Appendix 11-1: Assessment of Modifications to Zone B Discharges in Lake Tohopekaliga (Toho) and East Lake Tohopekaliga (E Toho)

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Assessment of Modifications to Zone B Discharges
in Lake Tohopekaliga (Toho) and East Lake Tohopekaliga (E Toho)

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Executive Summary

Modifications have been proposed for the Operation Rules of the S-61 structure, controlling water levels in Lake Tohopekaliga (Toho), and the S-59 structure, controlling water levels in Lake East Tohopekaliga (East Toho). The proposal would allow environmental releases (referred to as 'Zone B' releases in District Operating Manuals) from Toho and East Toho to substitute for a portion of the current environmental releases from Lakes Kissimmee, Hatchineha and Cypress. The intended benefit is to create a more natural pattern of lake stages in Toho and East Toho, with incidental flood protection benefits in Toho and East Toho. Potential risks include impacts to water supply, navigation, and recreation in the upper lakes and unwanted releases to Lake Okeechobee.

The Kissimmee Chain of Lakes Operational Model UKISS was used to assess this proposal. UKISS tests operating rules by subjecting them to a wide range of climate conditions (thirty-six years of rainfall and flows). Effectiveness is judged using four sets of performance measures: one set for lake recessions, one set for flood protection, one for water releases to Lake Okeechobee, and one set for water supply. (Note: The water supply performance measure uses dry season lake stage as surrogate for a variety of water supply issues such as changes in groundwater recharge, impacts on navigation or impacts on recreation.) Several Zone B lake regulation schedules and release rules were examined and compared to the behavior of the current schedule and release rules, called the BASE case.

The assessment found that modest Zone B releases were effective in creating a more natural spring drawdown pattern in Toho and East Toho. Modest Zone B releases also had a benefit in reducing in peak flood stage in Toho (0.08 ft on large events) and East Toho (0.25 ft on large events). These rules had only minor negative impacts. November lake stage remained within 0.5 ft of BASE in Lake Toho most years and within 0.1 ft of BASE in Lake East Toho most years. Spring recessions in Toho may be impacted by lowered lake stages in drier years (0.6 ft lower for 25% of years in Lake Toho). The annual releases into the Kissimmee River increased by an average of 10,000 acre-feet per year. The most effective set of Zone B release rules, Alternative 12, is presented.

More aggressive Zone B releases, obtained either through lower lake schedules or through more rapid S-59 and S-61 release rates, provide better flood protection in Toho and East Toho (Toho peak stages decrease by as much as 0.24 ft and East Toho peak stages decrease by as much as 0.52 ft. compared to BASE) but other performance measures slip. Deliveries to Lake Okeechobee increase to 17,000 acre-feet per year. November lake stages are almost one foot lower than BASE in Lake Toho most years but still remain within 0.1 ft of BASE in Lake East Toho.

Background

In a meeting with Operations (Susan Sylvester, Ron Mierau and Cal Neidrauer) on Friday, March 3rd 2006, HESM was asked to assess the following structure operation rule deviations under consideration by Operations:

- Add environmental release rules to S-59 operations (controlling Lake East Tohopekaliga) and S-61 operations (controlling Lake Tohopekaliga) from now through June 1 to benefit bass production and snail kite nesting. This would cause an earlier lake stage recession in both Toho and East Toho. The drawdown would begin at the start of nesting season and the recession would be gradual, ending on June 1. These releases are referred to as 'Zone B1' releases in this document.

- Add environmental release rules to S-59 and S-61 operations from June 2 through the end of October to partially replace releases from Kissimmee-Hatchineha-Cypress for environmental restoration of the Kissimmee River. This would lower wet season stages in Toho and East Toho and might result in lower peak stages during large storm events. These are referred to as 'Zone B2' releases in this document.

Objective

HESM was asked to evaluate the impacts of the proposed operation rule deviations discussed above. It was determined that the Kissimmee Chain of Lakes Operational Model UKISS would be used to assess the impacts of operation rule deviations.

Operation Rules

Operation rules exist for each of the seven major water control structures in the Kissimmee Chain of Lakes. On six of the structures, operation rules are simple, consisting of a "Zone A" regulation schedule that defines desired stage throughout the year. Releases are made to lower stage to the schedule and, when stages are at or below the regulation schedule, flows are stopped.

On the lowest structure, S-65, additional rules exist to allow environmental releases to be made even though stage is below the Zone A regulation schedule. The S-65 structure controls stages in Lakes Kissimmee, Hatchineha, and Cypress. S-65 environmental releases benefit the Kissimmee River ecosystem. Figure 1 shows both the Zone A Regulation schedule and the Zone B environmental schedule for the S-65 structure[1]. Note that release rates are at the capacity of the system when the lake stage is in Zone A but release rates are restrained to a depth dependent value when lake stage is in Zone B.

[1] The Zone B Operation Rules are those currently being used by District Operations, as described in a March 23rd communication from Susan Sylvester.

The proposed rule modifications add zone B releases to the S-61 and S-59 structures. The proposal does not modify the Zone A release rules. Figures 2 and 3 show the Zone A Regulation schedule for the S-61 and S-59 structures, respectively. The figures also show the proposed Zone B environmental schedule and release rules. The values shown are the release rules for Alternative 12, discussed below.

Process

Each set of operation rules were assessed by performing a 36-year (1965 to 2000) UKISS simulation and then comparing the results of each alternative against the performance of the existing operation rules. The UKISS simulation was a March 1 'Position Analysis (PA)', meaning that in each year of the simulation, all lake stages were reset to current March 1 stages. The PA mode demonstrates probable behavior over the upcoming year.

All Alternatives are compared to a BASE simulation that simulates existing operating rules[2]. The Alternatives test different rules for Zone B in Toho and East Toho. Specifically, the magnitude of the Zone B operational releases and the minimum stages of zone B2 were adjusted to improve effectiveness and minimize negative impacts. Details on the assessment can be found in the following section. Table 1 summarizes the simulated release rules of the various Alternatives. To simplify the display, the rules are stated relative to the release rules of Alternative 12. Table 1 also lists the figures relating to each Alternative.

Performance Metrics

A "Base Run" is a UKISS model run without the proposed Zones B1 and B2 for Toho and East Toho. An "Alternative" is a UKISS model run with a specific set of discharge rules in Zones B1 and B2 of Toho and East Toho.

The following performance metrics were chosen[3] to evaluate each Alternative:

- Carry-Over Effect: The carry-over assessment looks at lake stages on February 1. If lake stage is significantly below the lake Zone A regulation schedule, then the impact of the proposed Zone B rule will 'carry-over' into the following year. A carry-over effect reduces the environmental water supply needed for the following year's spring drawdown event, eliminating the interannual variability in lake drawdown and possibly impacting nesting and fish production.

[2] Initial UKISS model runs revealed a programming error in the code. This error was located and fixed and the details on the error and on the code modifications can be found in Appendix A. The effect of the error on past UKISS simulations was found to be minor and details of this can also be found in Appendix A.

[3] The Performance Metrics were discussed and agreed to at a meeting between Susan Sylvester, Dave Anderson, Ken Konyha and Rama Rani on the 21st March, 2006

The metric selected is the 50th percentile stage in Lakes Toho and East Toho on Februrary 1. The target is the 50th percentile stage of the Zone A regulation schedule. As long as there is a 50% probability that the stage will be within 0.5 feet of the regulation stage on February 1 for both Toho or East Toho, the 'Carry-Over' risk is considered acceptable.

- Water Supply: The water supply assessment looks at lake stages on November 15, near the start of the dry season. Since lake stages do not in general rise during the dry season, the Nov 15 lake stage is used as an indicator of dry season lake stage. A low lake stage is assumed to correlate with a suite of water supply issues and this metric is used as a surrogate for a range of water supply issues including recharge of groundwater and an impact on navigation and recreation.

  The metric selected is the 50th percentile stage in Lakes Toho and East Toho on November 15. The target is the November 15 stage of the 'BASE' simulation and, as long as there is a 50% probability that the stage is within 0.5 feet of the "Base Run" on both Toho and East Toho, the water supply impacts of the Alternative are considered acceptable. (Note: This definition of impact is not based on measured data.)

- Flood Protection: The flood protection assessment looks at Peak Lake Stage in Toho, East Toho and Kissimmee for large storm events. The Peak Lake Stage will change because pre-storm lake stages are influenced by Zone B releases from Toho and East Toho. The pre-storm lake stages in Toho and East Toho are lowered by these Zone B releases while stages in Kissimmee tend to be raised. Though the Peak Lake Stage predicted by UKISS does not replace peak lake stage predictions generated by a flood routing hydraulic model, the UKISS peak stages are considered to be a good indicator of the relative impact of Zone B releases on pre-storm storage.

  The metric selected is the top-ranked and the fourth-ranked maximum annual stage values in Lakes Toho, East Toho and Kissimmee; these correspond roughly to a 1-in-30 and a 1-in-10 storm event, respectively. The target is the corresponding maximum annual stages of the 'BASE' simulation. If maximum stage in Toho, East Toho or Kissimmee lakes for major events are lower than the maximum stages in the "BASE", flood protection is considered uncompromised.

- Impacts on Lake Okeechobee: The Lake Okeechobee assessment looks at annual flows at S-65. New zone B releases tend to increase flows at S-65 because stages in the upper lakes tend to be lower and this results in slightly less lake surface area, lower evaporation and, consequently, higher flows. The pattern of flows is also impacted but these effects are thought to be small. If necessary, a SFWMM[4] model run can be made by the Model Application Support Unit to study these effects. SFWMM simulations are not considered in this report.

[4] SFWMM is the primary regional planning model used by the District, It simulates stages in Lake Okeechobee.

The metric selected is the annual runoff at S-65, cumulated from March through the following February. (This period was selected to be consistent with the PA period.) The target is the corresponding runoff from the 'BASE' simulation. If S-65 flows are not significantly above "BASE", impacts on Lake Okeechobee are considered uncompromised. Significant is defined as a change in the annual deliveries equal to 0.5 inches over the surface of Lake Okeechobee; this volume is about 20,000 acre-feet per year.

Analysis

A total of sixteen Alternatives were assessed during this project but only three are discussed in this report: the BASE alternative, Alternative 12 and Alternative 16. The BASE alternative has no Zone B releases in Toho and East Toho; Alternative 12 has modest releases from Zone B and meets all Performance Measure Targets; Alternative 16 has high releases from Zone B and fails to meet several PM Targets.

Figures 2, 3 and 4 describe the Alternative 12 Operating Schedule and Rules for Lakes Kissimmee-Hatchineha-Cypress, Lake Toho, and Lake East Toho, respectively. Table 1 defines the operating rules for each Alternative.

Selected outputs from each simulation are presented. Percentile Traces, Maximum Annual Stage versus probability plots, and Annual S-65 Flows plots are shown for Alternatives 12 and 16 and the BASE. Figure identification is:

	Percentile Trace			Maximum Annual Stage v Probability	Annual S-65 Flow comparison
	Kissimmee	Toho	East Toho		
BASE	Fig 4a	Fig 4b	Fig 4c	Fig 5d & 6d	Fig 5e & 6e
Alt 12	Fig 5a	Fig 5b	Fig 5c	Fig 5d	Fig 5e
Alt 16	Fig 6a	Fig 6b	Fig 6c	Fig 6d	Fig 6e

Performance Measures are also presented: Table 2 presents 'Carry-Over' Performanace Metrics; Table 3 presents Water Supply Performance Metrics; Table 4 presents Flood Control Performanace Metrics; Table 5 presents Lake Okeechobee Performanace Metrics.

'Carry-Over' Performance Metrics (Table 2 and figures 4abc 5abc & 6abc)

Carry-Over looks at stages on February 1st, comparing the Alternative to the Base. For Lake East Toho in the BASE, most years (50% trace) had stages above 57.4 ft, close to the 58 ft Regulatory Stage. All Alternatives lowered the 50% trace to 57.1 ft though this 0.3 ft drop is not considered significant. For Lake Toho in the BASE, most years (50% trace) had stages at or above 55.0 ft, the Regulatory Stage. All Alternatives lowered the 50% trace to around 54.7 ft, again not a significant drop.

Looking at the 25% PA traces in Toho (figures 4b, 5b, 6b) may be impacted by lake stages that are lowered by 0.6 ft (Alternative 12) to 0.8 ft (Alternative 16) in drier years. This equates to a one-in-four chance of impact.

Water Supply Performance Metrics (Table 3 and figures 4abc 5abc & 6abc)

Water Supply looks at stages on November 15th, comparing the Alternative to the Base. For Alternative 12, November lake stages drop but remain within 0.5 ft of BASE in Lake Toho most years and within 0.1 ft of BASE in Lake East Toho most years. This falls within the accepted 0.5 ft limit. The effect on Lake Kissimmee is an increase in stage of 0.6 ft.

For Alternative 16, November lake stages are almost one foot lower than BASE in Lake Toho most years but remain within 0.1 ft of BASE in Lake East Toho. The one foot drop falls outside the accepted limit and may increase the likelihood of impacts on water supply, navigation, and recreation.

Figures 4bc, 5bc and 6bc show that the drier percentile traces (minimum, 10%, 25%) are unaffected by the new Zone B release rules. This seems reasonable since there is little water available for Zone B releases in dry periods; Zone B release rules affect water supply in average years.

Flood Protection Performance Metrics (Table 4 and figures 5d & 6d)

Flood Protection looks at maximum annual stages in each lake, comparing the Alternative to the BASE. Modest Zone B releases (Alternative 12) had a benefit in reducing in peak flood stage in Toho (0.08 ft on large events) and East Toho (0.25 ft on large events). More aggressive Zone B releases (Alternative 16) provide even better flood protection in Toho and East Toho; Toho peak stages decrease by as much as 0.24 ft and East Toho peak stages decrease by as much as 0.52 ft., compared to BASE.

The effect on peak flood depths is greatest for Lake East Toho. The effect of Zone B is seen on the large storm events, i.e. storms with an exceedance probability of less than 20% (storms with 1-in-5 return periods). The same pattern holds for Lake Toho but the impact of Zone B releases is not as noticeable. On Lake Kissimee the Zone B releases from Toho and East Toho tend to increase peak stages. This is not surprising since the upstream zone B releases reduce storage in the lower lakes.

CAUTION: UKISS does not model groundwater–surfacewater interactions and it assumes that inflows into the lakes are not influenced by lake management. This assumption may lead to a misestimation of flood protection impacts. A coupled groundwater-surfacewater model is currently under development and could be used to reexamine this issue. This model is expected to be ready for use in late 2006.

Lake Okeechobee Performance Metrics. (Table 5 and figures 5e & 6e)

Lake Okeechobee Impacts look at the annual volume of flow at S-65, comparing the Alternative to the BASE. In Alternative 12, the annual releases into the Kissimmee River are increased by an average of 10,000 acre-feet per year and by a maximum amount of 20,700 acre-feet per year. The average annual value is well below the impact threshold of 20,000 but the maximum annual value is close to the threshold. Looking at figures 5e and 6e, the increased flows do not occur on years with high outflows.

In Alternative 16, average annual deliveries to Lake Okeechobee increase to 17,000 acre-feet per year and the maximum annual value increases to 35,000 acre-feet per year, well above the 20,000 acre-foot per year threshold. The impacts on Lake Okeechobee may be significant.

General Observations from Position Analyis traces (figures 4abc 5abc & 6abc):

When the regulation schedule reaches its lowest stage on June 1, simulated stages almost always match the regulation schedule. This implies that there is little carry-over effect beyond this date, in any year.

The plots indicate that stages tend to rise during the winter (November through January) in Lakes Toho and East Toho and tend to decline during the winter in Lakes Kissimmee-Hatchineha-Cypress. The apparent ability of Lakes Toho and East Toho to recover during the dry season may be an artifact caused by faulty inflow values into the upper lakes. This feature should be reexamined when new watershed hydrology exists for all basins in the Kissimmee Watershed.

Conclusions

Several alternatives were simulated using UKISS and assessed using Performance Measures for flood control, water supply, environmental benefit and releases to Lake Okeechobee.

The assessment found that modest Zone B releases were effective in creating a more natural spring drawdown pattern in Toho and East Toho. Modest Zone B releases also had a benefit in reducing in peak flood stage in Toho (0.08 ft on large events) and East Toho (0.25 ft on large events). These rules had only minor negative impacts. November lake stage remained within 0.5 ft of BASE in Lake Toho most years and within 0.1 ft of BASE

in Lake East Toho most years. Spring recessions in Toho may be impacted by lowered lake stages in drier years (0.6 ft lower for 25% of years in Lake Toho). The annual releases into the Kissimmee River increased by an average of 10,000 acre-feet per year. The most effective set of Zone B release rules, Alternative 12, is presented.

More aggressive Zone B releases, obtained either through lower lake schedules or through more rapid S-59 and S-61 release rates, provide better flood protection in Toho and East Toho (Toho peak stages decrease by as much as 0.24 ft and East Toho peak stages decrease by as much as 0.52 ft. compared to BASE) but other performance measures slip. Deliveries to Lake Okeechobee increase to 17,000 acre-feet per year. November lake stages are almost one foot lower than BASE in Lake Toho most years but still remain within 0.1 ft of BASE in Lake East Toho.

Table 1. Description of Operation Rules for the tested Alternatives

	S-59 (East Lake Tohopekaliga)		S-61 (Lake Tohopekaliga)		Figure #	In Appendix A?
	B1	**B2**	**B1**	**B2**		
Base	No B Zones				**4a-4e**	**Y**
Alt 1	*133 cfs*	*0 cfs - 540 cfs*	*220 cfs*	*0 cfs - 990 cfs*	None	N
Alt 2	133 cfs	*None*	220 cfs	*None*	None	N
Alt 3	*300 cfs*	None	220 cfs	None	None	N
Alt 4	*75 cfs*	None	220 cfs	None	None	N
Alt 5	133 cfs	None	*450 cfs*	None	None	N
Alt 6	133 cfs	None	*100 cfs*	None	None	N
Alt 7	133 cfs	*0 cfs - 540 cfs*	120 cfs	*0 cfs - 990 cfs*	None	N
Alt 8	133 cfs	*0 cfs - 1500 cfs*	120 cfs	Same as Alternative 7	**5a-5e**	**Y**
Alt 9	133 cfs	Same as Alternative 7	120 cfs	*0 cfs - 250 cfs for 51.5 ft NGVD - 55 ft NGVD*	None	N
Alt 10	133 cfs	Same as Alternative 7	120 cfs	*Reduced the higher discharges from Alternative 7*	None	N
Alt 11	133 cfs	Same as Alternative 7	120 cfs	*Reduced the mid-range, increased the high discharges from Alternative 7*	None	N
Alt 12	133 cfs	Same as Alternative 7	120 cfs	*Alternative 9 for Lower Discharges, Alternative 10 for Higher Discharges*	None	N
Alt 13	133 cfs	*0 cfs - 1080 cfs*	120 cfs	*Increased Discharges from Alternative 12*	None	N
Alt 14	133 cfs	Same as Alternative 13	*220 cfs*	Same as Alternative 13	None	N
Alt 15	133 cfs	*0 cfs - 540 cfs*	220 cfs	*Lowered the Zone B2 by 0.5 ft*	None	N
Alt 16	133 cfs	*0 cfs - 1080*	220 cfs	*Combination of Alternatives 13 and 15*	**6a-6e**	**Y**

NOTES:

1. S-65 (Lake Kissimmee) schedule and release rules were not changed for any of the simulations (See Figure 1).
2. In *Red and Italics* are parameters that were changed for that specific alternative compared to the previous.
3. S-59 and S-61 schedule and release rules in Zone A were not changed. They were set to the capacity of the system.

Table 2. "Carry-Over" Performance Metrics

	Stage of 50% Percentile Trace on February 1		
	S-65 (LakeKissimmee)	S-59 (East Lake Tohopekaliga)	S-61 (Lake Tohopekaliga)
Target Stage	52.5	58.0	55.0
Base	*49.3*	*57.4*	55.0
Alternative 1	*50.0*	*57.1*	54.8
Alternative 12	*50.0*	*57.1*	54.8
Alternative 14	*49.9*	*57.1*	54.7
Alternative 15	*49.9*	*57.1*	54.8
Alternative 16	*49.9*	*57.1*	54.7

PM Target: Target is the Zone A Regulatory Stage on February 1 for each Lake

Acceptable Value: Any stage within 0.50 ft of the Target Stage (failures are in *red italics*)

Description of PM:

The carry-over effect looks at lake stages on February 1. If lake stage is significantly below the regulatory schedule, then the impact of the proposed Zone B rule is found to 'carry-over' into the following year. A carry-over effect reduces the environmental water supply needed for the following year's spring drawdown event, eliminating the desired interannual variability in lake drawdown and possibly impacting nesting and fish production. The metric selected is the 50th percentile stage in Lakes Toho and East Toho. As long as there is a 50% probability that the stage will be within 0.5 feet of the regulatory schedule for February 1 for both Toho or East Toho, the 'Carry-Over risk is considered acceptable.

Table 3. Water Supply Performance Metrics

	Stage of 50% Percentile Trace on November 15		
	S-65 (Lake Kissimmee)	S-59 (East Lake Tohopekaliga)	S-61 (Lake Tohopekaliga)
Target Stage	52.5	58.0	55.0
Base	50.1	56.9	54.9
Alternative 1	50.7	56.8	*54.1*
Alternative 12	50.7	56.8	54.5
Alternative 14	50.7	56.8	*54.0*
Alternative 15	50.7	56.8	*54.1*
Alternative 16	50.7	56.8	*54.0*

PM Target: Target is the BASE Stage on November 15 for each Lake

Acceptable Value: Any stage within 0.5 ft of the Target Stage (failures are in *red italics*)

Description of PM:

Water Supply: The water supply assessment looks at lake stages on the 15th of November, near the start of the dry season. Since lake stages do not generally rise during the dry season, the start of dry season lake stage is a reasonable indicator of dry season lake stage. A significant drop in November 15 lake stage is assumed to correlate with a suite of water supply issues and this metric is used as a surrogate for a range of water supply issues including recharge of groundwater and an impact on navigation and recreation. The metric selected is the 50th percentile stage in Lakes Toho and East Toho on November 15. The target is the November 1 stage of the 'BASE' simulation and, as long as there is a 50% probability that the stage is within 0.5 feet of the "Base Run" on both Toho or East Toho, the water supply impacts of the Alternative are considered acceptable.

Table 4. Flood Control Performance Metrics

	Value (ft-NGVD) of Top-ranked & fourth-ranked peak annual stages					
	S-65 (Lake Kissimmee)		S-59 (East Lake Tohopekaliga)		S-61 (Lake Tohopekaliga)	
	top-ranked stage	fourth-ranked stage	top-ranked stage	fourth-ranked stage	top-ranked stage	fourth-ranked stage
Target Stage	52.69	52.37	58.78	58.22	55.54	55.29
Base	52.69	52.37	58.78	58.22	55.54	55.29
Alternative 1	52.69	*52.39*	58.51	*58.23*	55.38	55.29
Alternative 12	52.69	52.37	58.53	*58.23*	55.46	55.29
Alternative 14	52.69	52.37	58.35	58.04	55.30	55.27
Alternative 15	52.69	*52.39*	58.42	58.13	55.38	55.29
Alternative 16	52.68	52.37	58.26	58.04	55.30	55.27

PM Target: Target is the corresponding stage of the BASE (i.e. maintain existing level of service)

Acceptable Value: Any stage equal-to or less-than Target stage (failures are in *red italics*)

Description of PM:

Flood Protection: The flood protection assessment looks at Peak Lake Stage in Toho, East Toho and Kissimmee for the large storm events. The Peak Lake Stage will change because pre-storm lake stages are influence by Zone B releases. The pre-storm lake stages in Toho and East Toho are lowered by Zone B releases but these same releases tend to raise pre-storm lake stages in Kissimmee. Though the Peak Lake Stage predicted by UKISS does not replace peak lake stage predictions generated by a flood routing hydraulic model, the UKISS peak stages are a good indicator of the relative impact of Zone B releases on pre-storm storage. The metric selected is the top-ranked and the fourth-ranked maximum annual stage value in Lakes Toho, East Toho and Kissimmee; these correspond roughly to a 1-in-30 and a 1-in-10 storm event, respectively. The target is the maximum annual stages of the 'BASE' simulation. If maximum stage in Toho, East Toho or Kissimmee lakes for major events are lower than the maximum stages in the "BASE", flood protection is considered uncompromised.

Table 5. Lake Okeechobee Impact Performance Metrics

	Change in Annual Flow at S-65, compared to BASE (acre-feet per year)	
	Average Change in annual flow	Maximum change in annual flow
Target	20,000	20,000
Base	0	0
Alternative 1	12,705	25,631
Alternative 12	10,474	20,718
Alternative 14	16,887	*34,198*
Alternative 15	12,881	25,361
Alternative 16	17,114	*34,991*

PM Target: Target is the annual S-65 releases for the BASE simulation.

Acceptable Value: The change in the annual discharges should be <20,000 acre-feet per year

Description of PM:

Impacts on Lake Okeechobee: The Lake Okeechobee assessment looks at annual flows at S-65. New zone B releases tend to increase flows at S-65 because stages in the upper lakes tend to be lower and this results in slightly less lake surface area, lower evaporation and, consequently, higher flows. The pattern of flows is also impacted but these effects are thought to be small. If necessary, a SFWMM model run can be made by the Model Application Support Unit to study these effects. SFWMM simulations are not considered in this report. The metric selected is the annual runoff at S-65, cumulated from March through the following February. This period was selected to be consistent with the PA period. The target is the corresponding runoff from the 'BASE' simulation. If S-65 flows are not significantly above "BASE", impacts on Lake Okeechobee are considered uncompromised. Significant is defined as a change in the annual deliveries equal to 0.5 inches over the surface of Lake Okeechobee; this volume is about 20,000 acre-feet.

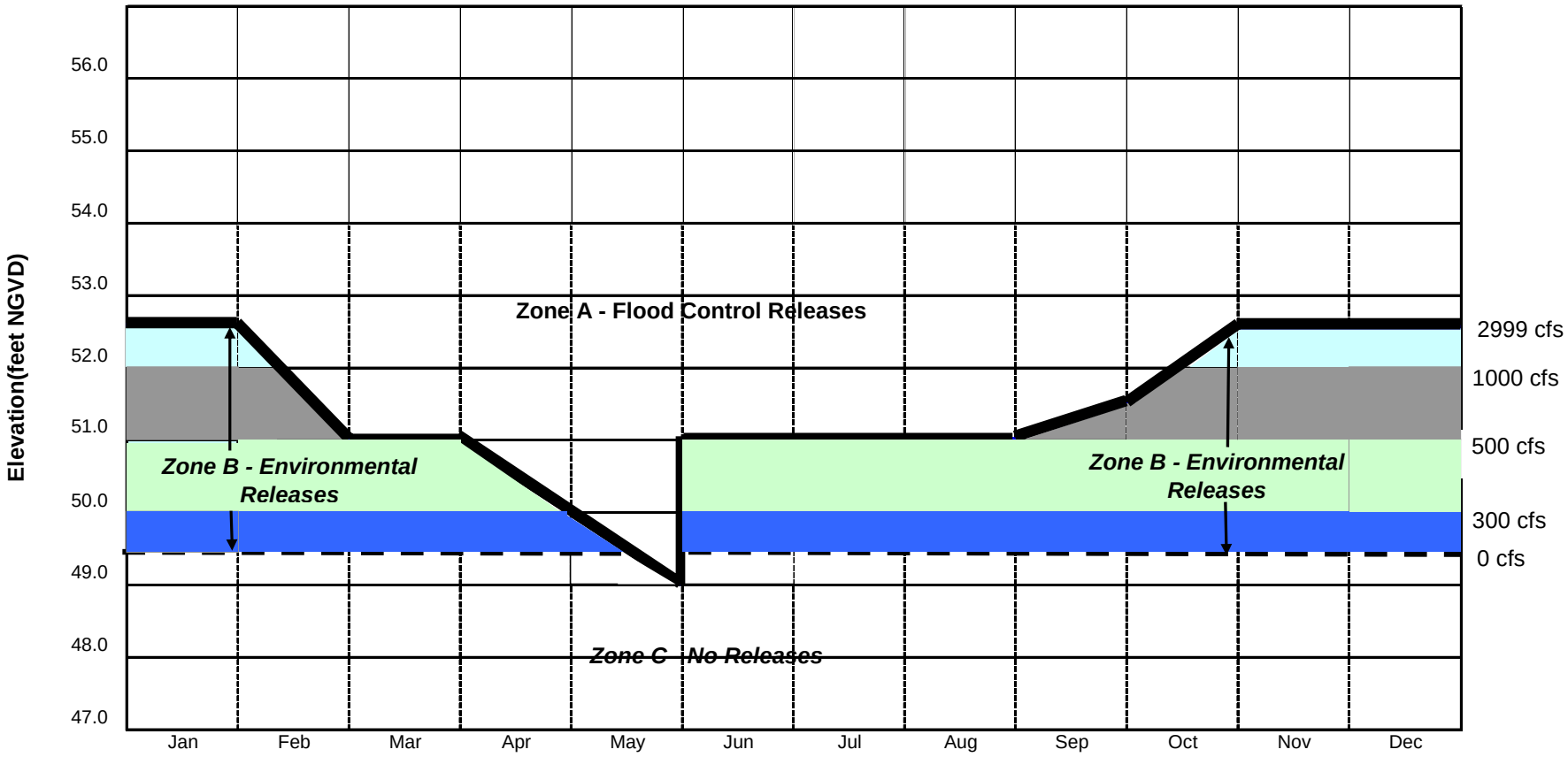


Figure 1. Interim Operational Schedule and Release Rules for Lakes Kissimmee-Hatchineha-Cypress controlled by S-65.

Note:

- In Zone A releases are equal to the capacity of the system.
- In Zone B, releases range from 0 cfs at 49.4 feet NGVD to 2999 cfs at 52.5 feet NGVD.

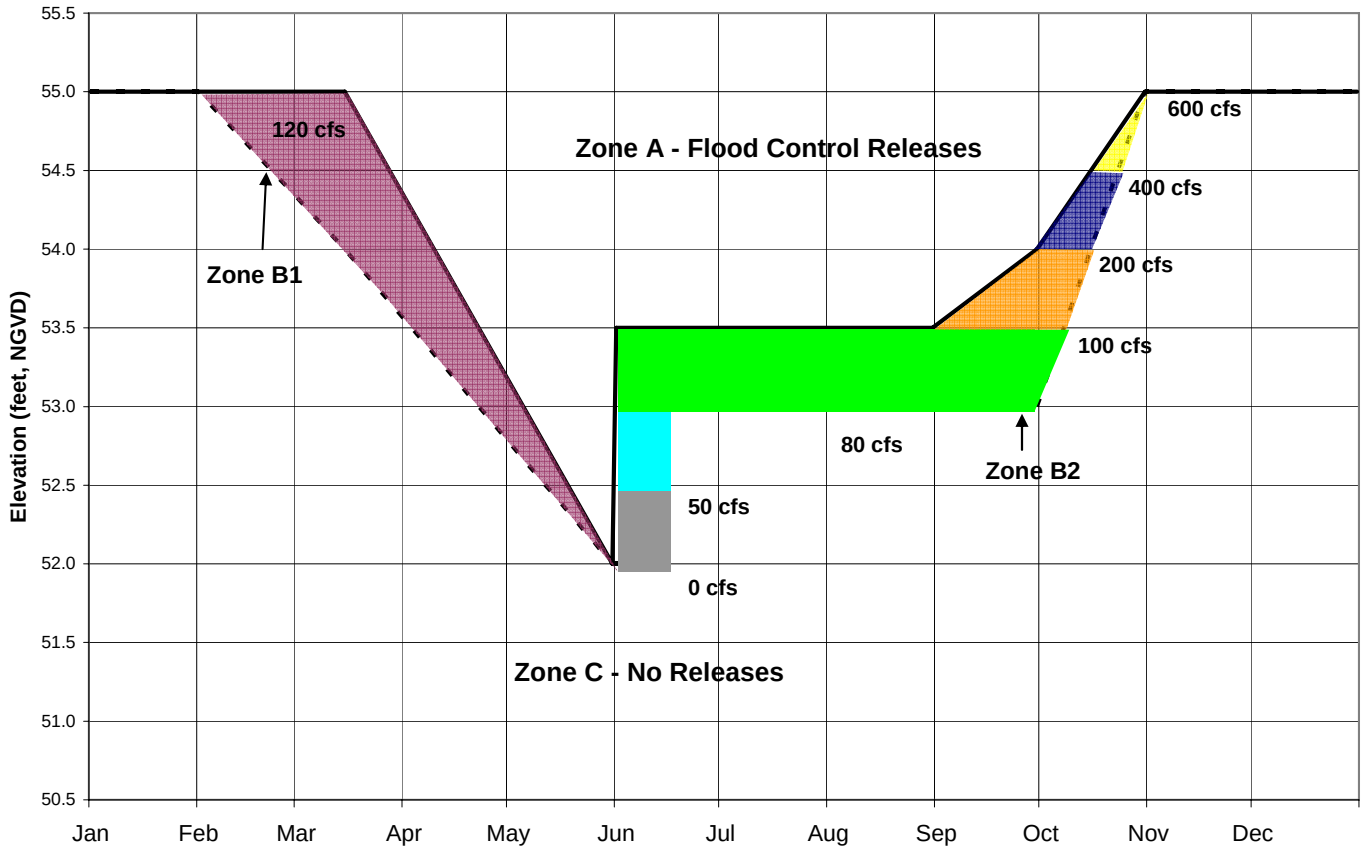


Figure 2. Schedule and Release Rules for Lake Tohopekaliga controlled by S-61 in Alternative 12

Note:

- In Zone A releases are equal to the capacity of the system.
- In Zone B1, releases are a constant of 120 cfs.
- In Zone B2, releases ramp from low value to high value in each range.

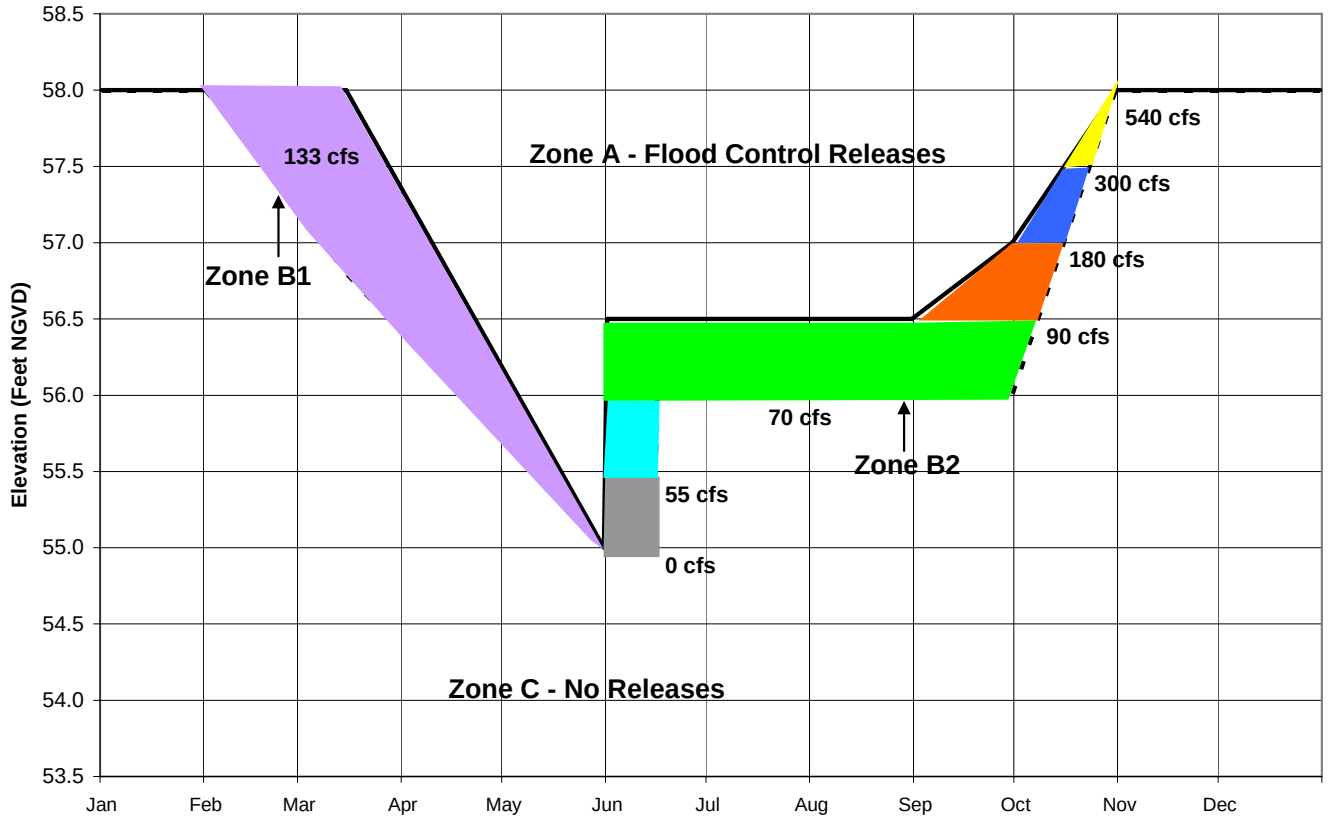


Figure 3. Schedule and release Rules for East Lake Tohopekaliga controlled by S-59 in Alternative 12

Note:

- In Zone A releases are equal to the capacity of the system.
- In Zone B1, releases are a constant of 133 cfs.
- In Zone B2, releases ramp from low to high value in each range.

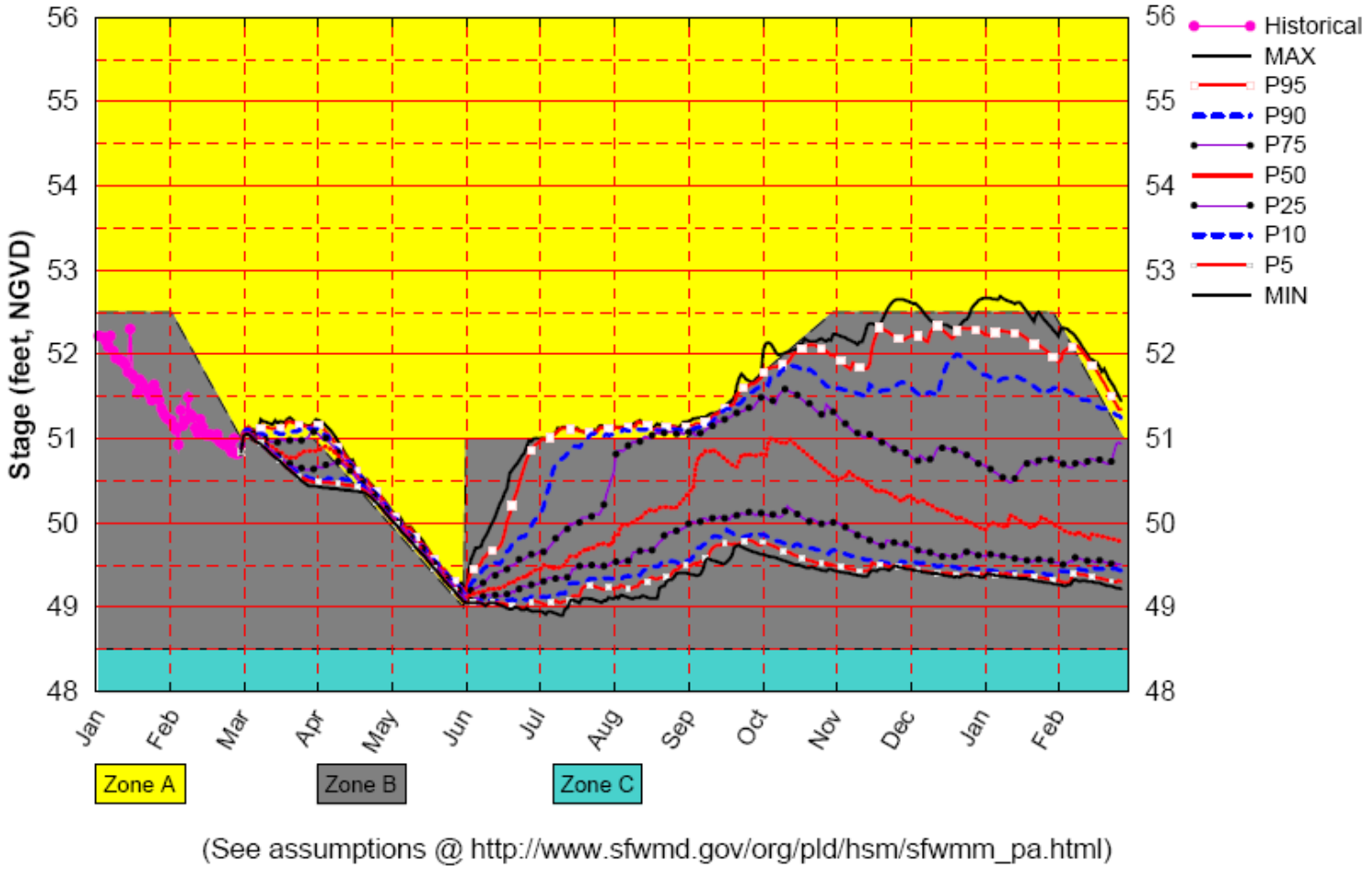


Figure 4a. March Position Analysis for Lake Kissimmee - Base Run

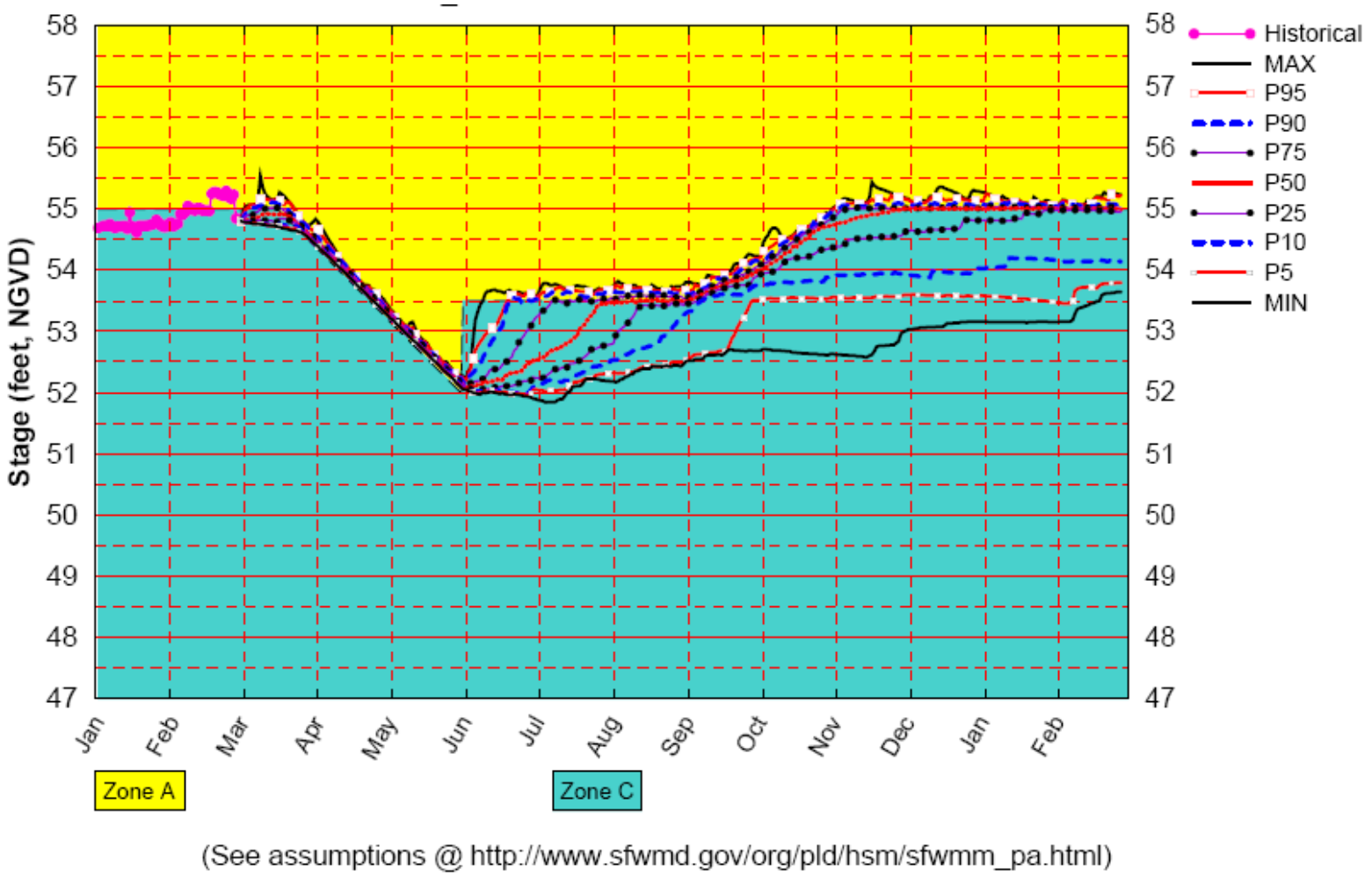
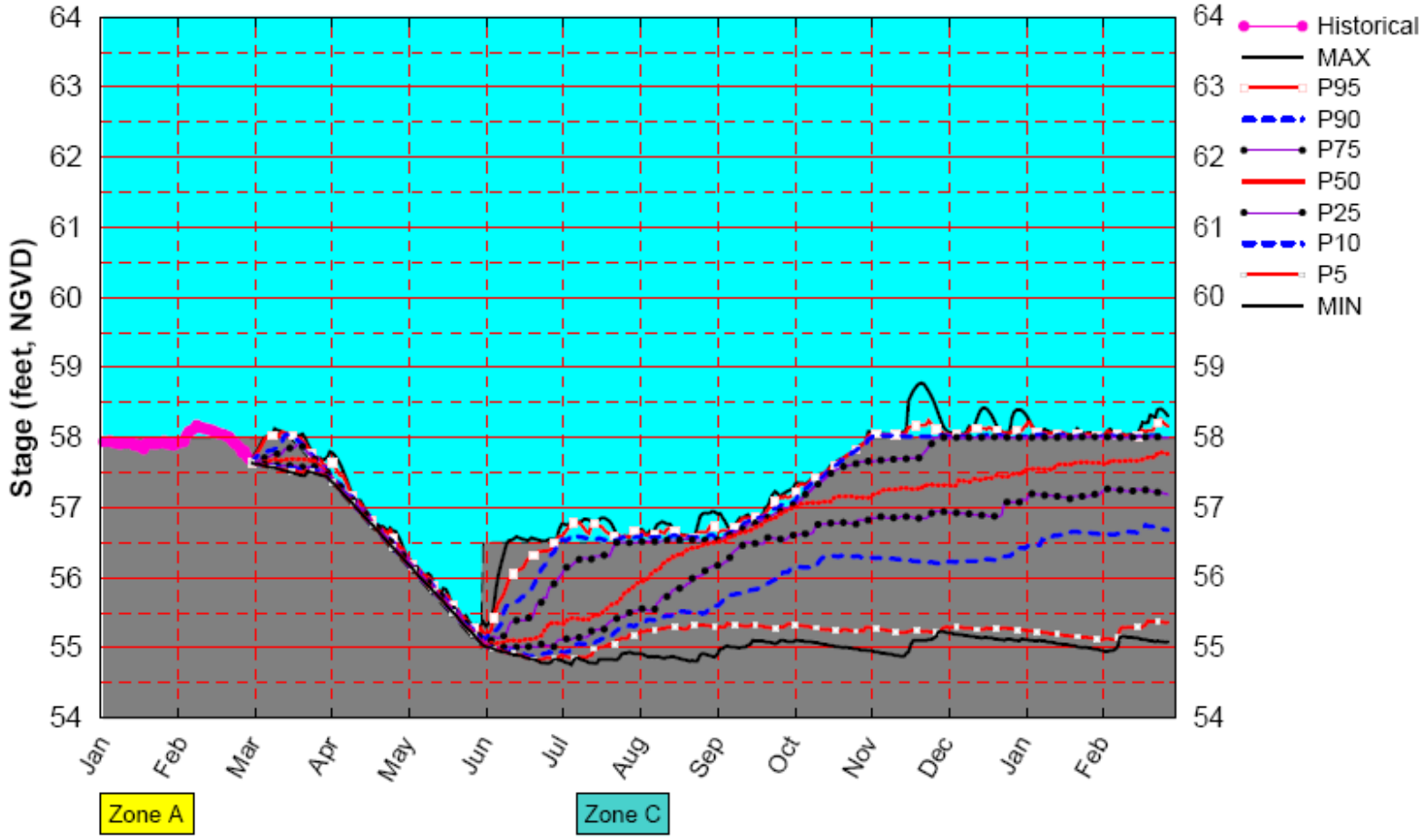


Figure 4b. March Position Analysis for Lake Tohopekaliga - Base Run



(See assumptions @ http://www.sfwmd.gov/org/pld/hsm/sfwmm_pa.html)

Figure 4c. March Position Analysis for East Lake Tohopekaliga - Base Run

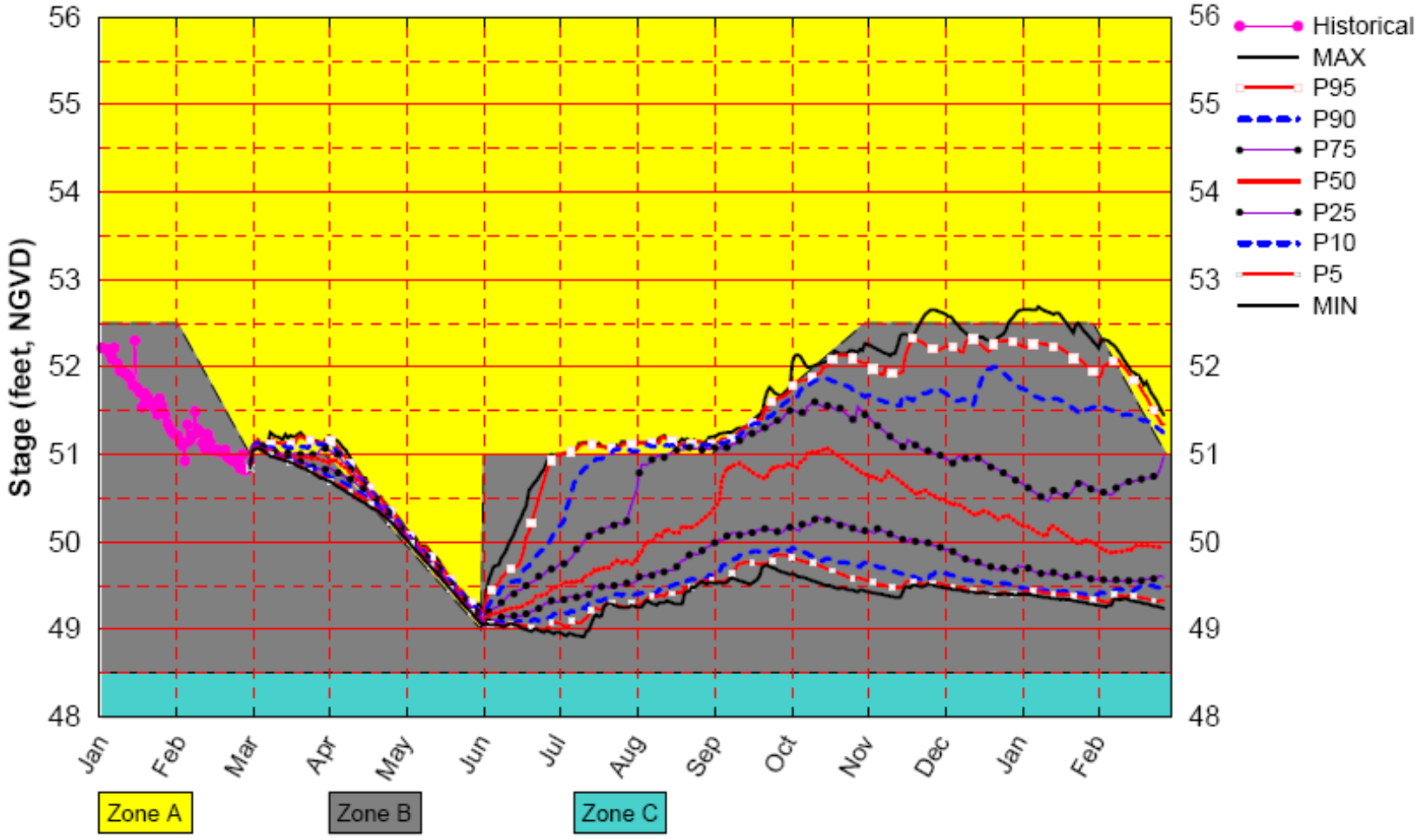
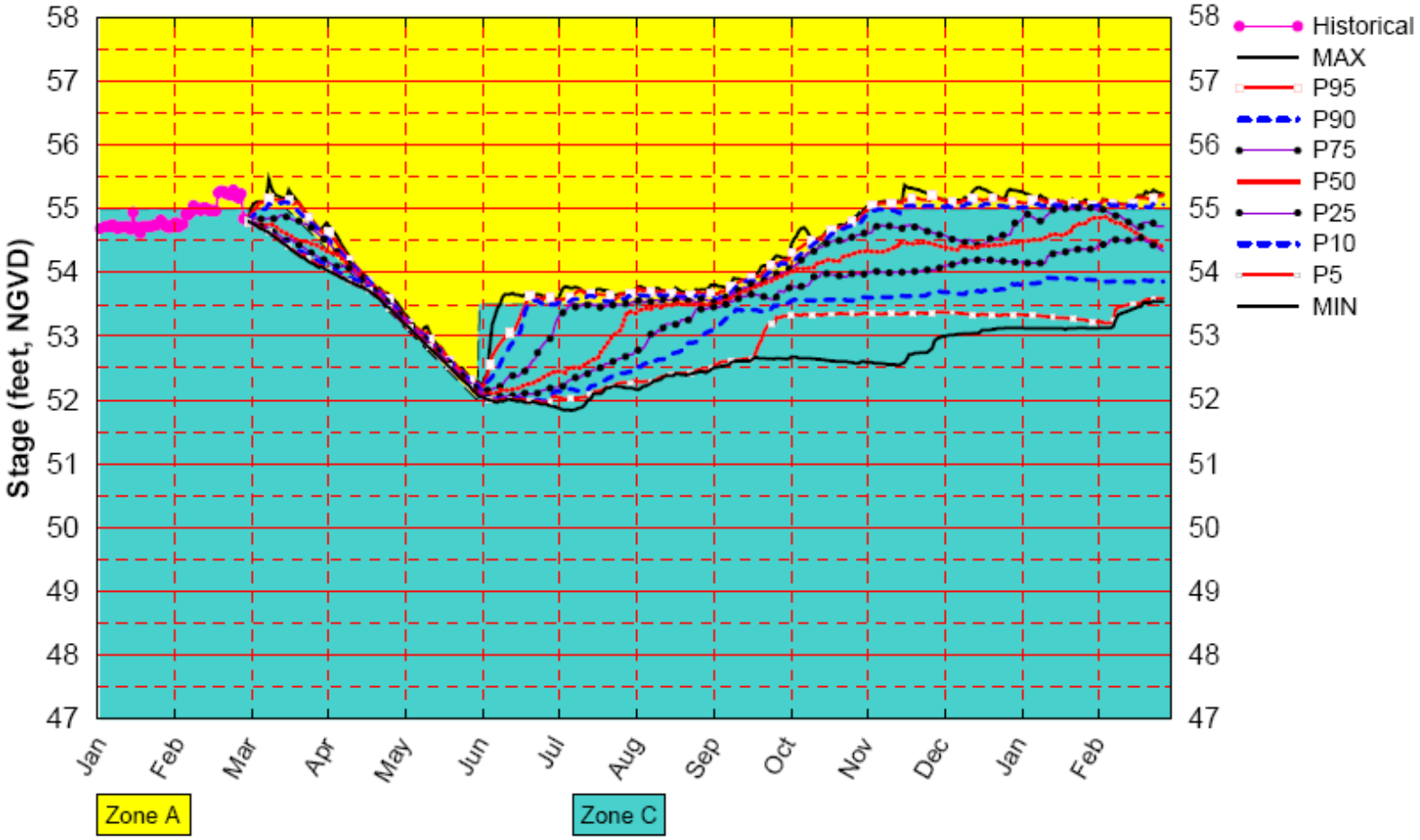
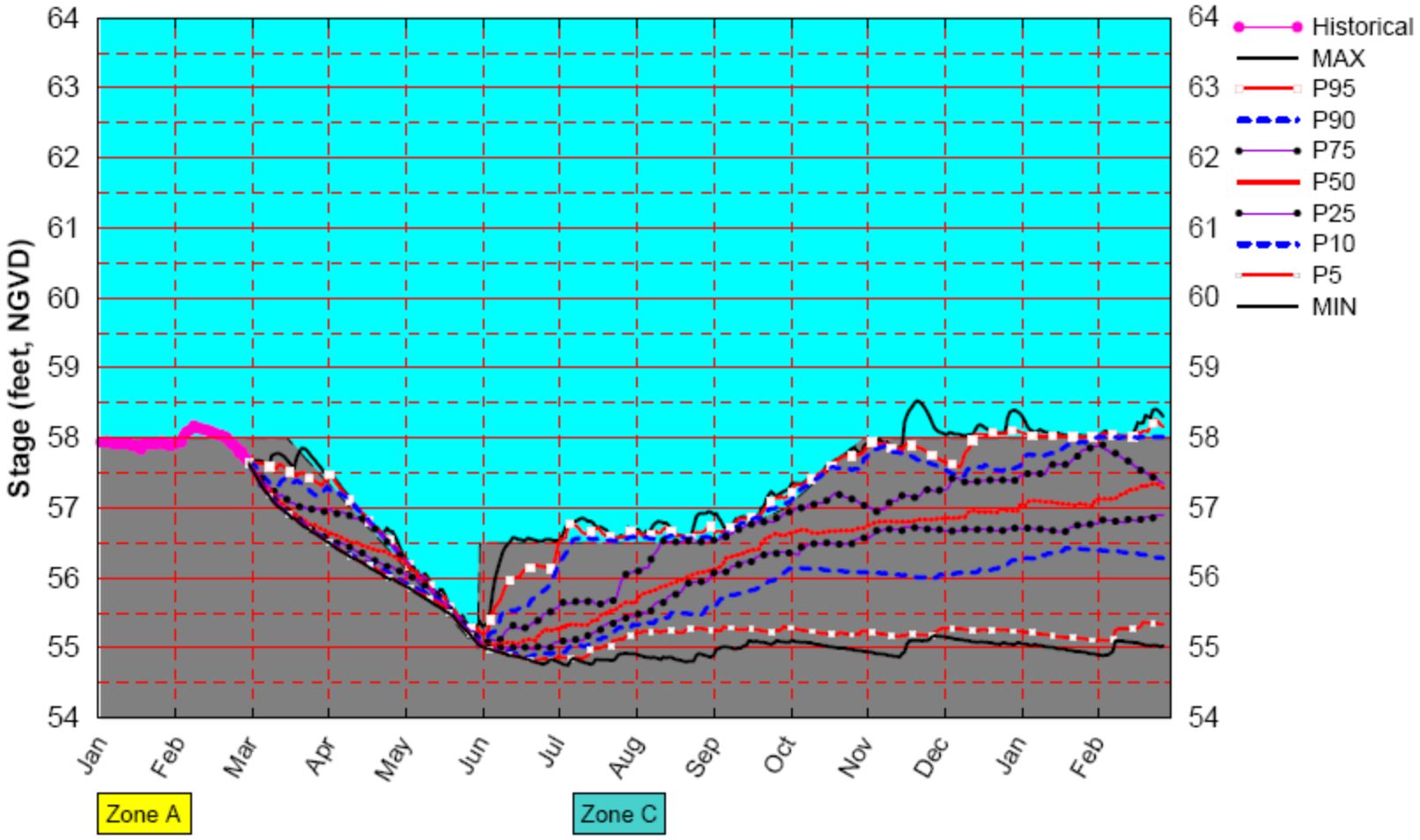


Figure 5a. March Position Analysis for Lake Kissimmee - Alternative 12



(See assumptions @ http://www.sfwmd.gov/org/pld/hsm/sfwmm_pa.html)

Figure 5b. March Position Analysis for Lake Tohopekaliga - Alternative 12



(See assumptions @ http://www.sfwmd.gov/org/pld/hsm/sfwmm_pa.html)

Figure 5c. March Position Analysis for East Lake Tohopekaliga - Alternative 12

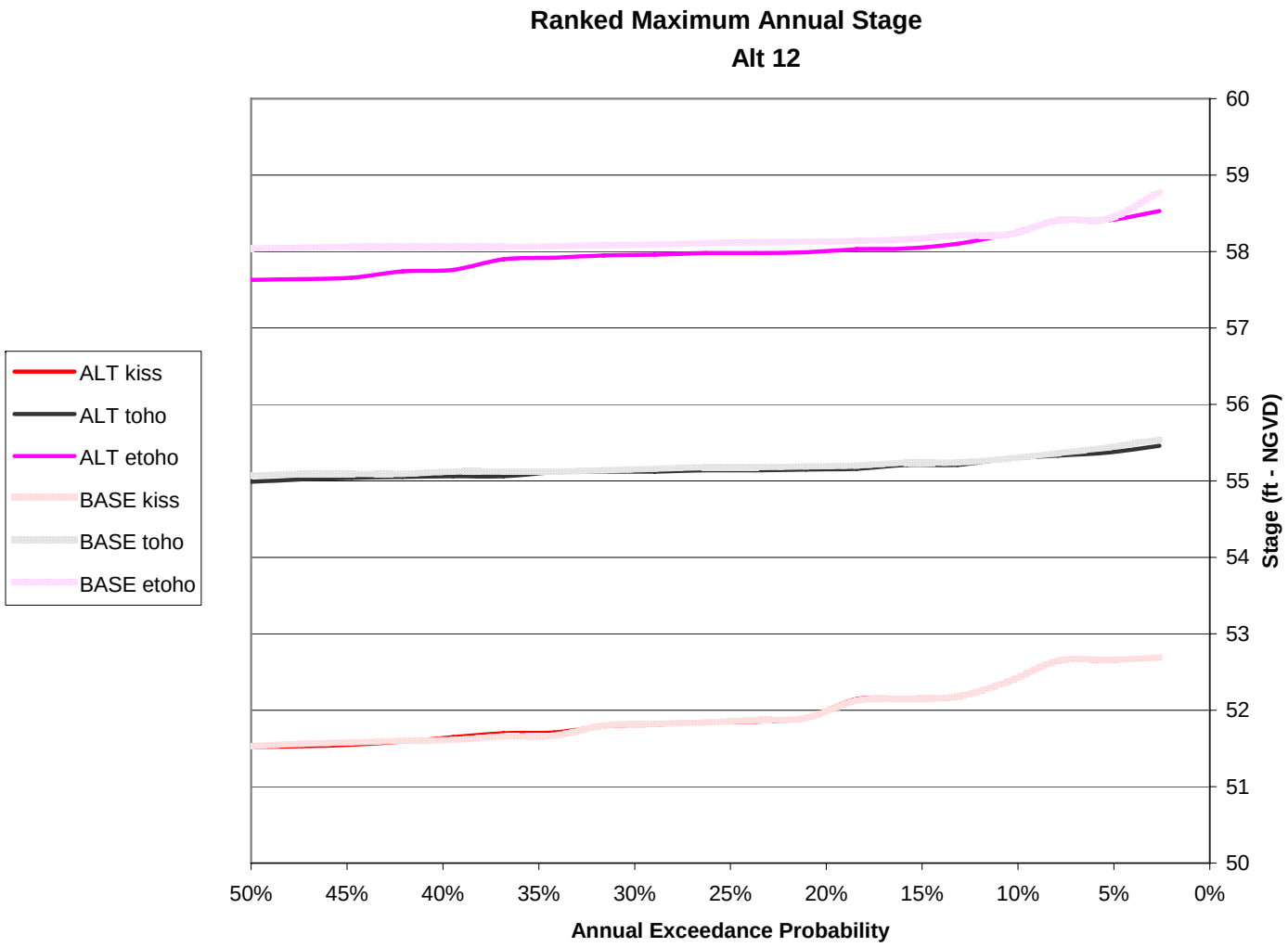


Figure 5d. Ranked Maximum Stage for Lakes Kissimmee, Tohopekaliga and East Lake Tohopekaliga - Alternative 12

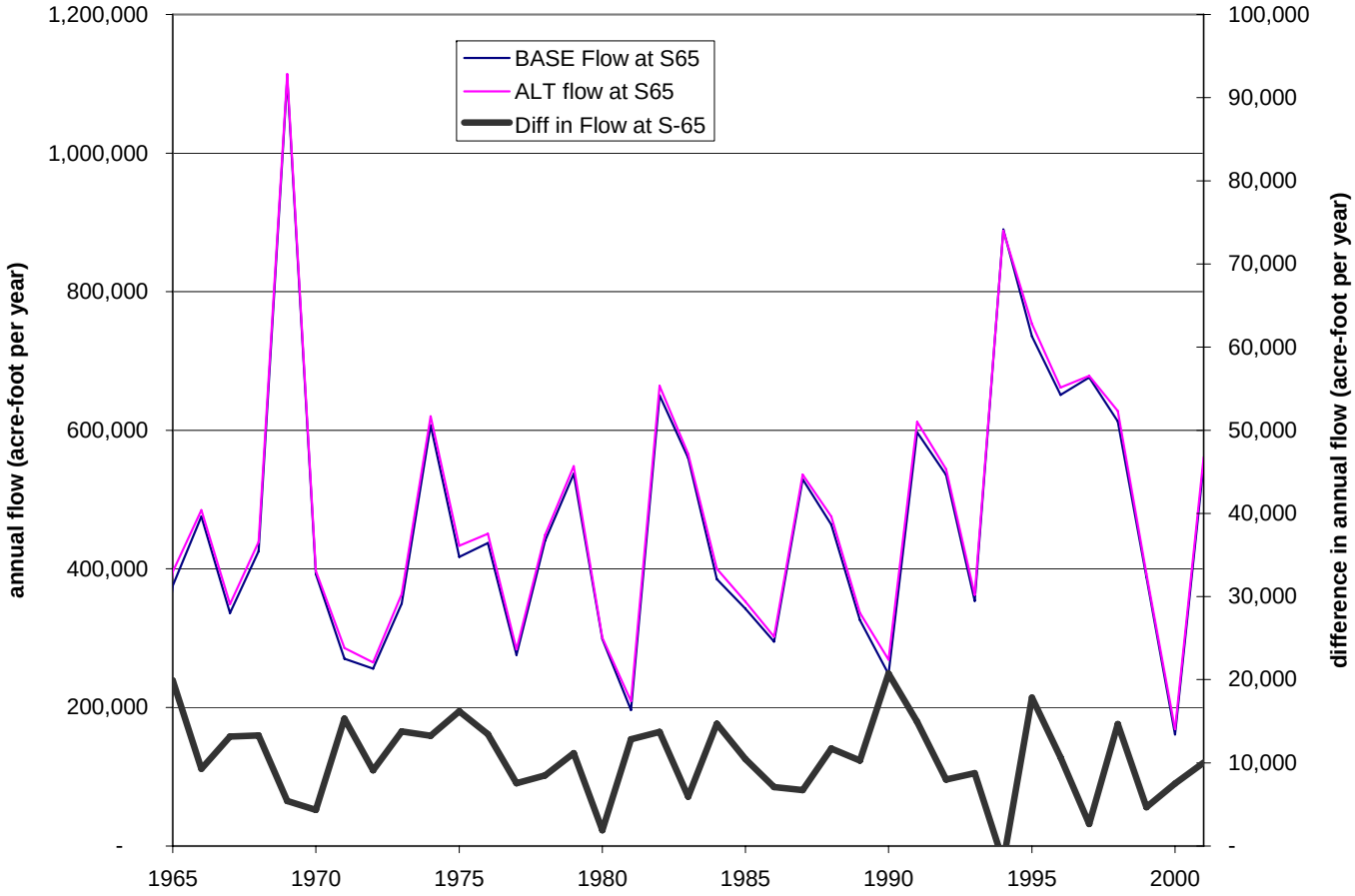


Figure 5e. Ranked S-65 Annual Flows - Alternative 12

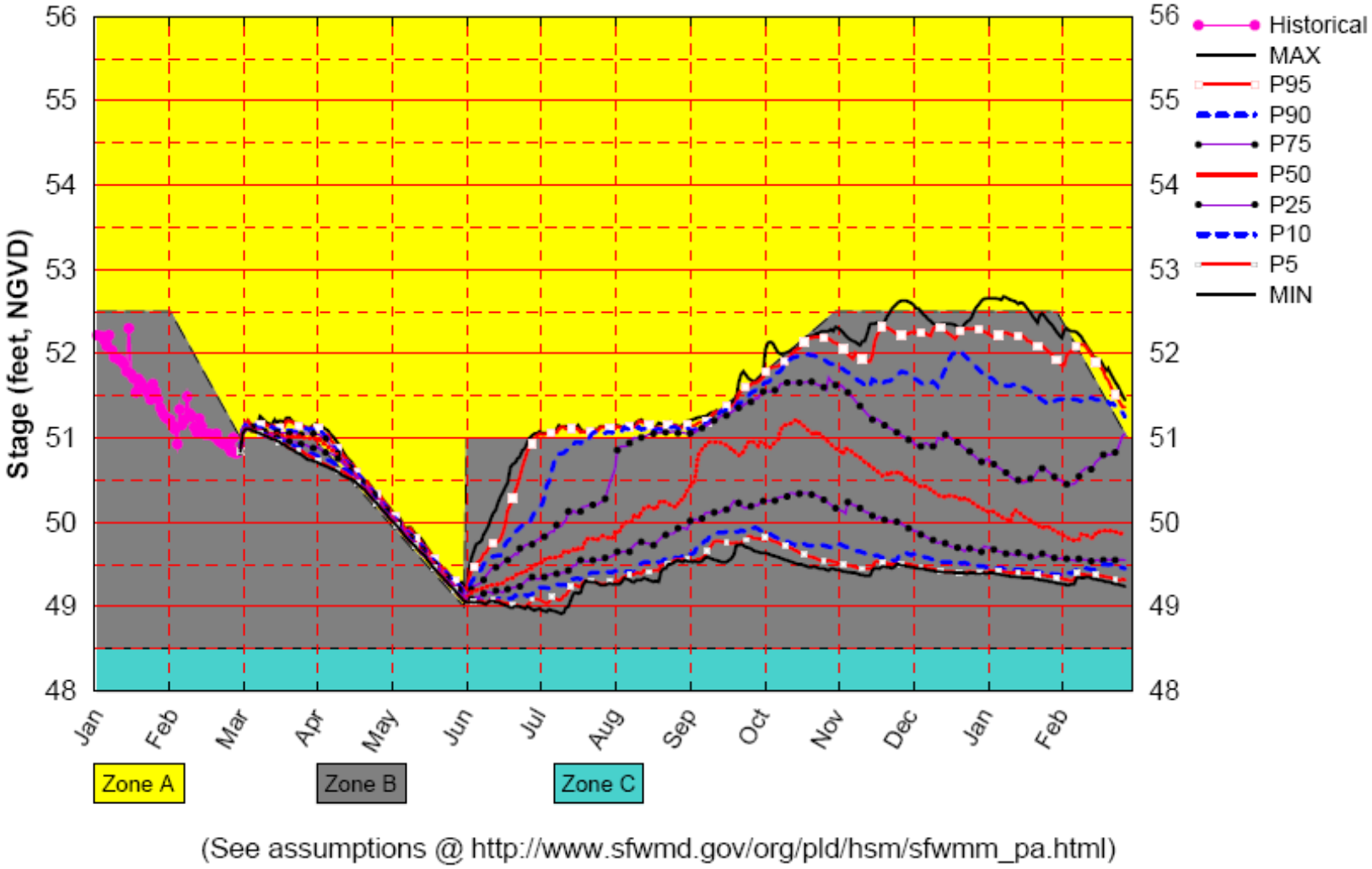
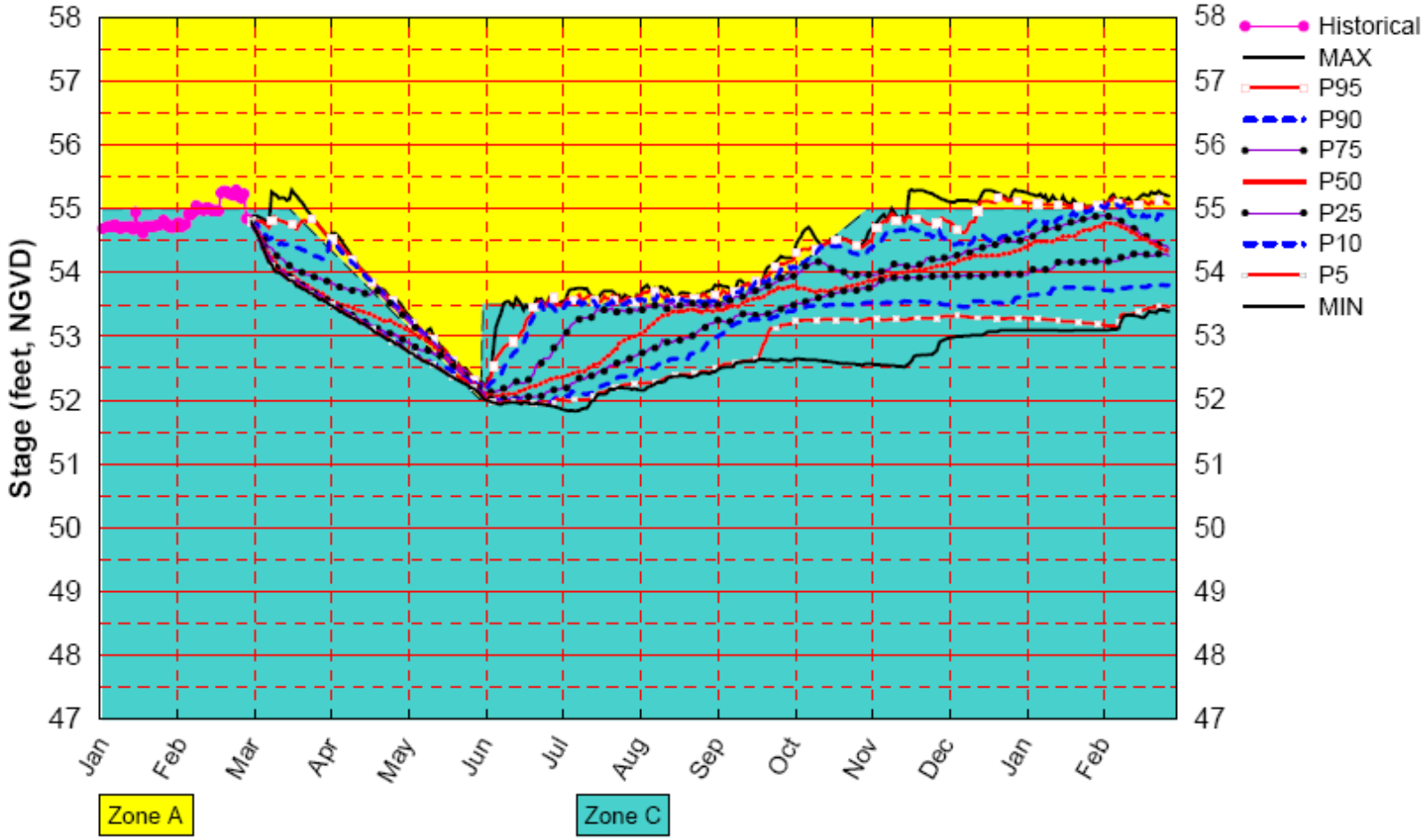
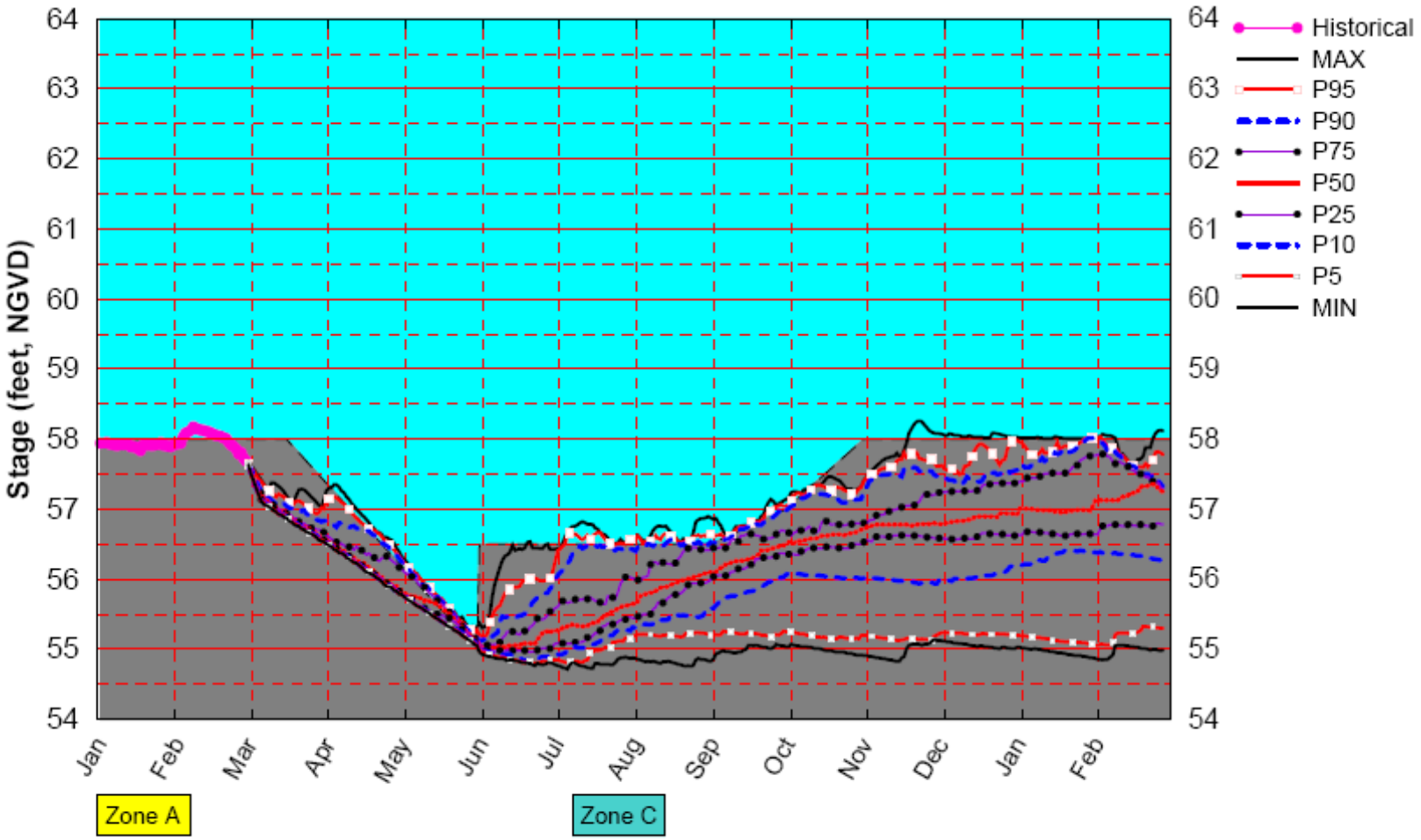


Figure 6a. March Position Analysis for Lake Kissimmee - Alternative 16



(See assumptions @ http://www.sfwmd.gov/org/pld/hsm/sfwmm_pa.html)

Figure 6b. March Position Analysis for Lake Tohopekaliga - Alternative 16



(See assumptions @ http://www.sfwmd.gov/org/pld/hsm/sfwmm_pa.html)

Figure 6c. March Position Analysis for East Lake Tohopekaliga - Alternative 16

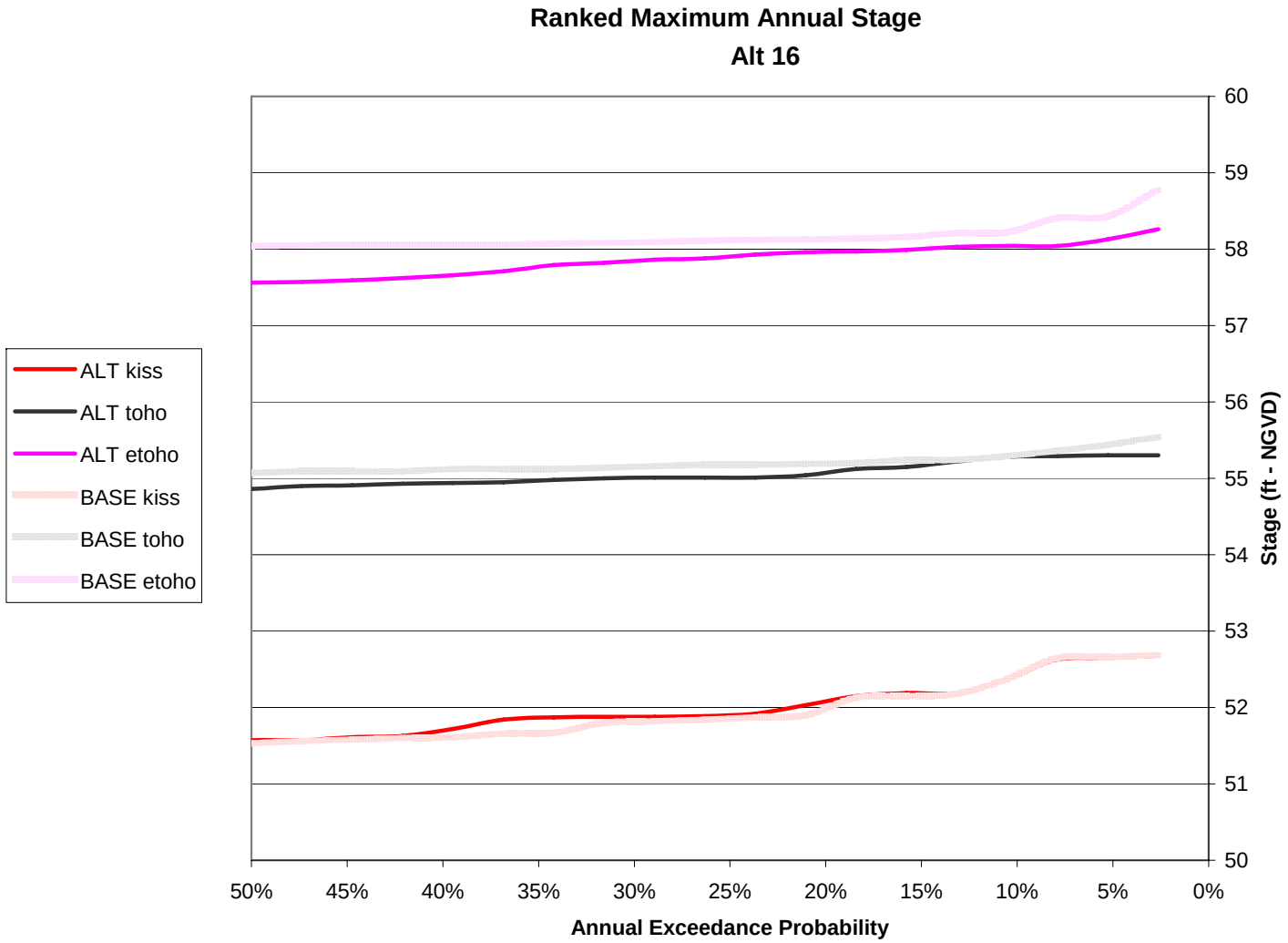


Figure 6d. Ranked Maximum Stage for Lakes Kissimmee, Tohopekaliga and East Lake Tohopekaliga - Alternative 16

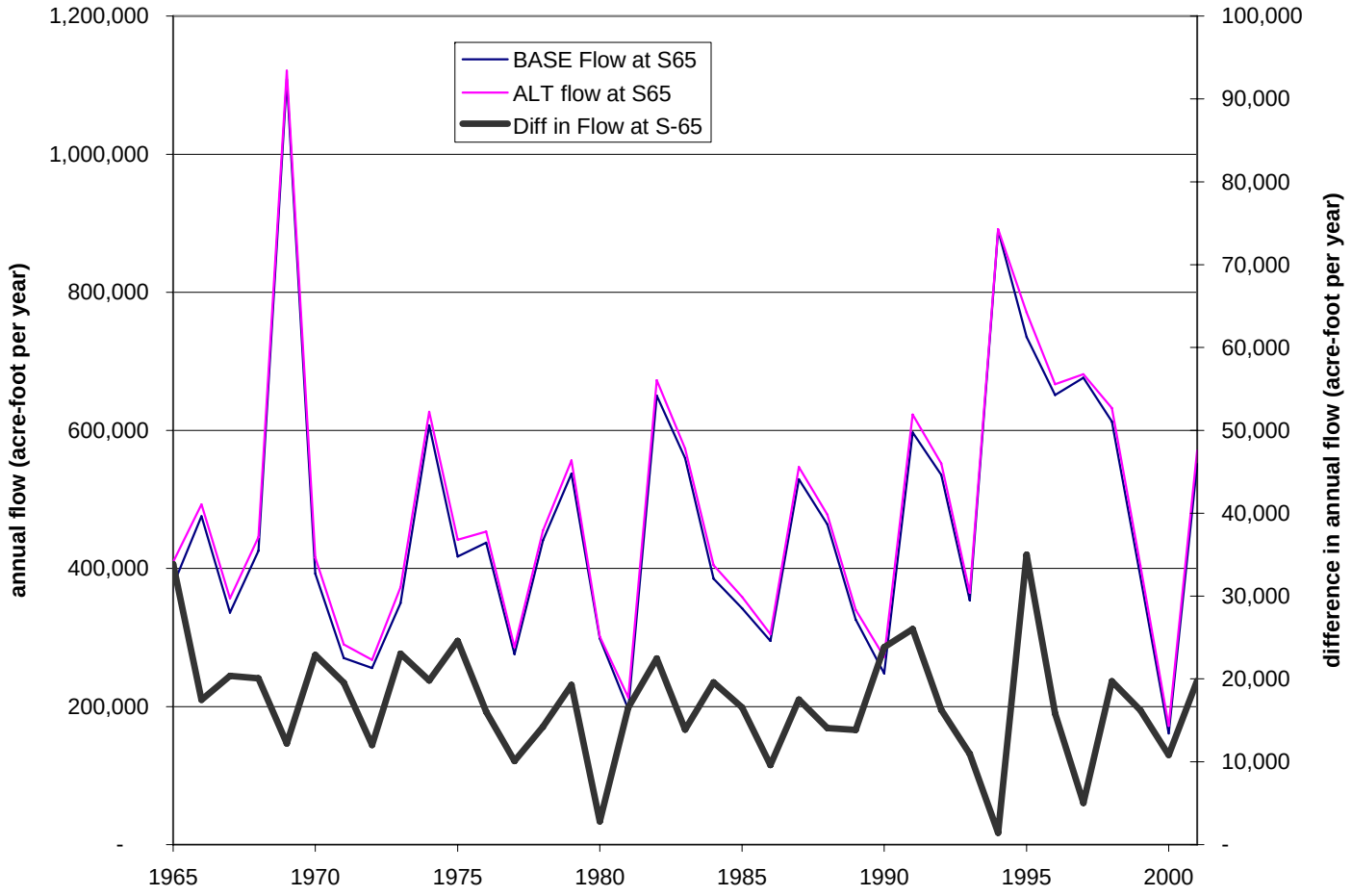


Figure 6e. Ranked S-65 Annual Flows - Alternative 16