the same general pattern, but the original data were much more sporadic with more pronounced deviations. In addition to the graphical comparison, statistics were extracted (also only for the period being used to calibrate the AFET-W) and is presented in **Table A-2**. The statistics show that overall, the revised RET data set was slightly higher (110 percent of original) at the point of comparison. The revised RET data however, had a lower maximum and lower standard deviation.

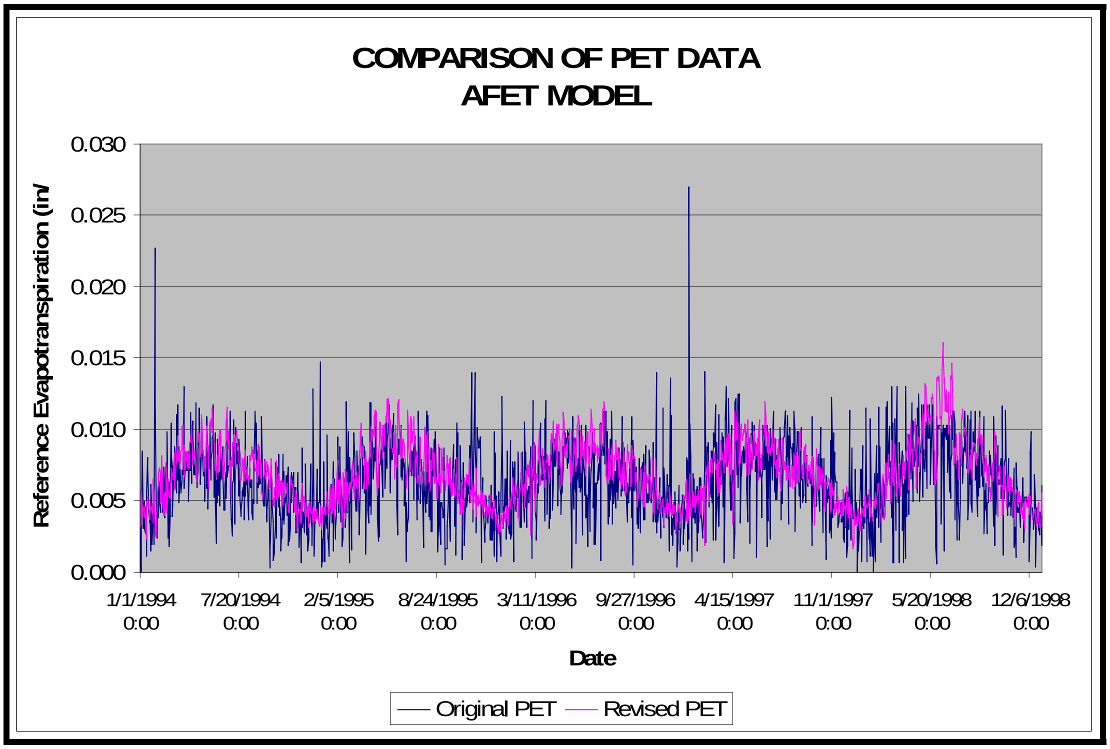


Figure A-6: Comparison of RET Daily Data

Table A-2: RET Statistics (1994 to 1998)

Statistic	Original Potential Evapotranspiration (PET) in/hr	Revised PET in/hr
Mean	0.0063	0.0069
Maximum	0.0270	0.0168
Minimum	0.0000	0.0014
Standard Deviation	0.0027	0.0021

1.2.1.2.2 Comparison of RET Annual Averages

The blue line in **Figure A-7** corresponds to the average of the spatially distributed RET data. This new timeseries is the RET data that were used in the "with project" base conditions, also referenced as Revision Two. This new timeseries is higher than the previous timeseries in the period between 1970 and 1980. This period is also the period when the base condition simulated runoff in the previous base condition simulations fell the farthest from the observed data.

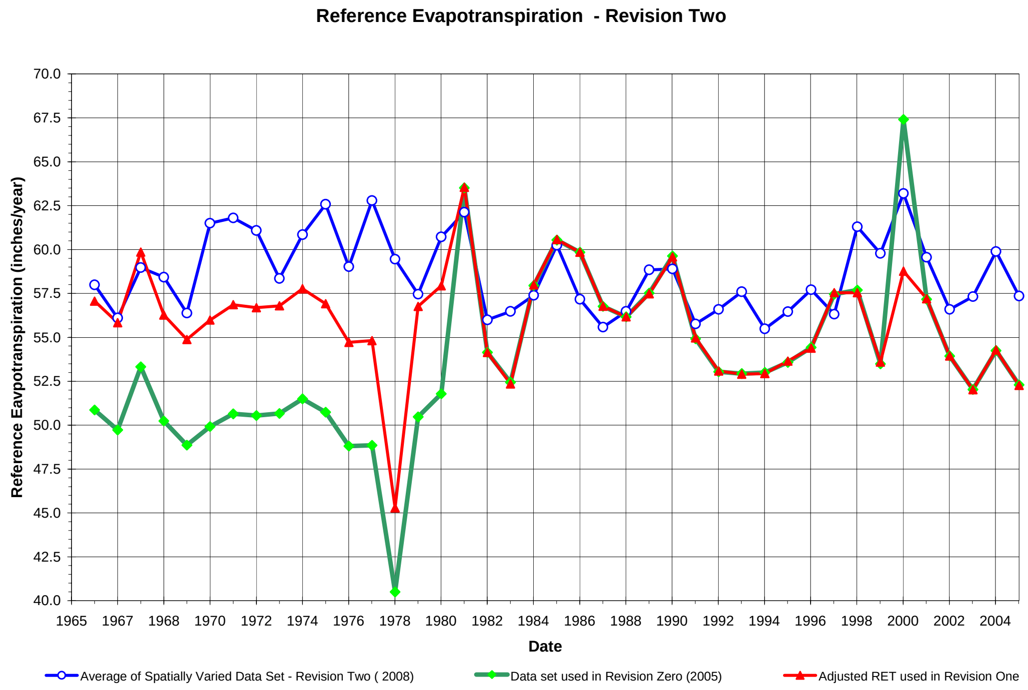
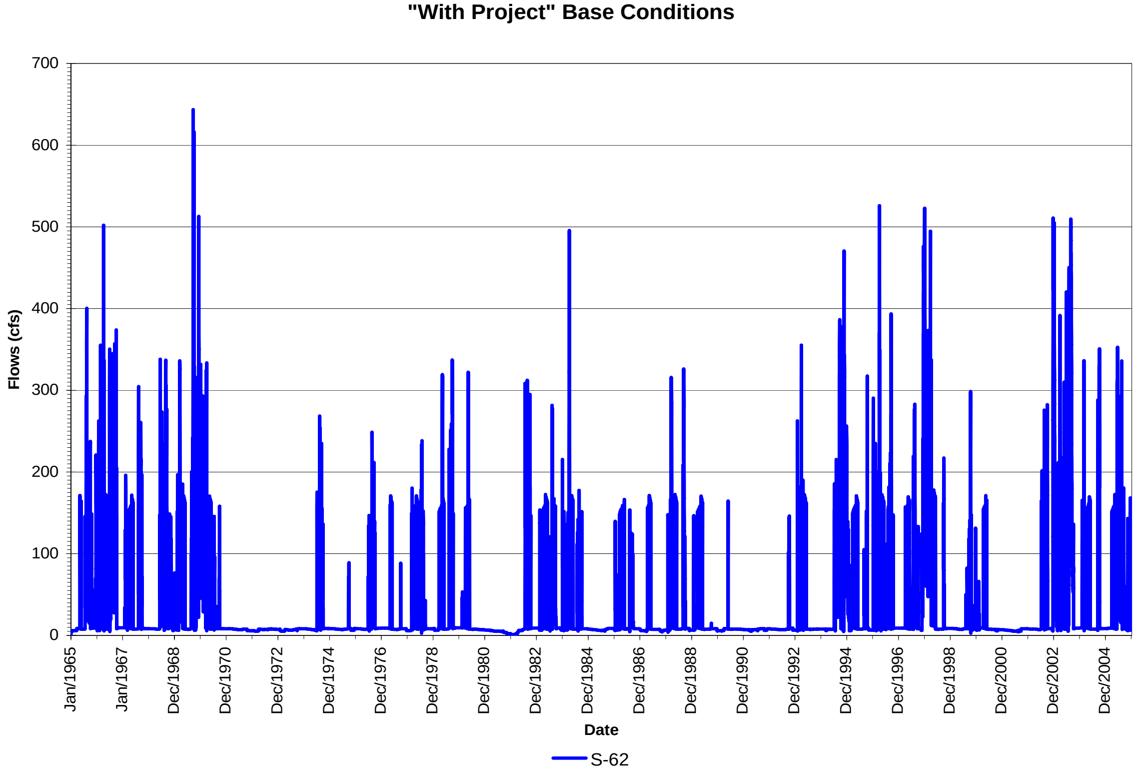


Figure A-7: Annual Summary of RET Data to be used in the "With Project" Base Conditions

APPENDIX B

Stage and Flow Hydrographs at Key Location Obtained for the “With Project” Base Condition Run

FLOWS


"With Project" Base Conditions
Flows (cfs)
700
600
500
400
300
200
100
0
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
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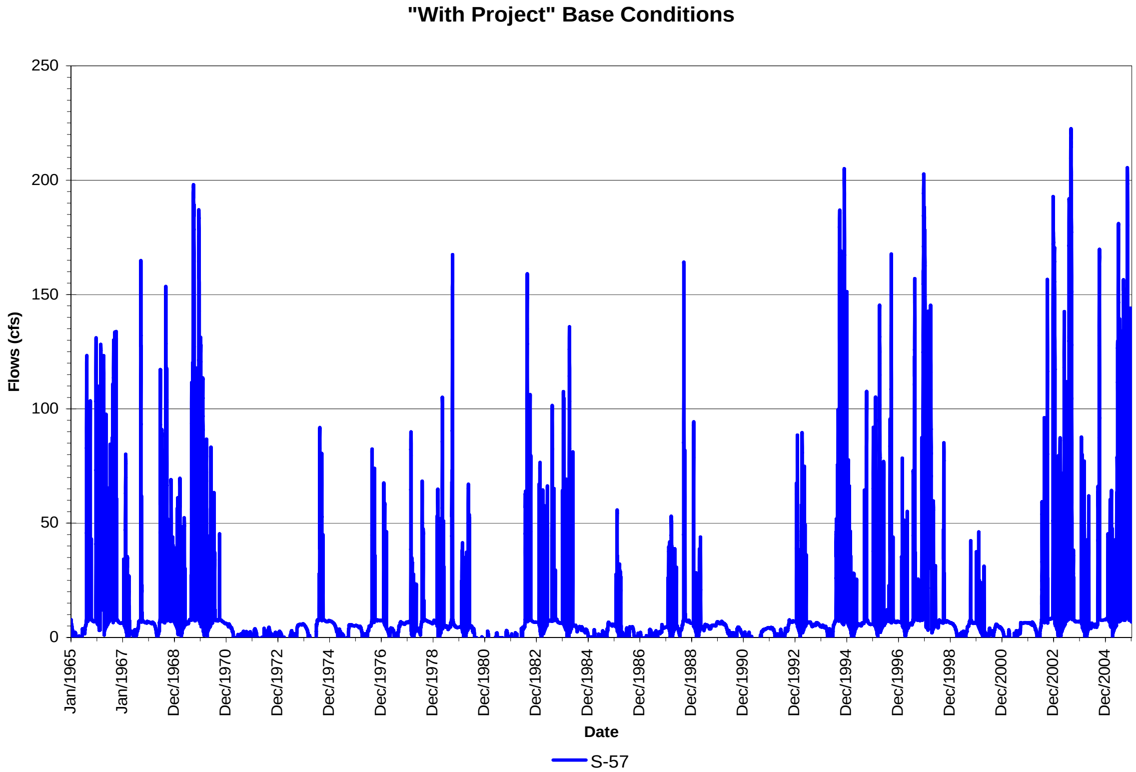
Dec/2000
Dec/2002
Dec/2004
Date
S-62


"With Project" Base Conditions
Flows (cfs)
250
200
150
100
50
0
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
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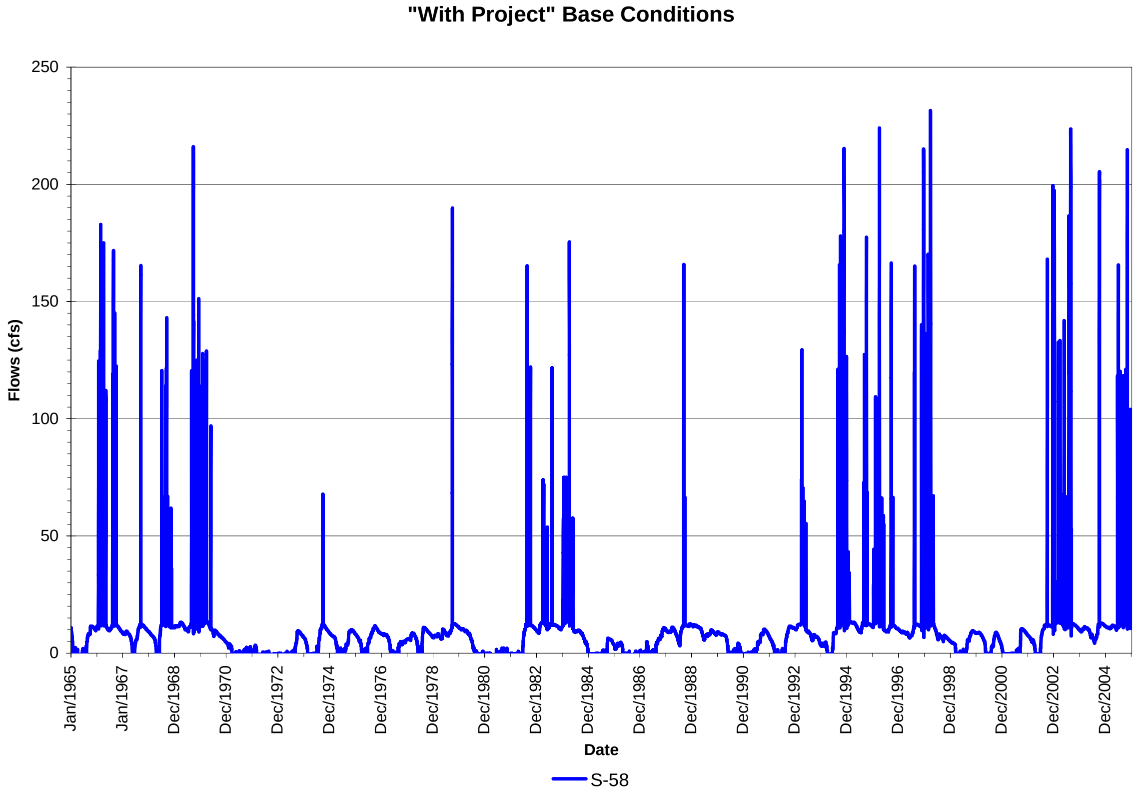
Dec/2002
Dec/2004
Date
S-57


"With Project" Base Conditions
Flows (cfs)
250
200
150
100
50
0
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
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Dec/1996
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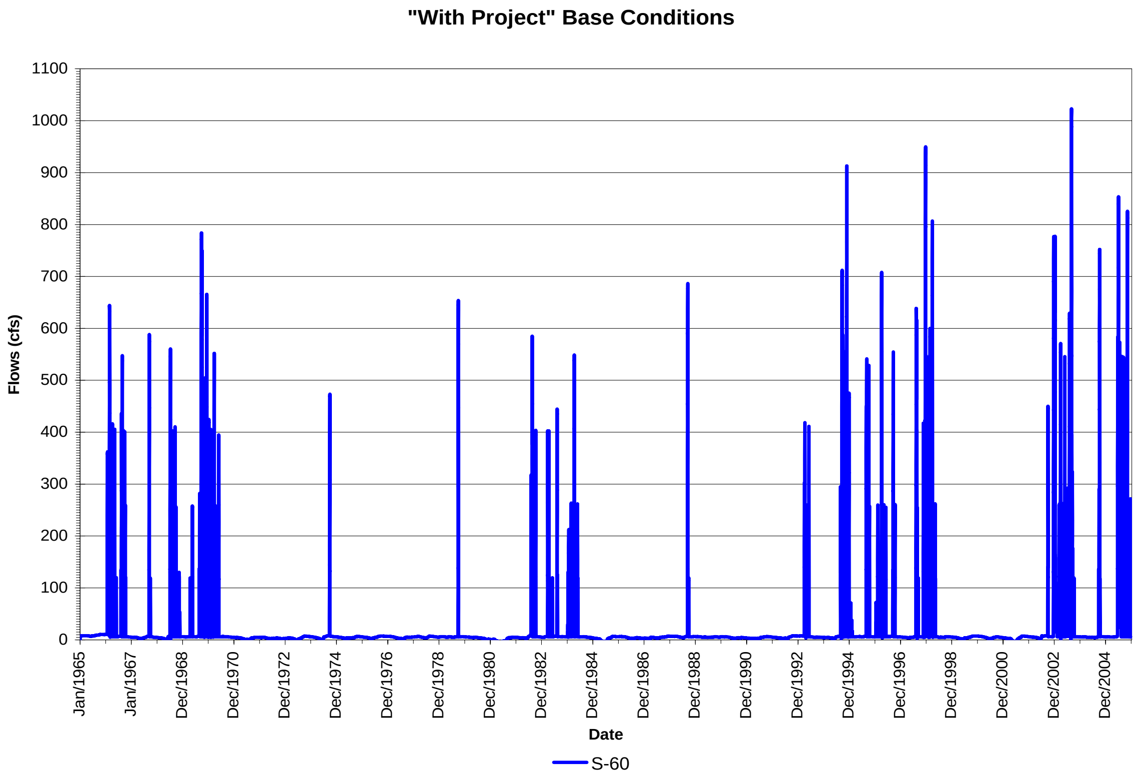
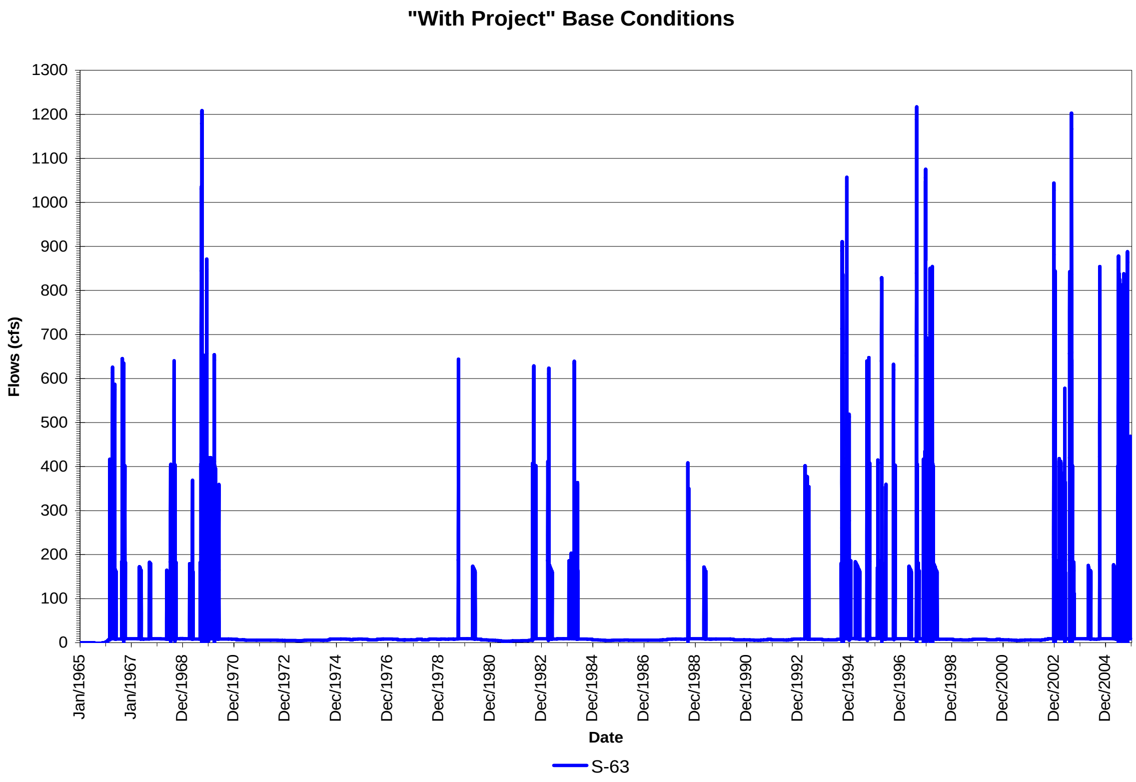
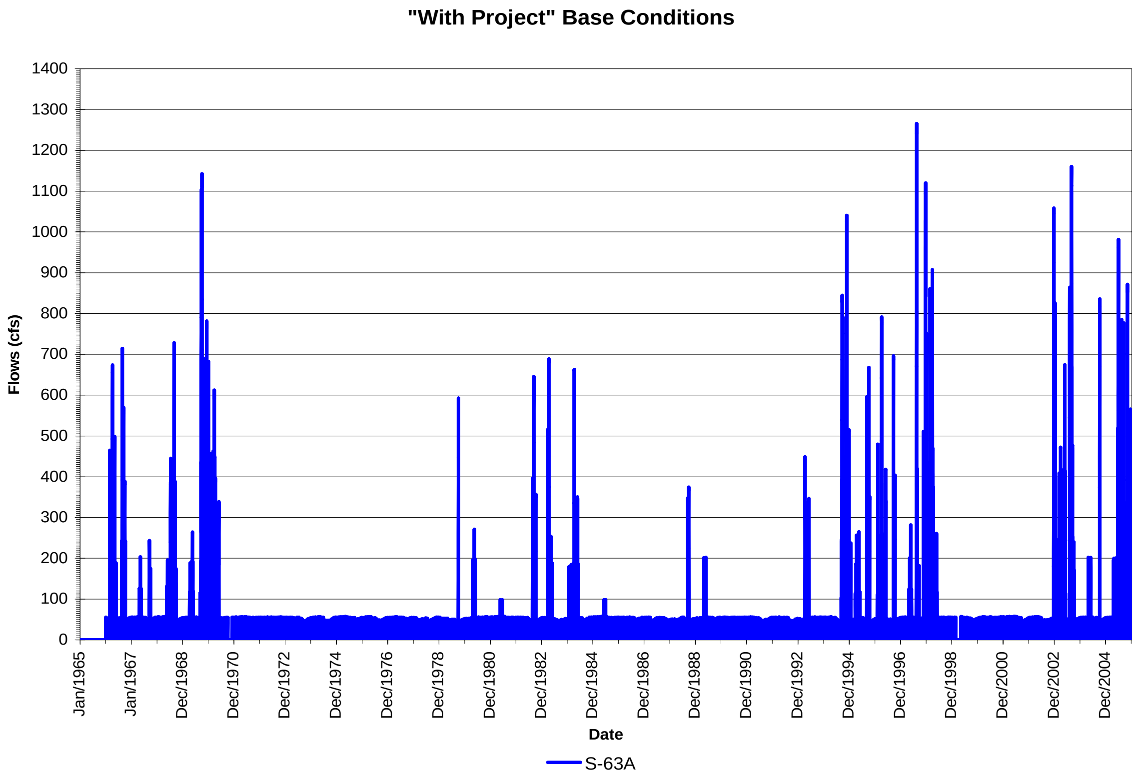
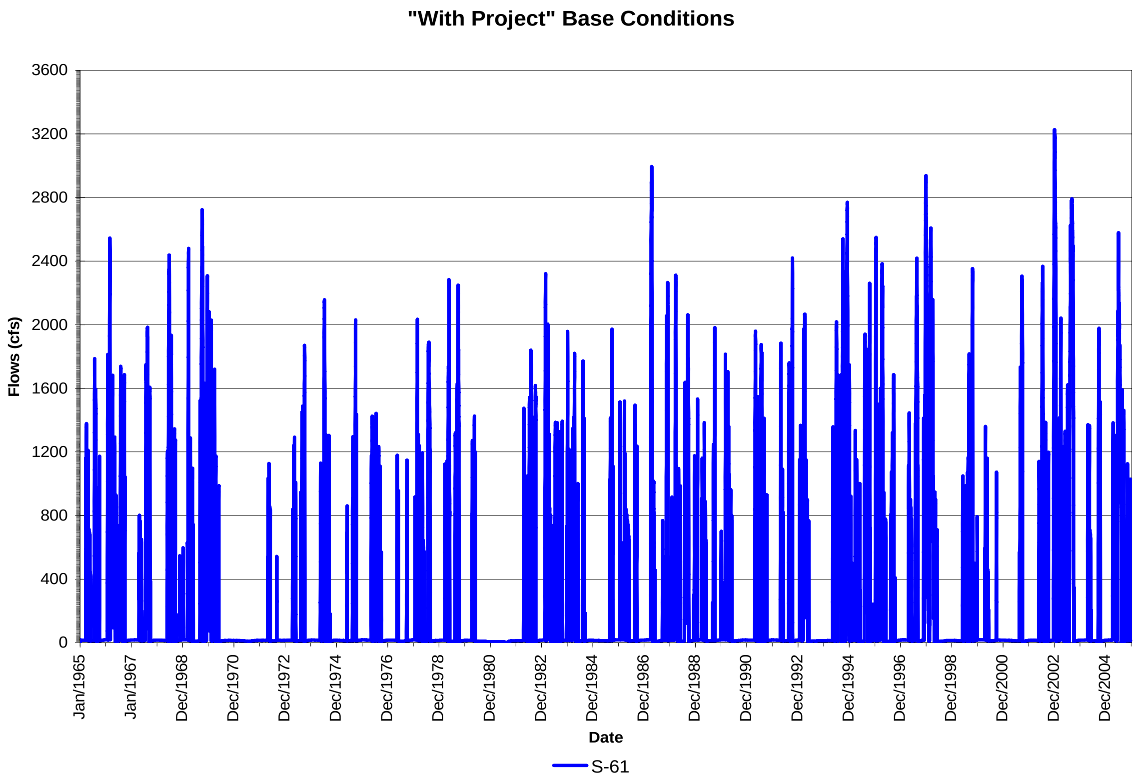
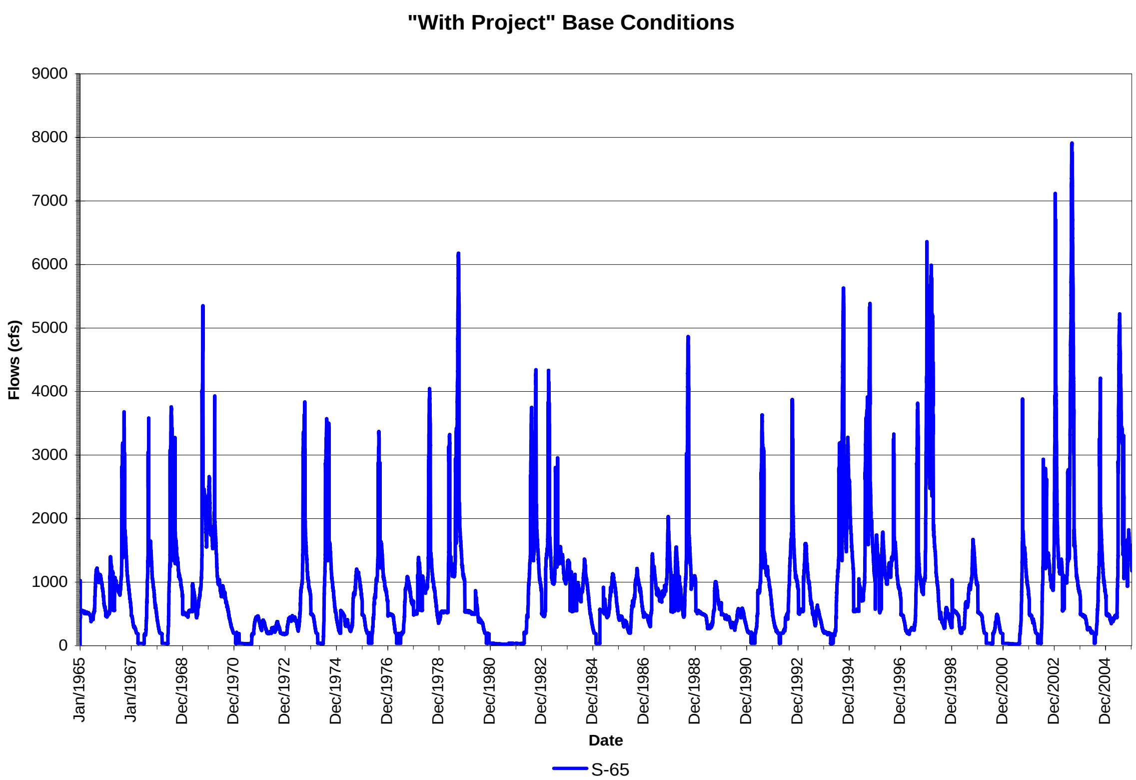
Dec/2000
Dec/2002
Dec/2004
Date
S-58


"With Project" Base Conditions
Flows (cfs)
1100
1000
900
800
700
600
500
400
300
200
100
0
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
S-60

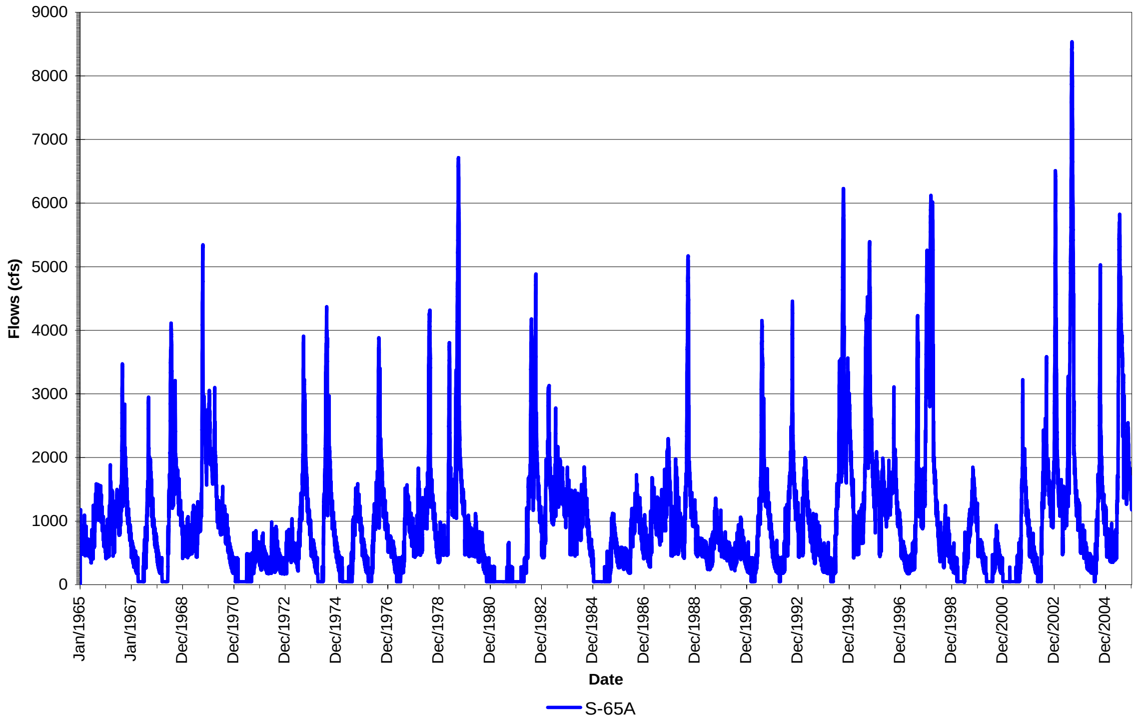

"With Project" Base Conditions
Flows (cfs)
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
S-63


"With Project" Base Conditions
Flows (cfs)
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
S-63A

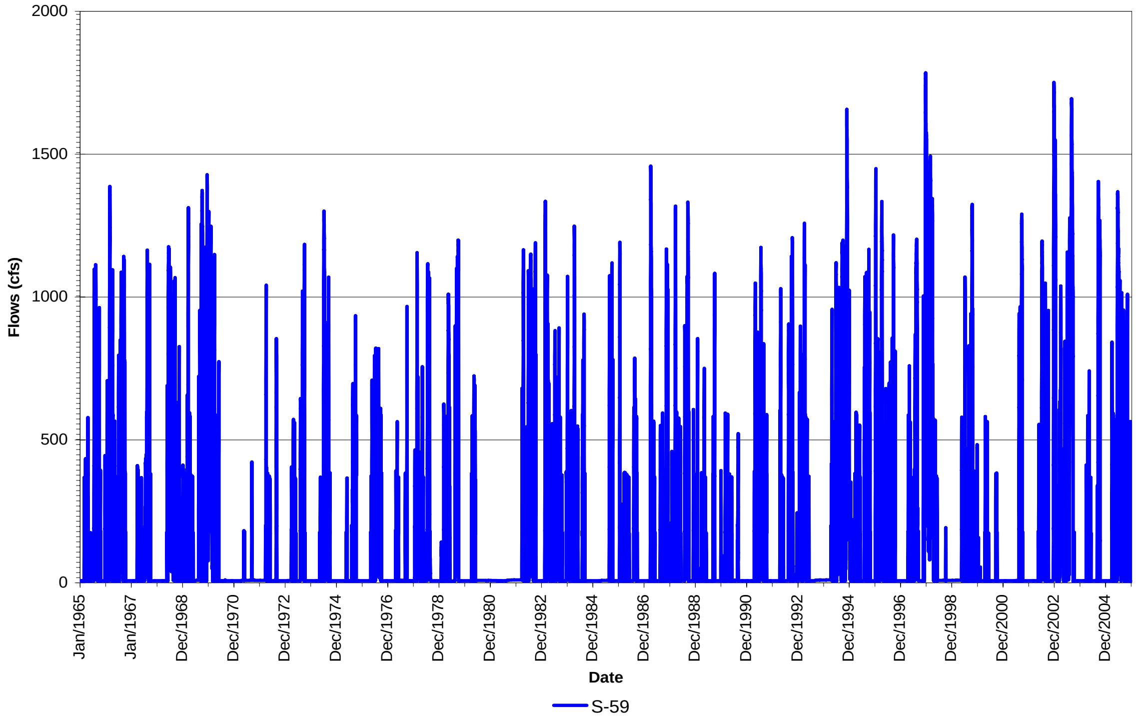

"With Project" Base Conditions
Flows (cfs)
3600
3200
2800
2400
2000
1600
1200
800
400
0
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
S-61

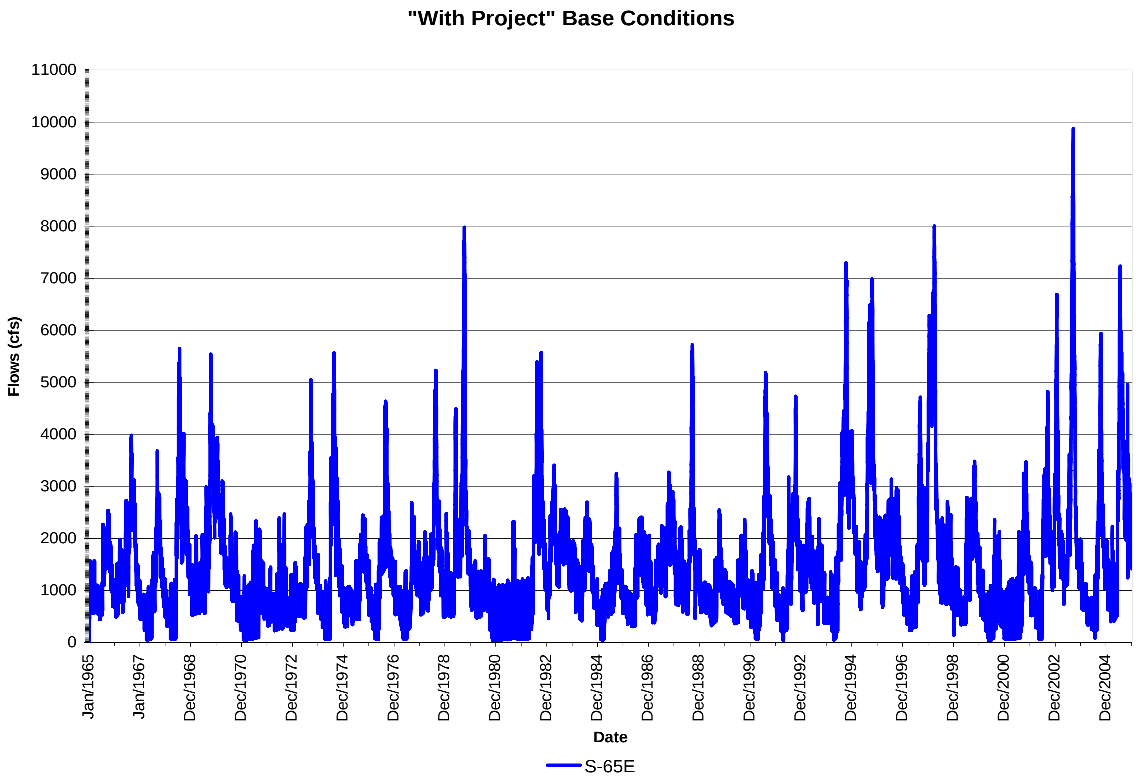

"With Project" Base Conditions
Flows (cfs)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
S-65

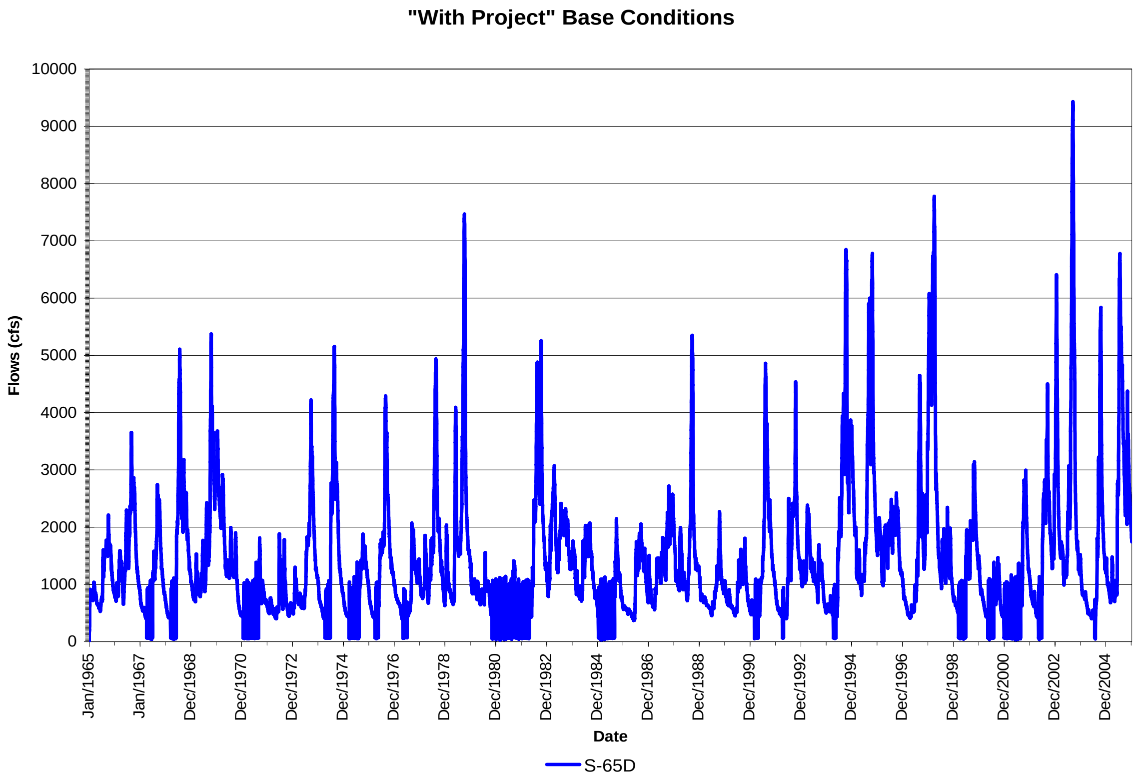
"With Project" Base Conditions

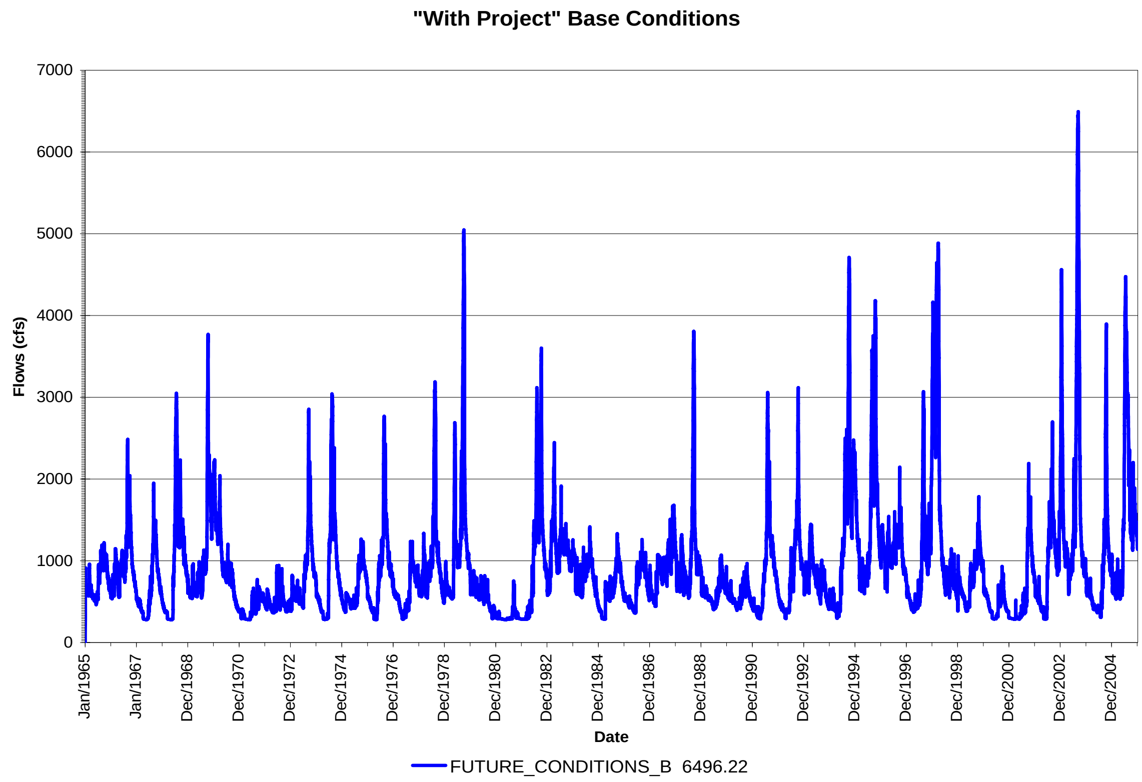


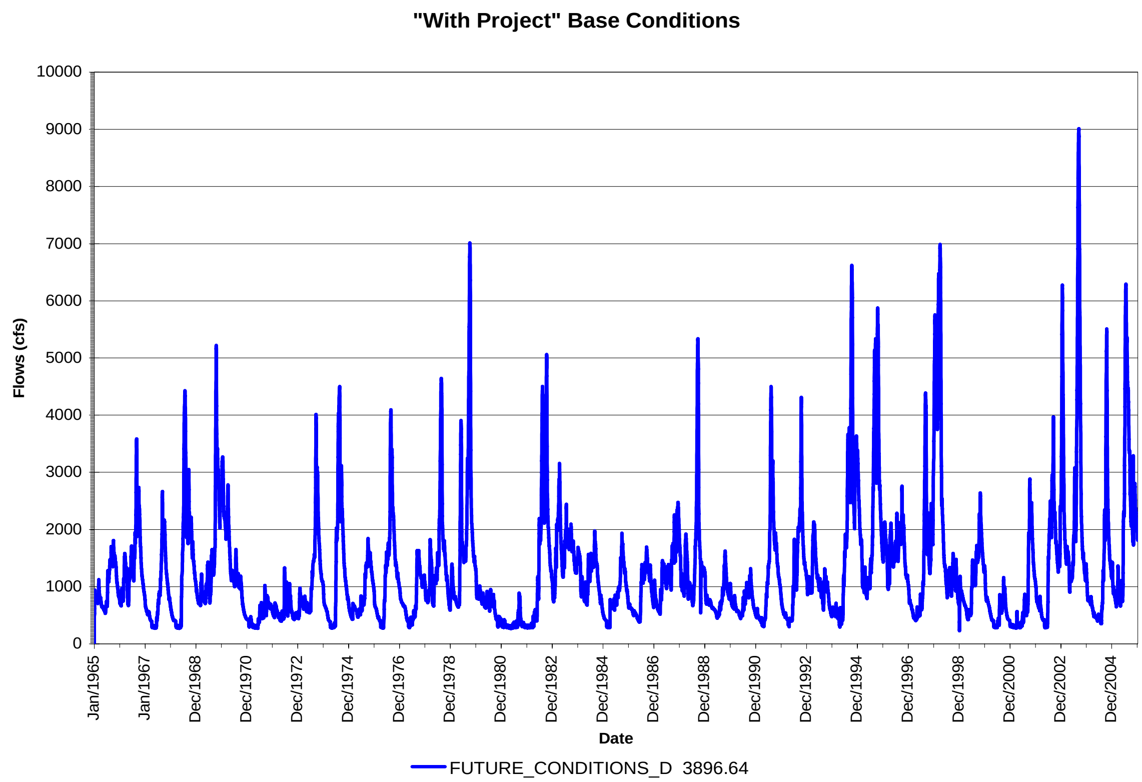
"With Project" Base Conditions

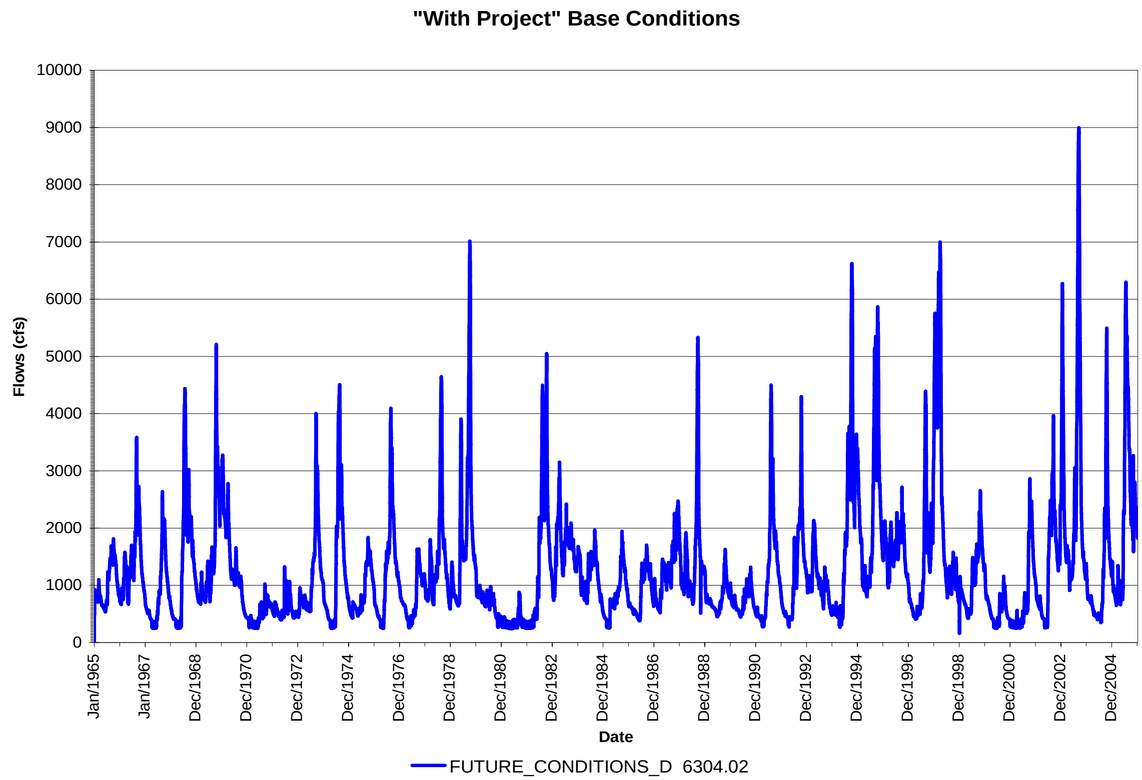


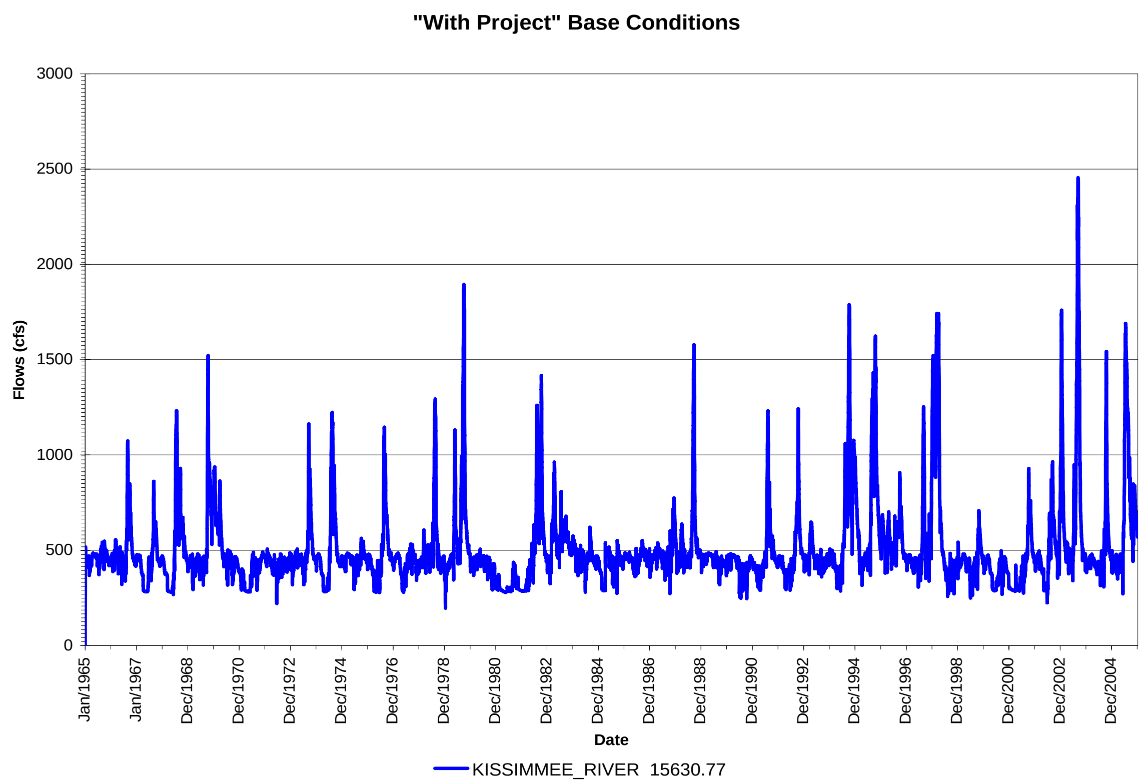

"With Project" Base Conditions
Flows (cfs)
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
S-65E

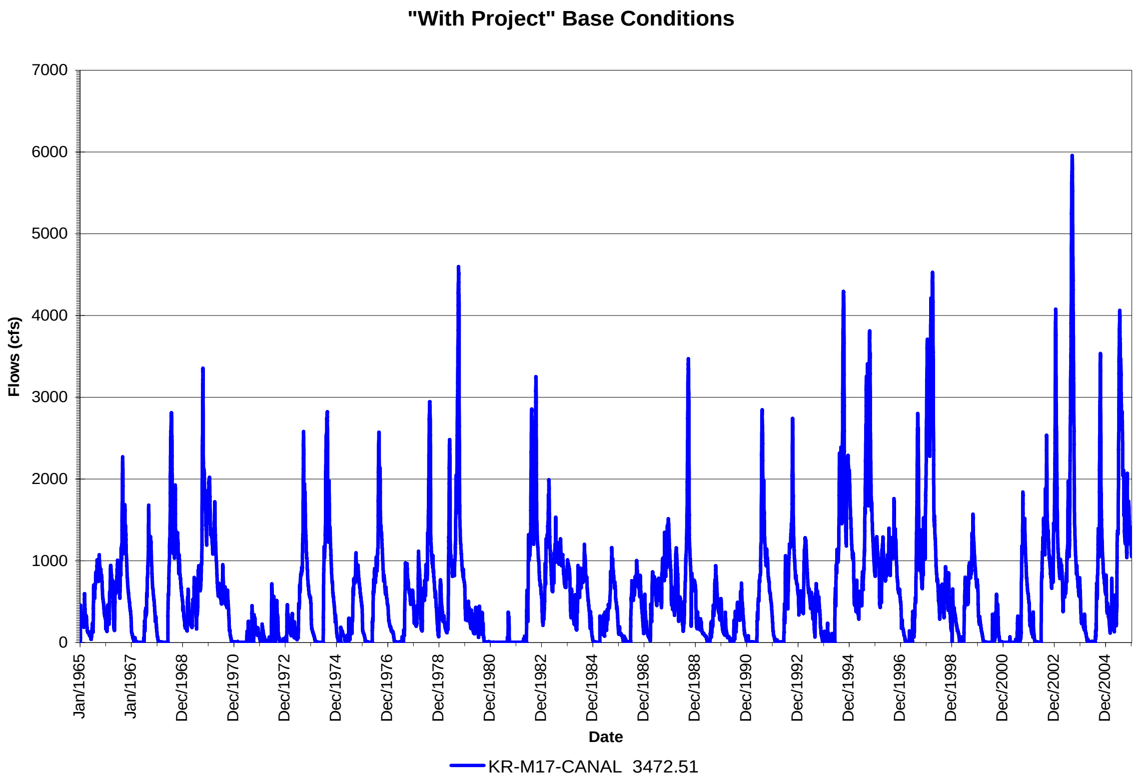

"With Project" Base Conditions
Flows (cfs)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
S-65D

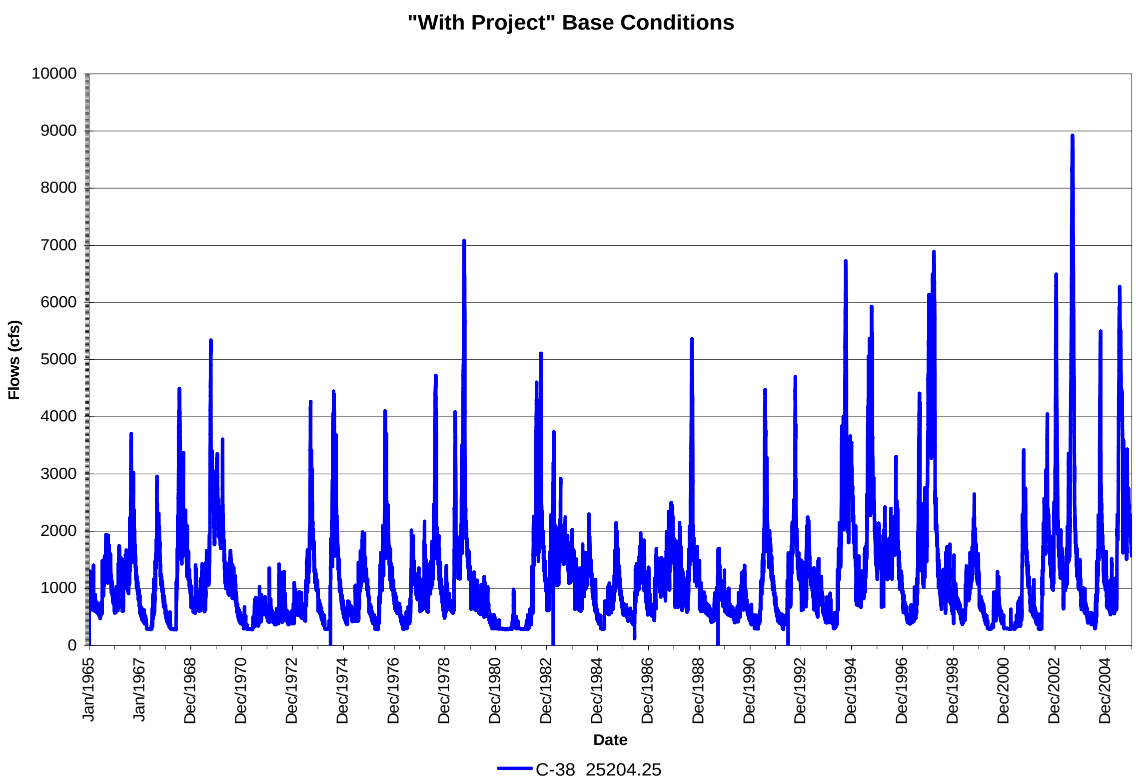

"With Project" Base Conditions
Flows (cfs)
7000
6000
5000
4000
3000
2000
1000
0
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
FUTURE_CONDITIONS_B 6496.22

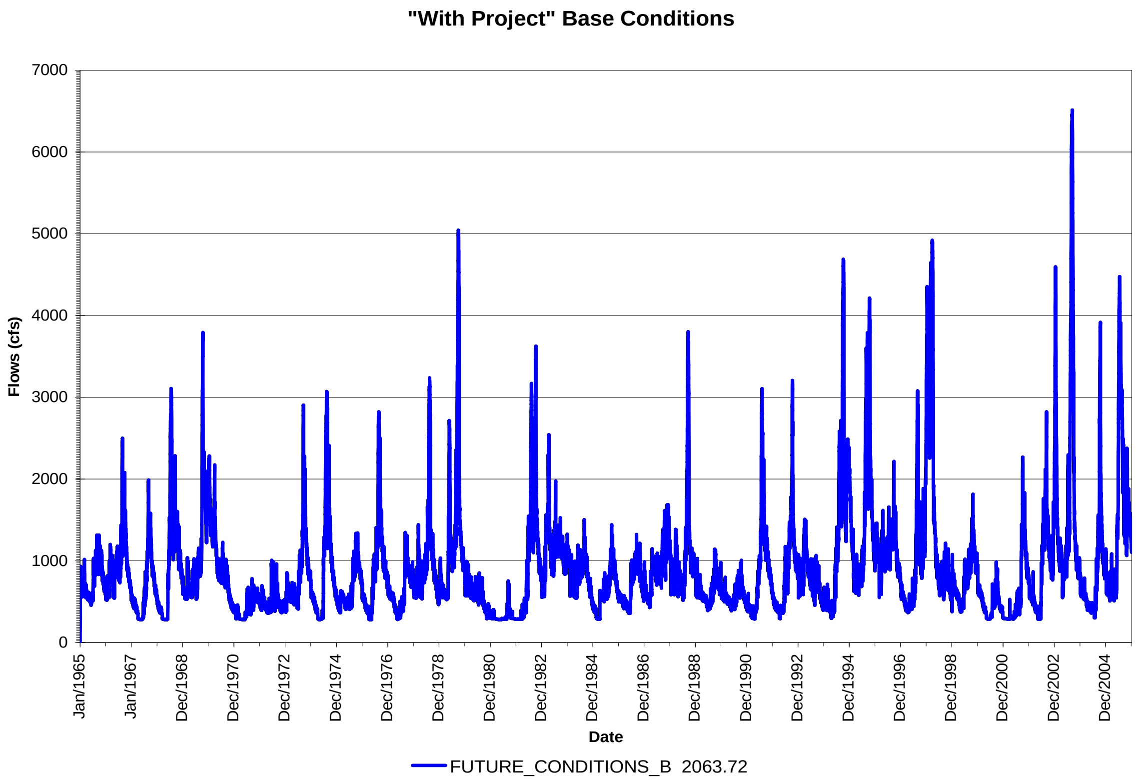

"With Project" Base Conditions
Flows (cfs)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
FUTURE_CONDITIONS_D 3896.64

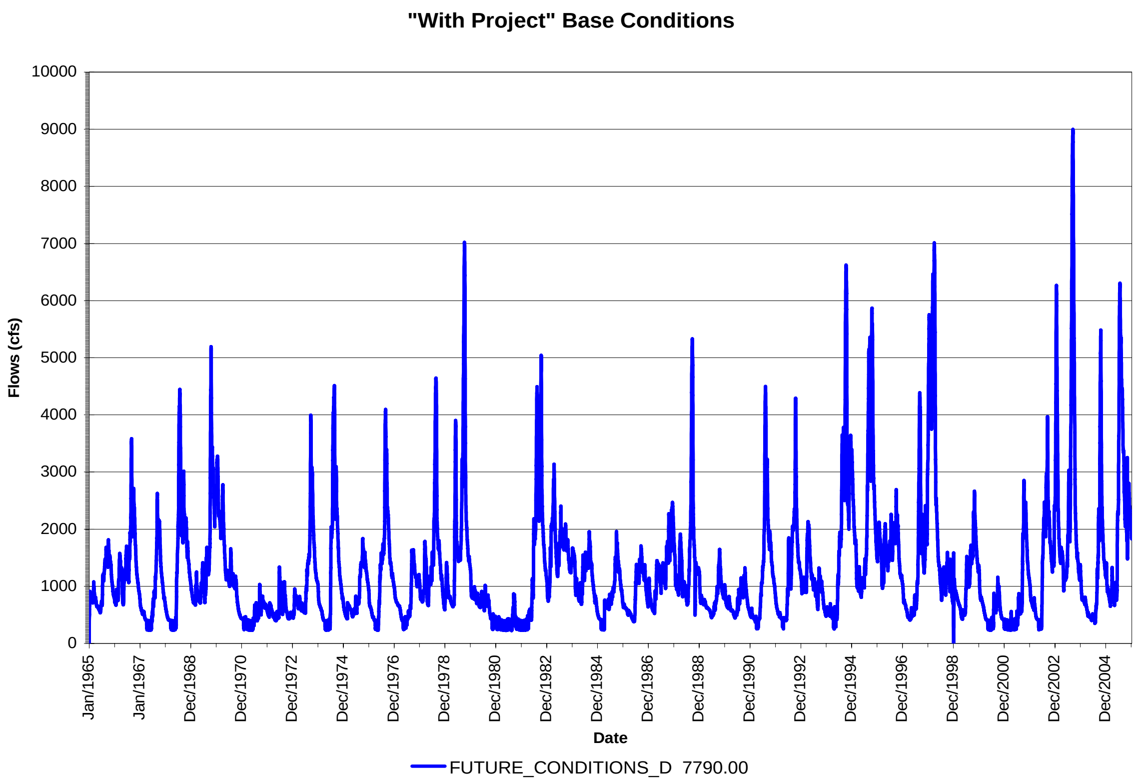

"With Project" Base Conditions
Flows (cfs)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
FUTURE_CONDITIONS_D 6304.02


"With Project" Base Conditions
Flows (cfs)
3000
2500
2000
1500
1000
500
0
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
KISSIMMEE_RIVER 15630.77

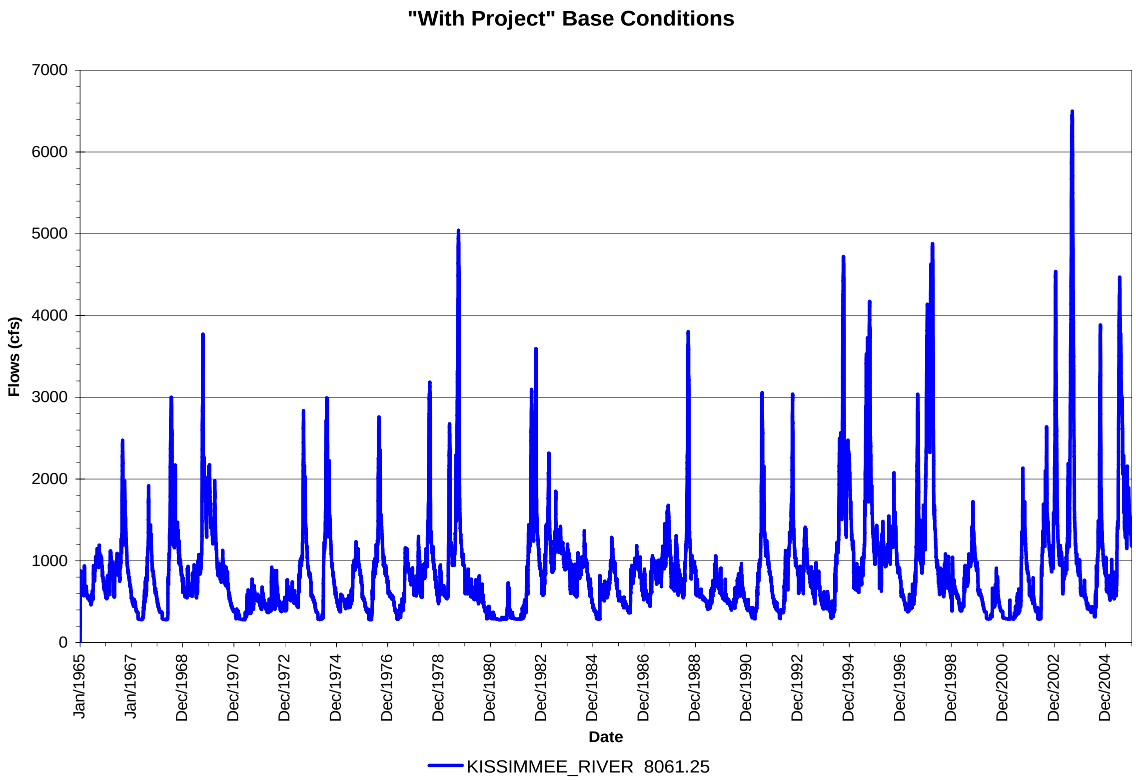

"With Project" Base Conditions
Flows (cfs)
7000
6000
5000
4000
3000
2000
1000
0
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
KR-M17-CANAL 3472.51

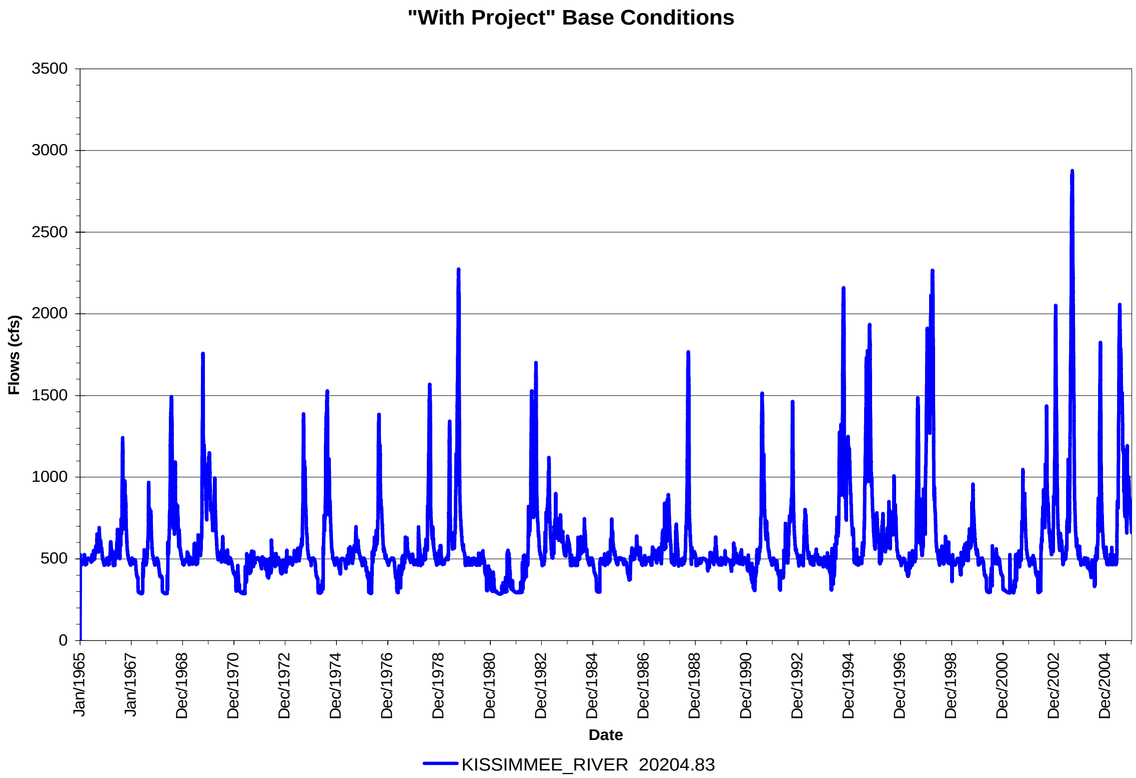

"With Project" Base Conditions
Flows (cfs)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
C-38 25204.25


"With Project" Base Conditions
7000
6000
5000
4000
3000
2000
1000
0
Flows (cfs)
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
FUTURE_CONDITIONS_B 2063.72


"With Project" Base Conditions
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Flows (cfs)
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
FUTURE_CONDITIONS_D 7790.00

AECOM


"With Project" Base Conditions
7000
6000
5000
4000
3000
2000
1000
0
Flows (cfs)
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
KISSIMMEE_RIVER 8061.25


"With Project" Base Conditions
3500
3000
2500
2000
1500
1000
500
0
Flows (cfs)
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
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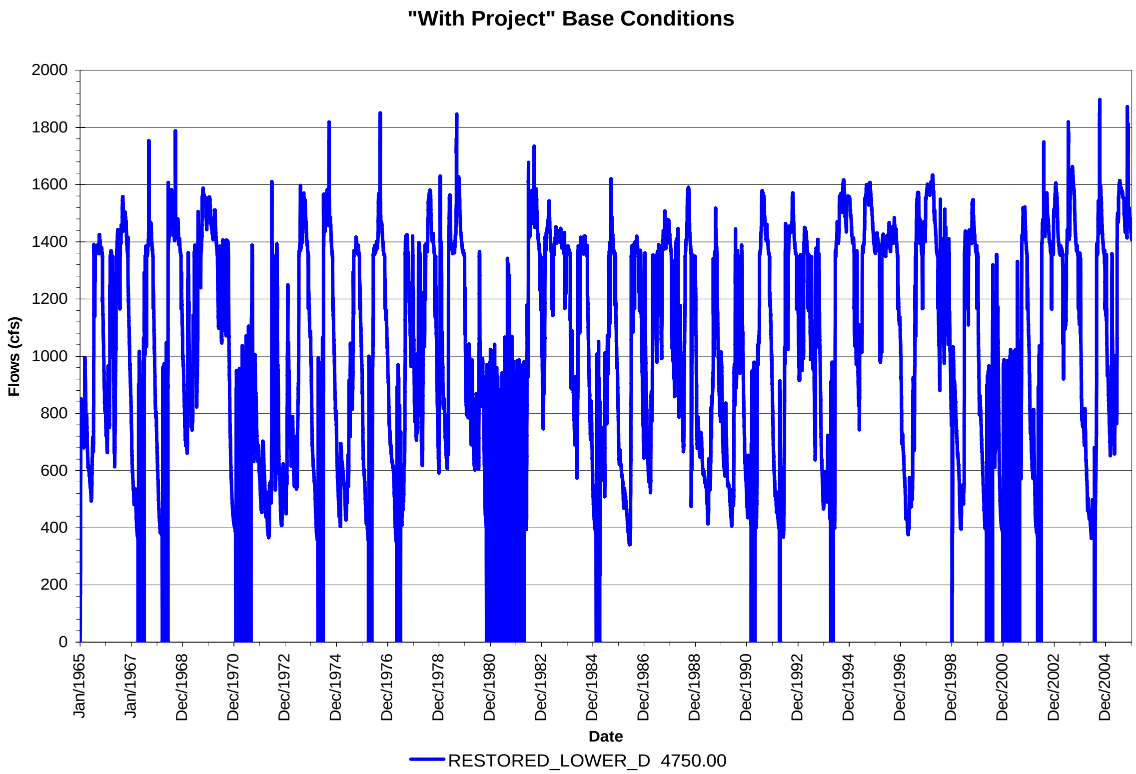
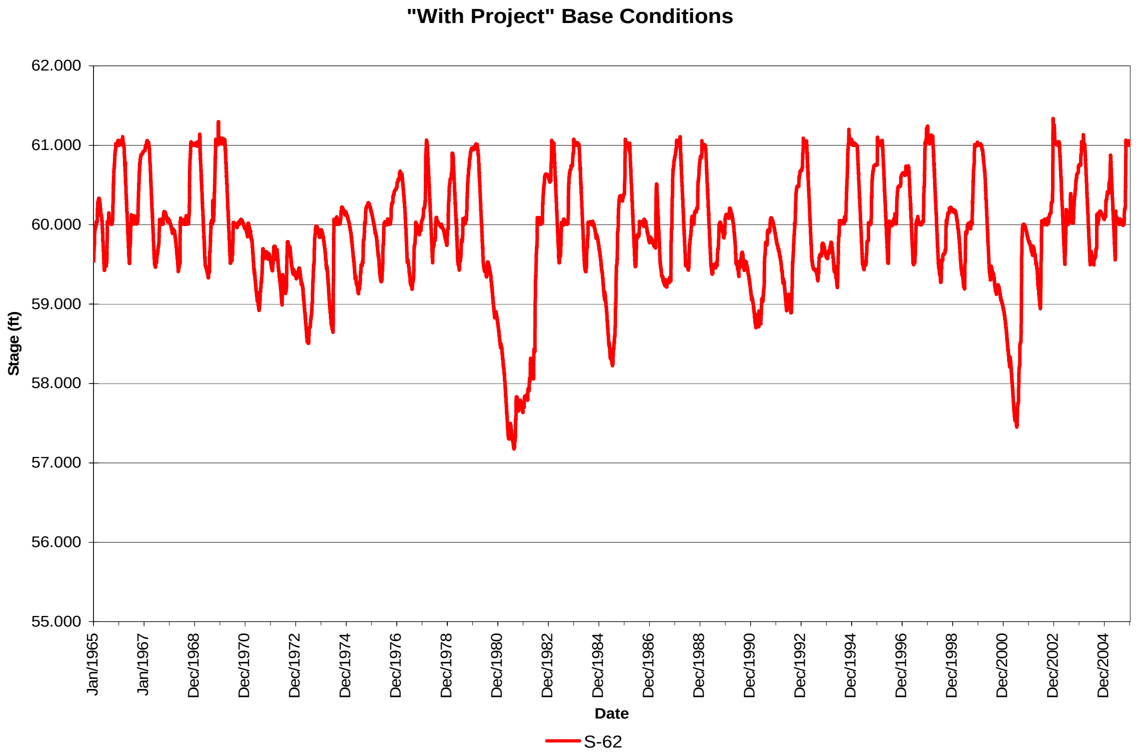
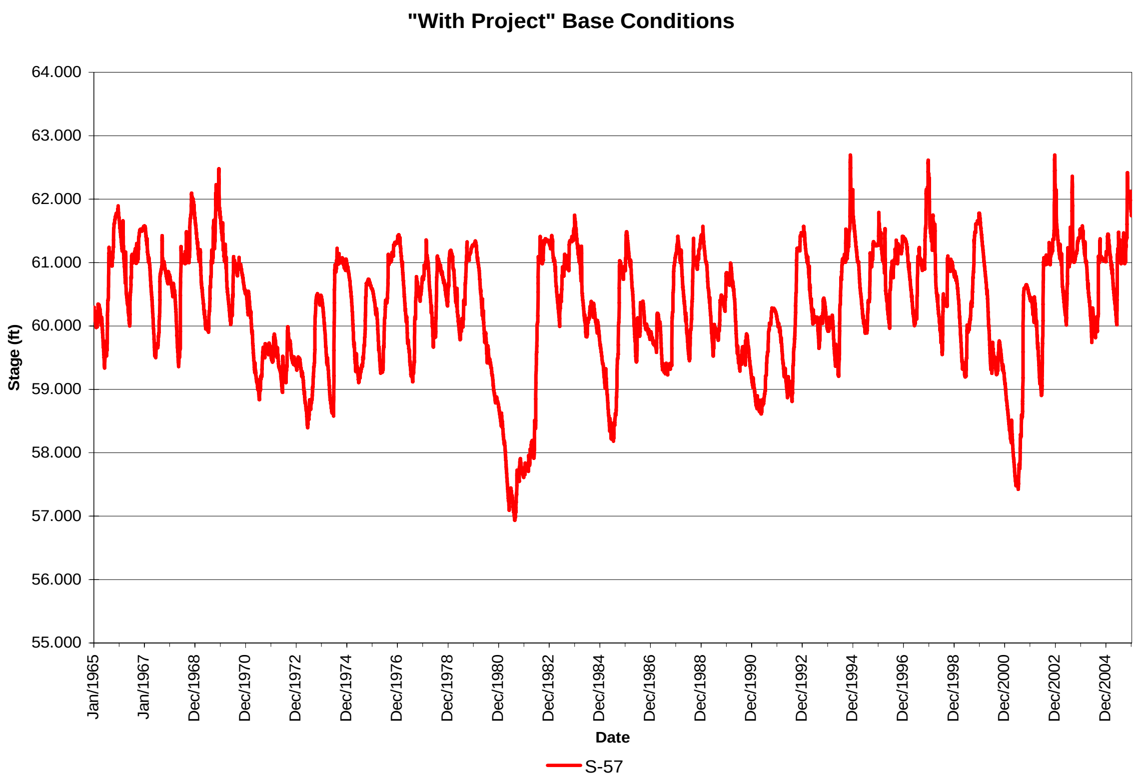
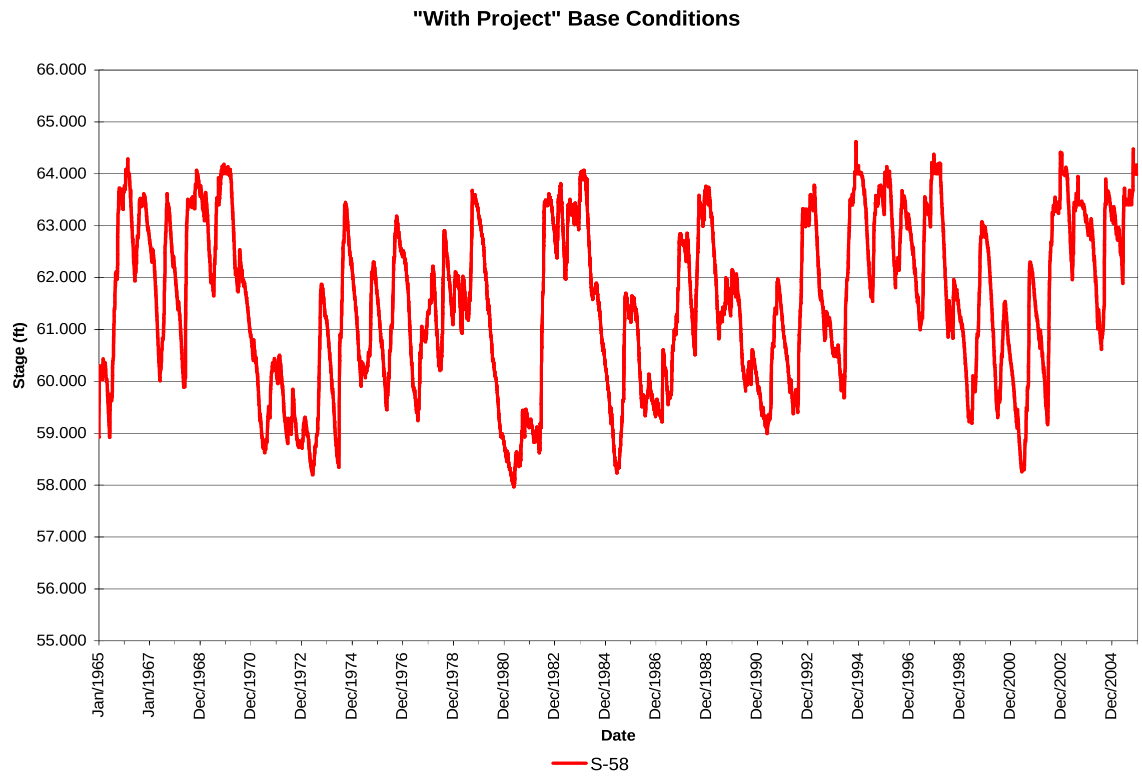
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
KISSIMMEE_RIVER 20204.83


"With Project" Base Conditions
Flows (cfs)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
RESTORED_LOWER_D 4750.00

STAGE


"With Project" Base Conditions
62.000
61.000
60.000
59.000
58.000
57.000
56.000
55.000
Stage (ft)
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
S-62


"With Project" Base Conditions
64.000
63.000
62.000
61.000
60.000
59.000
58.000
57.000
56.000
55.000
Stage (ft)
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
S-57


"With Project" Base Conditions
66.000
65.000
64.000
63.000
62.000
61.000
60.000
59.000
58.000
57.000
56.000
55.000
Stage (ft)
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
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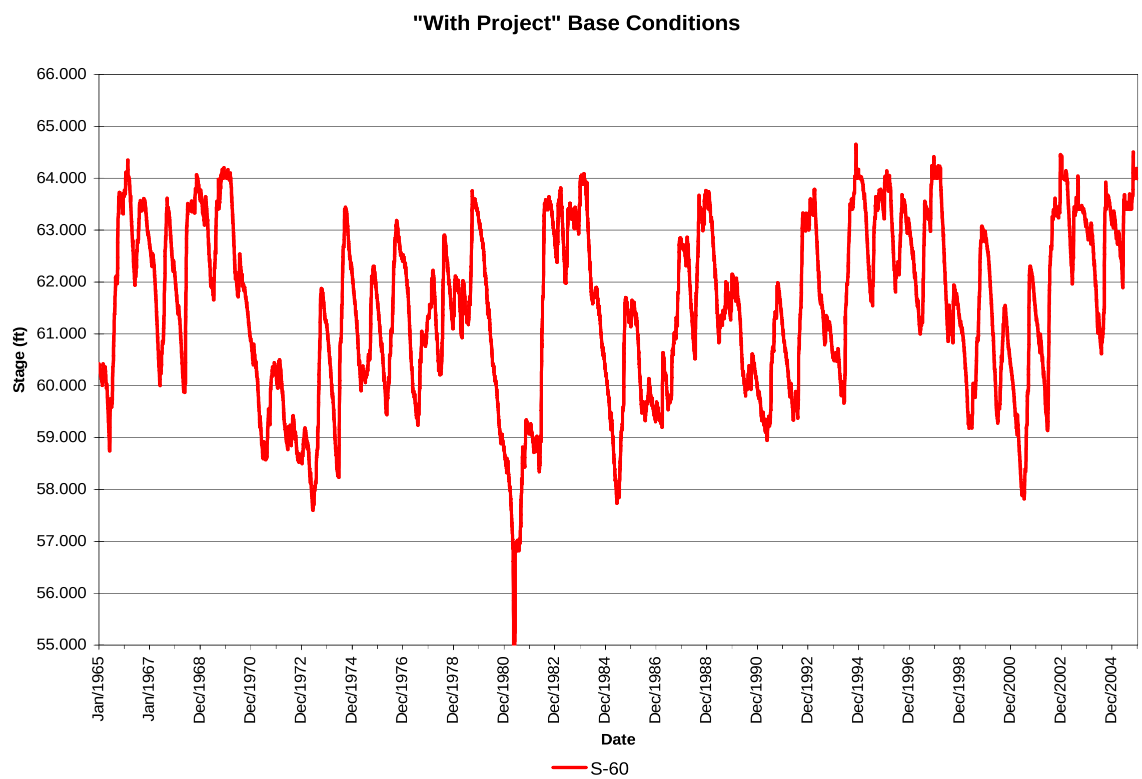
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
S-58


"With Project" Base Conditions
66.000
65.000
64.000
63.000
62.000
61.000
60.000
59.000
58.000
57.000
56.000
55.000
Stage (ft)
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
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Dec/1992
Dec/1994
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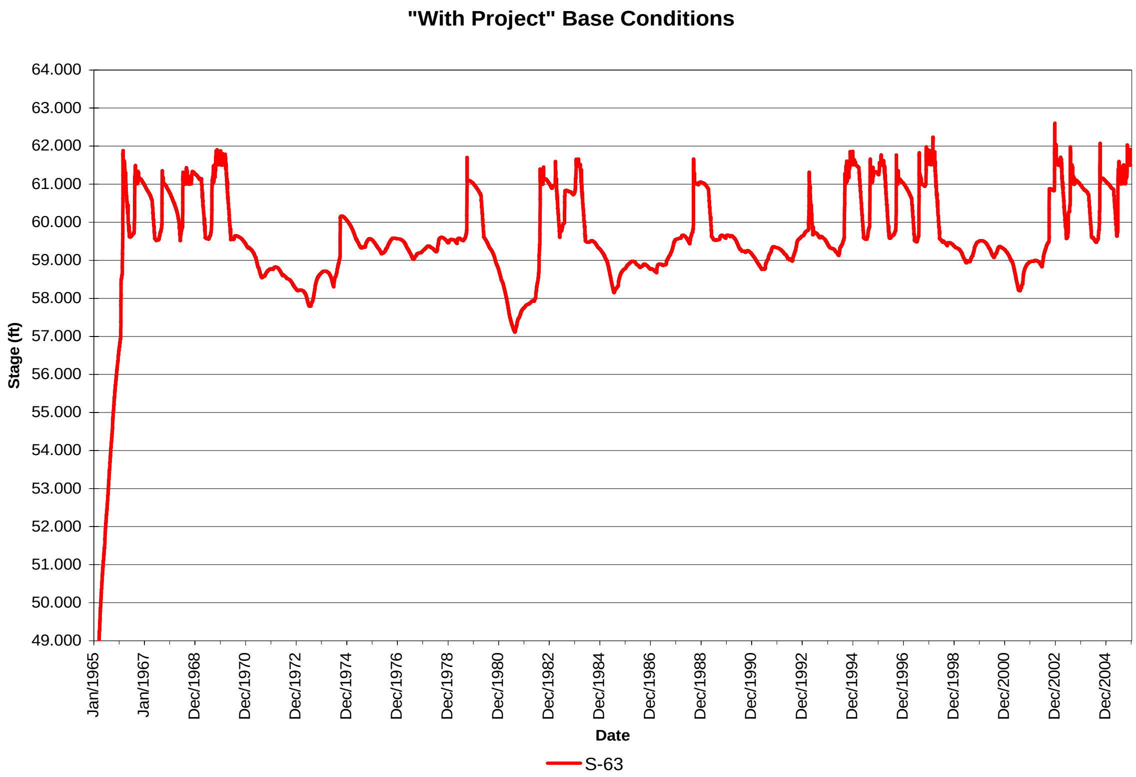
Dec/2000
Dec/2002
Dec/2004
Date
S-60


"With Project" Base Conditions
64.000
63.000
62.000
61.000
60.000
59.000
58.000
57.000
56.000
55.000
54.000
53.000
52.000
51.000
50.000
49.000
Stage (ft)
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
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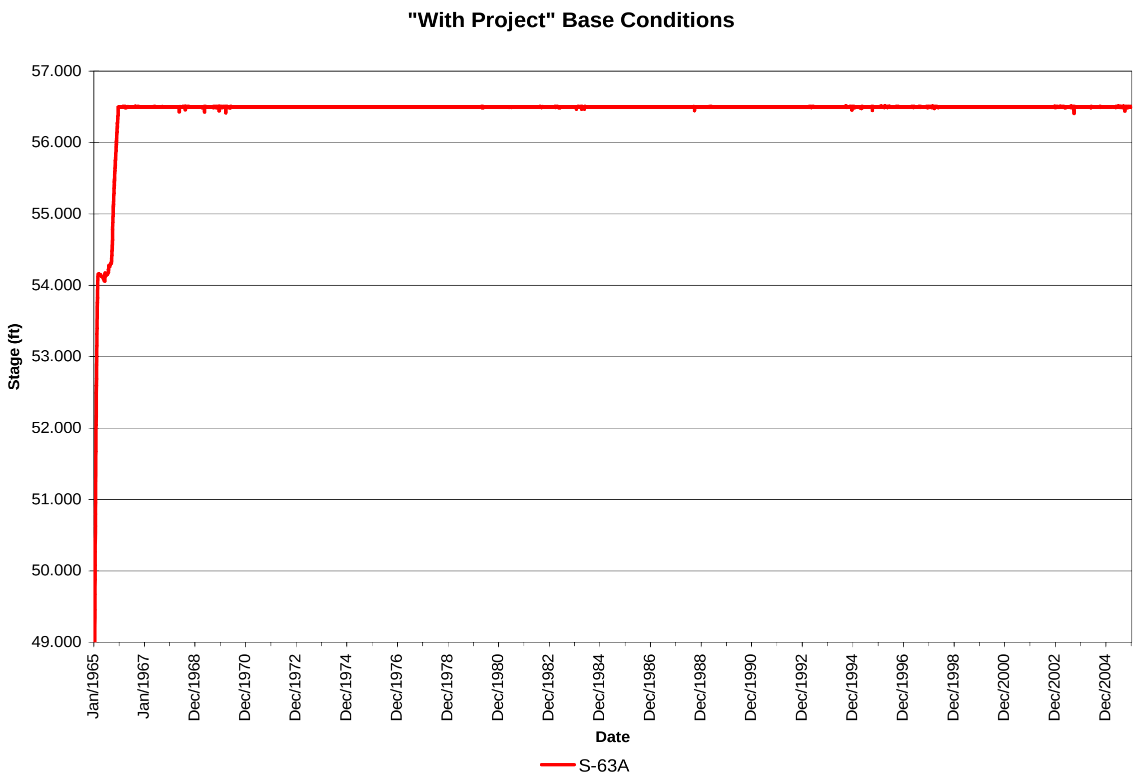
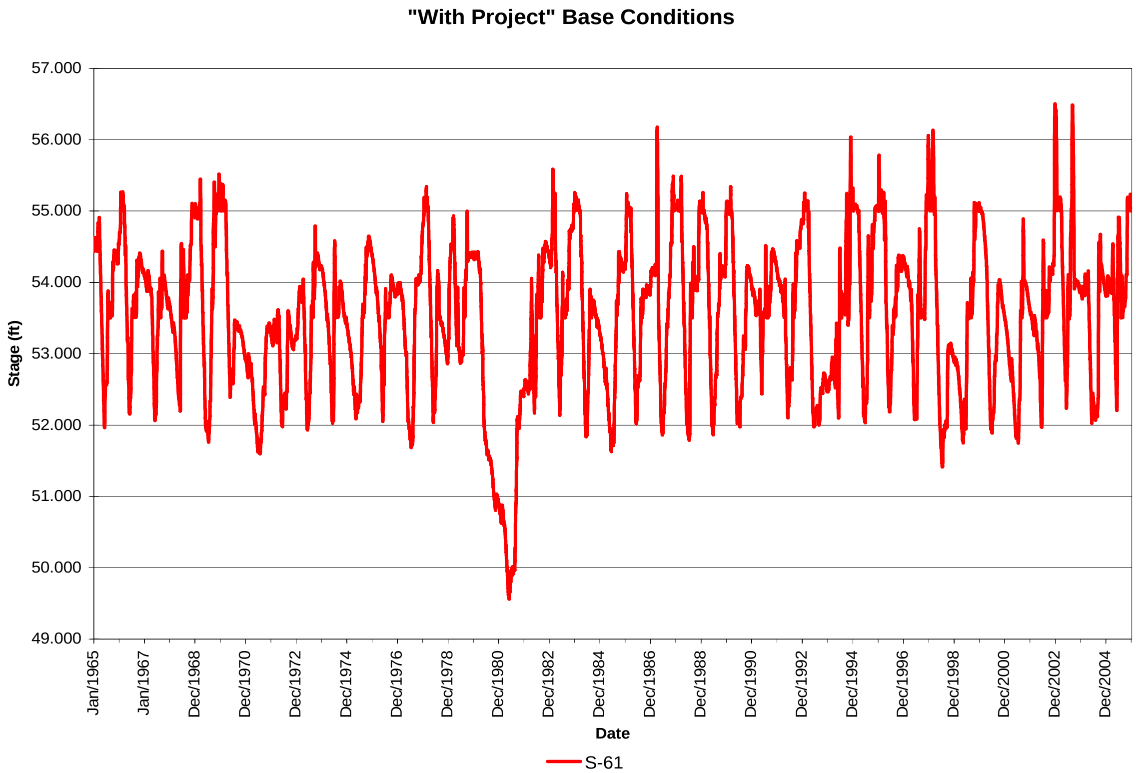
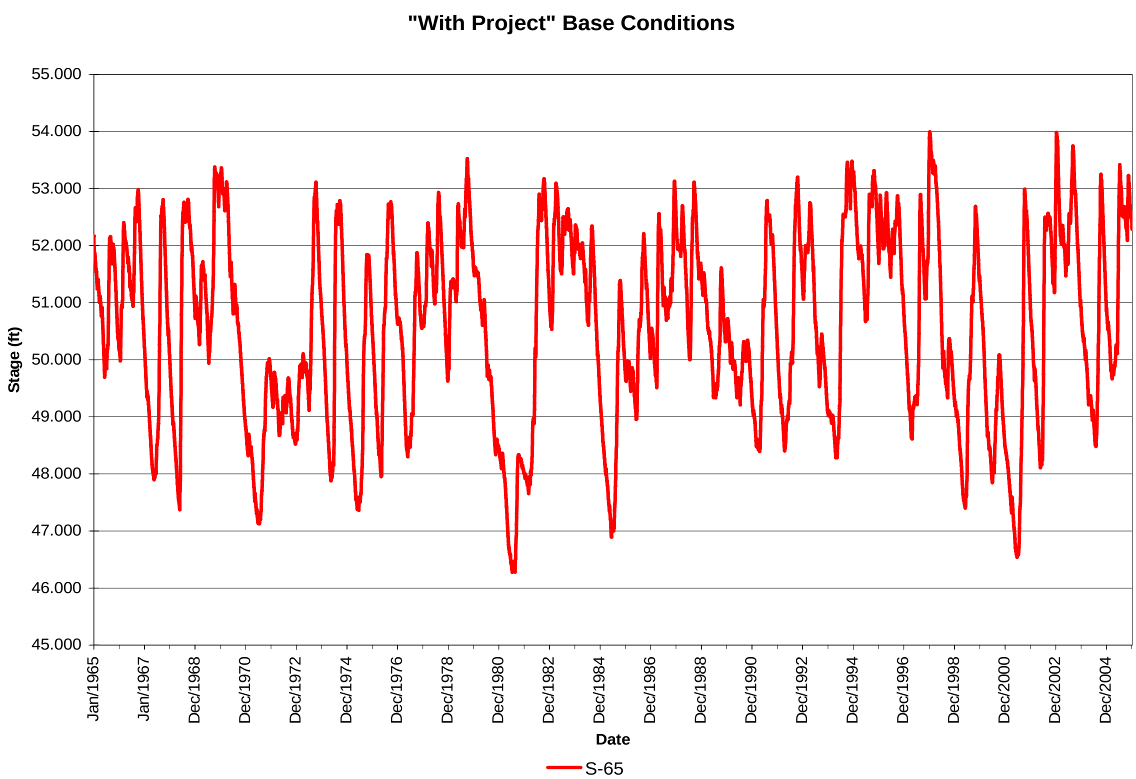
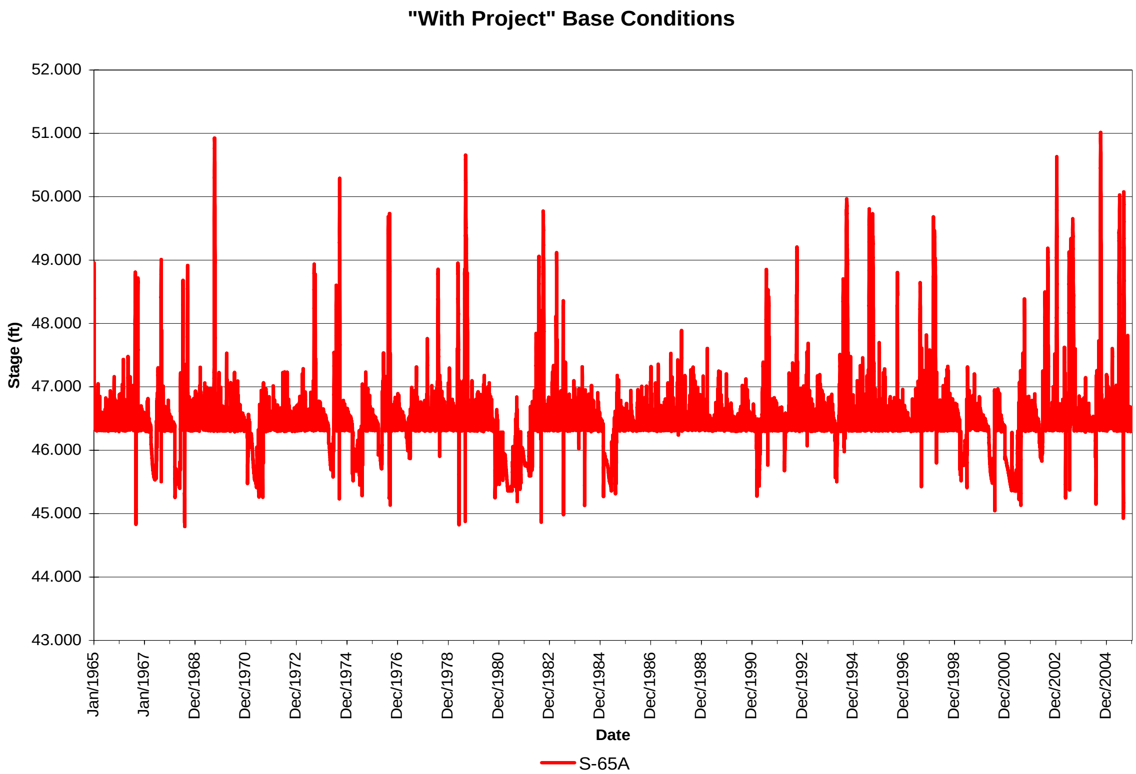
Dec/2000
Dec/2002
Dec/2004
Date
S-63

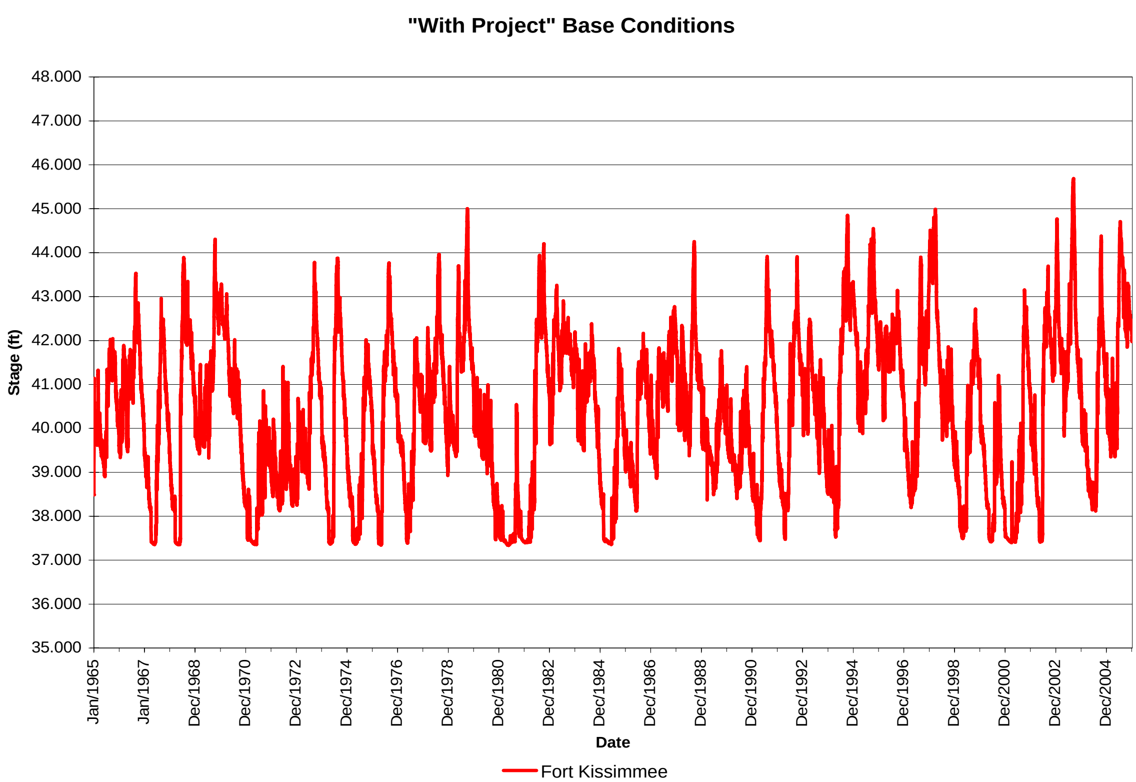

"With Project" Base Conditions
57.000
56.000
55.000
54.000
53.000
52.000
51.000
50.000
49.000
Stage (ft)
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
S-63A

AECOM


"With Project" Base Conditions
57.000
56.000
55.000
54.000
53.000
52.000
51.000
50.000
49.000
Stage (ft)
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
S-61


"With Project" Base Conditions
55.000
54.000
53.000
52.000
51.000
50.000
49.000
48.000
47.000
46.000
45.000
Stage (ft)
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
S-65


"With Project" Base Conditions
52.000
51.000
50.000
49.000
48.000
47.000
46.000
45.000
44.000
43.000
Stage (ft)
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
S-65A


"With Project" Base Conditions
48.000
47.000
46.000
45.000
44.000
43.000
42.000
41.000
40.000
39.000
38.000
37.000
36.000
35.000
Stage (ft)
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
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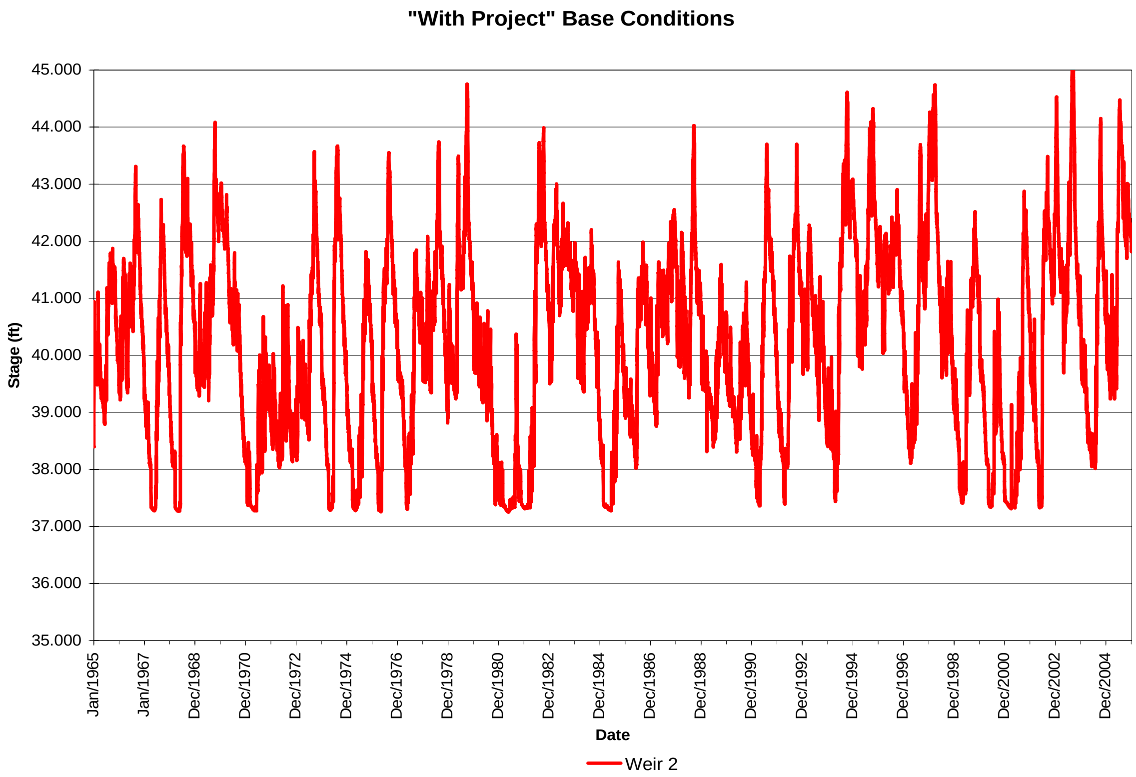
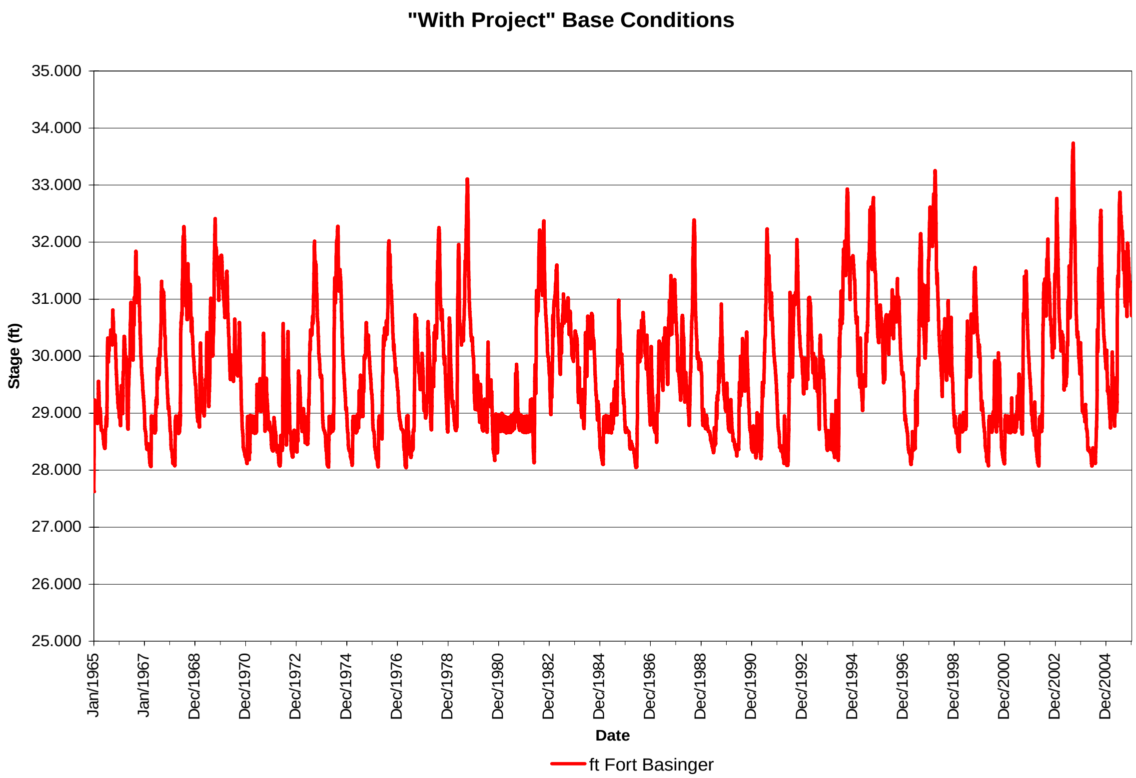
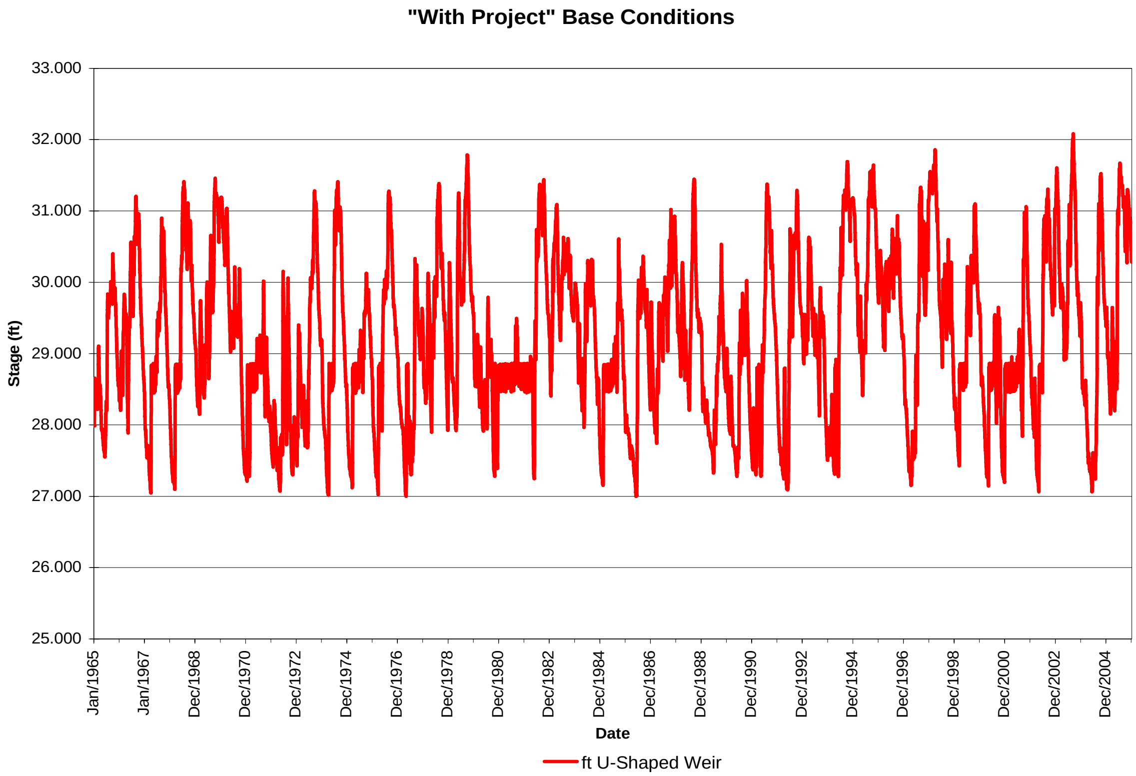
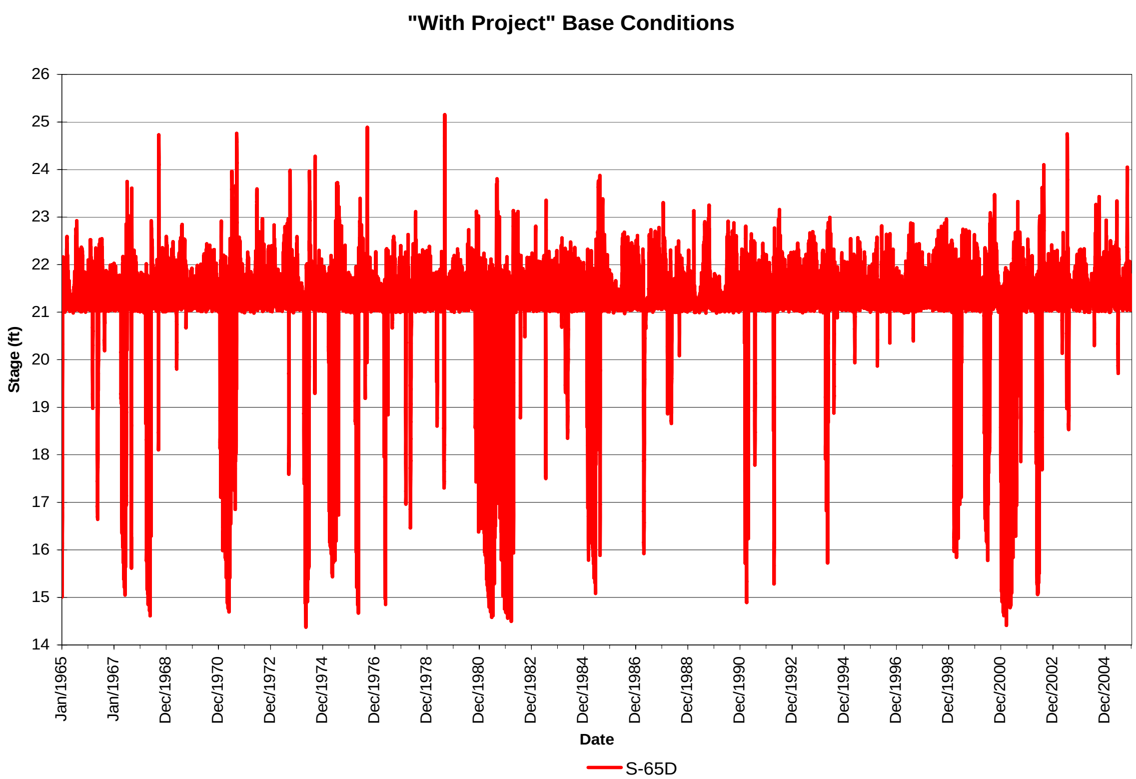
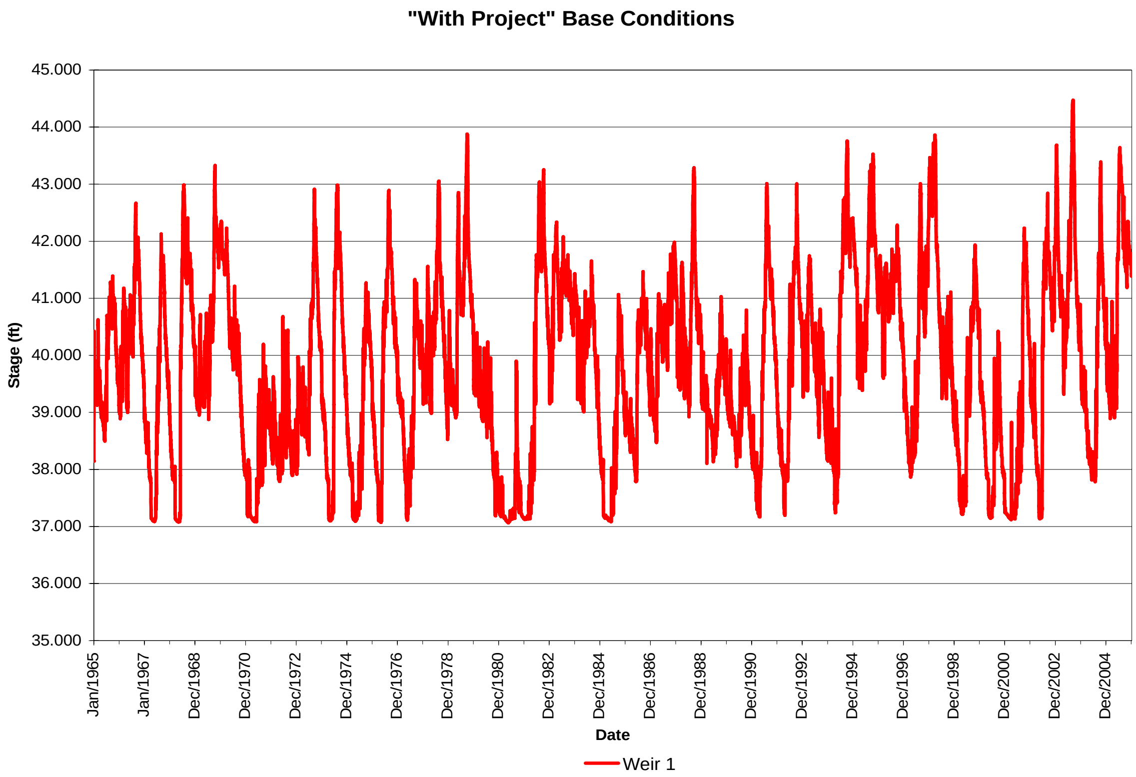
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
Fort Kissimmee

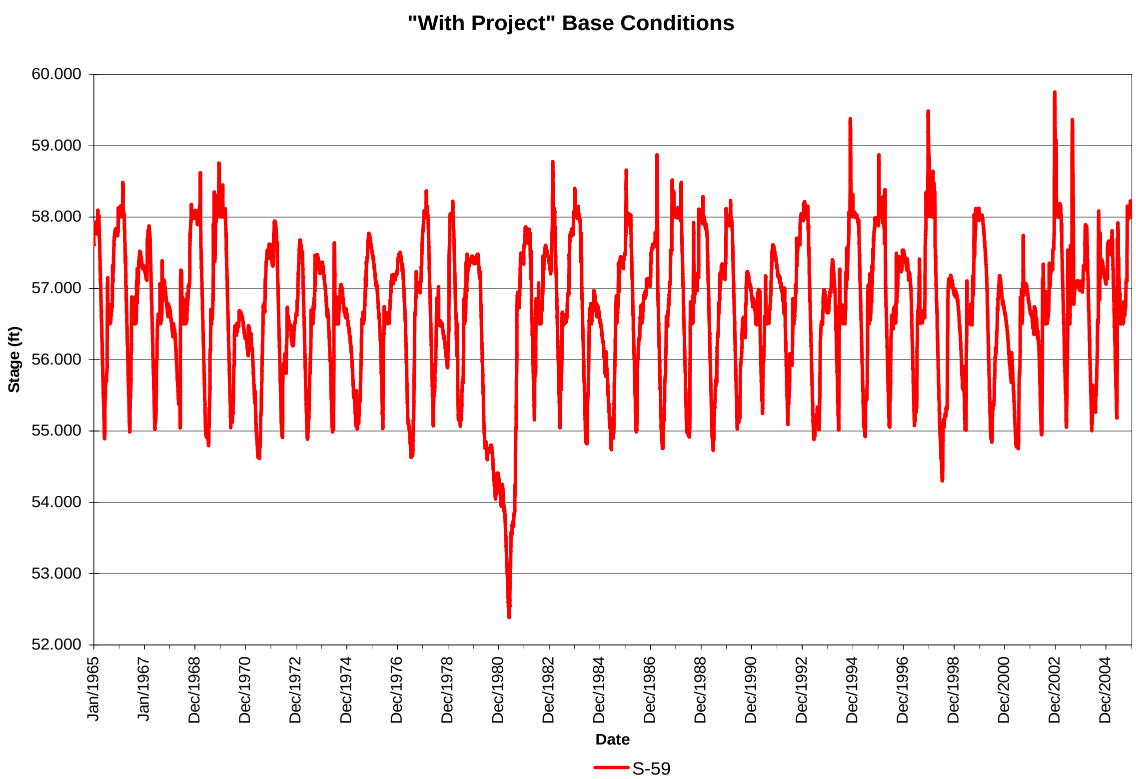

"With Project" Base Conditions
45.000
44.000
43.000
42.000
41.000
40.000
39.000
38.000
37.000
36.000
35.000
Stage (ft)
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
Weir 2


"With Project" Base Conditions
35.000
34.000
33.000
32.000
31.000
30.000
29.000
28.000
27.000
26.000
25.000
Stage (ft)
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
ft Fort Basinger

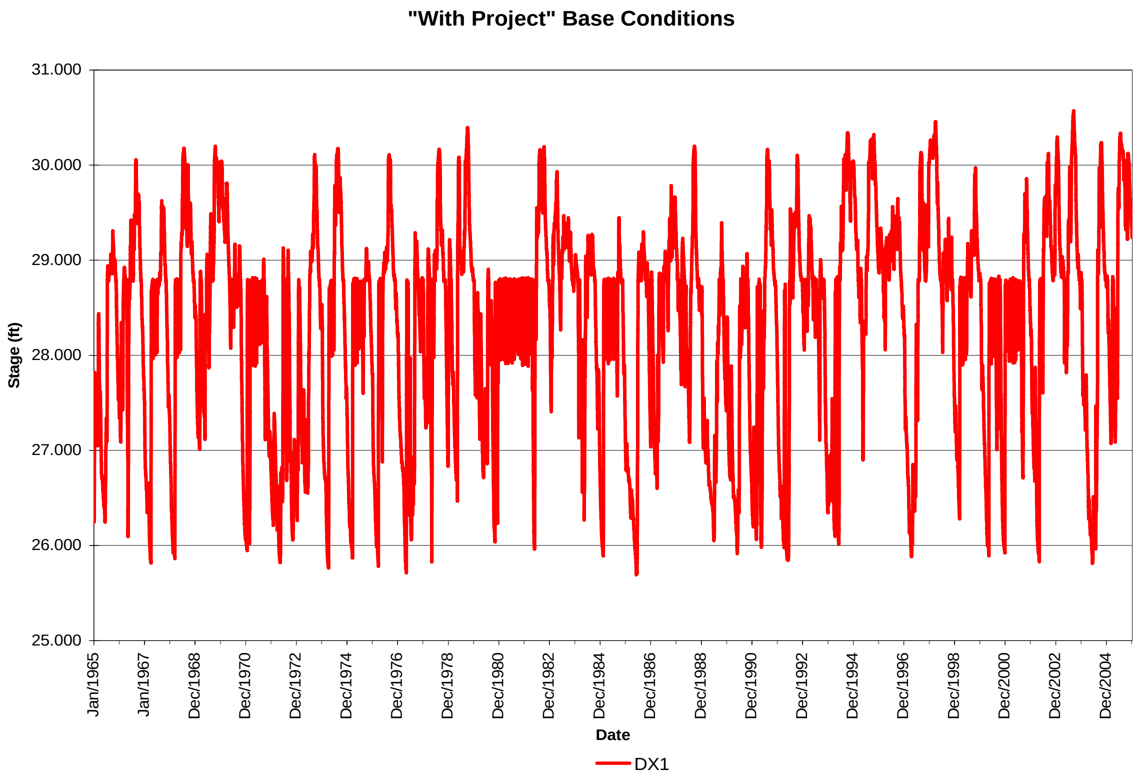

"With Project" Base Conditions
Stage (ft)
33.000
32.000
31.000
30.000
29.000
28.000
27.000
26.000
25.000
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
ft U-Shaped Weir

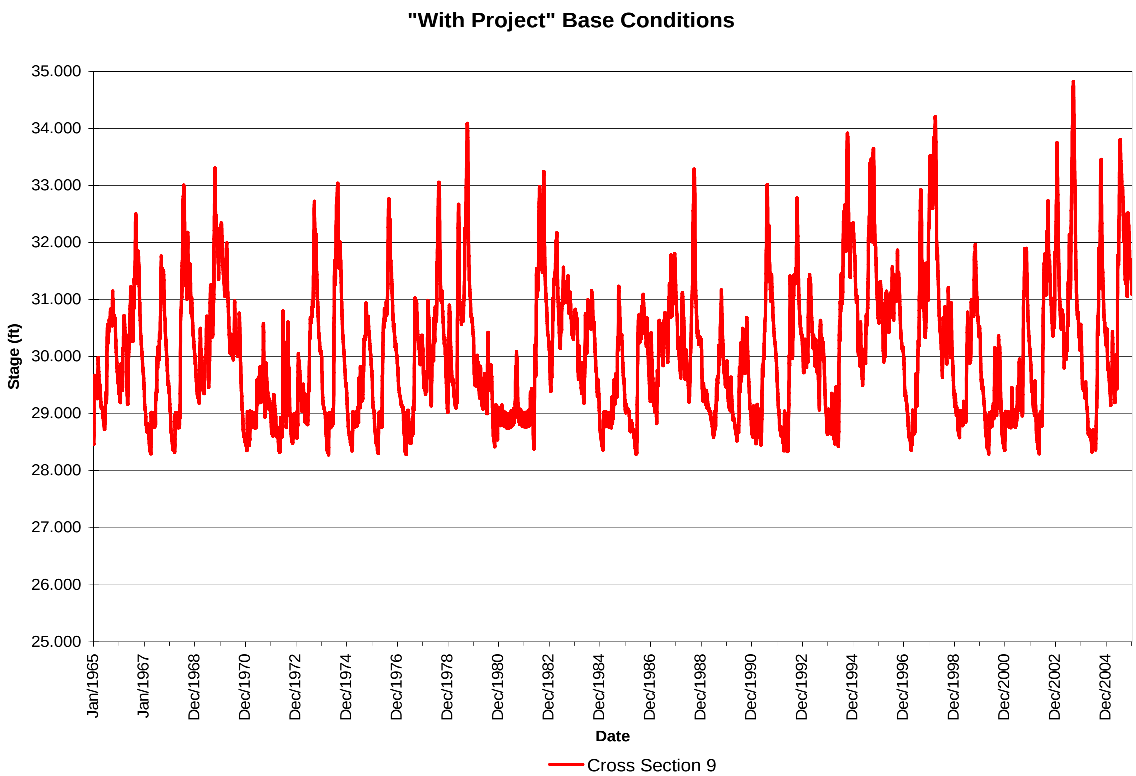

"With Project" Base Conditions
Stage (ft)
26
25
24
23
22
21
20
19
18
17
16
15
14
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
S-65D


"With Project" Base Conditions
Stage (ft)
45.000
44.000
43.000
42.000
41.000
40.000
39.000
38.000
37.000
36.000
35.000
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
Weir 1


"With Project" Base Conditions
Stage (ft)
60.000
59.000
58.000
57.000
56.000
55.000
54.000
53.000
52.000
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
S-59

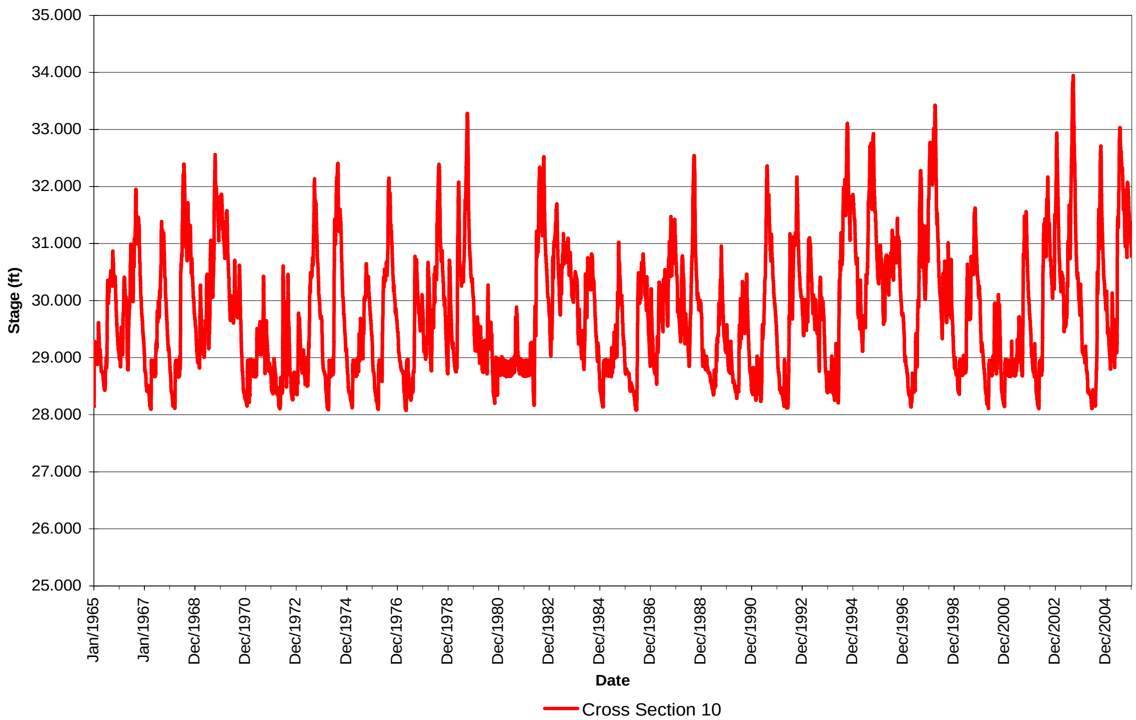
AECOM


"With Project" Base Conditions
Stage (ft)
31.000
30.000
29.000
28.000
27.000
26.000
25.000
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
DX1


"With Project" Base Conditions
Stage (ft)
35.000
34.000
33.000
32.000
31.000
30.000
29.000
28.000
27.000
26.000
25.000
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
Cross Section 9

AECOM

"With Project" Base Conditions



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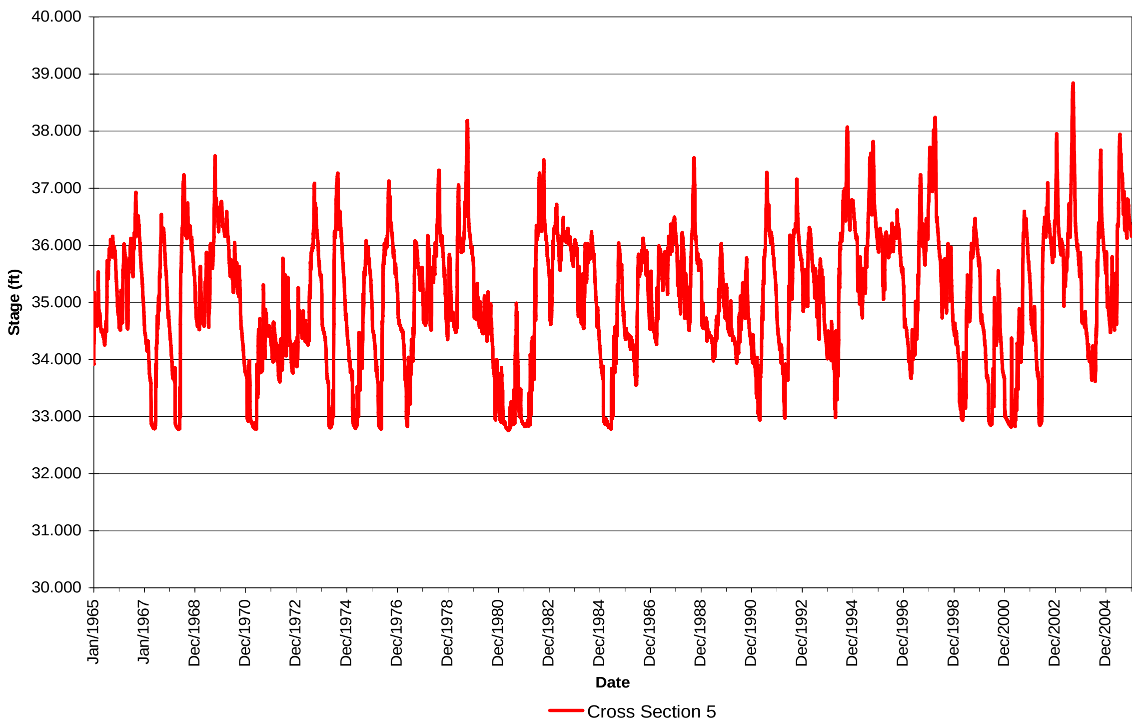

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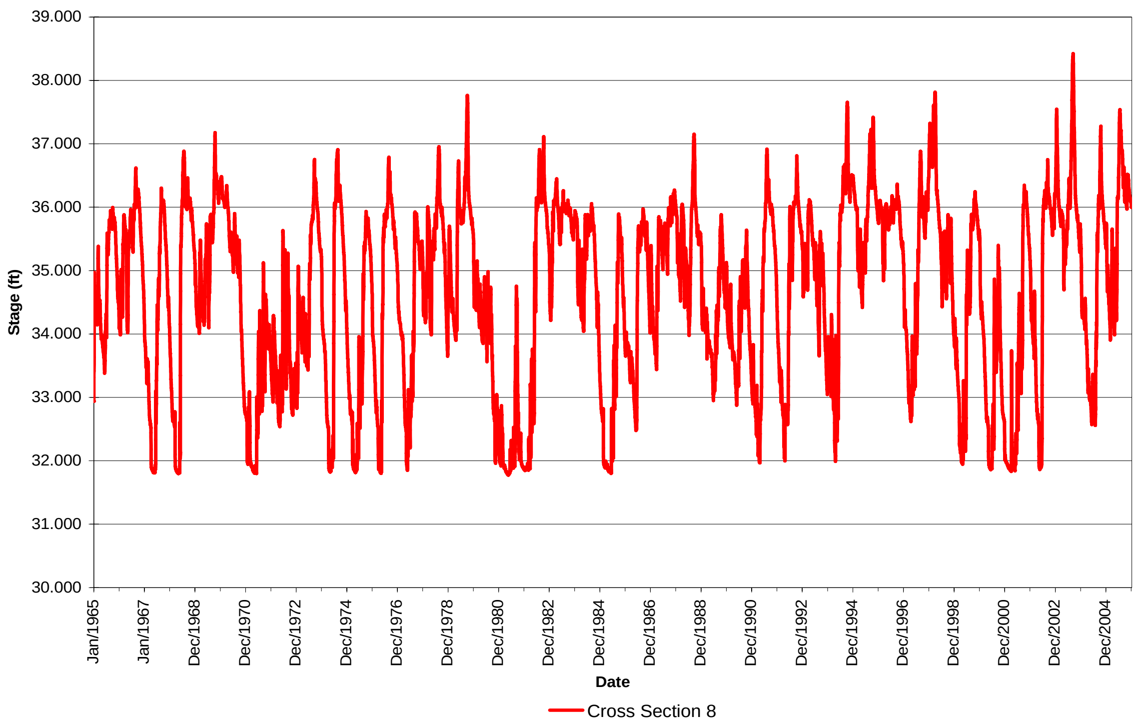
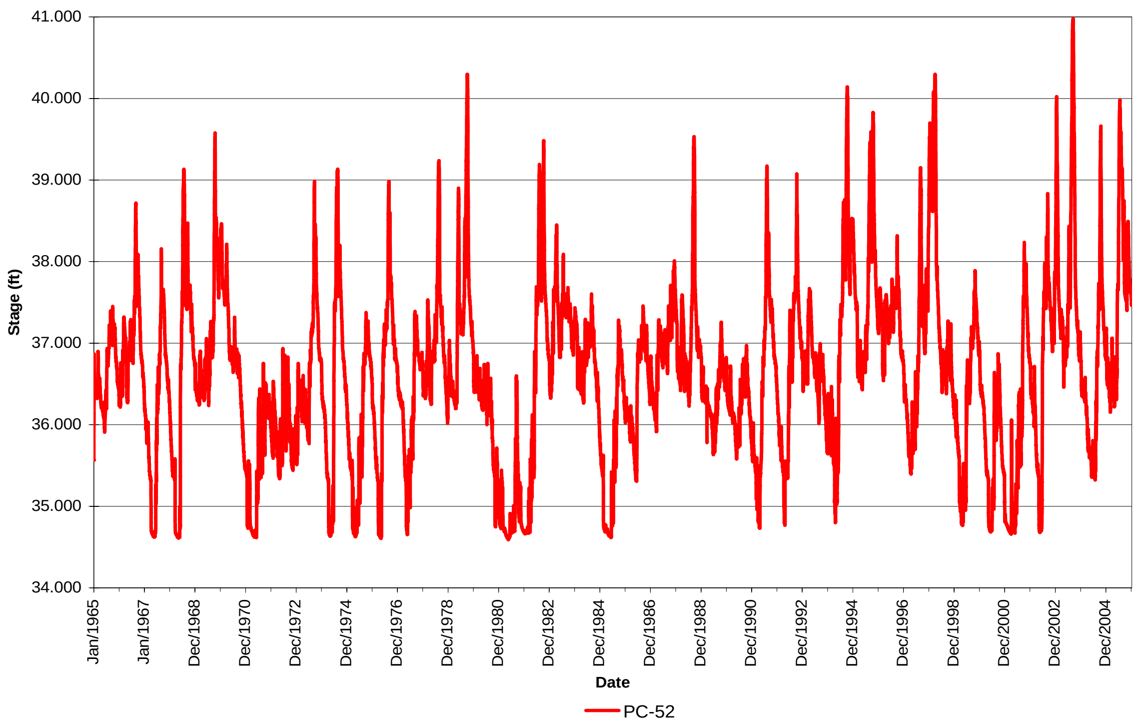


"With Project" Base Conditions



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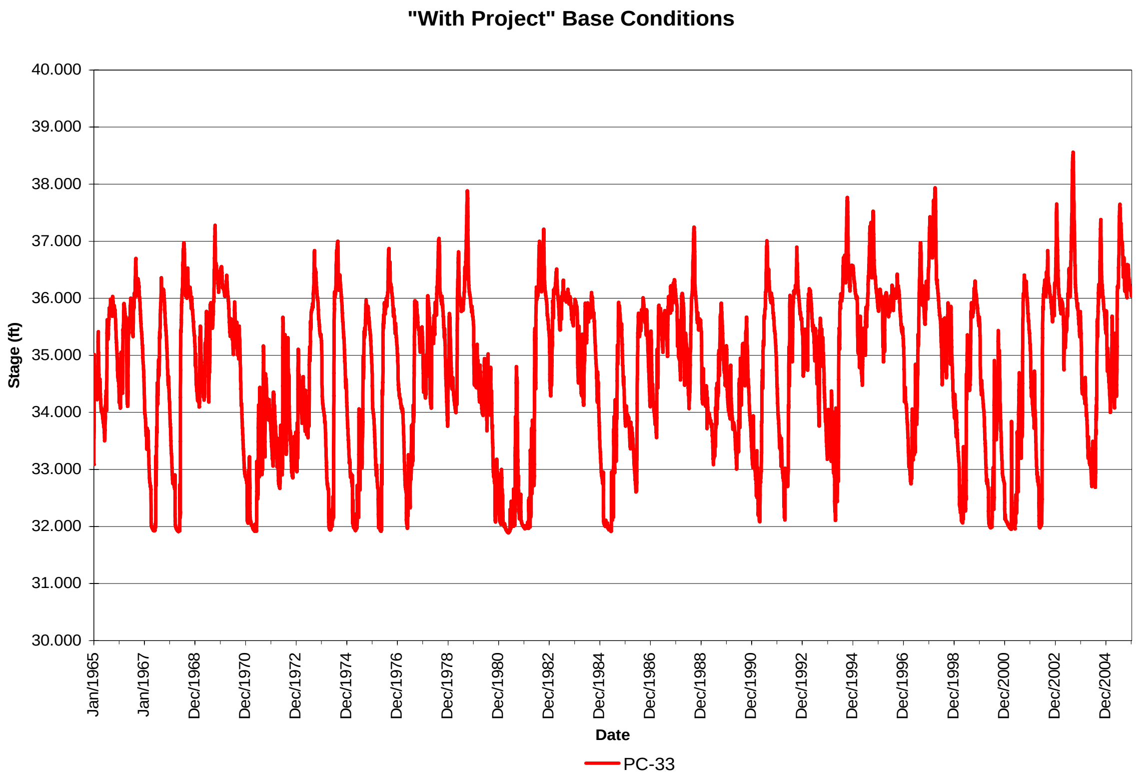
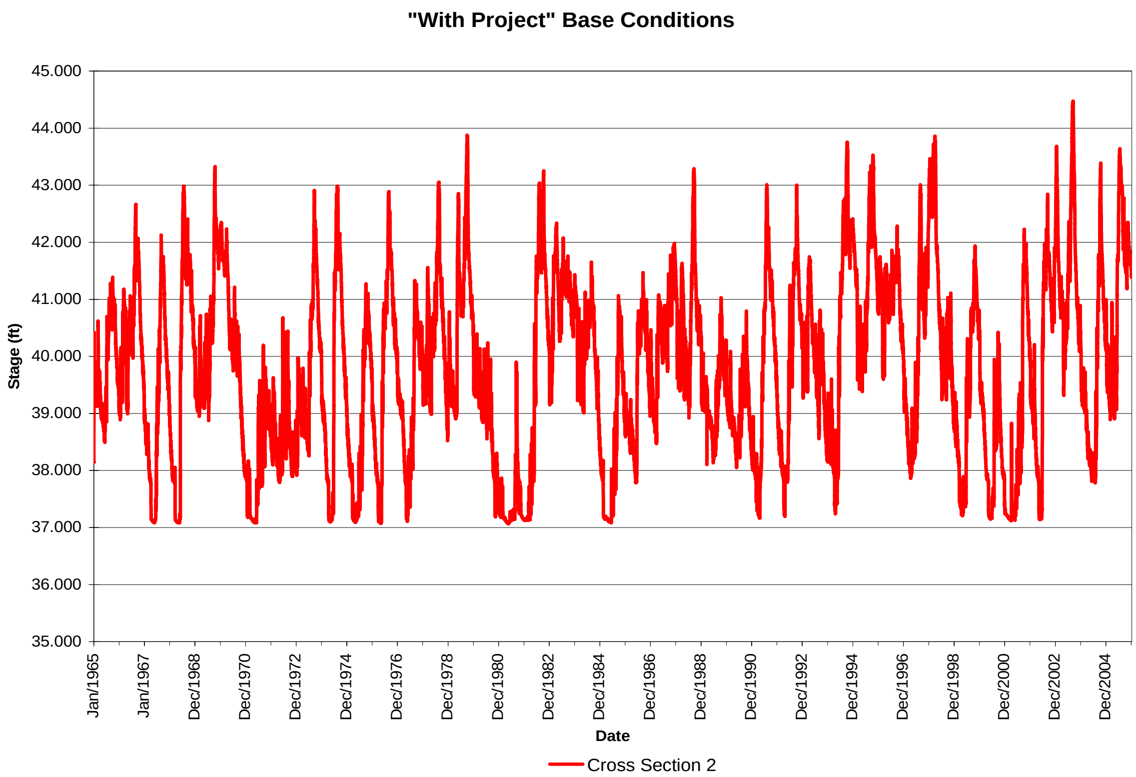

"With Project" Base Conditions
40.000
39.000
38.000
37.000
36.000
35.000
34.000
33.000
32.000
31.000
30.000
Stage (ft)
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
PC-33


"With Project" Base Conditions
45.000
44.000
43.000
42.000
41.000
40.000
39.000
38.000
37.000
36.000
35.000
Stage (ft)
Jan/1965
Jan/1967
Dec/1968
Dec/1970
Dec/1972
Dec/1974
Dec/1976
Dec/1978
Dec/1980
Dec/1982
Dec/1984
Dec/1986
Dec/1988
Dec/1990
Dec/1992
Dec/1994
Dec/1996
Dec/1998
Dec/2000
Dec/2002
Dec/2004
Date
Cross Section 2

AECOM