

Environmental and Water Supply Opportunities

Spreadsheet Analyses for Alternatives A-J

June 12, 1996

(FINAL)



CALFED
BAY-DELTA
PROGRAM

CALFED Alternatives Analysis

Background

Each of the ten CALFED Bay-Delta alternatives were evaluated for water supply and environmental supply opportunities. Spreadsheet models were developed for eight of them to post-process results derived from State Water Project/Central Valley Project (SWP/CVP) operation simulations previously performed by the modeling branch of the California Department of Water Resource's (DWR's) Planning Division. The previous simulations were performed using the model, DWRSIM.

Standard DWRSIM output was provided for three scenarios:

- Present level of development, existing facilities -- Study 411 (5/8/95)
- Year 2020 level of development, added south Delta improvements -- Study 414.F.B (9/25/95)
- Year 2020 level of development, added SDI and a 1.7 million AF Los Banos Grandes -- Study 416.F.B (8/29/95)

Each of these studies are monthly simulations for the seventy-one year period, 1922 through 1992. Each contains the assumption that the December 15, 1994 Delta standards are in effect and being met by the SWP/CVP. Project demands are met in each of the years in the simulation period to the extent that simulated hydrologic conditions permit. Deficiencies are imposed on SWP and CVP project demands when necessary.

Study 411 was use to analyze the CALFED alternatives containing no new facilities. Study 414 was used to provide a baseline for the analysis of all alternatives containing south Delta improvements (SDI) as an assumption. Study 416 was used to compare results of alternatives that include proposed south of Delta storage facilities.

Key DWRSIM output items that made the spreadsheet modeling process possible included:

- River flows at key locations for the Sacramento, Feather, American, San Joaquin, Stanislaus, and eastside Delta streams,
- Delta flow conditions including total inflow, required outflow, simulated outflow, and simulated X2 position,
- Delta exports for all users including in-basin, North Bay Aqueduct, Contra Costa Canal, and south Delta,
- Reservoir storages for all SWP and CVP reservoirs including separate for San Luis, and
- Excess combined south Delta pumping capacity, and excess capacity in the California Aqueduct from Banks PP down passed Edmunston PP.

Analysis

The analytical process used to provide the preliminary analyses of each of the alternatives for the Phase I CALFED process contains some key assumptions:

- There was to be no reoperation of SWP and CVP upstream regulatory facilities. This is beyond the capability of a spreadsheet post-processing approach. The results of these preliminary assessments will be used to guide further DWRSIM runs which will then be used to make appropriate adjustments to upstream and in-Delta operations while simulating the proposed CALFED alternative's features.
- Use only spill and surplus Delta tributary water to identify water supply opportunities. Operational flexibility to determine the preliminary capabilities of the proposed CALFED physical features was limited to the use of simulated in-stream excess flows and Delta outflows surplus to those required to maintain December 15 Delta standards.
- Target water supply demands were not set in excess of current contracts. The capability of CALFED proposed features intended to provide added water supply opportunities were limited to unmet SWP/CVP demands in below normal, dry, and critically deficient years. (There is a feature in the spreadsheet models to add additional levels of demand should the question arise.)
- Temporary targets were established for environmental supply analyses. If it was not clear as to what the intended purpose of an environmental goal in a given alternative was in terms of quantities of water, flow schedules, or quality objectives, "strawmen" were used to anticipate and test a variety of options in the spreadsheet models. Once clear targets are known the models can be easily modified to test them.

Results

Eight of the ten CALFED alternatives were analyzed for approximate capability to meet environmental and water supply opportunities. No specific analyses were made for Alternatives A and E, but each could be tested with features of the models developed for the other alternatives once a DWRSIM run has been provided which simulates reduce in-basin demands through land fallowing and water conservation and appropriate environmental targets are set.

Table 1 summarizes the results. The preliminary results for Alternatives B, C (two variations), D, F, G, H, I (two variations), and J are show graphically in the tabbed sections that follow. These are only the results of analyses that incorporate the sizes of the facilities as noted on the graphs. Many other runs have been made using other facility size assumptions.

Table 1 includes the average annual increase in water supply and environmental opportunities for each Alternative under the assumptions stated herein. Following Table 1 are Figures 1 through 5 which depict, graphically, the frequency of each Alternative's water supply opportunity capability to meet unmet SWP demands. This is a logical point of comparison since annual simulated SWP deliveries are a byproduct of the DWRSIM runs used for this analysis. Since unmet SWP demand was the water supply opportunity target for each Alternative this provides for a reasonable measure of accomplishment.

The frequency of potential SWP delivery of each Alternatives has been plotted against similar results taken from DWRSIM simulations which included existing facilities and 1) D-1485 Delta standards, and, 2) December 15, 1994 Delta standards as a point of reference. Each of the Alternatives has been grouped according to water supply opportunity potential as follows:

- Figure 1 -- Alternatives B and D.
- Figure 2 -- Alternatives C and C1.
- Figure 3 -- Alternatives F and G.
- Figure 4 -- Alternatives H and I-1.
- Figure 5 -- Alternative J.

Similar frequency graphs depicting environmental supply opportunities, expressed as added Delta outflow, for each Alternative are included with the tabbed sections that follow.

Note

All of the spreadsheet models were developed to easily test a range of reservoir and conveyance sizes for costing purposes. Also the models are set up to evaluate a wide range of reoperation of Delta pumps as well. Once specific environmental targets are known the reoperation potential of the south Delta pumps can be quickly determined.

Table 1

CALFED Alternatives -- B, C, D, F, G, H, I and J
Spreadsheet Modeling Results

Alternative	Physical Features			Environmental Supply Opportunities		Water Supply Opportunities TAF/YR	Total New Water TAF/YR	Reoperation Potential TAF/YR
				Delta Outflow TAF/YR	Vernalis Flow Enhancement TAF/YR			
B	Storage	North (TAF)	1000	198		55	517	Note ⁵
		South (TAF)	1000			197 ¹		
	Groundwater	North (TAF)	500	41		26		
		South (TAF)	350					
Conveyance	SDI							
C-1	Storage	North (TAF)	1000	199		53	642	
		South (TAF)	1000			321 ¹		
	Groundwater	North (TAF)	500	41		28		
		South (TAF)	350					
Conveyance	Isolated	7000 CFS						
C-2	Storage	North (TAF)	1000	201		52	695	
		South (TAF)	1000			186 ¹		
	Groundwater	North (TAF)	500	41		25		
		South (TAF)	350					
Conveyance	Isolated	7000 CFS						
D	Storage	North (TAF)	None			235 ¹	390	
		South (TAF)	1500					
	Groundwater	North (TAF)	500	93		22		
		South (TAF)	350					
Conveyance	Through Delta 15,000 CFS							
F	Storage	North (TAF)	None	186		96	433	
		South (TAF)	None					
		In-Delta (TAF)	400					
	Groundwater	North (TAF)	500	93		58		
South (TAF)		350						
Conveyance	Through Delta							
G	Storage	North (TAF)	None	74			405	
		South (TAF)	None					
		Delta (TAF)	100					
	Groundwater	North (TAF)	500	93	88	88		
South (TAF)		350						
Conveyance	Isolated	7000 CFS			62			
H	Storage	North (TAF)	None	198		196	551	
		South (TAF)	None					
		Chain of Lakes (600 TAF)						
	Groundwater	North (TAF)	500	93		64		
South (TAF)		350						
Conveyance	Chain of Lakes							
I ⁶ (Shasta & Oroville Spills to West Storage -- No Delta Pumps)	Storage	North (TAF)	6000				-2626 ⁴	
		South (TAF)	None					
	Groundwater	North (TAF)	500					
		South (TAF)	350					
Conveyance	Sac Valley	15,000 CFS						
I-1 ⁶ (Shasta only to West Storage. Delta Isolated Facility to Pumps.)	Storage	North (TAF)	3000	235		139	591	
		South (TAF)	None					
	Groundwater	North (TAF)	500	48		80		
		South (TAF)	350					
Conveyance	Isolated	7000 CFS			89			
J	Storage	North (TAF)	None				273	
		South (TAF)	None					
	Groundwater	North (TAF)	500	93		92		
		South (TAF)	350					
Conveyance	Isolated	15,000 CFS			88			

¹ All south of Delta storage facilities were assessed for water supply potential using unmet SWP/CVP demands as targets. A portion of this new water could also go for environmental purposes.

² Size and location chosen based on MWD proposed storage facility at Domingoni.

³ Alternative G was evaluated assuming water banked in New Melones only. Amount would increase slightly using Don Pedro as well.

⁴ Without some south Delta pumping, this is the estimated forgone SWP and CVP pumping. Delta outflow would increase accordingly.

⁵ All of the alternatives have reoperation potential to move Delta pumping from fish critical months to non-critical months. This feature would vary greatly with the desired shifting. The spreadsheet models are set up to accommodate this analysis once definitive targets are known.

⁶ Both Alternative I and I-1 provide for service to Glenn Colusa ID, Tehama Colusa, and Corning Canals directly from Shasta.

Frequency Diagrams
Water Supply Opportunities

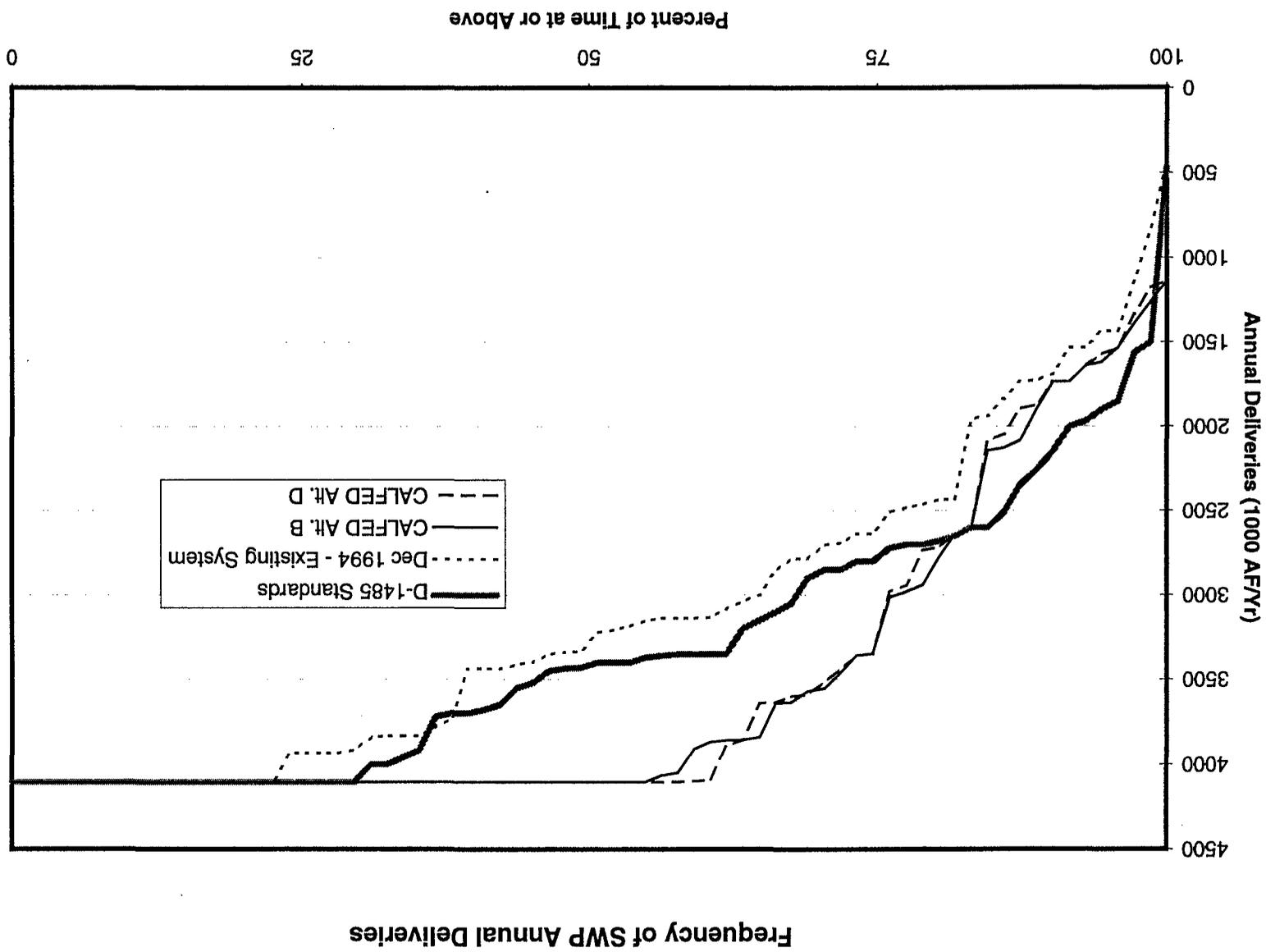


FIGURE 1

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B-005636

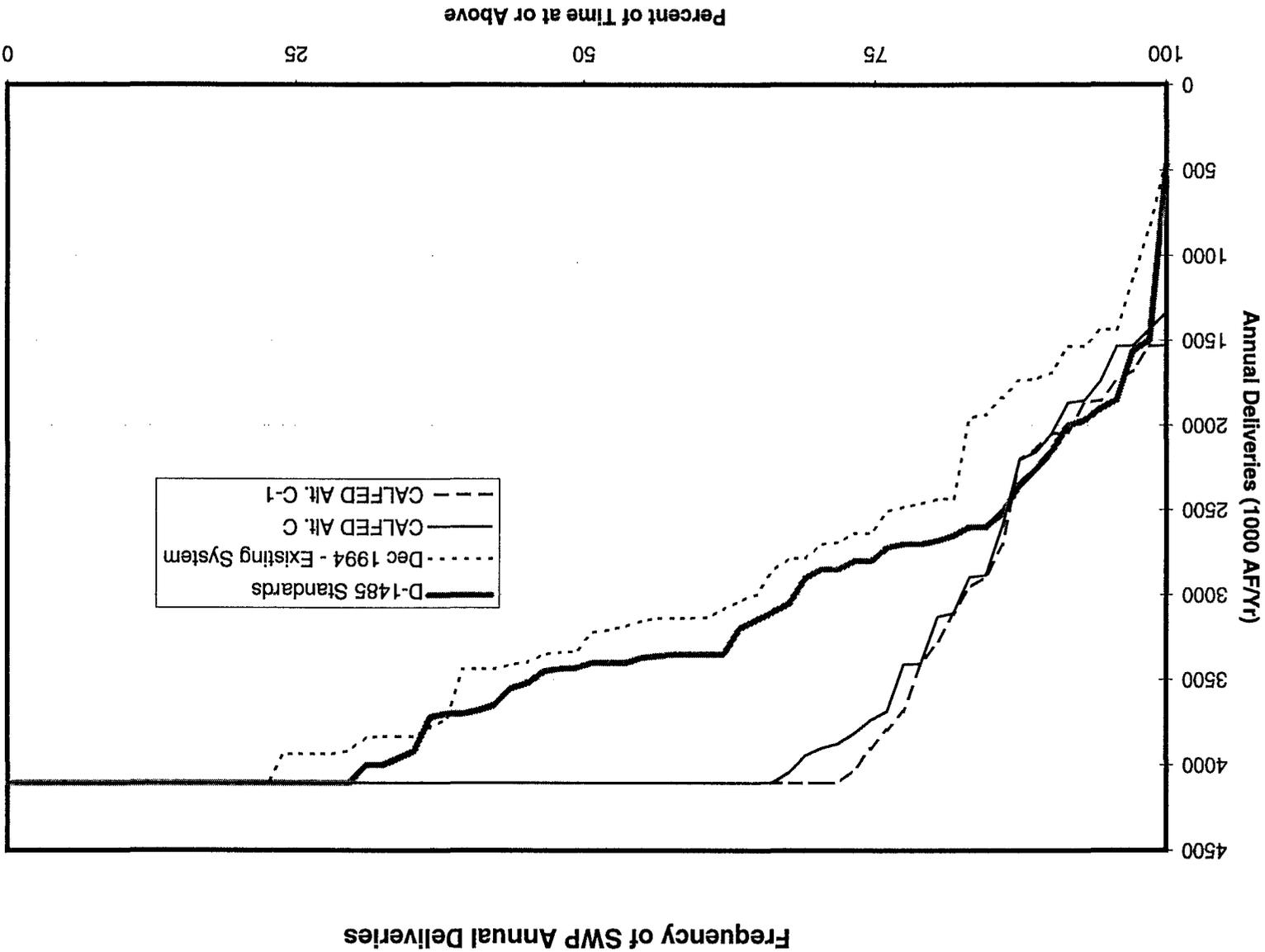


FIGURE 2

B-005637

FIGURE 3

Frequency of SWP Annual Deliveries

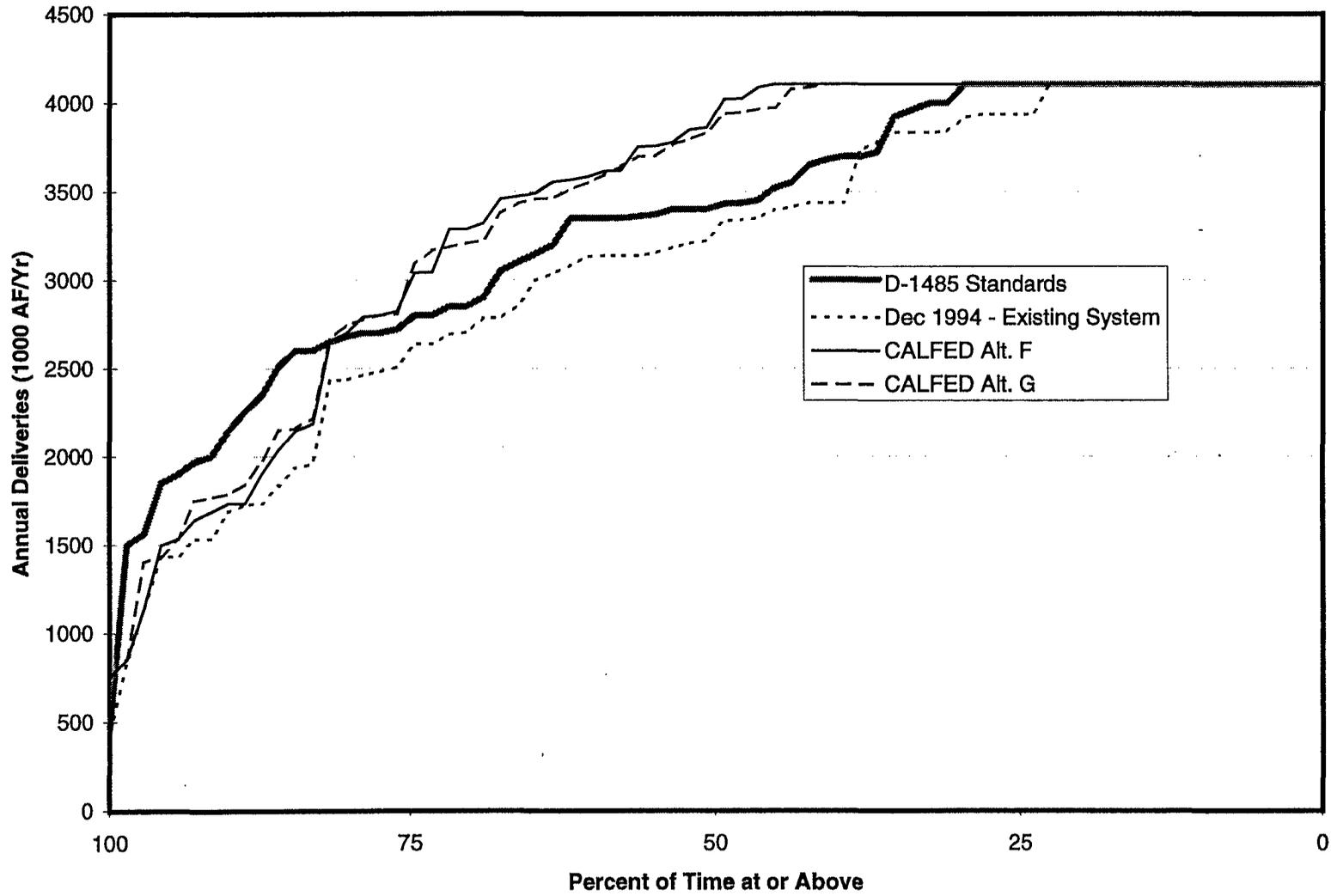
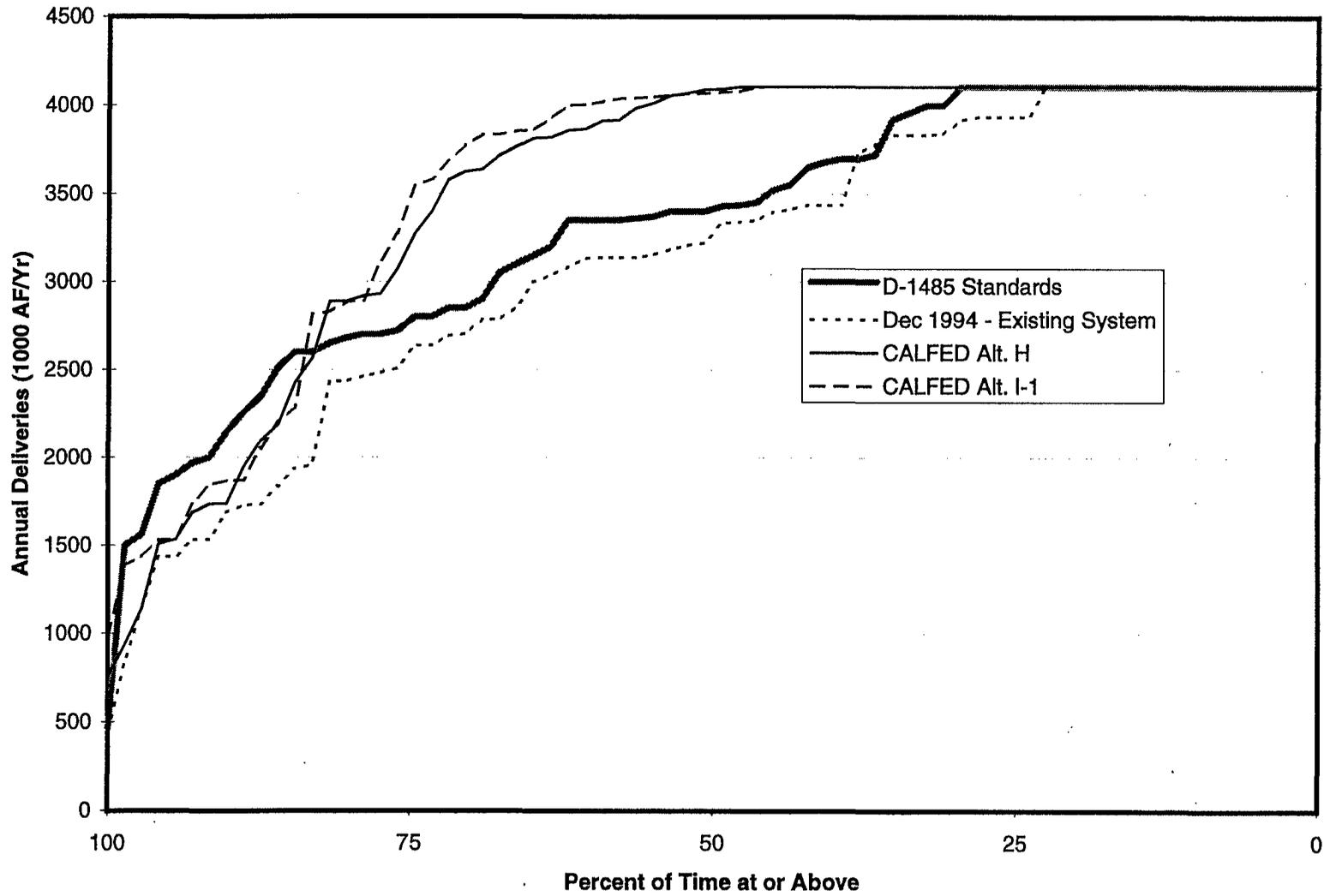
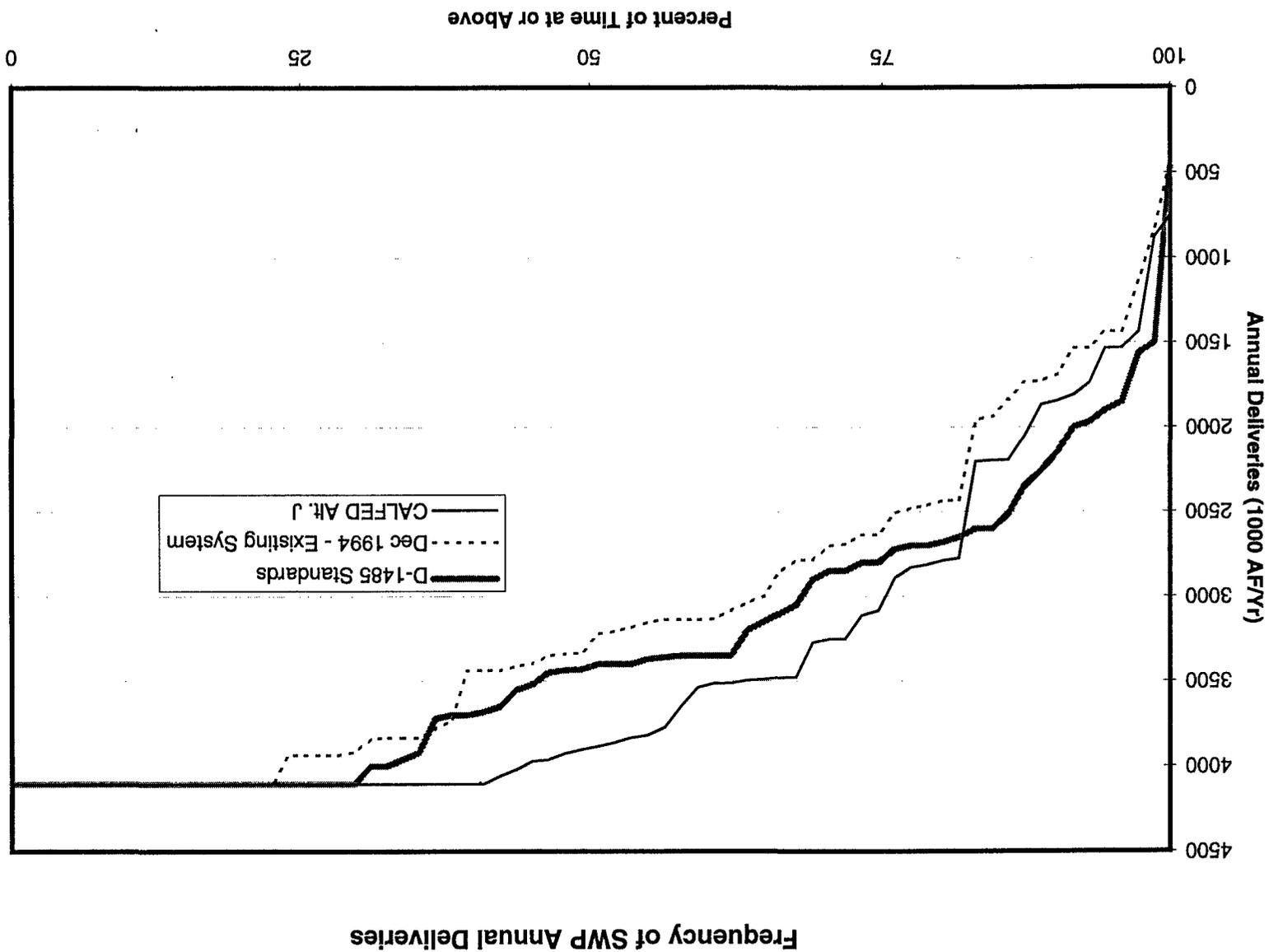


FIGURE 4

Frequency of SWP Annual Deliveries



B-005639



Frequency of SWP Annual Deliveries

FIGURE 5

B-005640

B-005640



No detailed spreadsheet analysis was done for this alternative. To be done at a later date using other spreadsheet models once specific enviromental goals have been set for this alternative.

Alternative B



B - 0 0 5 6 4 3

B-005643

Alternative B

Facilities

North of Delta Storage:	1,000,000 Acre/Feet
South of Delta Storage:	1,000,000 Acre/Feet
In-Delta Storage:	None
Delta Conveyance:	Through Delta.

Additional Criteria Assumptions for New Water Supply Opportunities

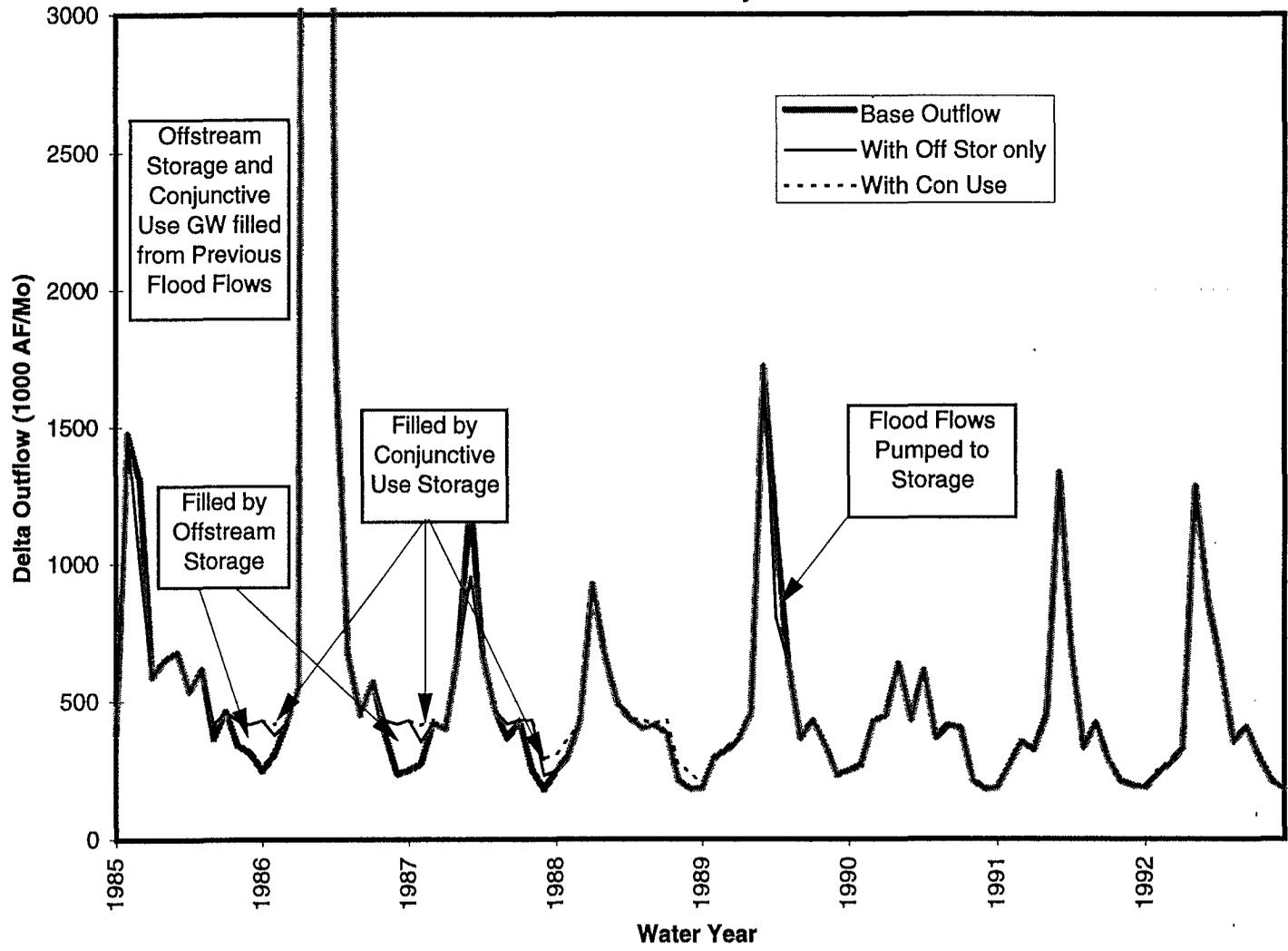
Water Supply Targets: To offset deficits in CVP/SWP demands as determined by base DWRSIM operation simulations to the extent possible. Demands are met on delivery patterns provided by DWR and the Bureau of Reclamation.

Environmental Targets: Provide for no less than 7000 CFS Delta outflow to the extent possible.

Simulation Assumptions

- Use Sacramento River spill water below Keswick to fill north of Delta storage. Concurrent Delta surplus conditions, timing and quantity, are tested to insure availability of spill as storable water.
- Operate new north of Delta offstream storage to share water development potential on a 50/50 percent basis between environmental and supply opportunities.
- Operate north of Delta groundwater storage in a conjunctive use mode for environmental opportunities. (To enhance Delta outflow.)
- Operate south of Delta storage for water supply opportunities for demonstration purposes. Modules allow for reoperation for environmental targets as well.
- Operate south of Delta groundwater storage in a water banking mode for water supply opportunities. (To meet demand deficits.)
- Uses DWRSIM 414 output to allow simulation of south Delta improvement conditions.
- Pumped Delta surpluses are tested for Export/Inflow ratio to not violate December 15 criteria.
- Assumes full permitted use of Banks PP only when south Delta inflow conditions (flood flows) allow.

Total Modeled Delta Outflow -- 1985 to 1992 Supplemented by North of Delta Offstream Storage and Conjunctive Use



Alternative B

Offstream Storage:
North: 1000 TAF
South:
Res. A: 1000 TAF
Res. B: None

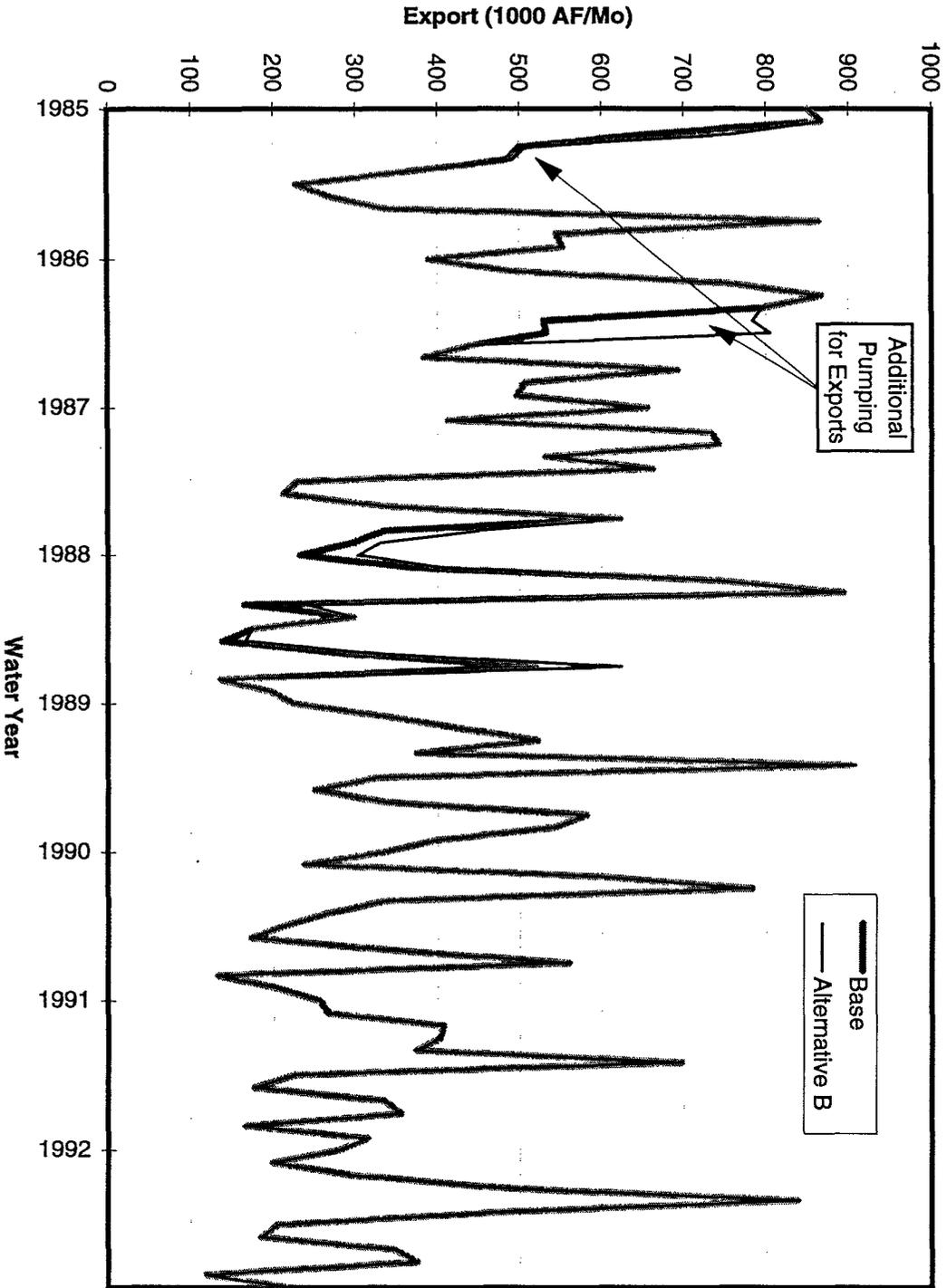
Delta Conveyance:
South Delta flood flows=Max. Permit pumping.

Ecosystem Demand:
Delta Out =7000 CFS

Conjunctive Use:
North: 500 TAF
South: 350 TAF

B - 0 0 5 6 4 5

Total Modeled South Delta Export -- 1985 to 1992



Alternative B

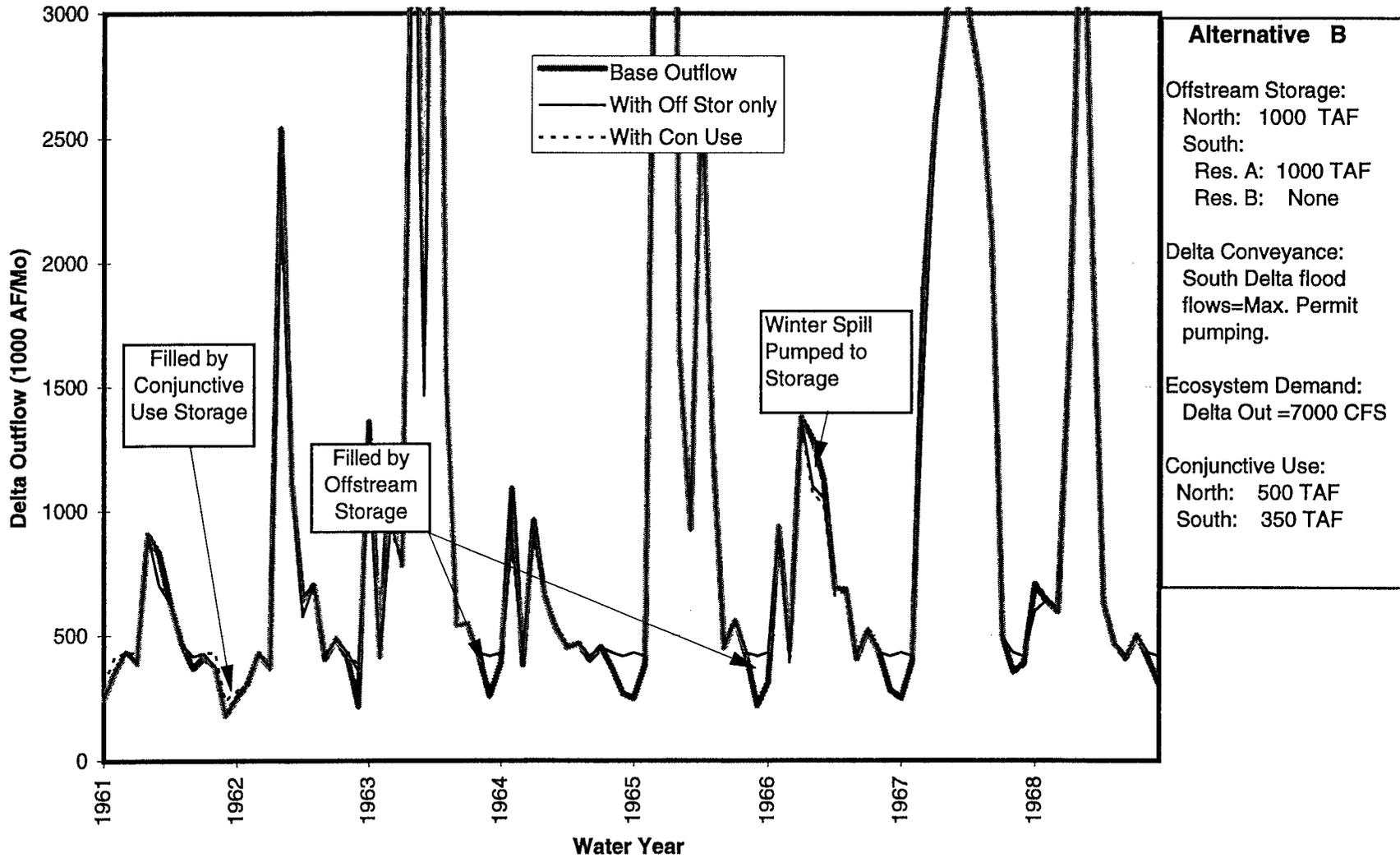
Offstream Storage:
 North: 1000 TAF
 South:
 Res. A: 1000 TAF
 Res. B: None

Delta Conveyance:
 South Delta flood flows=Max. Permit pumping.

Ecosystem Demand:
 Delta Out =7000 CFS

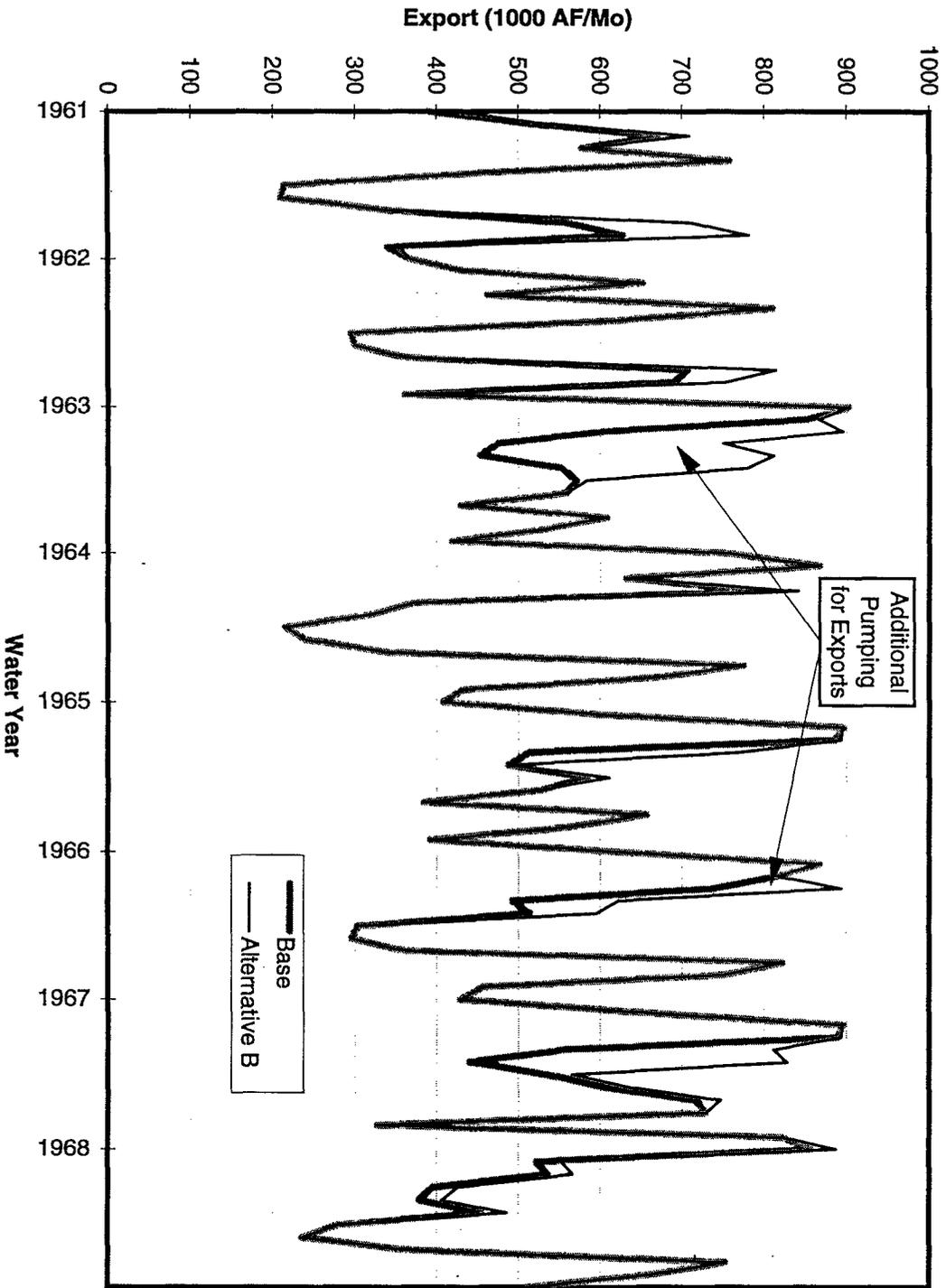
Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

Total Modeled Delta Outflow -- 1961 to 1968 Supplemented by North of Delta Offstream Storage and Conjunctive Use



B-005647

Total Modeled South Delta Export -- 1961 to 1968



— Base
 - - - Alternative B

Additional Pumping for Exports

Alternative B

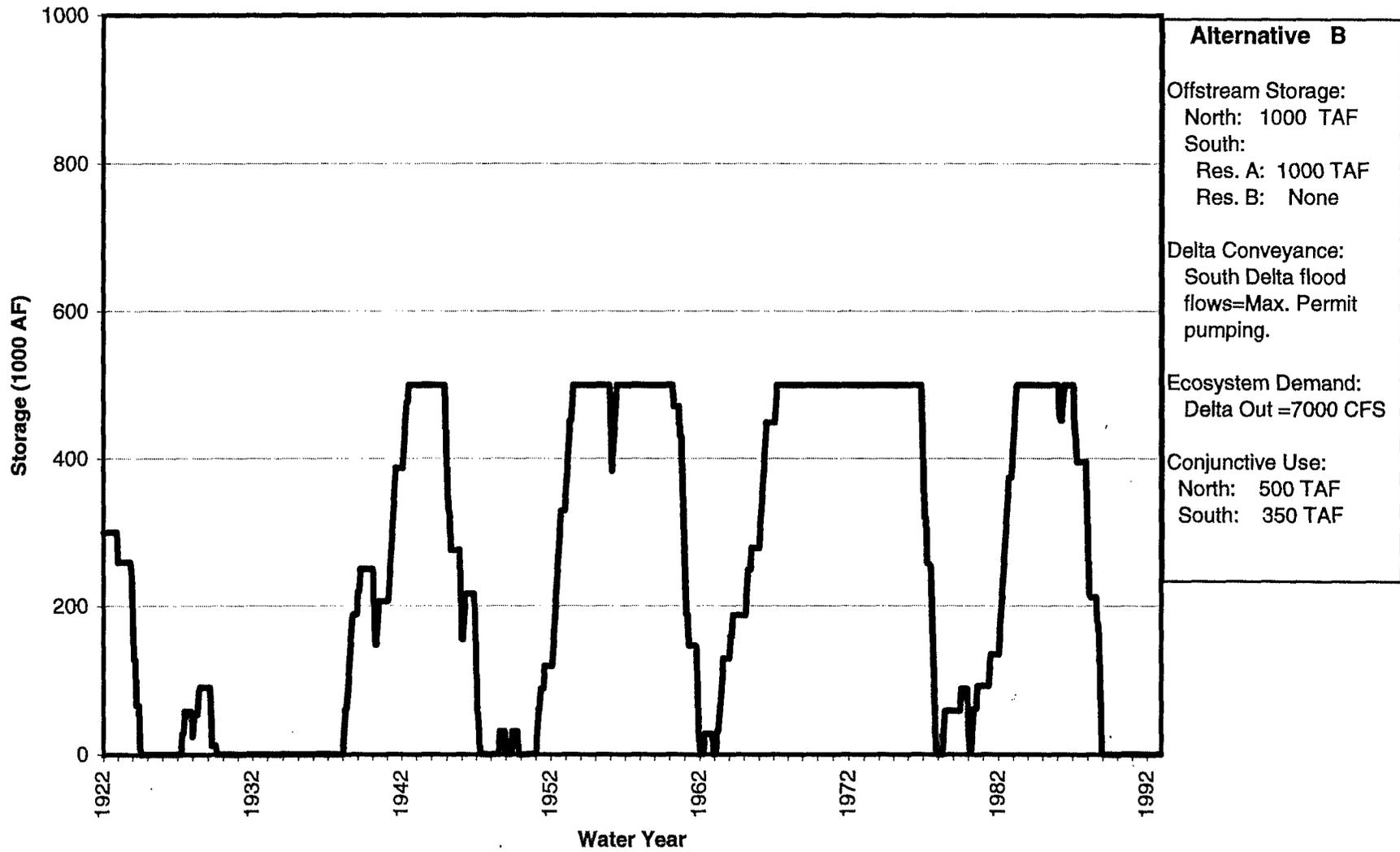
Offstream Storage:
 North: 1000 TAF
 South:
 Res. A: 1000 TAF
 Res. B: None

Delta Conveyance:
 South Delta flood flows=Max. Permit pumping.

Ecosystem Demand:
 Delta Out = 7000 CFS

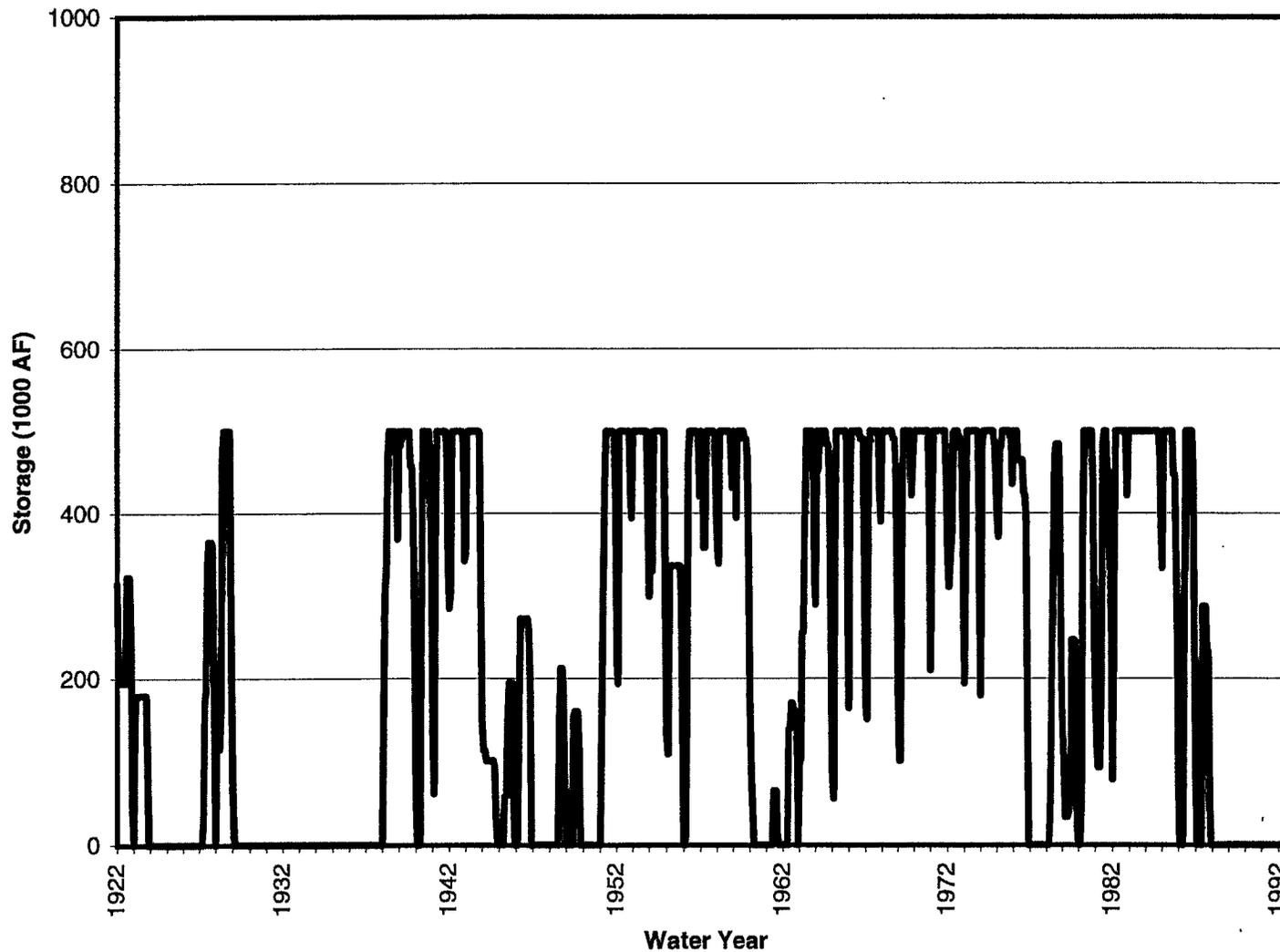
Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

North of Delta Groundwater Operation (Managed for Delta Outlow)



B-005649

North of Delta Storage Managed for Environmental Needs (Outflow)



Alternative B

Offstream Storage:
North: 1000 TAF
South:
Res. A: 1000 TAF
Res. B: None

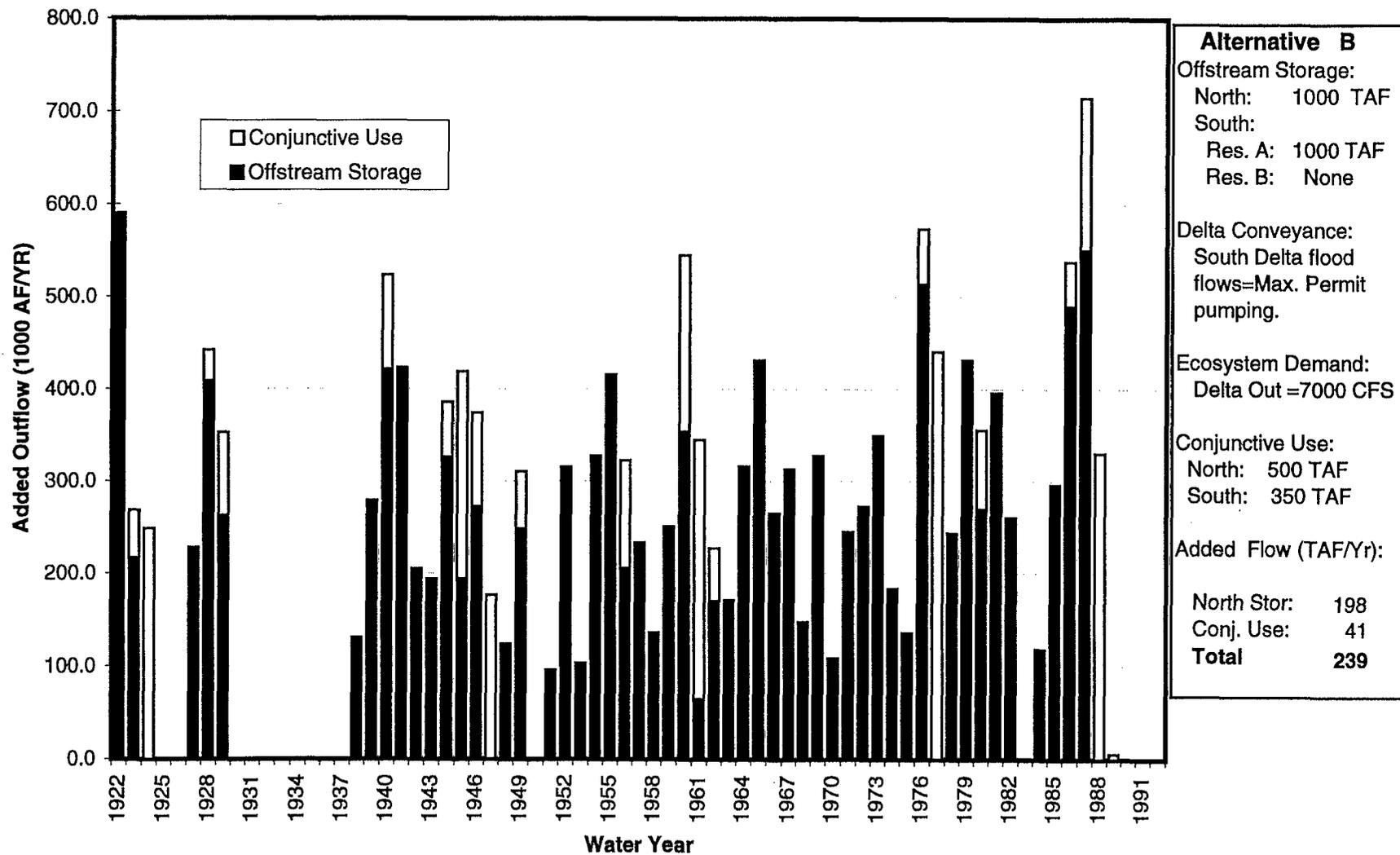
Delta Conveyance:
South Delta flood flows=Max. Permit pumping.

Ecosystem Demand:
Delta Out = 7000 CFS

Conjunctive Use:
North: 500 TAF
South: 350 TAF

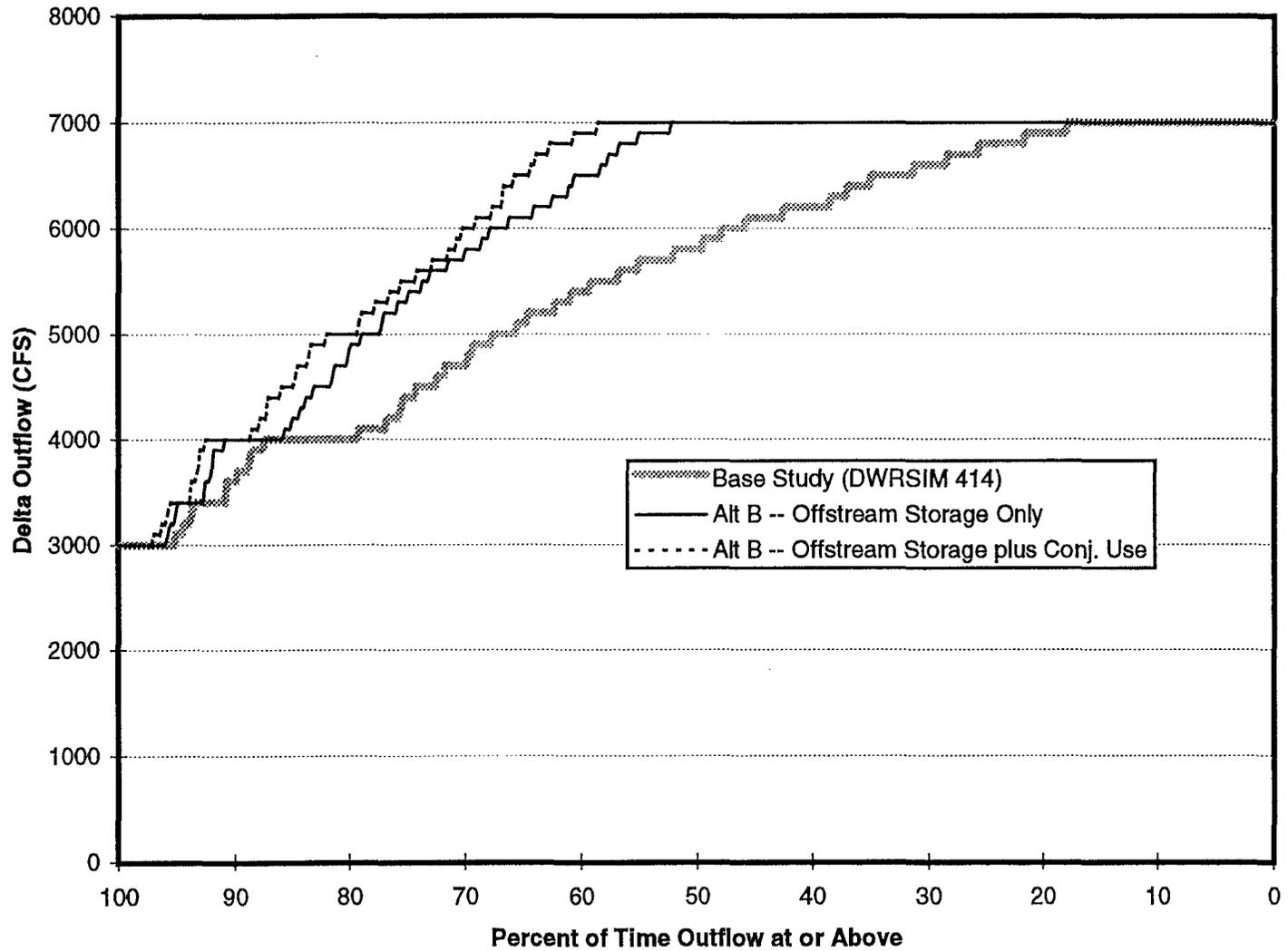
B-005650

Supplemental Delta Outflow from New North Storage and Conjunctive Use



B-005651

Frequency of Delta Outflow -- Target = 7000 CFS April through September



Alternative B

Offstream Storage:
North: 1000 TAF
South:
Res. A: 1000 TAF
Res. B: None

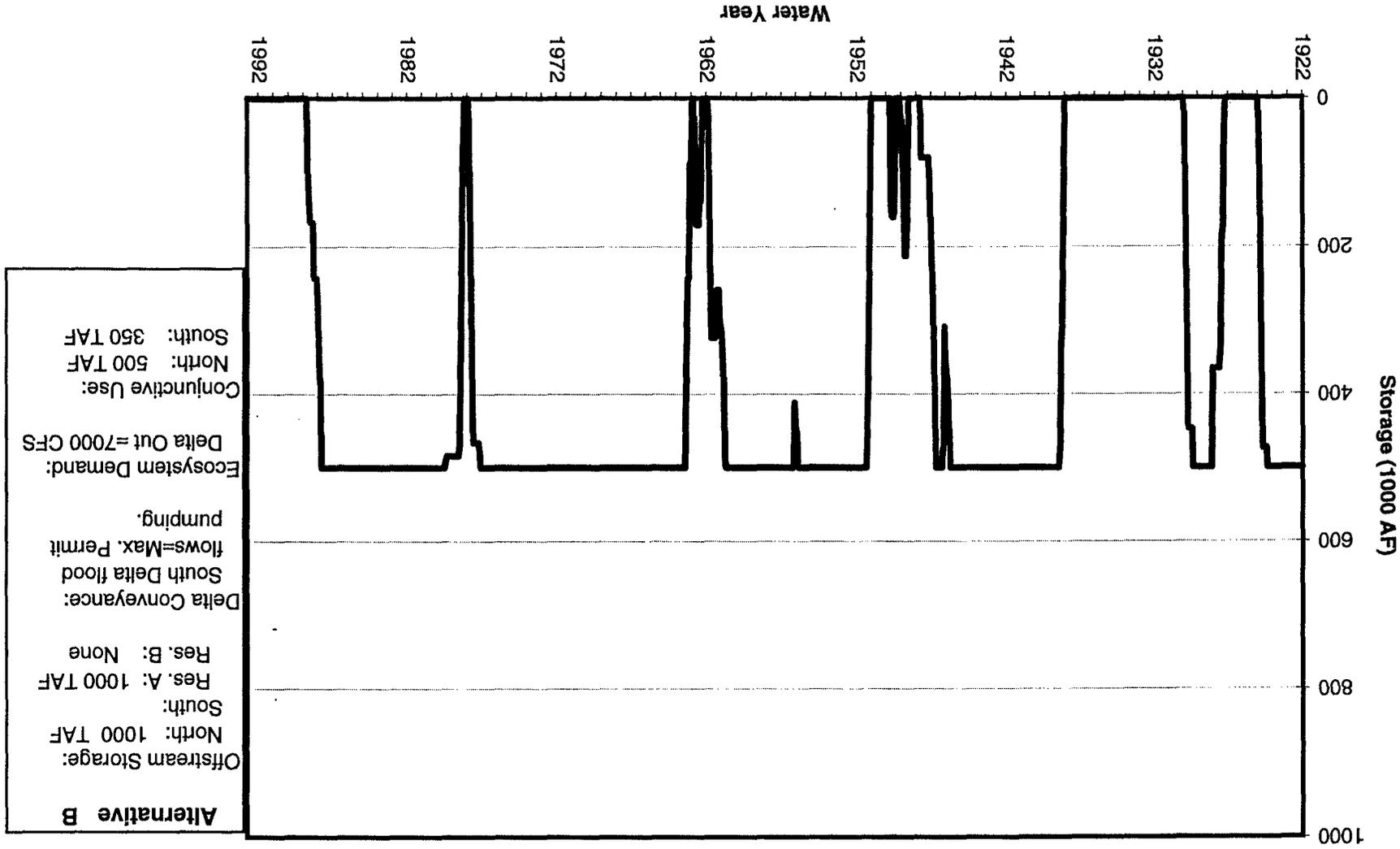
Delta Conveyance:
South Delta flood flows=Max. Permit pumping.

Ecosystem Demand:
Delta Out =7000 CFS

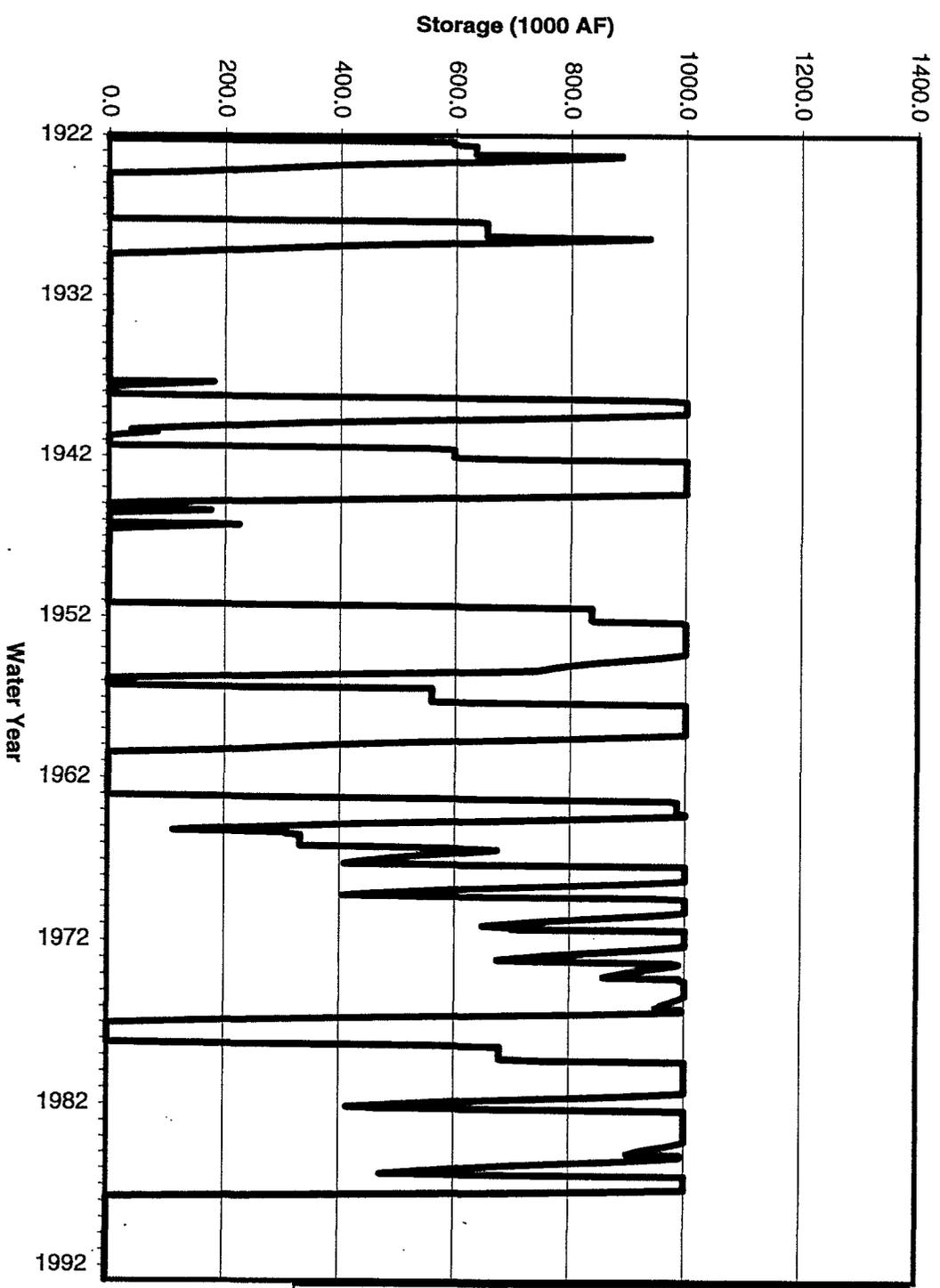
Conjunctive Use:
North: 500 TAF
South: 350 TAF

B-005652

North of Delta Storage Managed for Water Supply Opportunities
(Exports)



Offstream South of Delta Storage Reservoir A



Alternative B

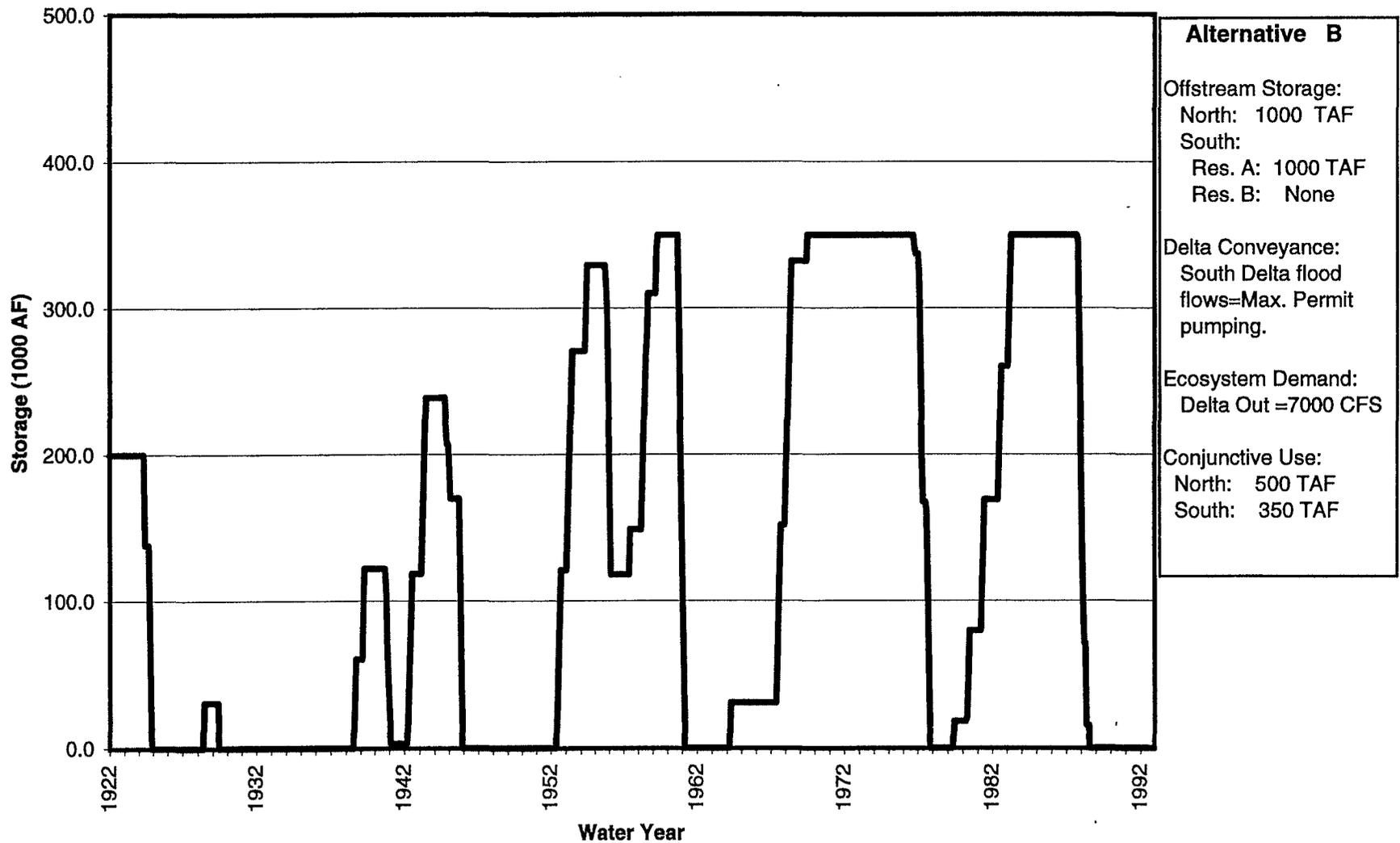
Offstream Storage:
 North: 1000 TAF
 South:
 Res. A: 1000 TAF
 Res. B: None

Delta Conveyance:
 South Delta flood flows=Max. Permit pumping.

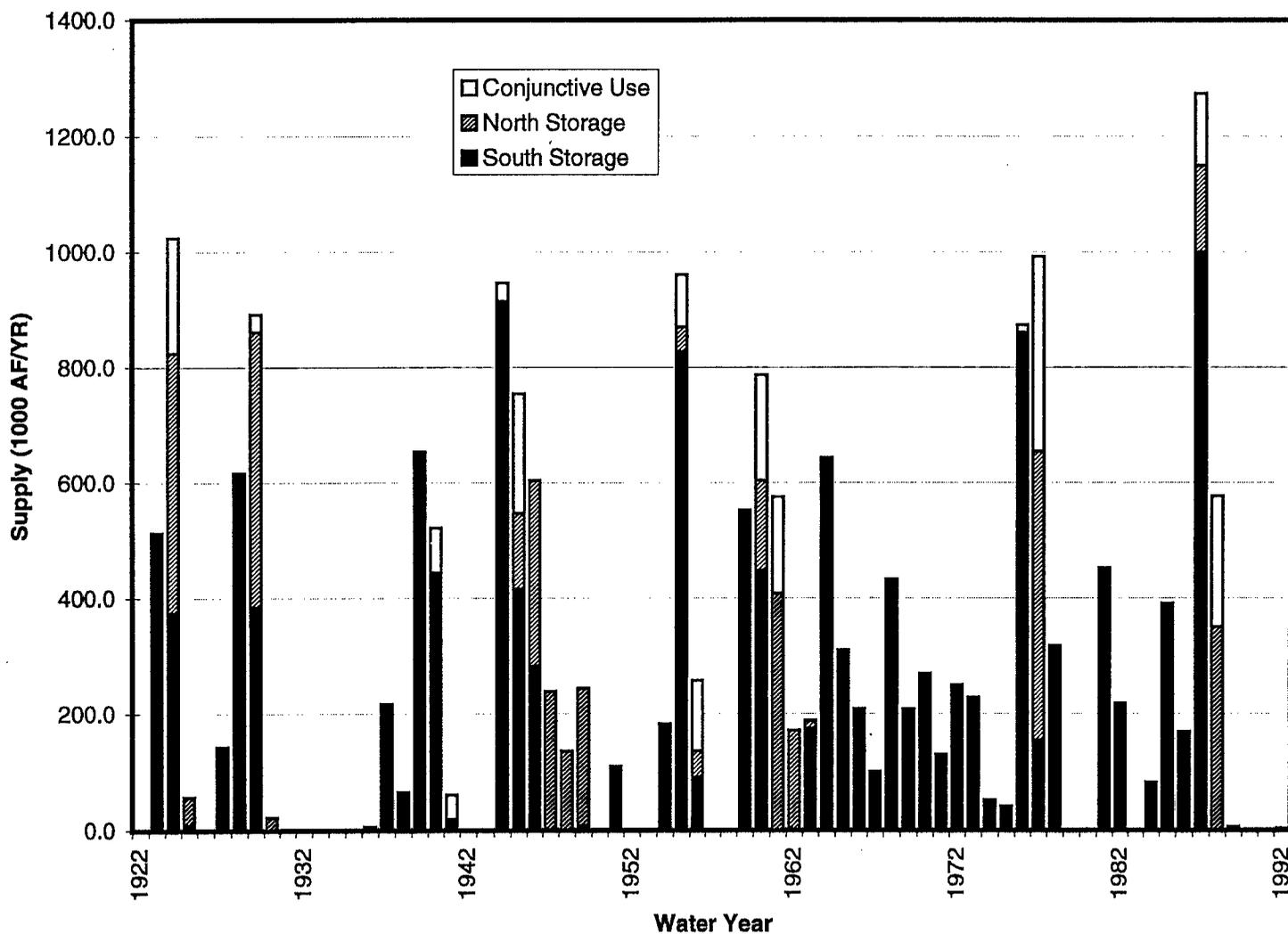
Ecosystem Demand:
 Delta Out = 7000 CFS

Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

South of Delta Groundwater Storage (Managed for Water Supply)



Water Supply Opportunities from North and South Offstream Storage plus Conjunctive Use



Alternative B
 Offstream Storage:
 North: 1000 TAF
 South:
 Res. A: 1000 TAF
 Res. B: (None)

Delta Conveyance:
 South Delta flood flows=Max. Permit pumping.

Ecosystem Demand:
 Delta Out =7000 CFS

Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

Water Supp. (TAF/YR):
 South Stor.: 197
 North Stor.: 55
 So. Conj. Use: 26
Total 278

B-005656

Alternative C



There are two sets of graphs in this section.

Alternative C was evaluated from two standpoints; C) a single offstream storage south of the Delta, and, C-1) two offstream storage sites located south of the Delta but operated jointly

Alternative C An assumed 1 million AF south of Delta storage facility in the San Joaquin Valley located between San Luis Reservoir and Edmunston Pumping Plant.

Alternative C-1 The same as above but with a second 800,000 AF facility south of the Tehachapi Mountains. The southernmost reservoir was given first shot at the Delta surplus flows limited by the conveyance capacity of the Edmunston Pumping Plant to simulate the new proposed MWD reservoir.

Alternative C

Facilities

North of Delta Storage:	1,000,000 Acre/Feet
South of Delta Storage:	1,000,000 Acre/Feet
In-Delta Storage:	None
Delta Conveyance:	Isolated facility at 7000 CFS.

Additional Criteria Assumptions for New Water Supply Opportunities

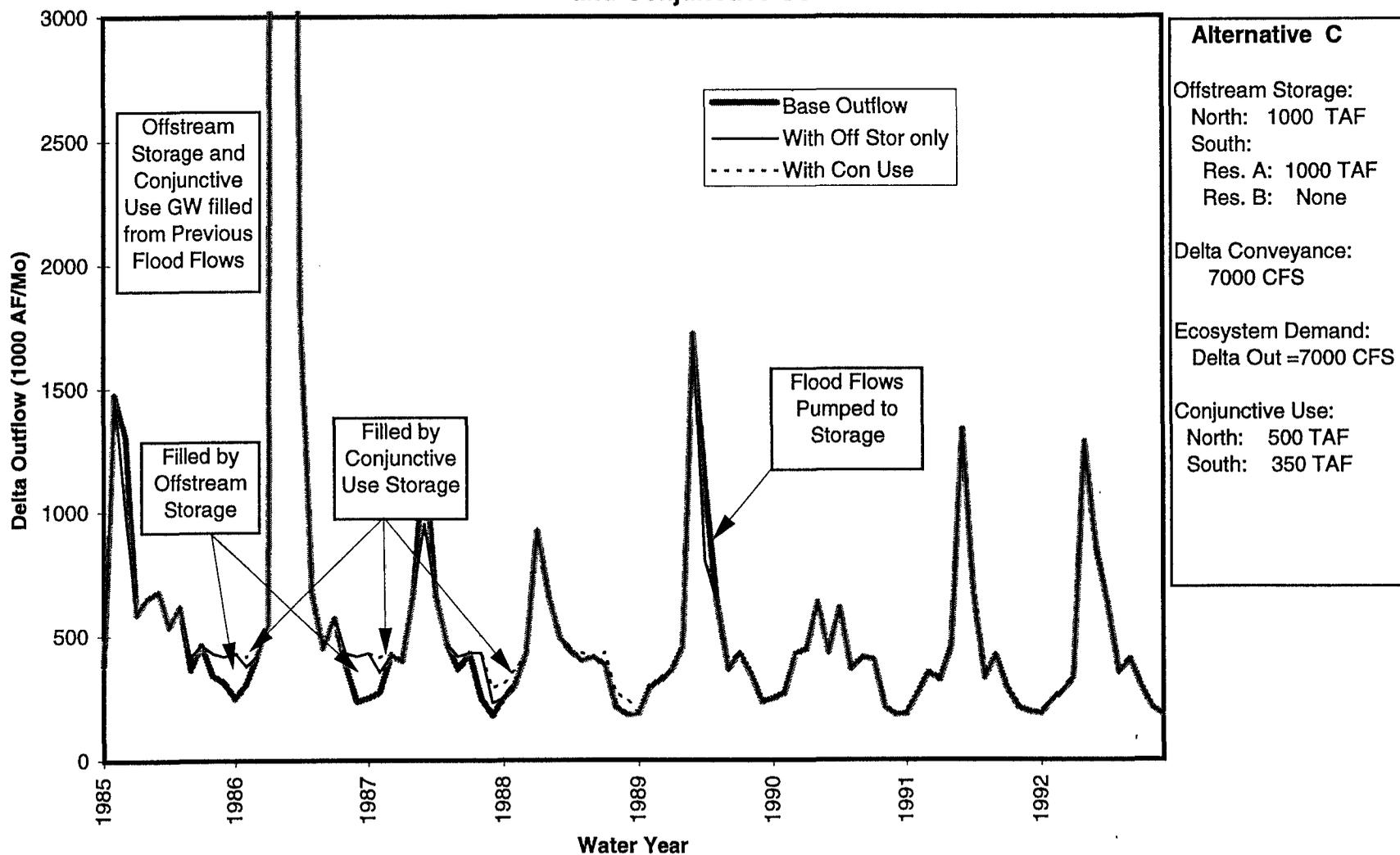
Water Supply Targets: To offset deficits in CVP/SWP demands as determined by base DWRSIM operation simulations to the extent possible. Demands are met on delivery patterns provided by DWR and the Bureau of Reclamation.

Environmental Targets: Provide for no less than 7000 CFS Delta outflow to the extent possible.

Simulation Assumptions

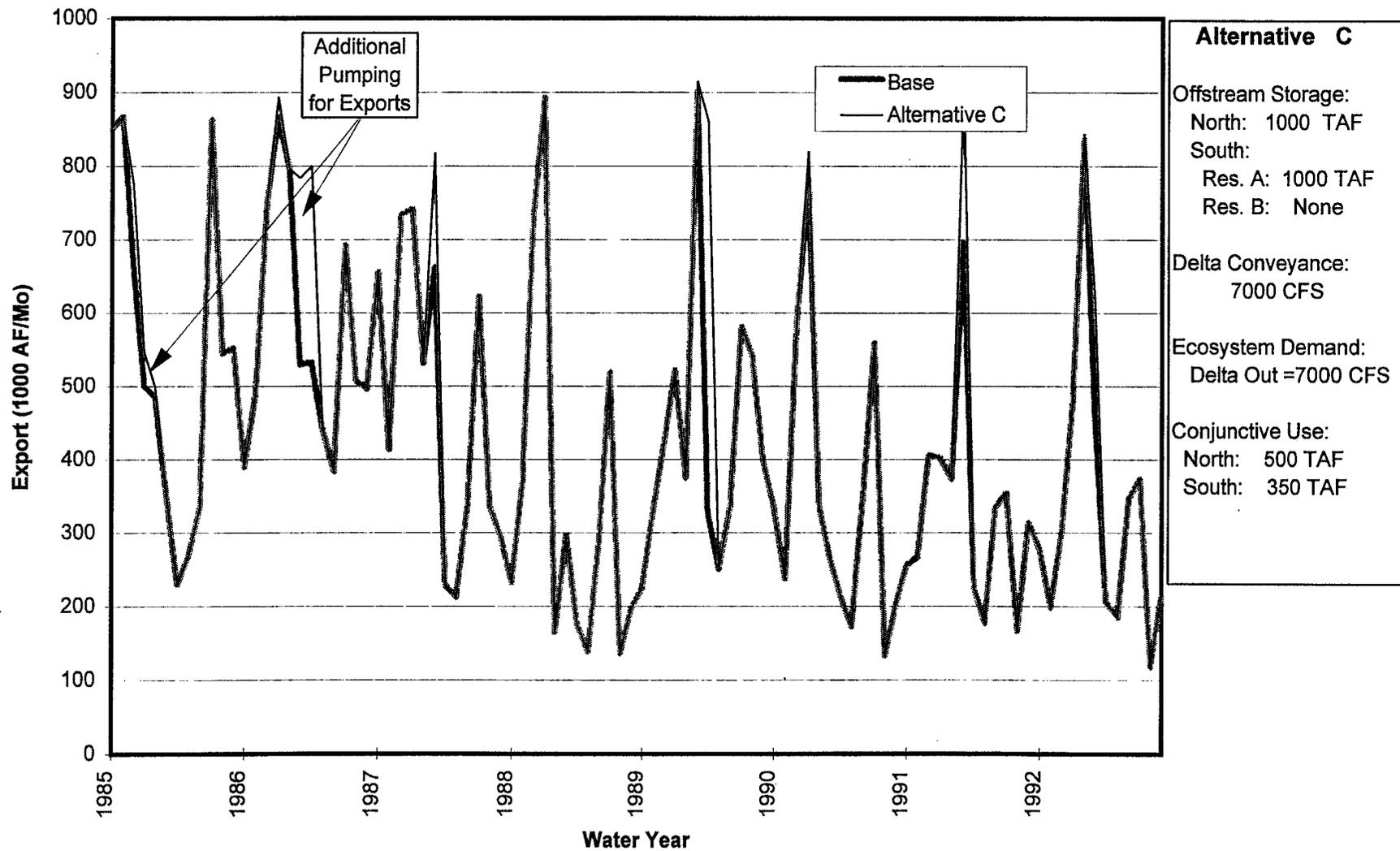
- Use Sacramento River spill water below Keswick to fill north of Delta storage. Concurrent Delta surplus conditions, timing and quantity, are tested to insure availability of spill as storable water.
- Operate new north of Delta offstream storage to share water development potential on a 50/50 percent basis between environmental and supply opportunities.
- Operate north of Delta groundwater storage in a conjunctive use mode for environmental opportunities. (To enhance Delta outflow.)
- Operate south of Delta storage for water supply opportunities for demonstration purposes. Modules allow for reoperation for environmental targets as well.
- Operate south of Delta groundwater storage in a water banking mode for water supply opportunities. (To meet demand deficits.)
- Uses DWRSIM 416 output to provide Banks PP capacity with an isolated facility.
- Assumes the first 7000 CFS is available for export purposes. Remaining pumping tested for Export/Inflow ratio.

Total Modeled Delta Outflow -- 1985 to 1992 Supplemented by North of Delta Offstream Storage and Conjunctive Use



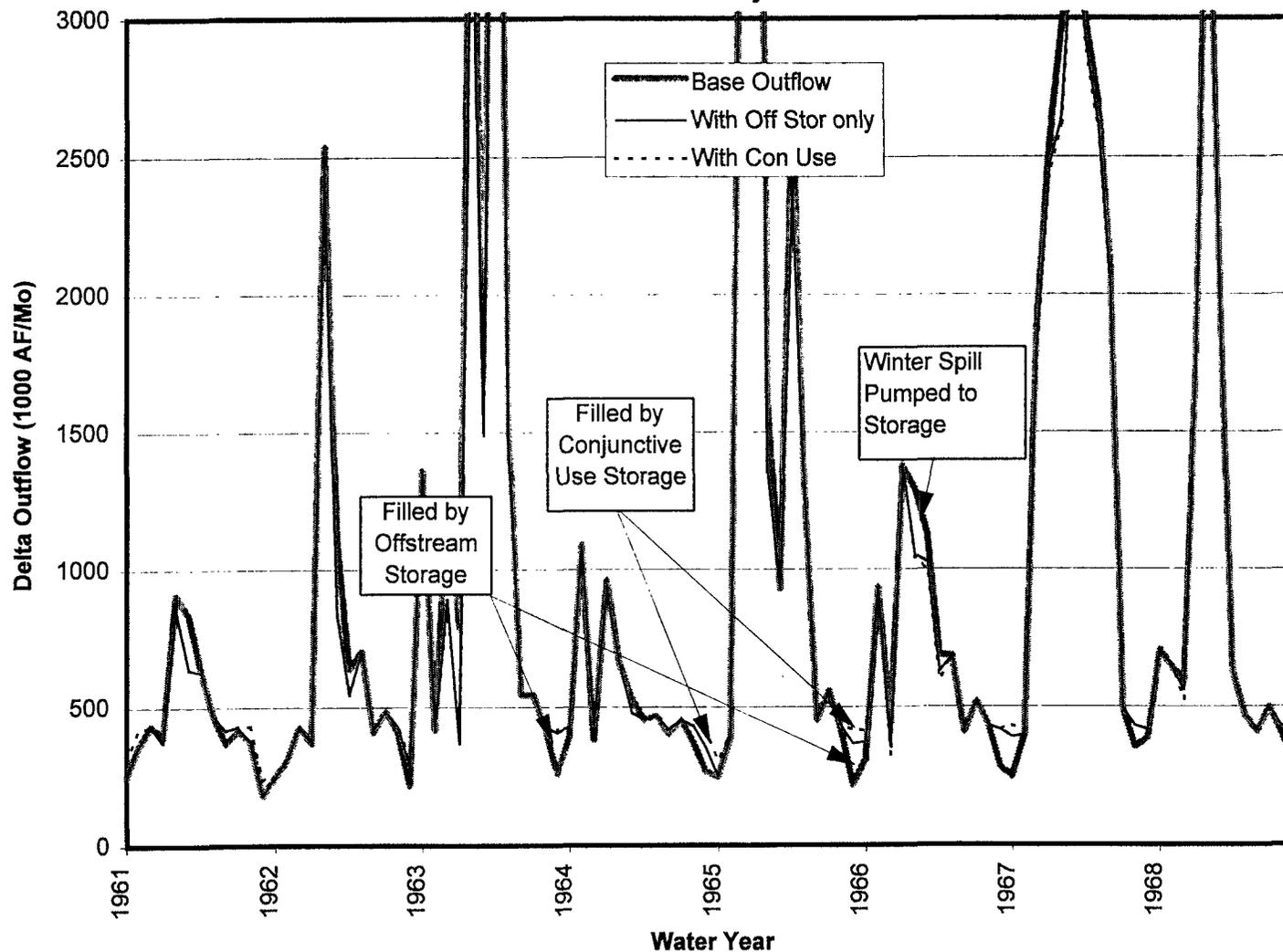
B-005660

Total Modeled South Delta Export -- 1985 to 1992



B-005661

**Total Modeled Delta Outflow -- 1961 to 1968
Supplemented by North of Delta Offstream Storage
and Conjunctive Use**



Alternative C

Offstream Storage:
 North: 1000 TAF
 South:
 Res. A: 1000 TAF
 Res. B: None

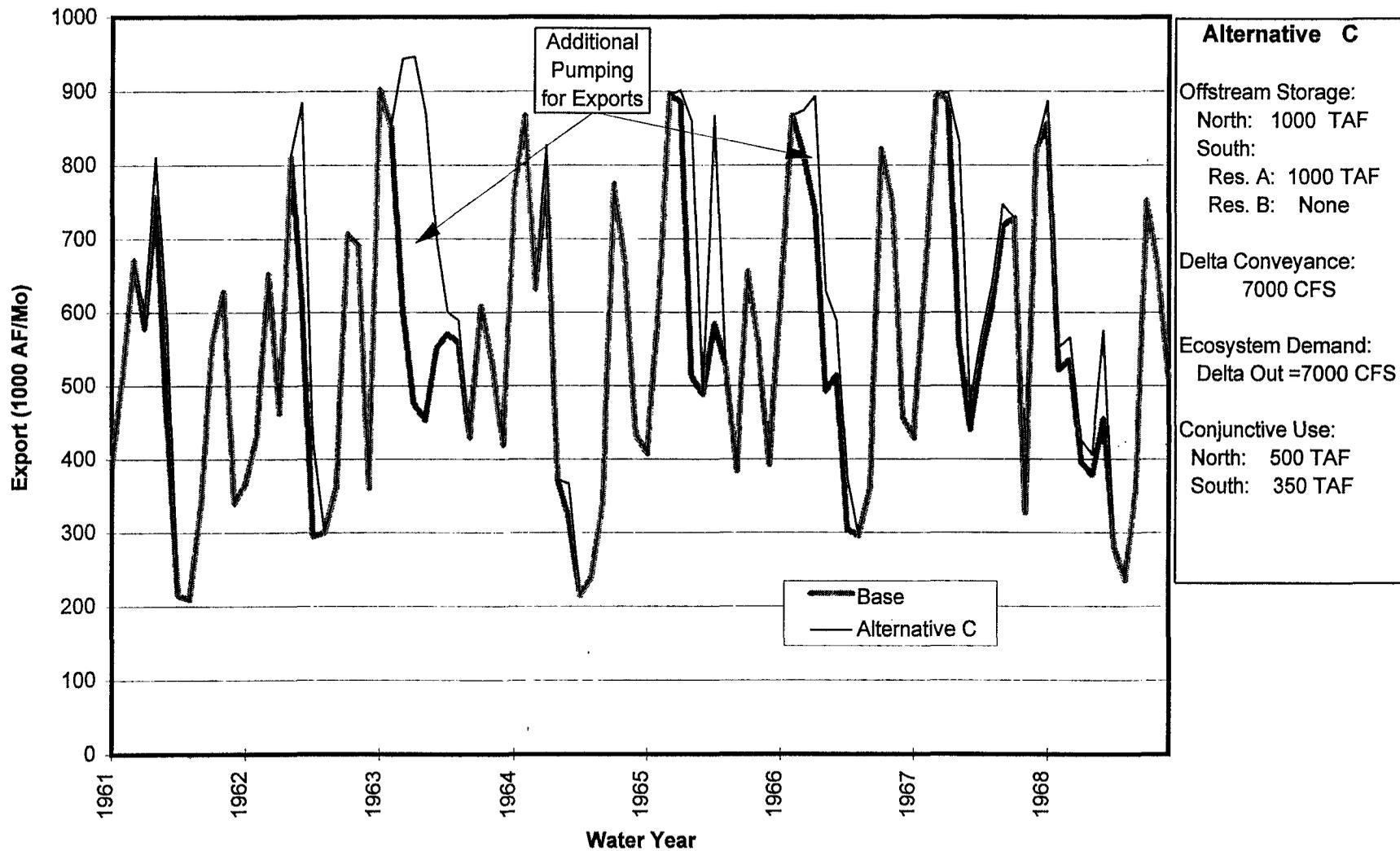
Delta Conveyance:
 7000 CFS

Ecosystem Demand:
 Delta Out = 7000 CFS

Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

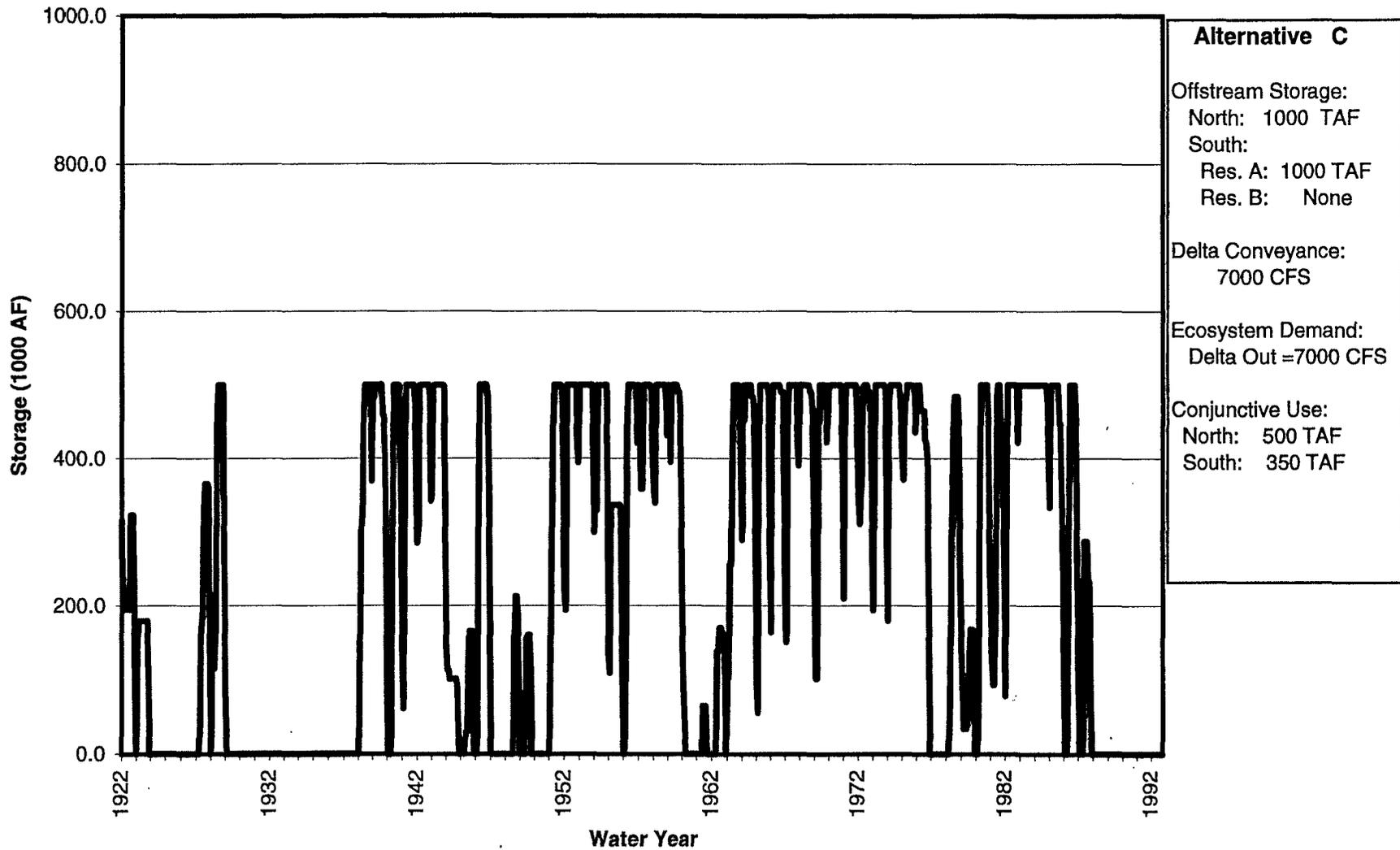
B-005662

Total Modeled South Delta Export -- 1961 to 1968



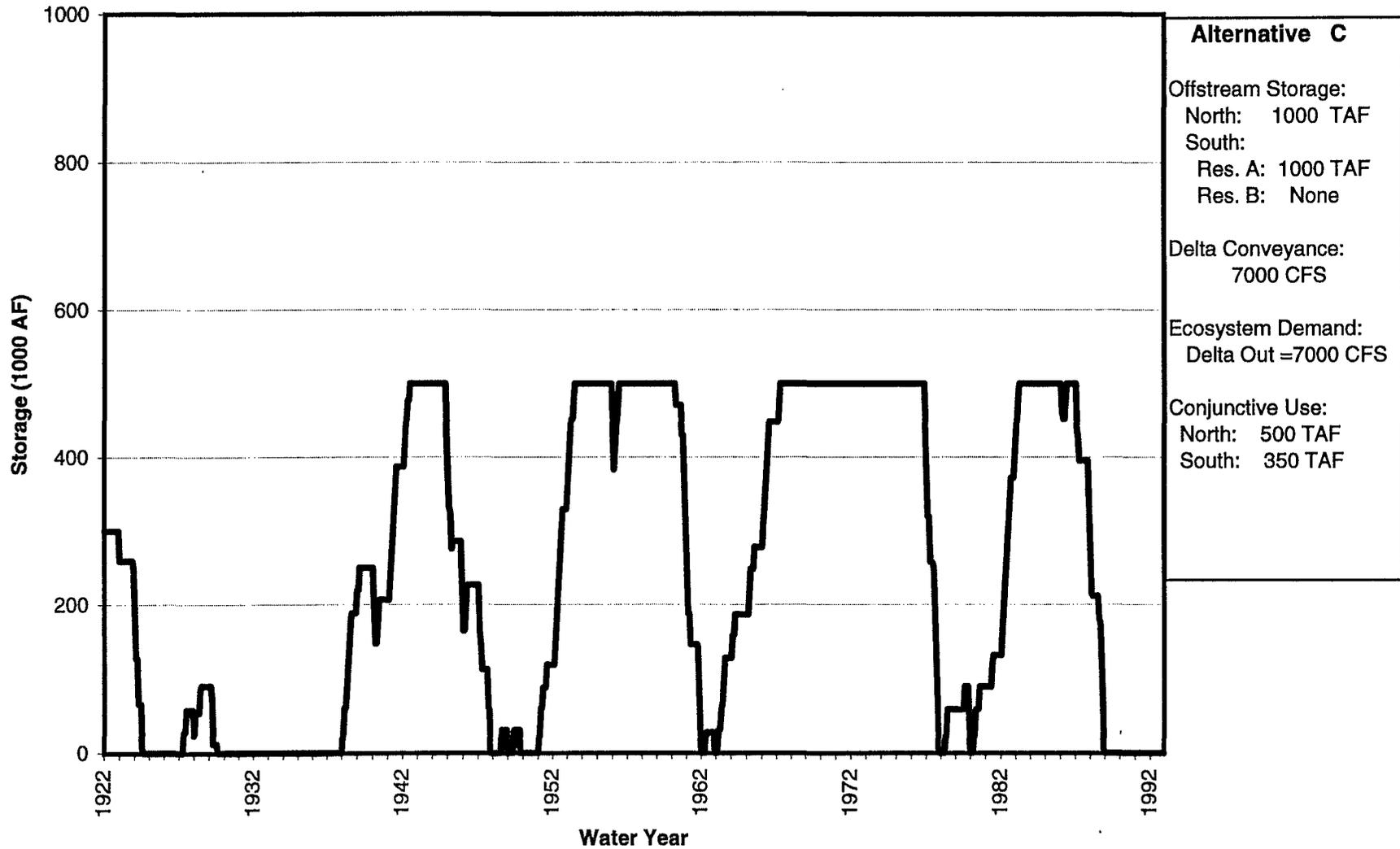
B-005663

North of Delta Storage Managed for Environmental Needs (Outflow)



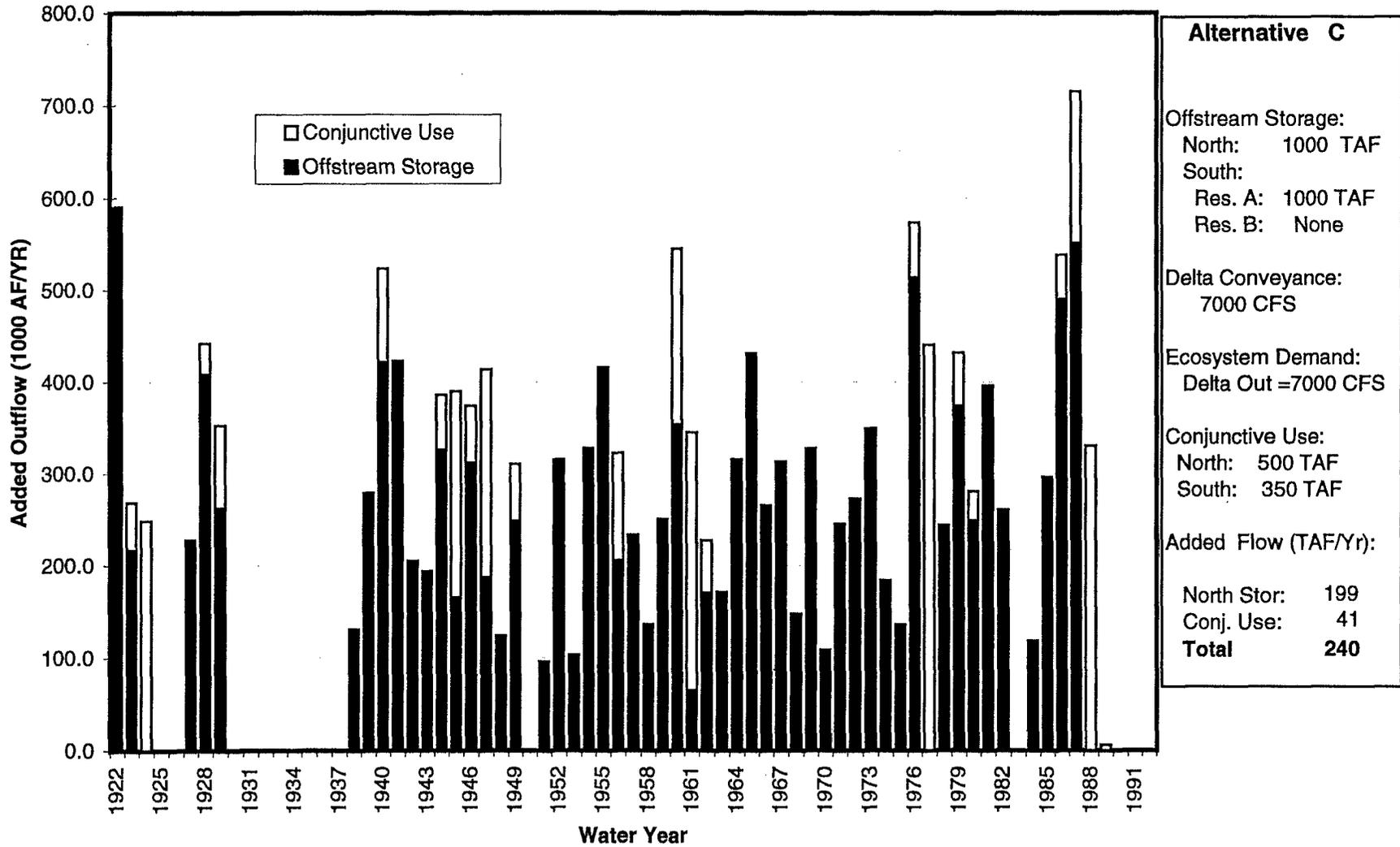
B - 0 0 5 6 6 4

North of Delta Groundwater Operation (Managed for Delta Outflow)



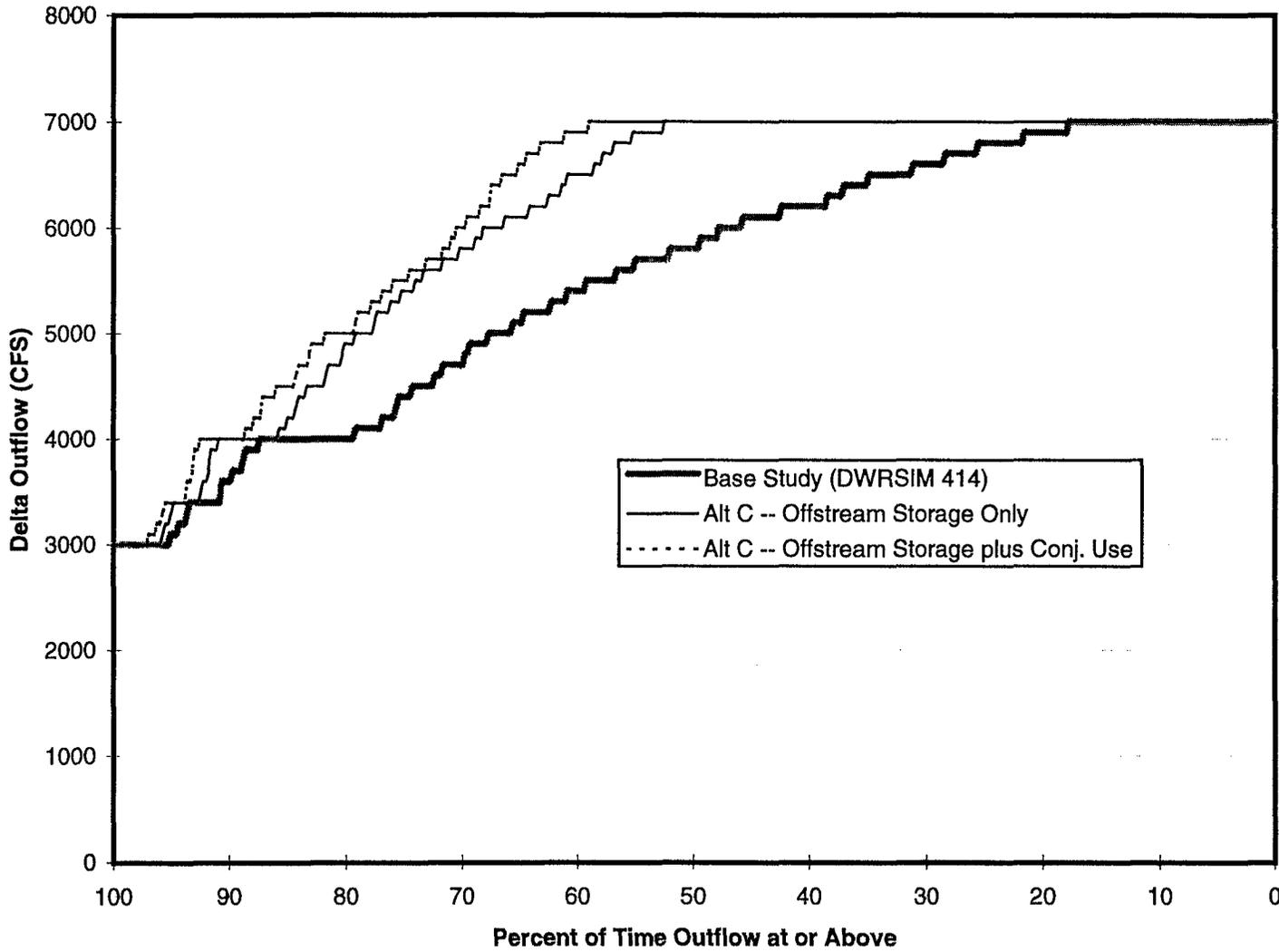
B-005665

Supplemental Delta Outflow from New North Storage and Conjunctive Use



B-005666

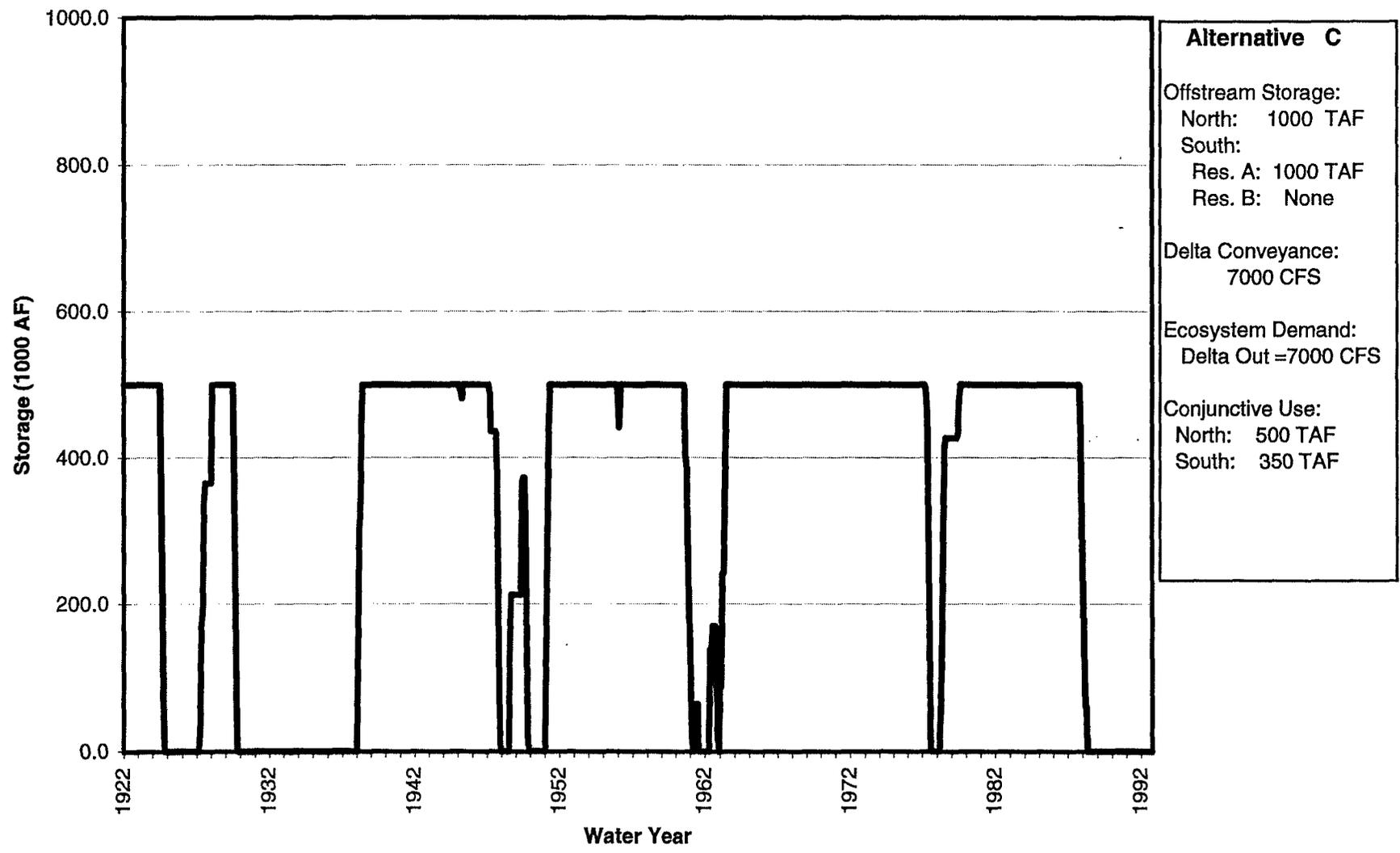
Frequency of Delta Outflow -- Target = 7000 CFS April through September



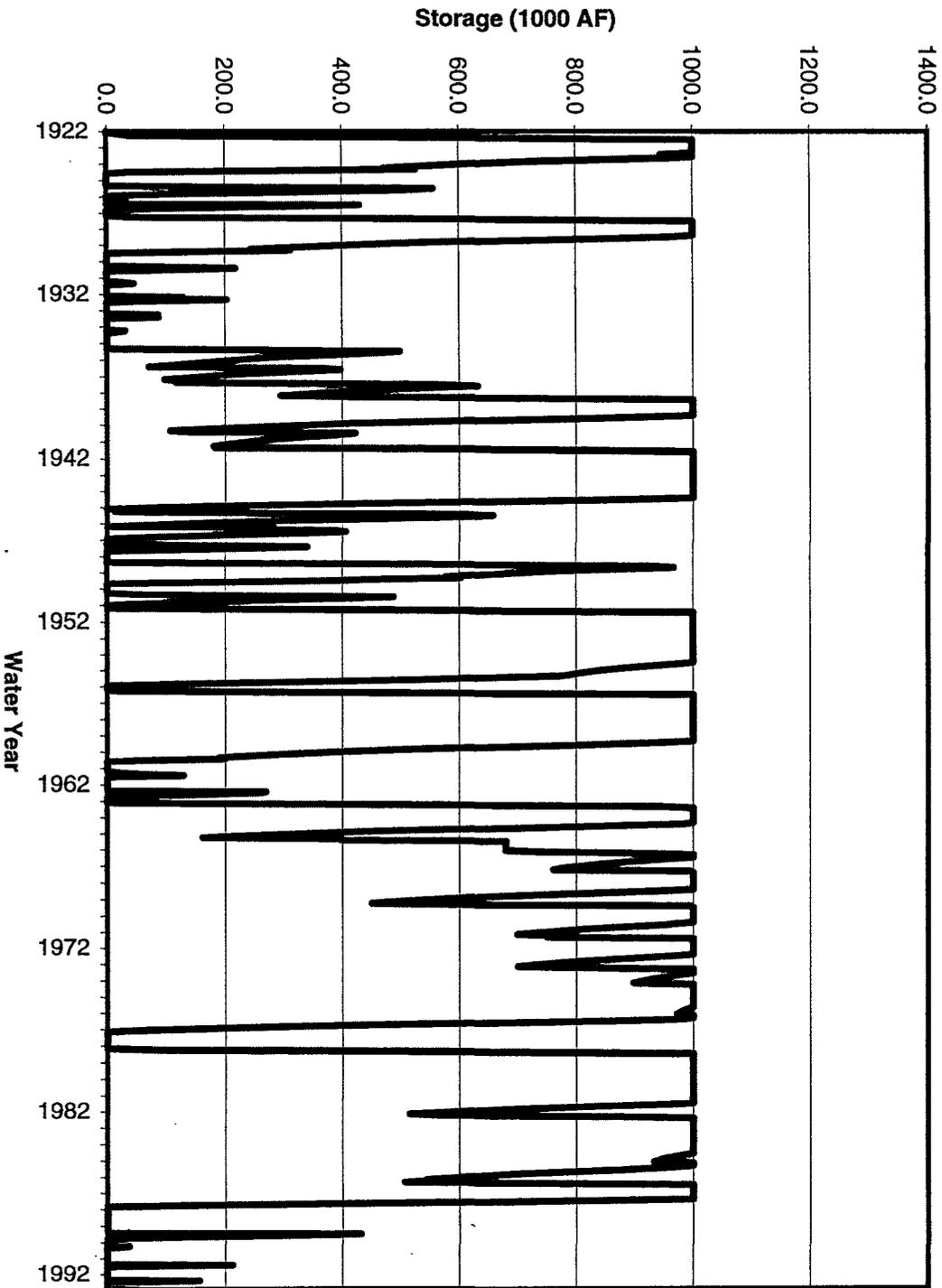
Alternative C
Offstream Storage:
North: 1000 TAF
South:
Res. A: 1000 TAF
Res. B: None
Delta Conveyance:
7000 CFS
Ecosystem Demand:
Delta Out = 7000 CFS
Conjunctive Use:
North: 500 TAF
South: 350 TAF

B-005667

North of Delta Storage Managed for Water Supply Opportunities (Exports)



**Offstream South of Delta Storage
Reservoir A**



Alternative C

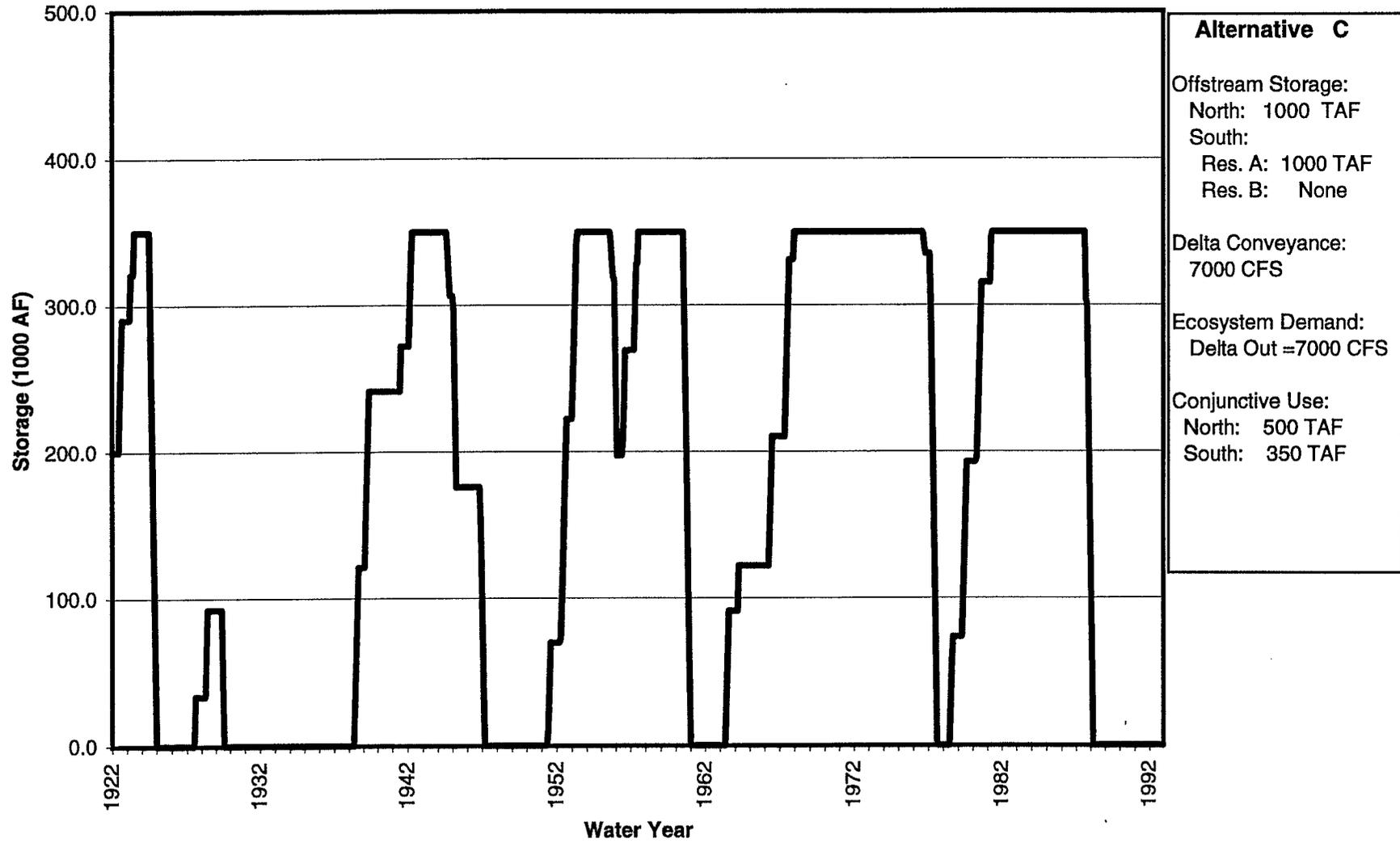
Offstream Storage:
 North: 1000 TAF
 South:
 Res. A: 1000 TAF
 Res. B: None

Delta Conveyance:
 7000 CFS

Ecosystem Demand:
 Delta Out = 7000 CFS

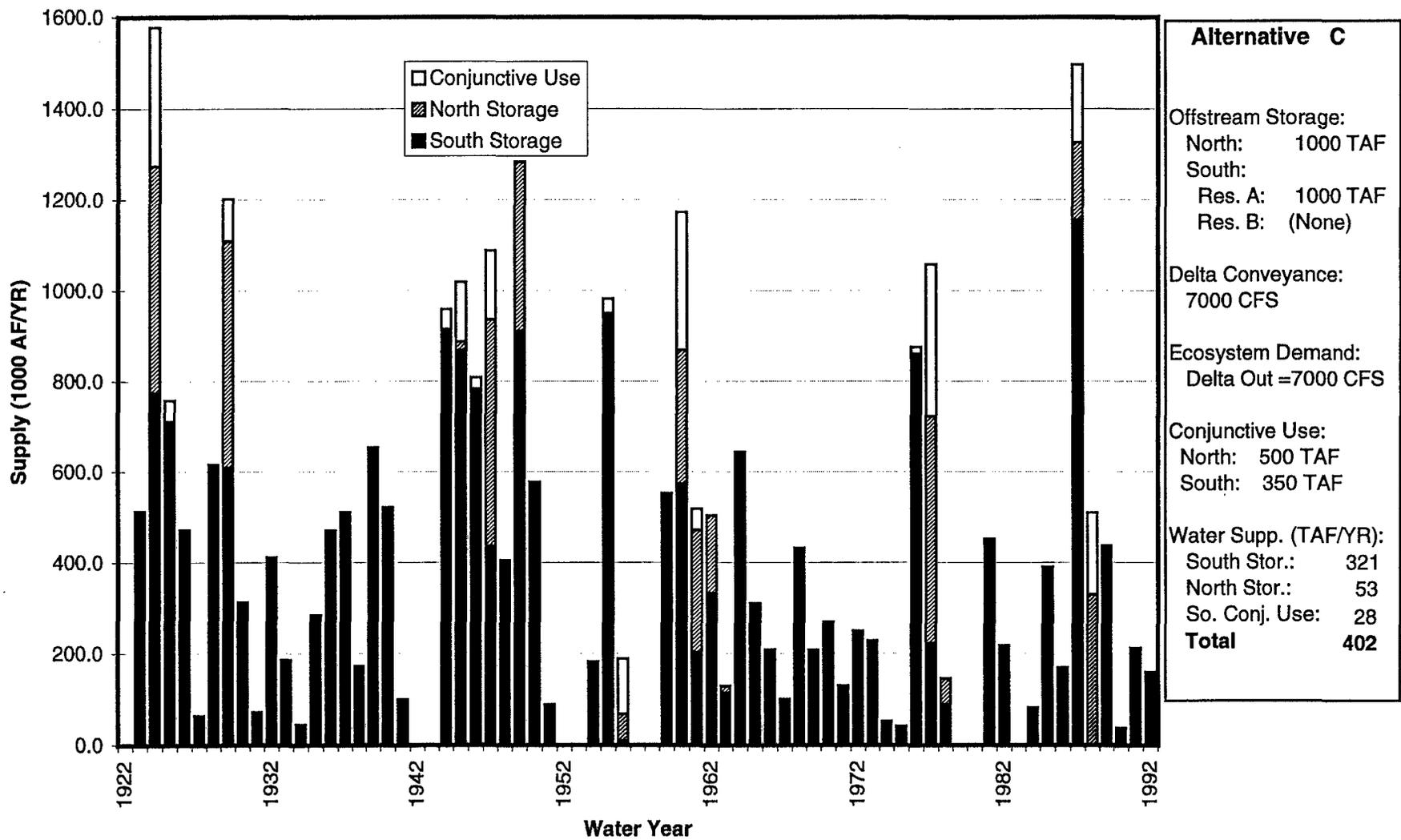
Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

South of Delta Groundwater Storage (Managed for Water Supply)



B-005670

Water Supply Opportunities from North and South Offstream Storage plus Conjunctive Use



B-005671

Alternative C-1

Facilities

North of Delta Storage:	1,000,000 Acre/Feet
South of Delta Storage:	1,000,000 Acre/Feet in San Joaquin Basin 800,000 Acre/Feet in LA Basin
In-Delta Storage:	None
Delta Conveyance:	Isolated facility at 7000 CFS.

Additional Criteria Assumptions for New Water Supply Opportunities

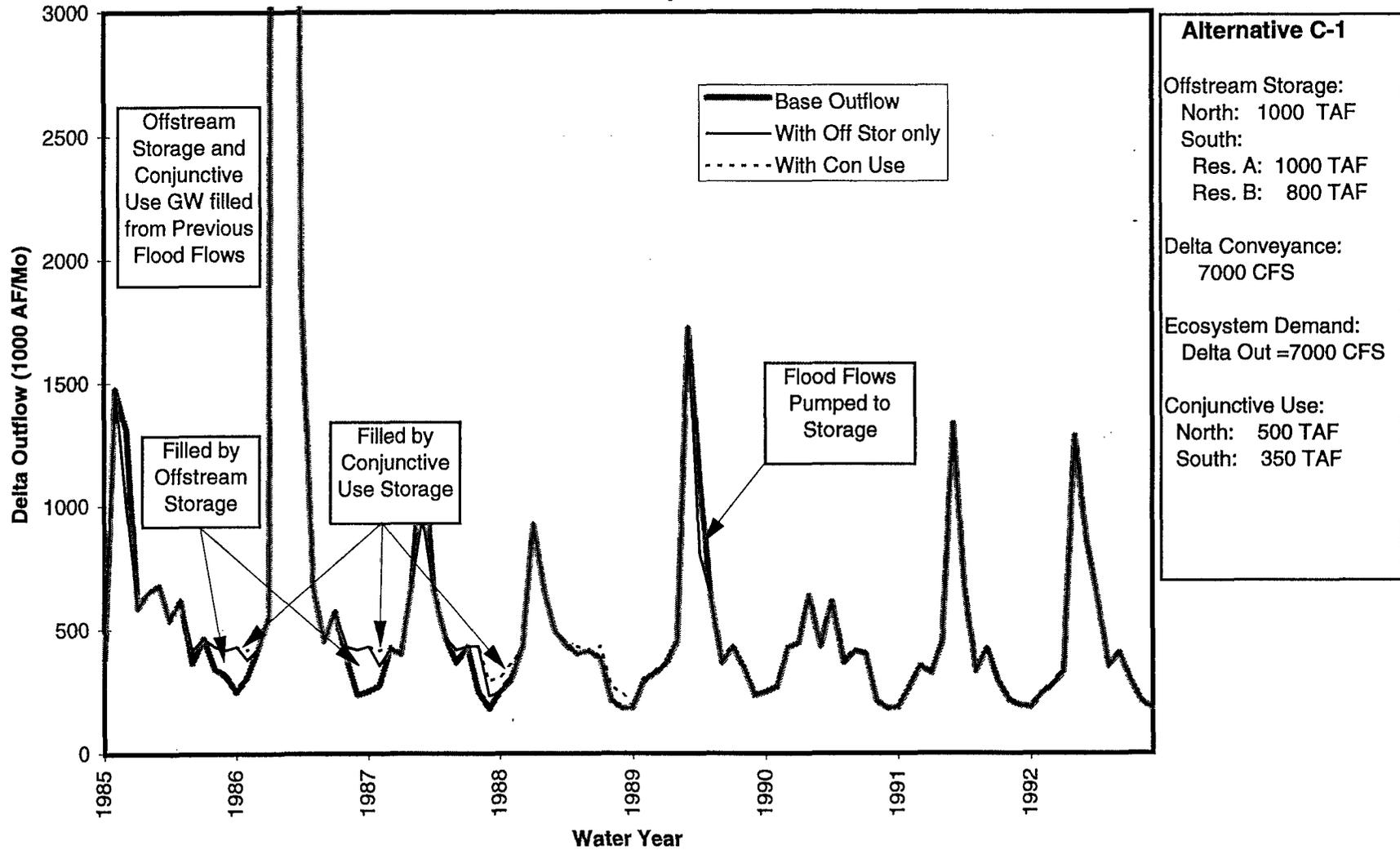
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Environmental Targets: Provide for no less than 7000 CFS Delta outflow to the extent possible.

Simulation Assumptions

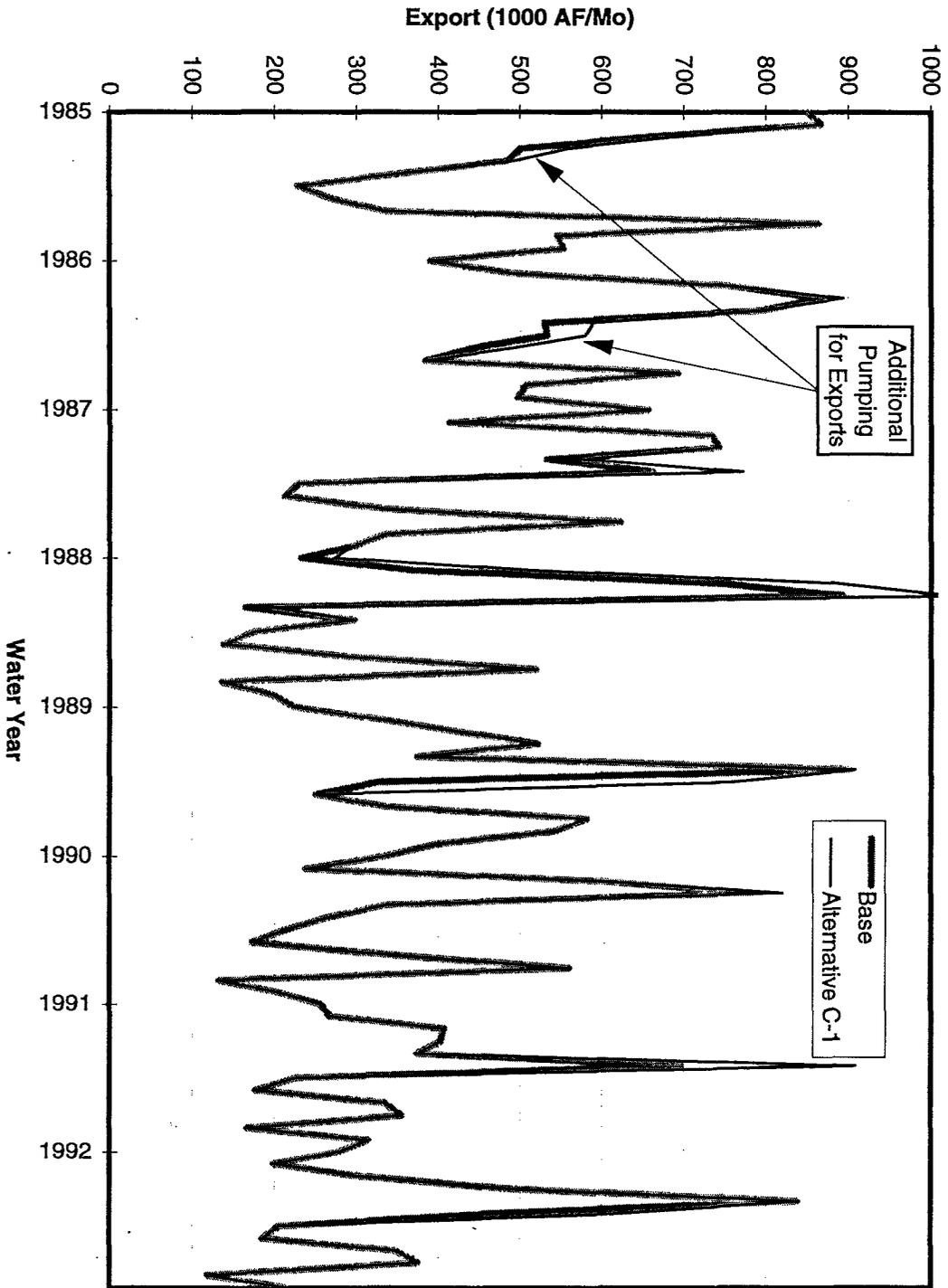
- Use Sacramento River spill water below Keswick to fill north of Delta storage. Concurrent Delta surplus conditions, timing and quantity, are tested to insure availability of spill as storable water.
- Operate new north of Delta offstream storage to share water development potential on a 50/50 percent basis between environmental and supply opportunities.
- Operate north of Delta groundwater storage in a conjunctive use mode for environmental opportunities. (To enhance Delta outflow.)
- Operate south of Delta storage for water supply opportunities for demonstration purposes. Modules allow for reoperation for environmental targets as well.
- Operates for 800,000 AF south of Delta LA basin storage first limited remaining capacity at Edmunston Pumping Plant. San Joaquin basin storage operated second.
- Operate south of Delta groundwater storage in a water banking mode for water supply opportunities. (To meet demand deficits.)
- Uses DWRSIM 416 output to provide Banks PP capacity with an isolated facility.
- Assumes the first 7000 CFS is available for export purposes. Remaining pumping tested for Export/Inflow ratio.

**Total Modeled Delta Outflow -- 1985 to 1992
Supplemented by North of Delta Offstream Storage
and Conjunctive Use**



B-005673

Total Modeled South Delta Export -- 1985 to 1992



Alternative C-1

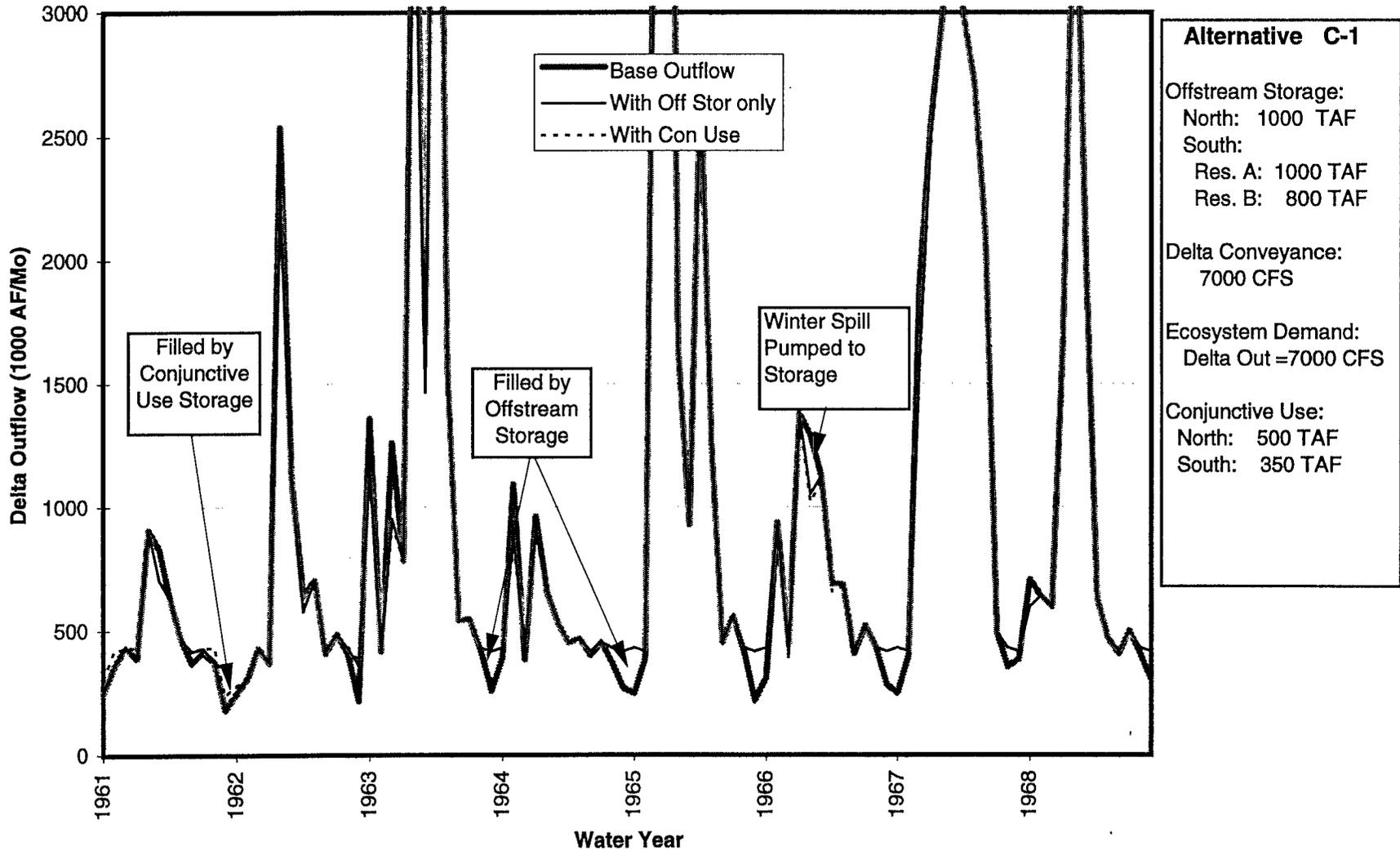
Offstream Storage:
 North: 1000 TAF
 South:
 Res. A: 1000 TAF
 Res. B: 800 TAF

Delta Conveyance:
 7000 CFS

Ecosystem Demand:
 Delta Out = 7000 CFS

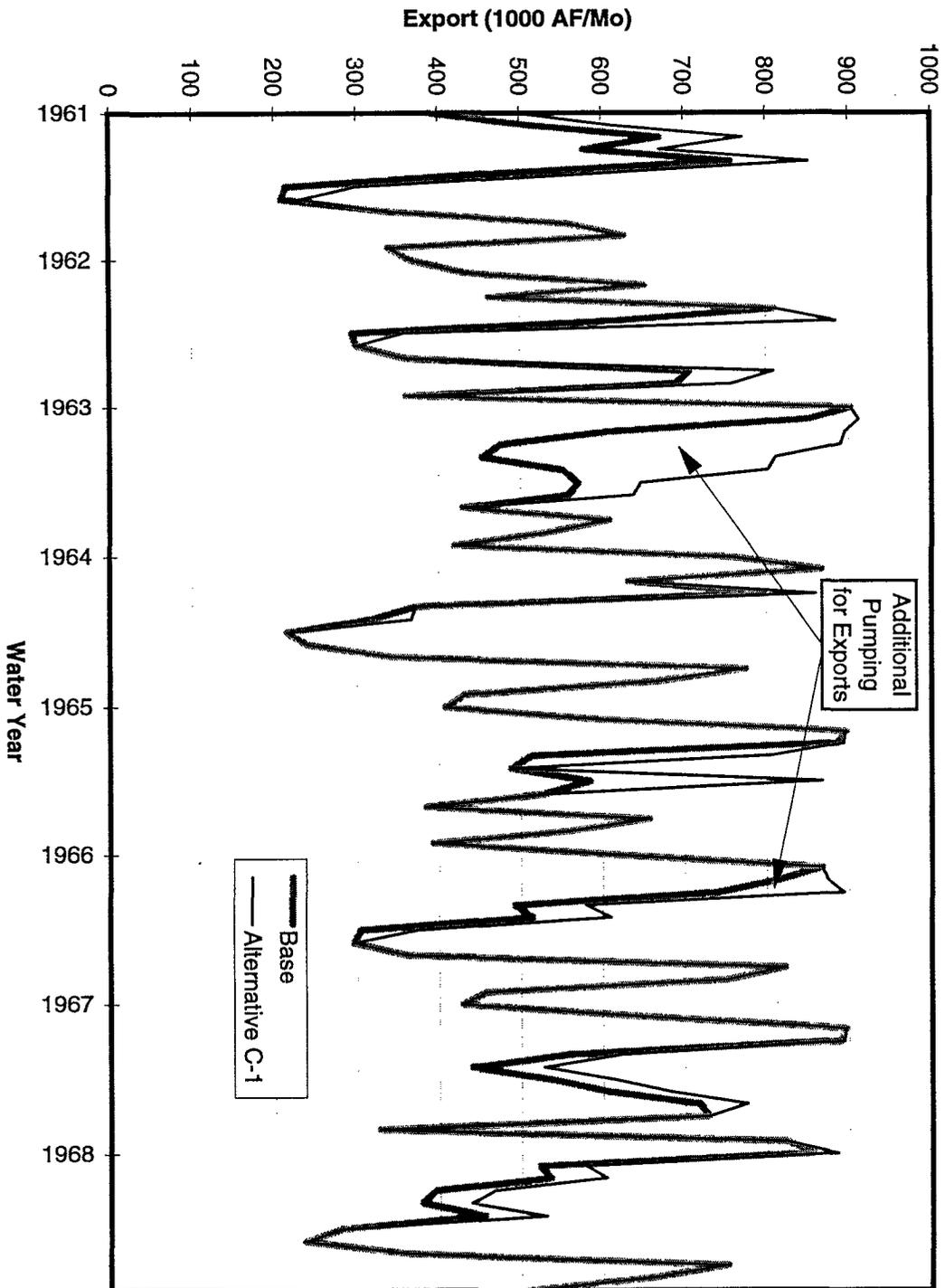
Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

Total Modeled Delta Outflow -- 1961 to 1968 Supplemented by North of Delta Offstream Storage and Conjunctive Use



B-005675

Total Modeled South Delta Export -- 1961 to 1968

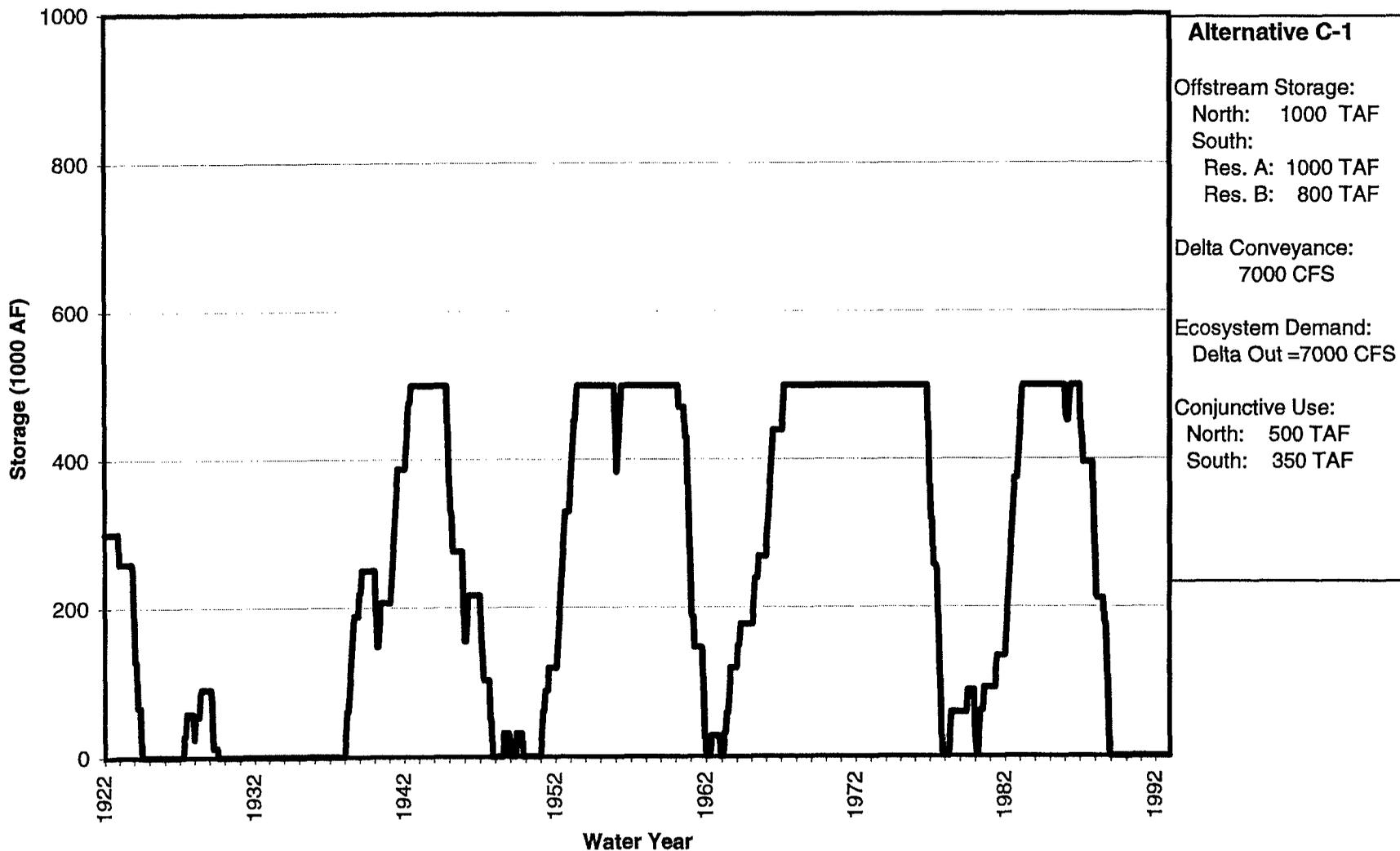


— Base
 - - - Alternative C-1

Additional Pumping for Exports

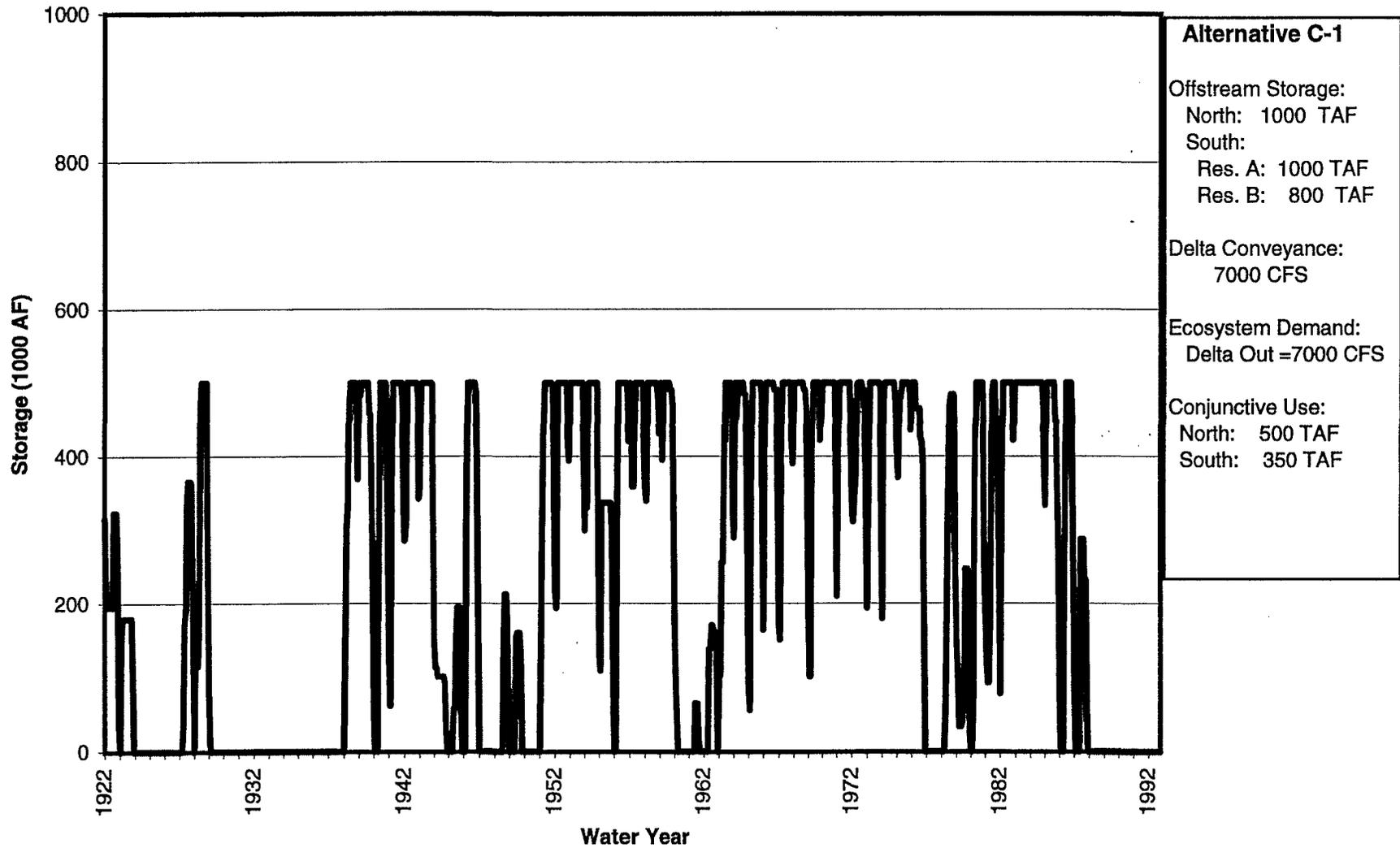
Alternative C-1
 Offstream Storage:
 North: 1000 TAF
 South:
 Res. A: 1000 TAF
 Res. B: 800 TAF
 Delta Conveyance:
 7000 CFS
 Ecosystem Demand:
 Delta Out = 7000 CFS
 Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

North of Delta Groundwater Operation (Managed for Delta Outflow)



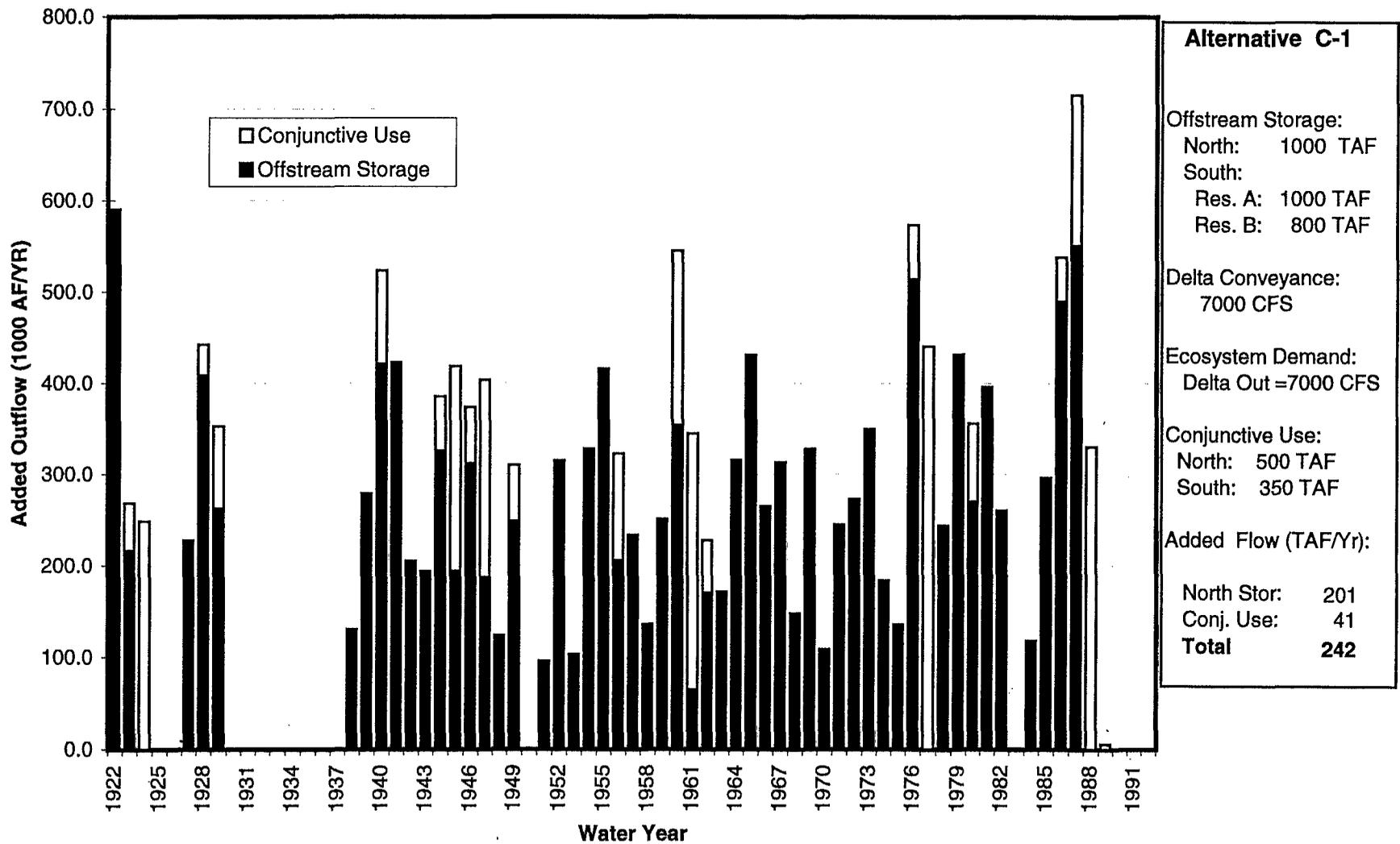
B-005677

North of Delta Storage Managed for Environmental Needs (Outflow)



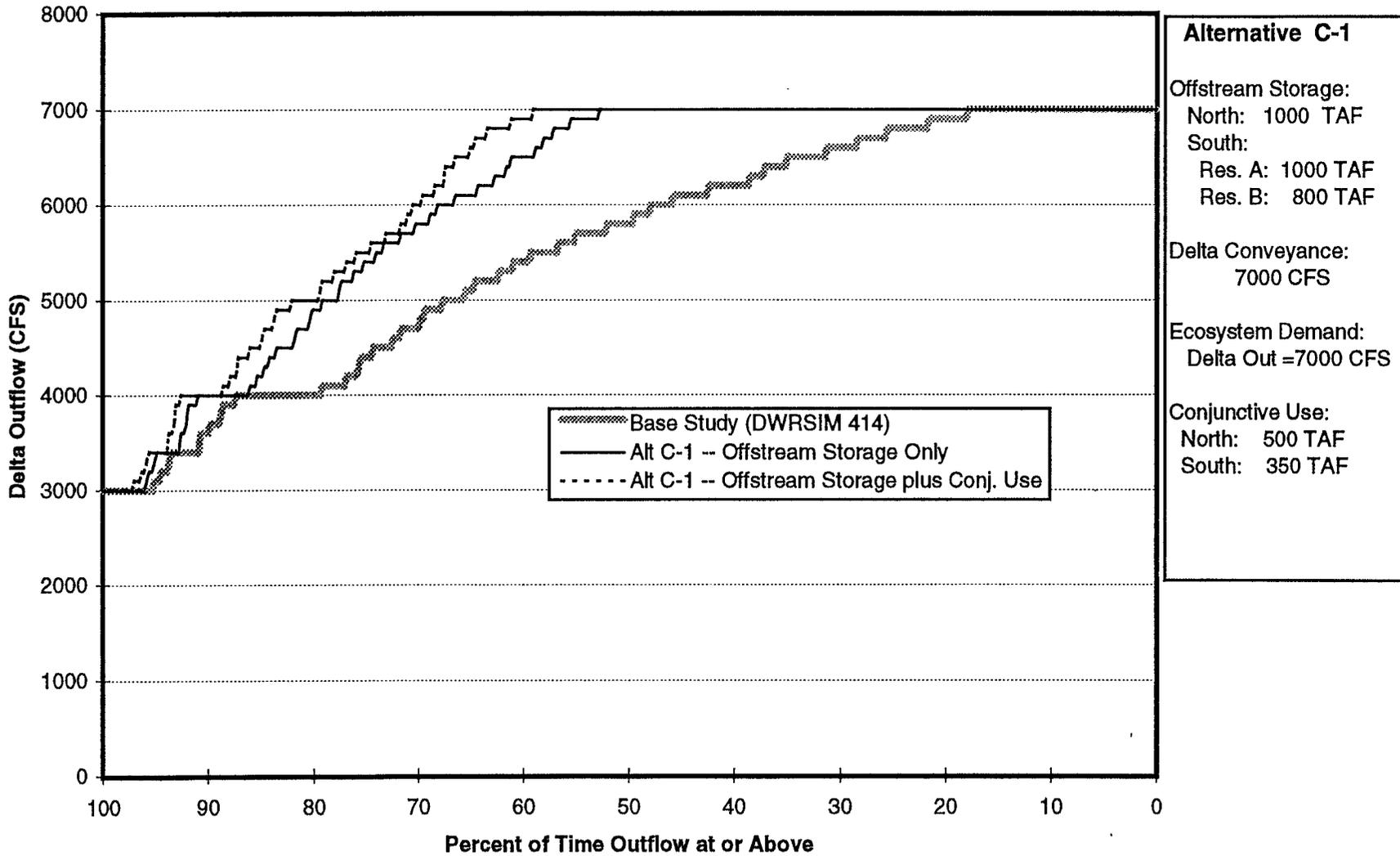
B-005678

Supplemental Delta Outflow from Storage and Conjunctive Use



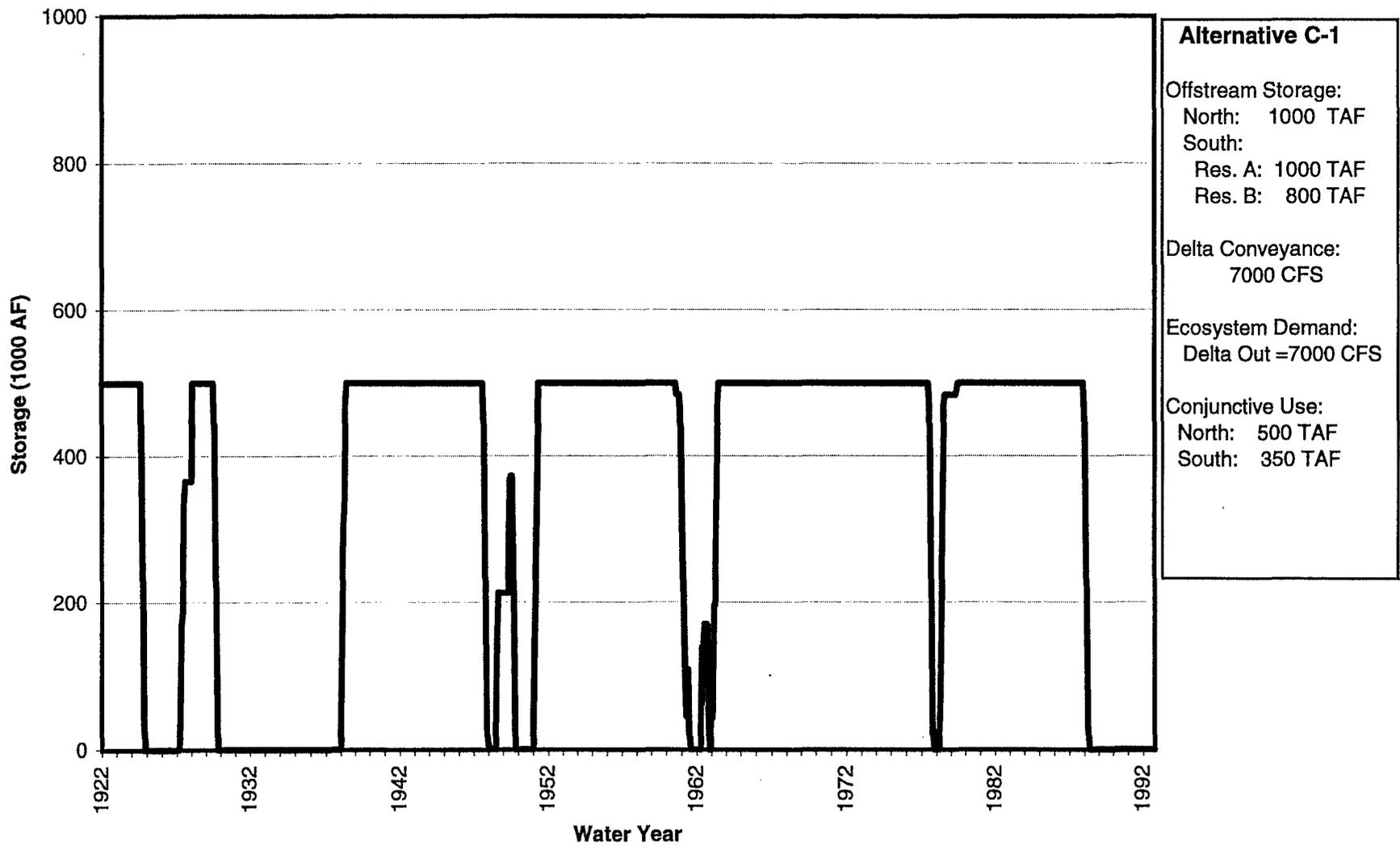
B - 0 0 5 6 7 9

Frequency of Delta Outflow -- Target = 7000 CFS April through September



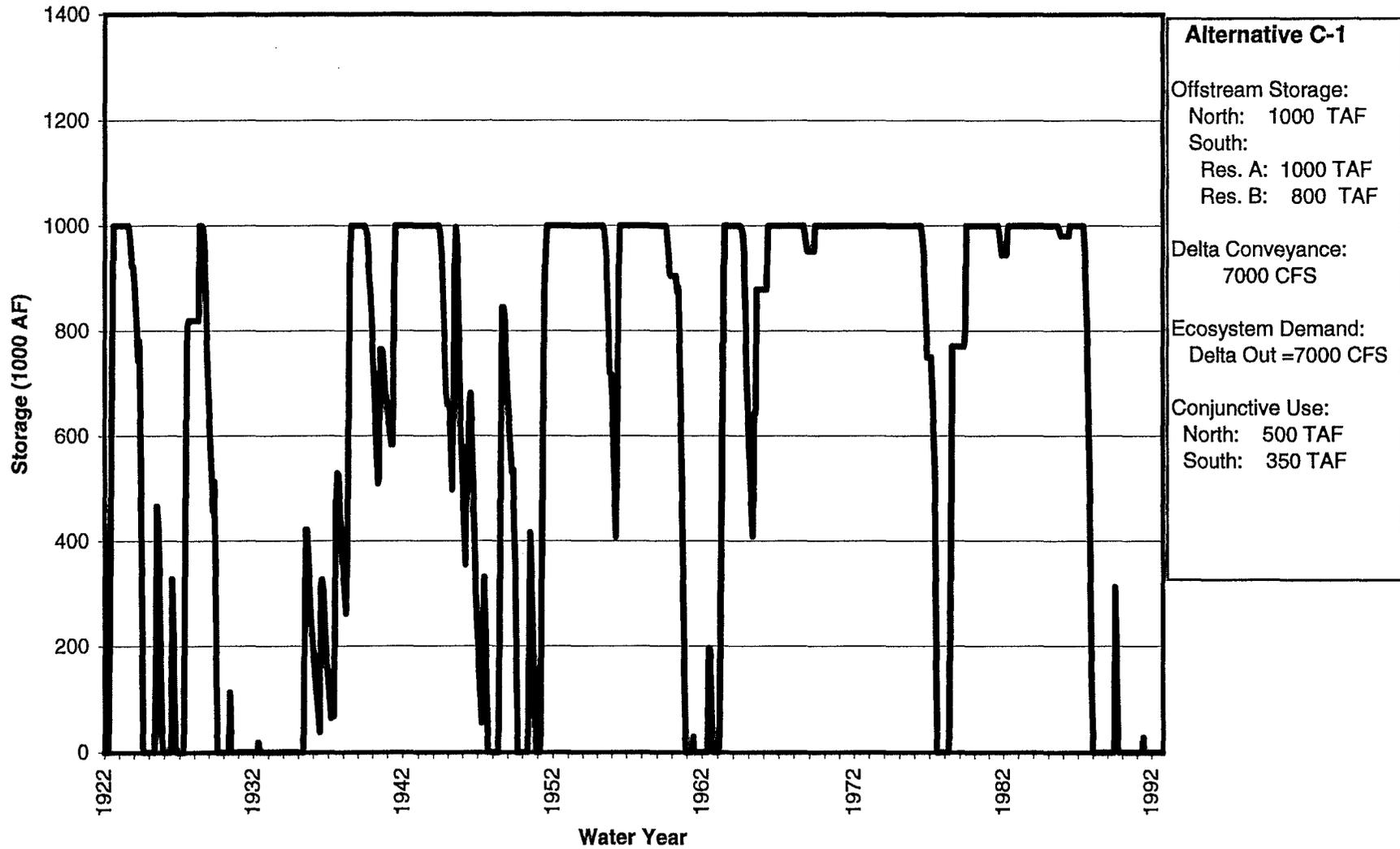
B-005680

North of Delta Storage Managed for Water Supply Opportunities (Exports)



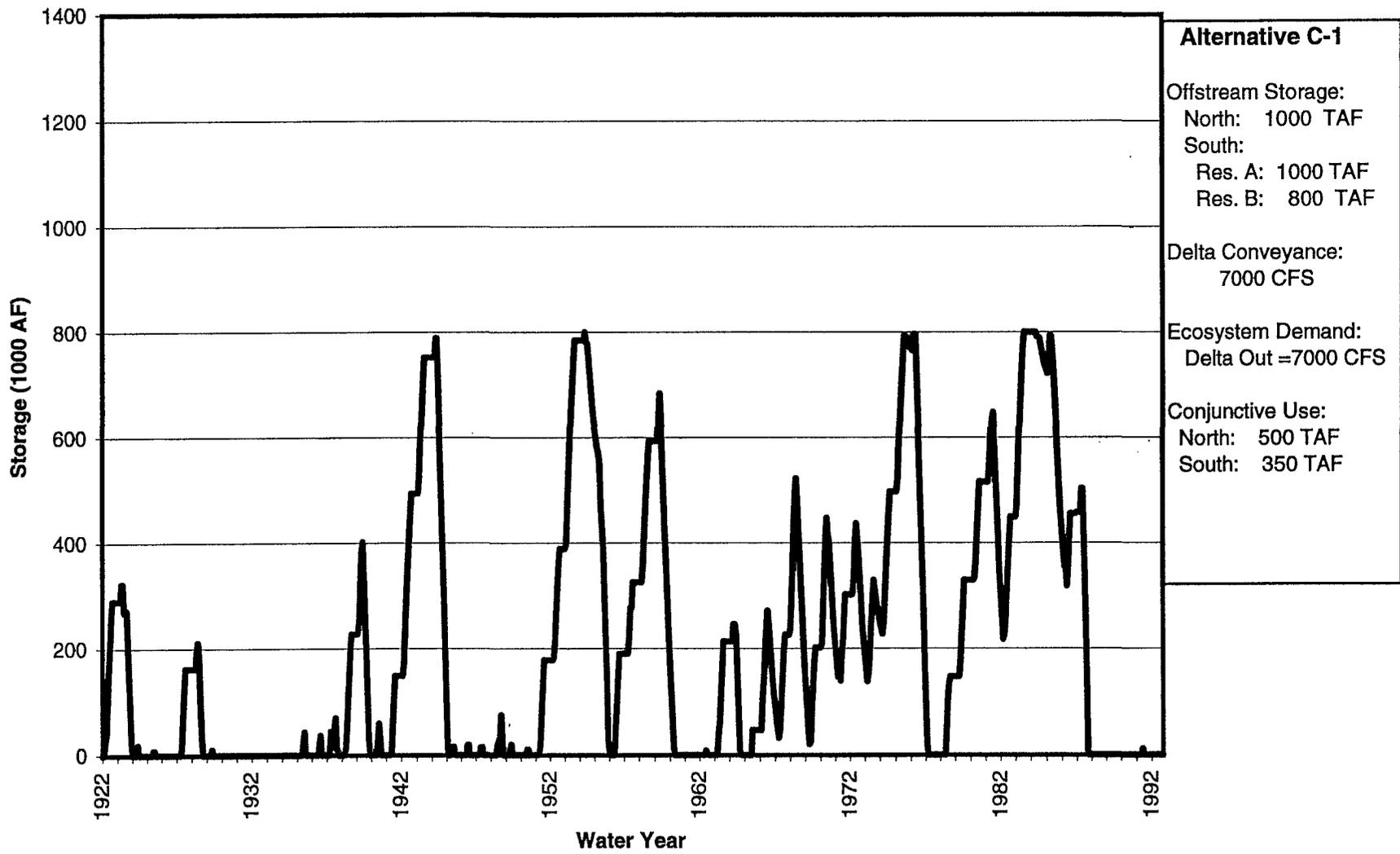
B-005681

Offstream South of Delta Storage Reservoir A



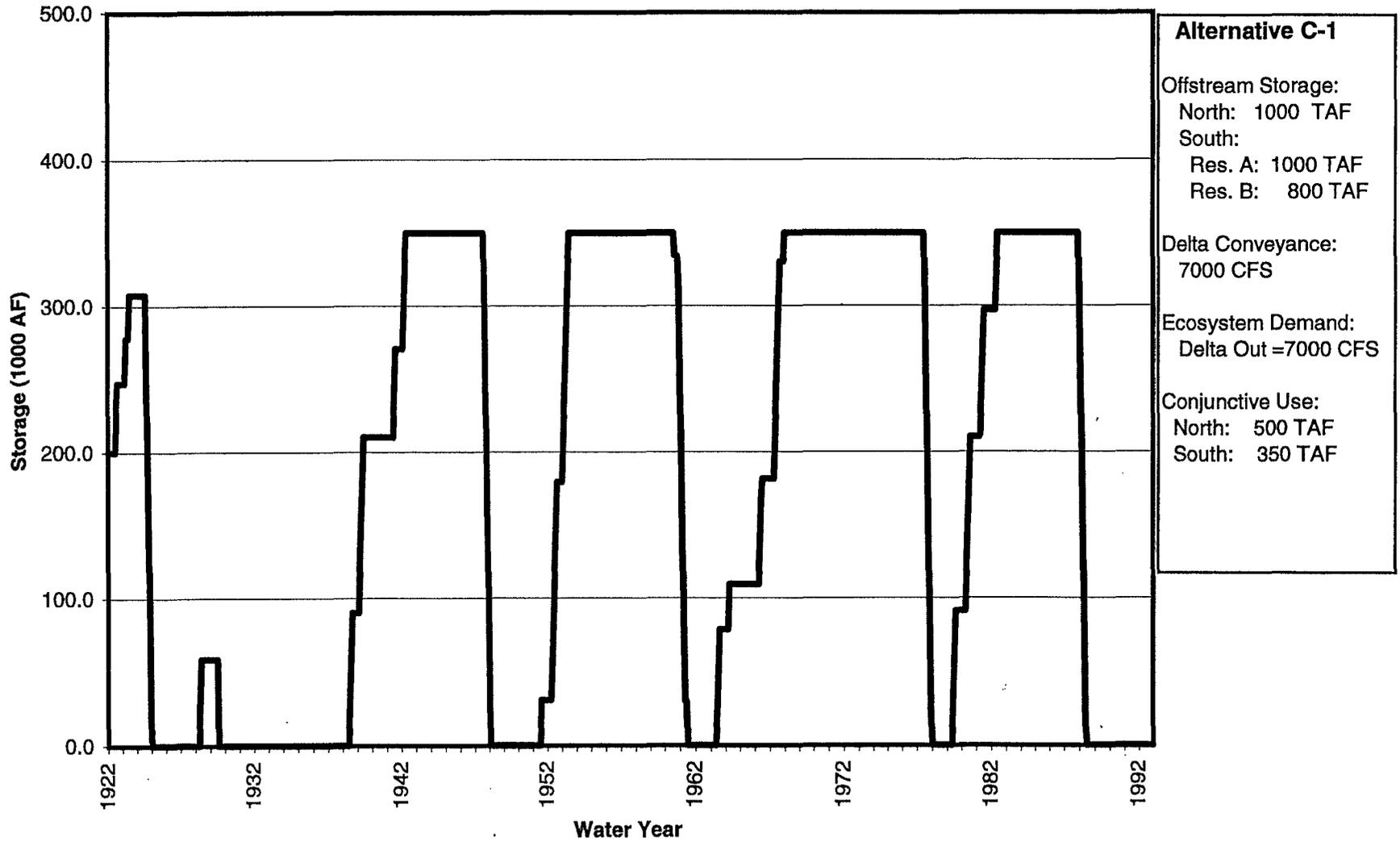
B-005682

Offstream South of Delta Storage Reservoir B



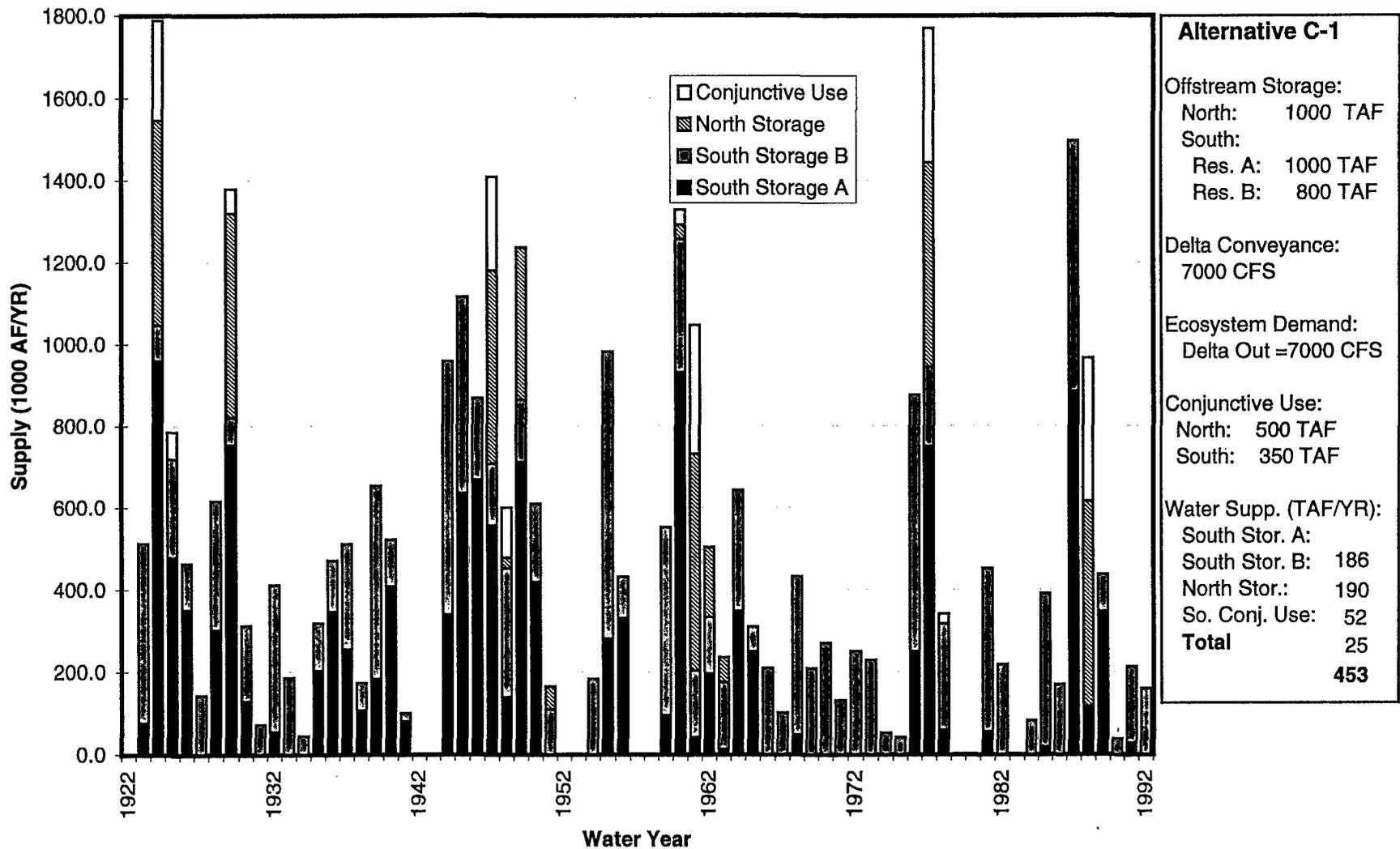
B - 0 0 5 6 8 3

South of Delta Groundwater Storage (Managed for Water Supply)



B-005684

Water Supply Opportunities from North and South Offstream Storage A and B plus Conjunctive Use



B-005685

Alternative D



B - 0 0 5 6 8 6

B-005686

Alternative D

Facilities

North of Delta Storage:	None
South of Delta Storage:	1,500,000 Acre/Feet in San Joaquin Basin
In-Delta Storage:	None
Delta Conveyance:	Through Delta -- 15,000 CFS

Additional Criteria Assumptions for New Water Supply Opportunities

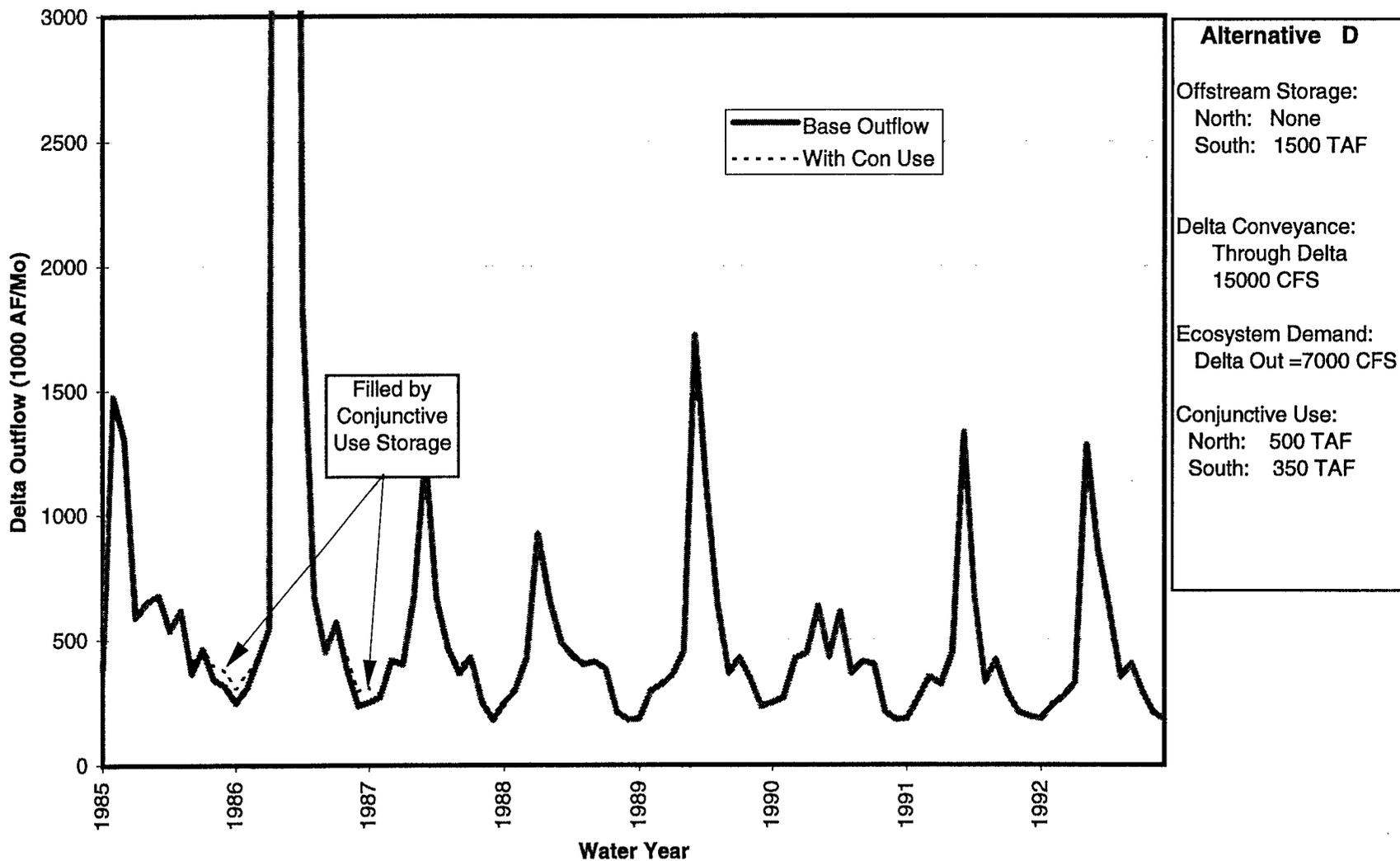
Water Supply Targets: To offset deficits in CVP/SWP demands as determined by base DWRSIM operation simulations to the extent possible. Demands are met on delivery patterns provided by DWR and the Bureau of Reclamation.

Environmental Targets: Provide for no less than 7000 CFS Delta outflow to the extent possible.

Simulation Assumptions

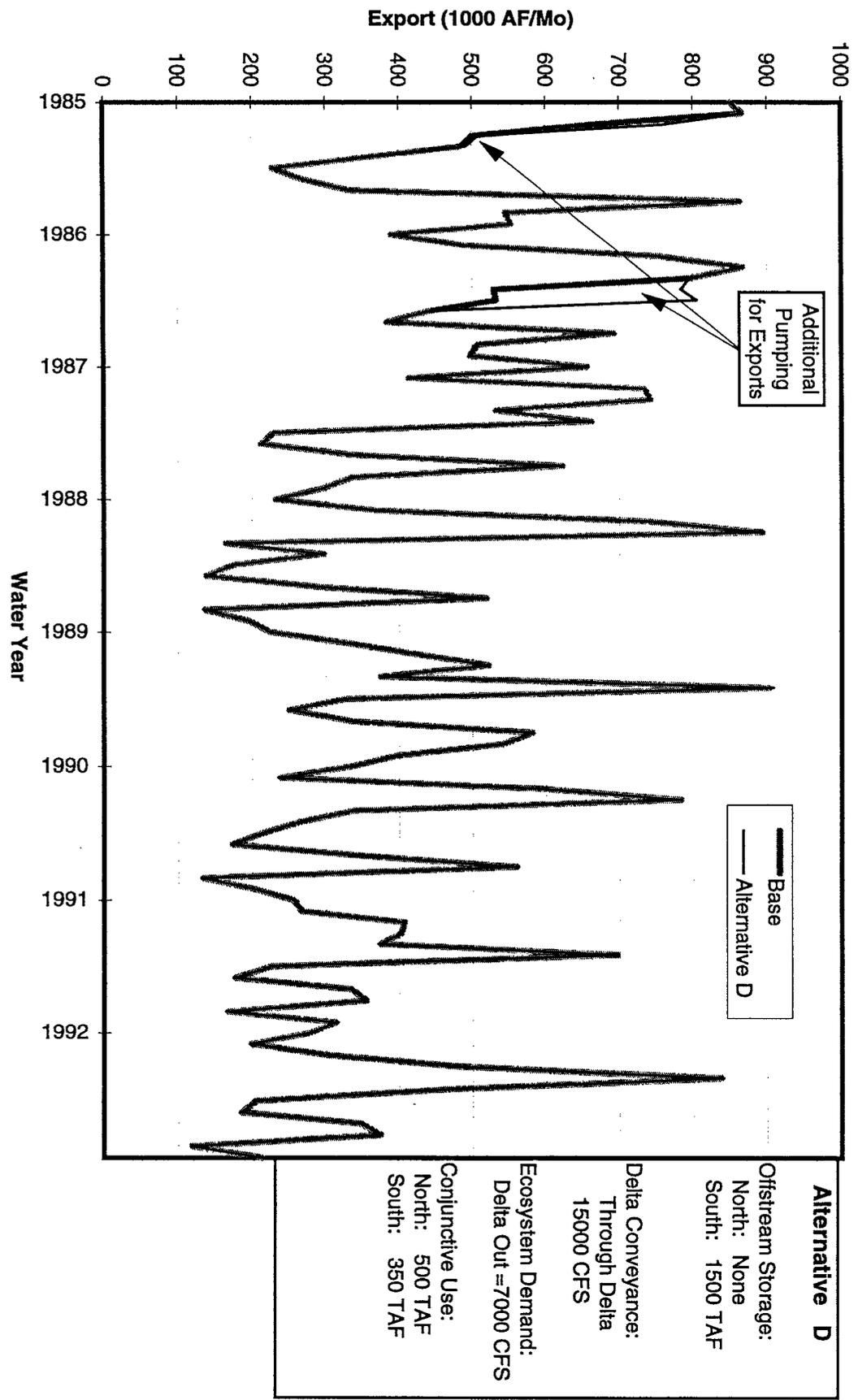
- Operate north of Delta groundwater storage in a conjunctive use mode for environmental opportunities. (To enhance Delta outflow.)
- Operate south of Delta storage for water supply opportunities for demonstration purposes. Modules allow for reoperation for environmental targets as well.
- Operate south of Delta groundwater storage in a water banking mode for water supply opportunities. (To meet demand deficits.)
- Assumes full permitted use of Banks PP only when south Delta inflow conditions (flood flows) allow.

Total Modeled Delta Outflow -- 1985 to 1992 Supplemented by North of Delta Conjunctive Use

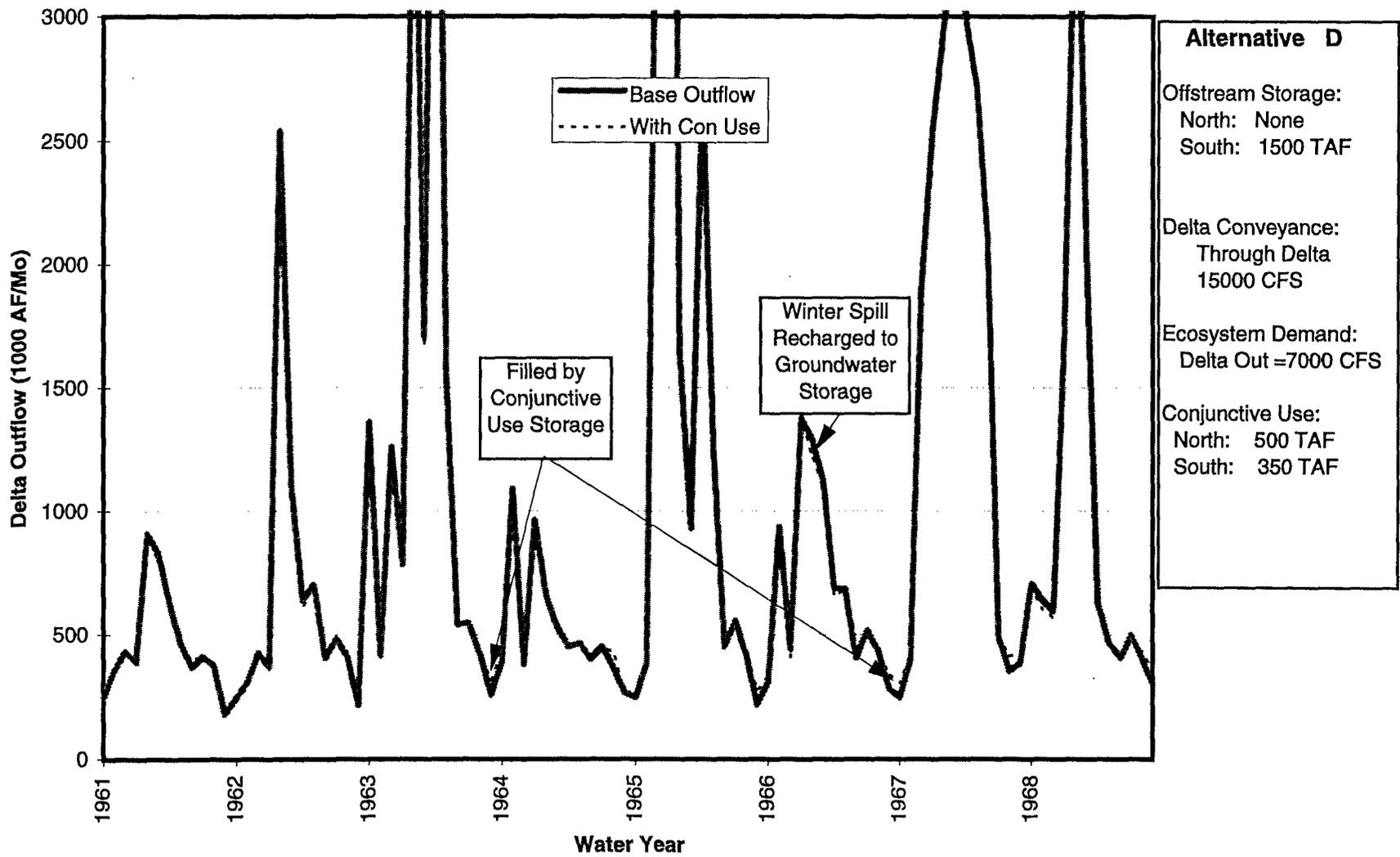


B-005688

Total Modeled South Delta Export – 1985 to 1992

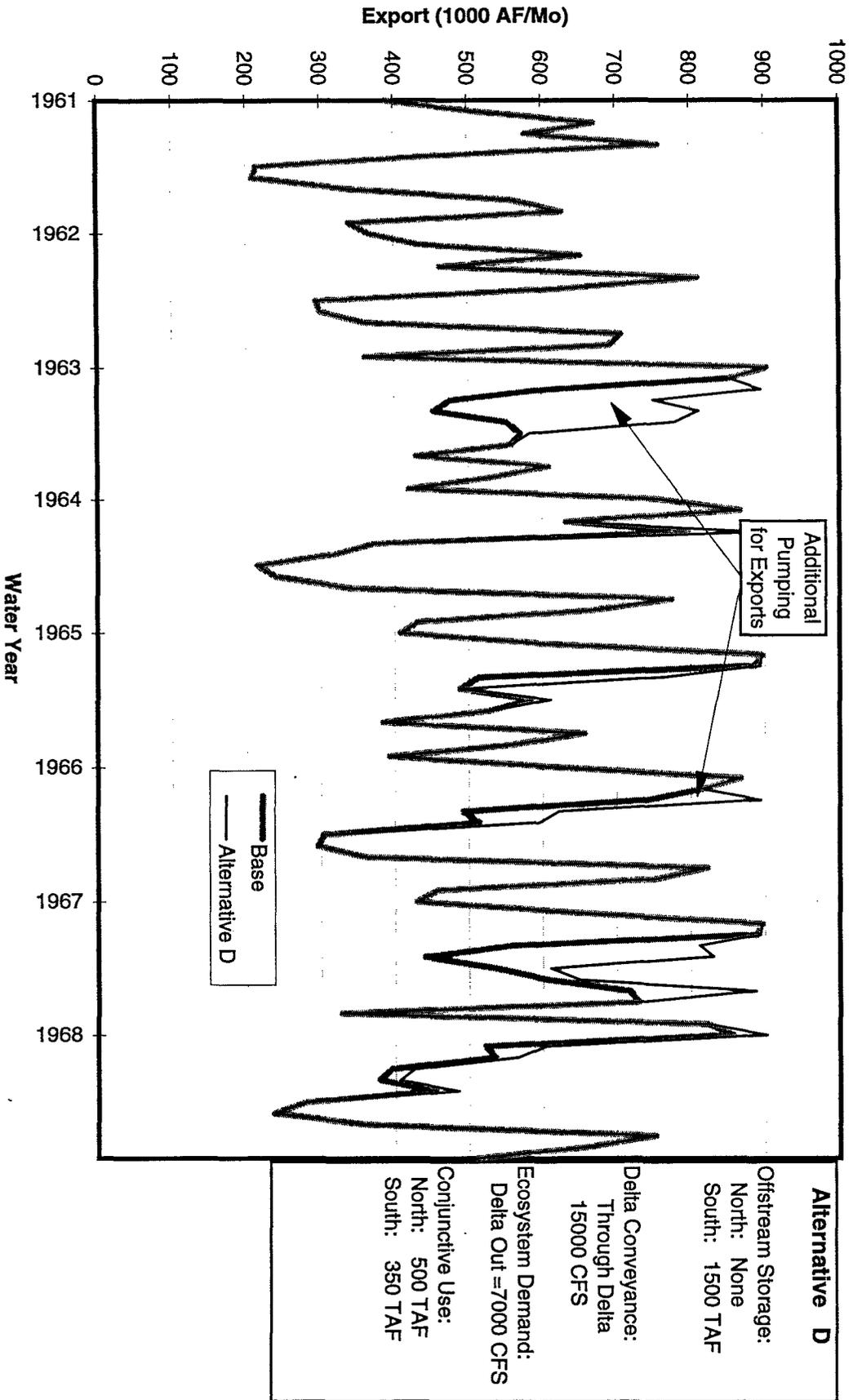


Total Modeled Delta Outflow – 1961 to 1968 Supplemented by North of Delta Conjunctive Use



B-005690

Total Modeled South Delta Export -- 1961 to 1968



Alternative D

Offstream Storage:
 North: None
 South: 1500 TAF

Delta Conveyance:
 Through Delta
 15000 CFS

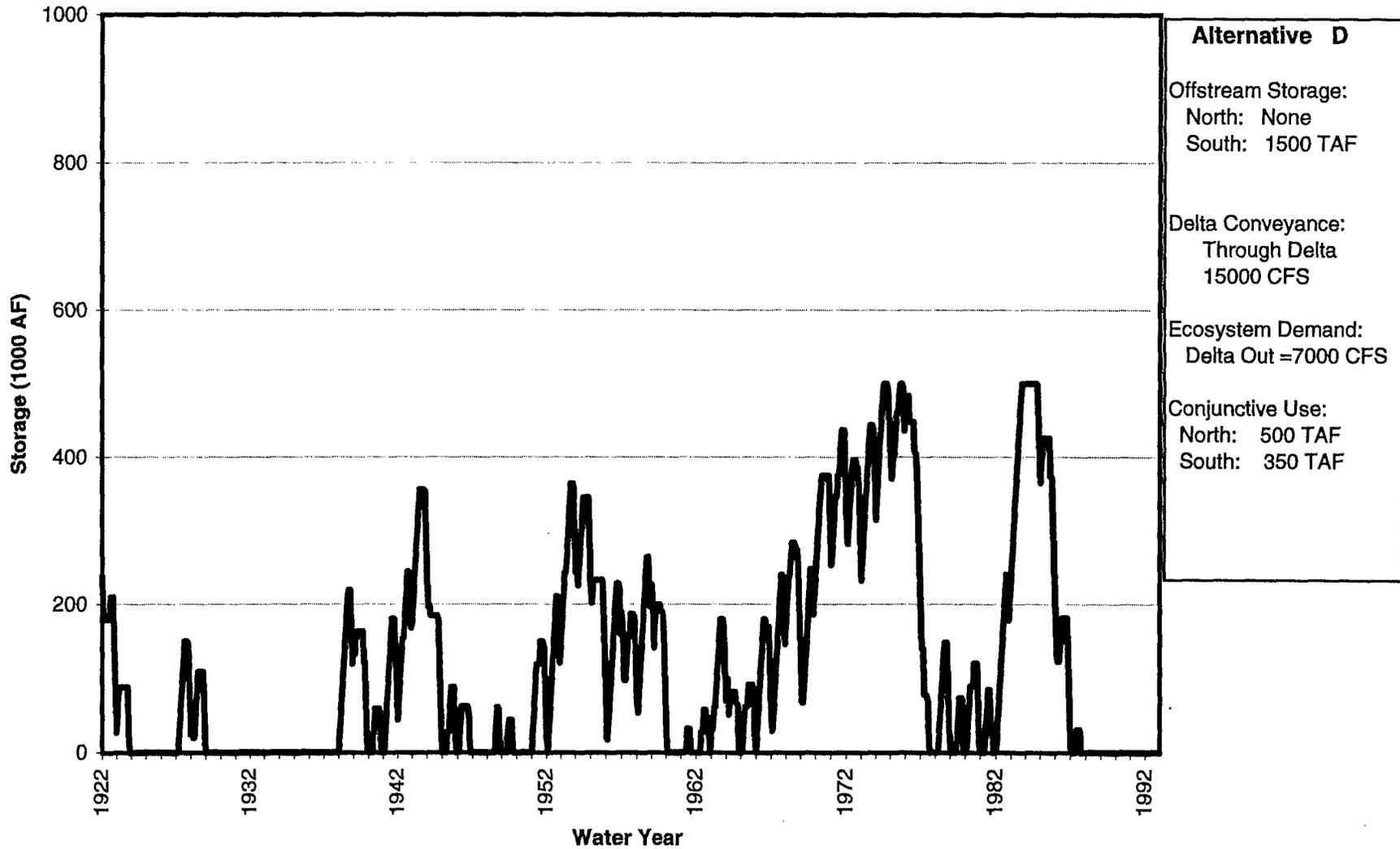
Ecosystem Demand:
 Delta Out = 7000 CFS

Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

— Base
 - - - Alternative D

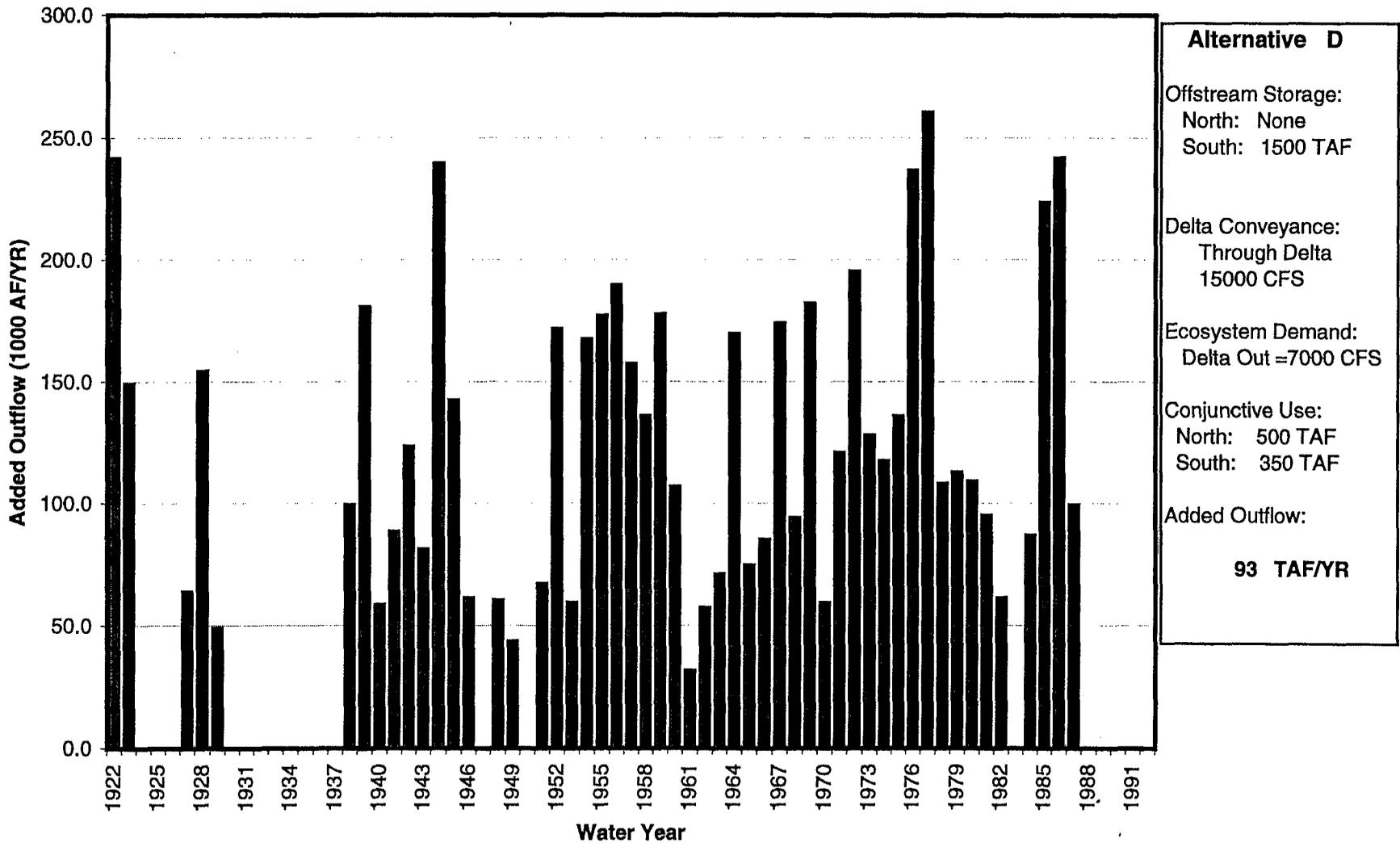
Additional Pumping for Exports

North of Delta Groundwater Operation (Managed for Delta Outflow)



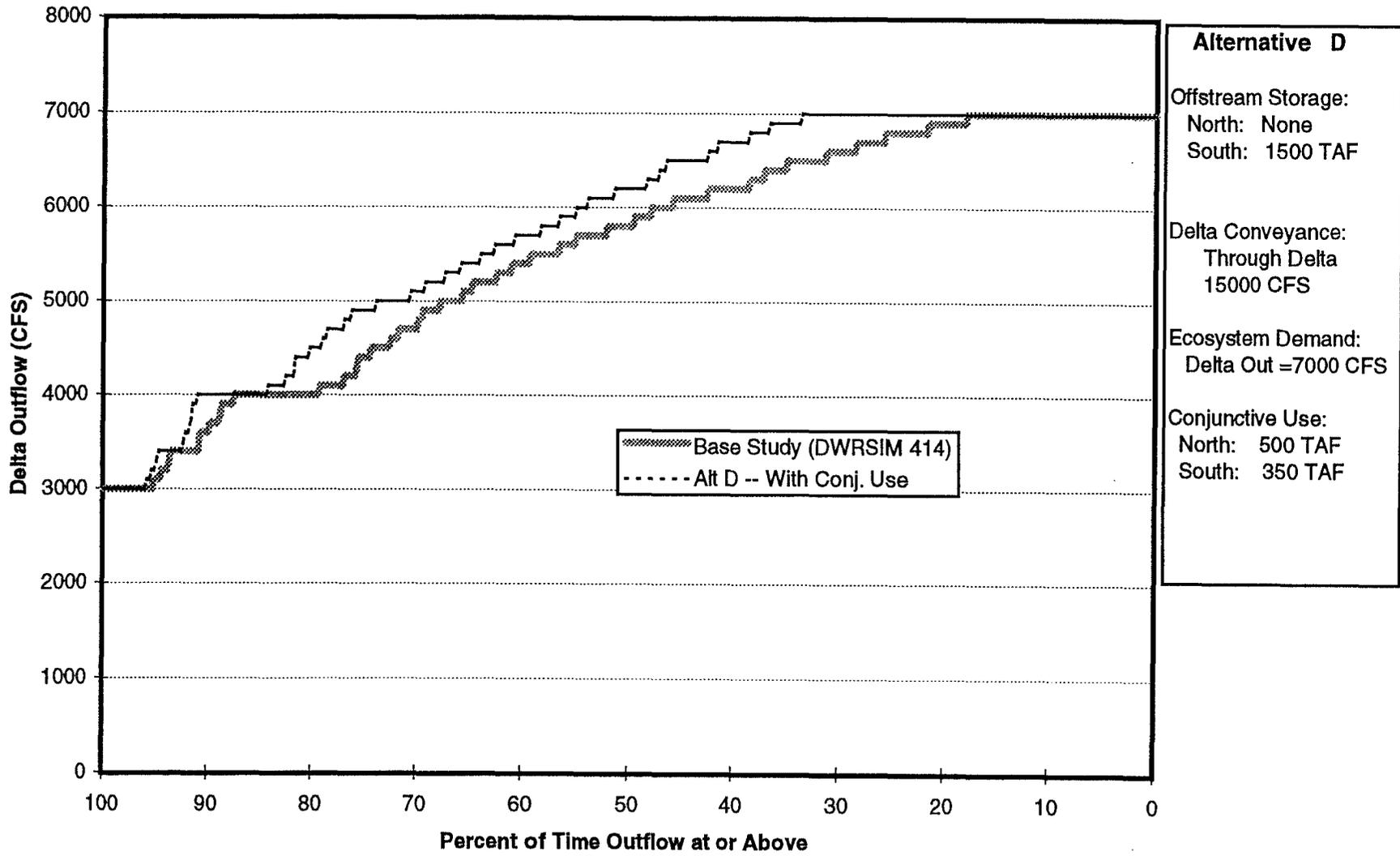
B - 0 0 5 6 9 2

Supplemental Delta Outflow from North of Delta Conjunctive Use

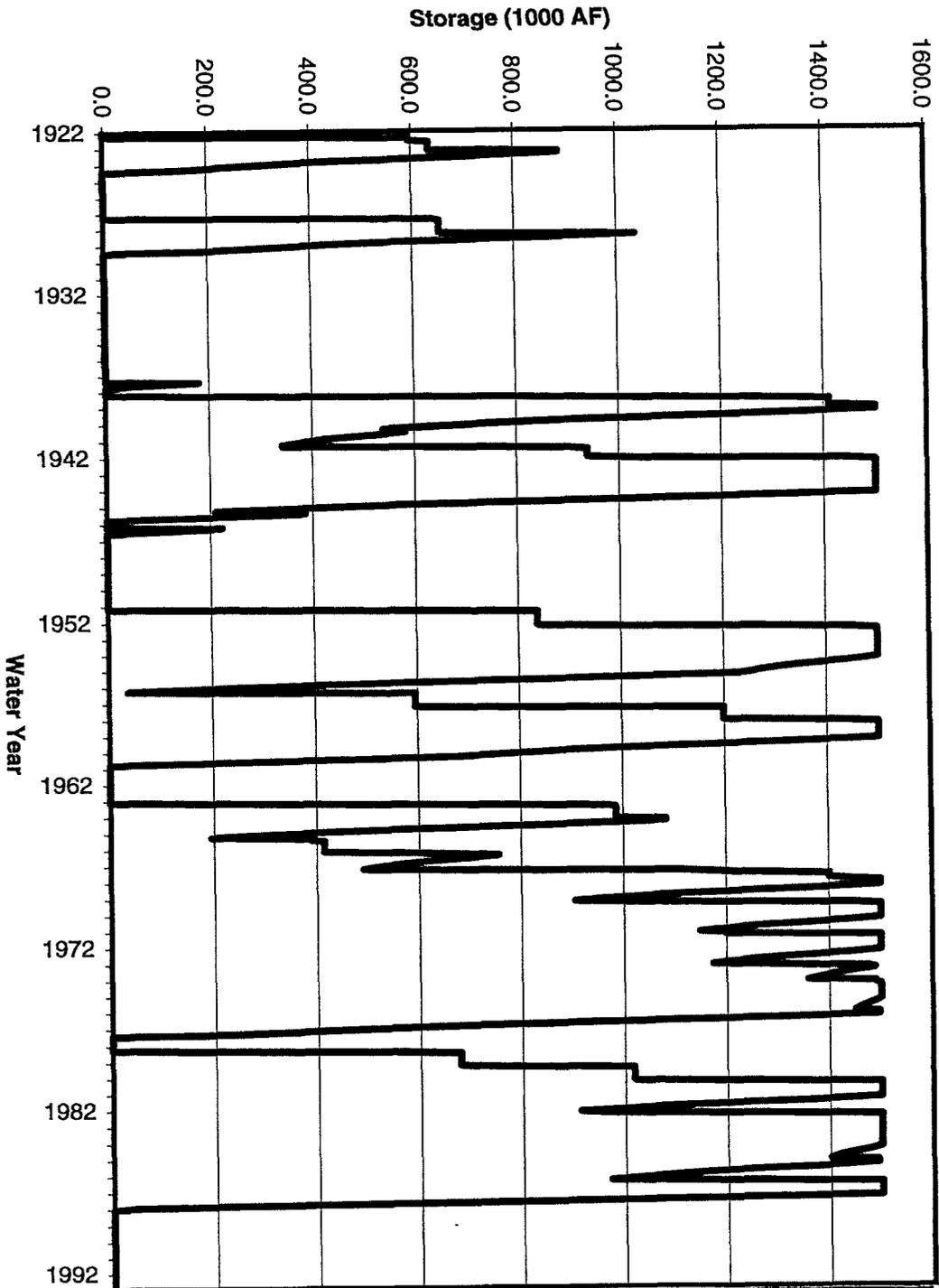


B - 0 0 5 6 9 3

Frequency of Delta Outflow -- Target = 7000 CFS April through September

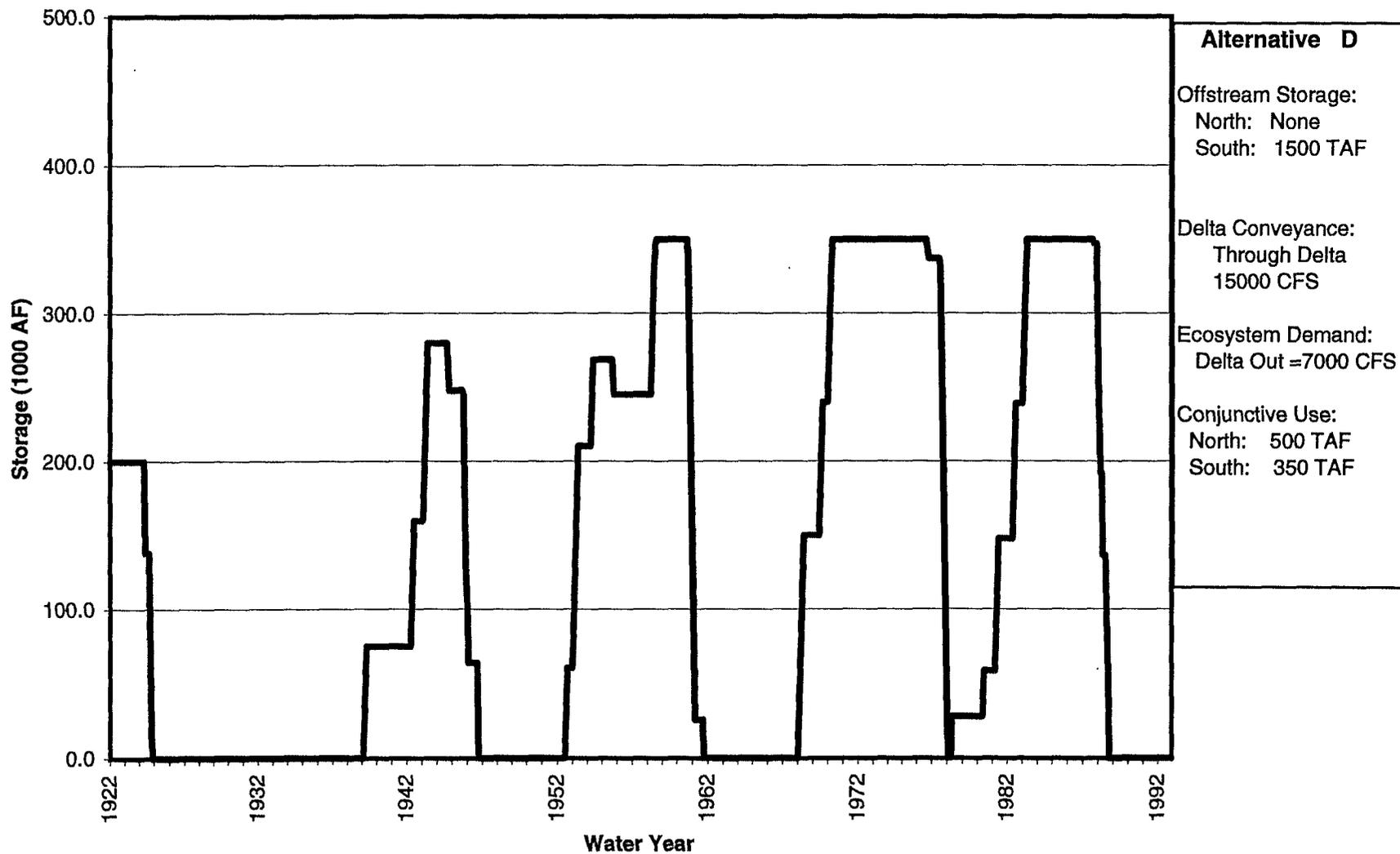


Offstream South of Delta Storage



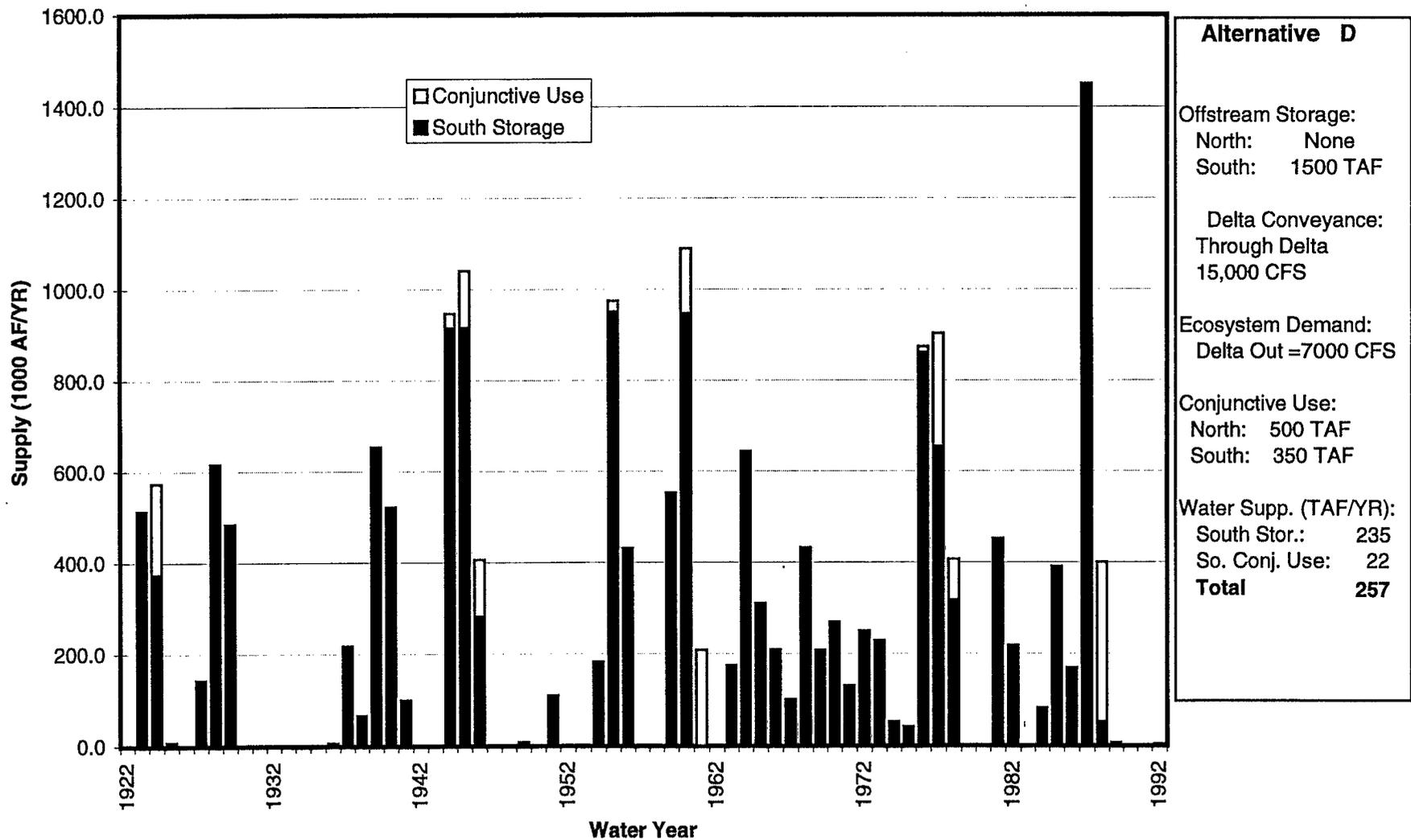
Alternative D
 Offstream Storage:
 North: None
 South: 1500 TAF
 Delta Conveyance:
 Through Delta
 15000 CFS
 Ecosystem Demand:
 Delta Out = 7000 CFS
 Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

South of Delta Groundwater Storage (Managed for Water Supply)



B-005696

Water Supply Opportunities from South Offstream Storage plus Conjunctive Use



B-005697



Alternative E

No detailed spreadsheet analysis was done for this alternative. To be done at a later date using other spreadsheet models once specific enviromental goals have been set for this alternative.



Alternative F

Facilities

North of Delta Storage:	None
South of Delta Storage:	None
In-Delta Storage:	400,000 Acre/Feet
Delta Conveyance:	Through Delta

Additional Criteria Assumptions for New Water Supply Opportunities

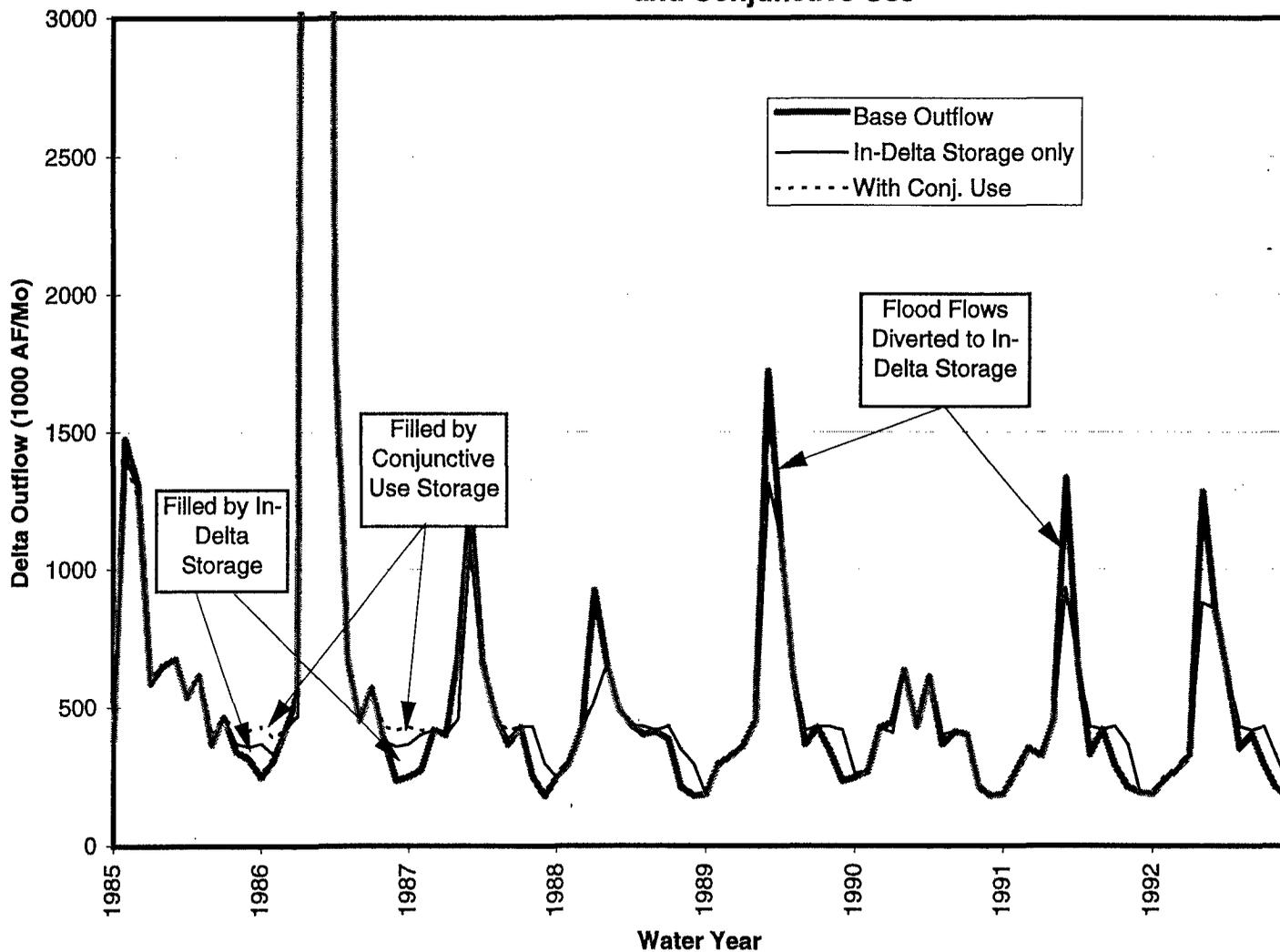
Water Supply Targets: To offset deficits in CVP/SWP demands as determined by base DWRSIM operation simulations to the extent possible. Demands are met on delivery patterns provided by DWR and the Bureau of Reclamation.

Environmental Targets: Provide for no less than 7000 CFS Delta outflow to the extent possible. Meet December 15 Delta criteria for Vernalis and south Delta with banked water from New Melones when available.

Simulation Assumptions

- Operate north of Delta groundwater storage in a conjunctive use mode for environmental opportunities. (To enhance Delta outflow.)
- Operate in-Delta storage for maximum outflow benefits. Provide incidental supply for exports from late fall in-Delta storage after outflows have been met.
- Meet deliveries to export areas as available.
- Operate south of Delta groundwater storage in a water banking mode for water supply opportunities. (To meet demand deficits.)
- Assumes full permitted use of Banks PP only when south Delta inflow conditions (flood flows) allow.

Total Modeled Delta Outflow -- 1985 to 1992 Supplemented by InDelta Storage and Conjunctive Use



Alternative F

Offstream Storage:
North: None
South: None
In-Delta: 400 TAF

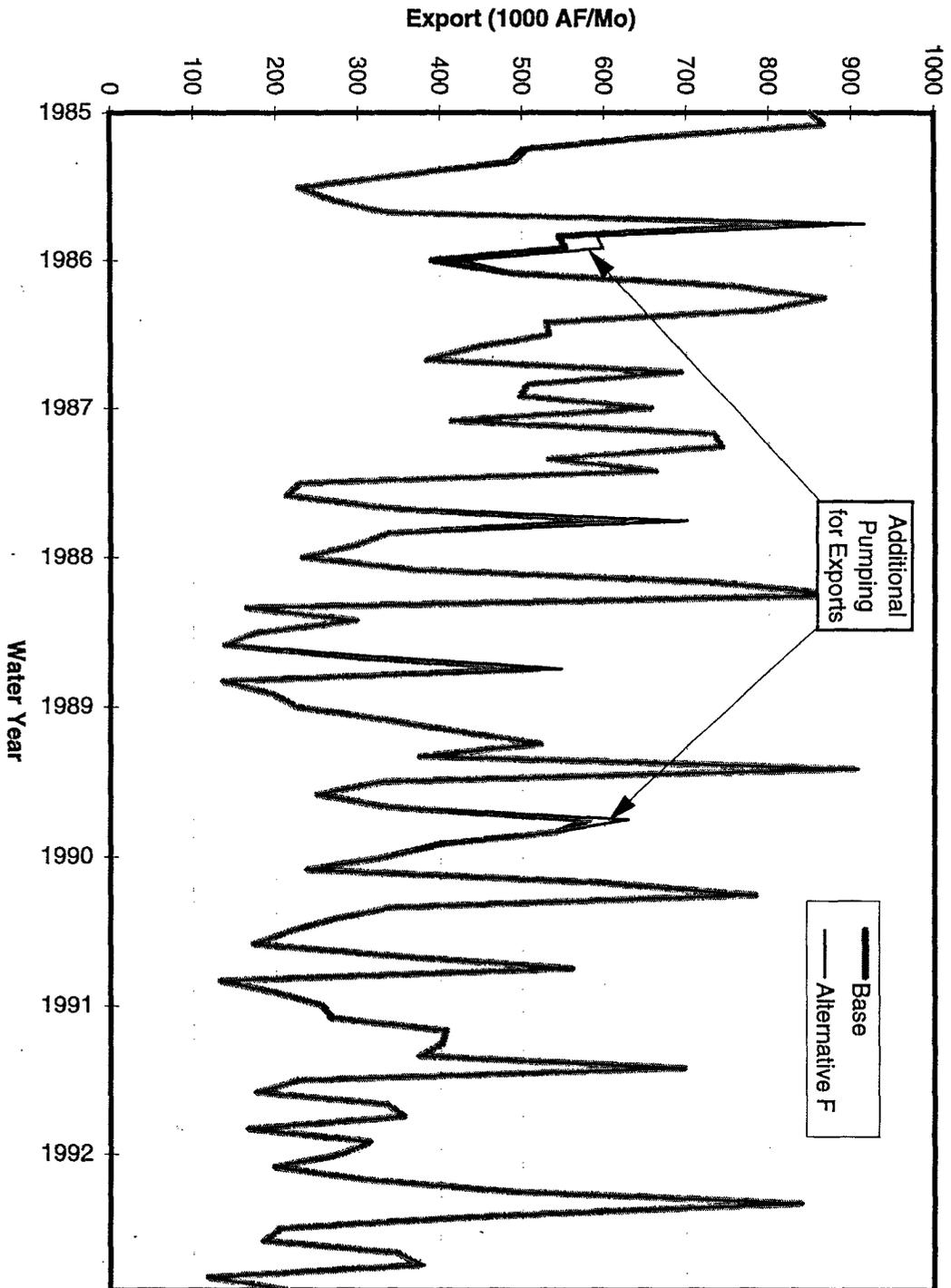
Delta Conveyance:
Through Delta

Ecosystem Demand:
Delta Out = 7000 CFS

Conjunctive Use:
North: 500 TAF
South: 350 TAF

B-005702

Total Modeled South Delta Export -- 1985 to 1992



Alternative F

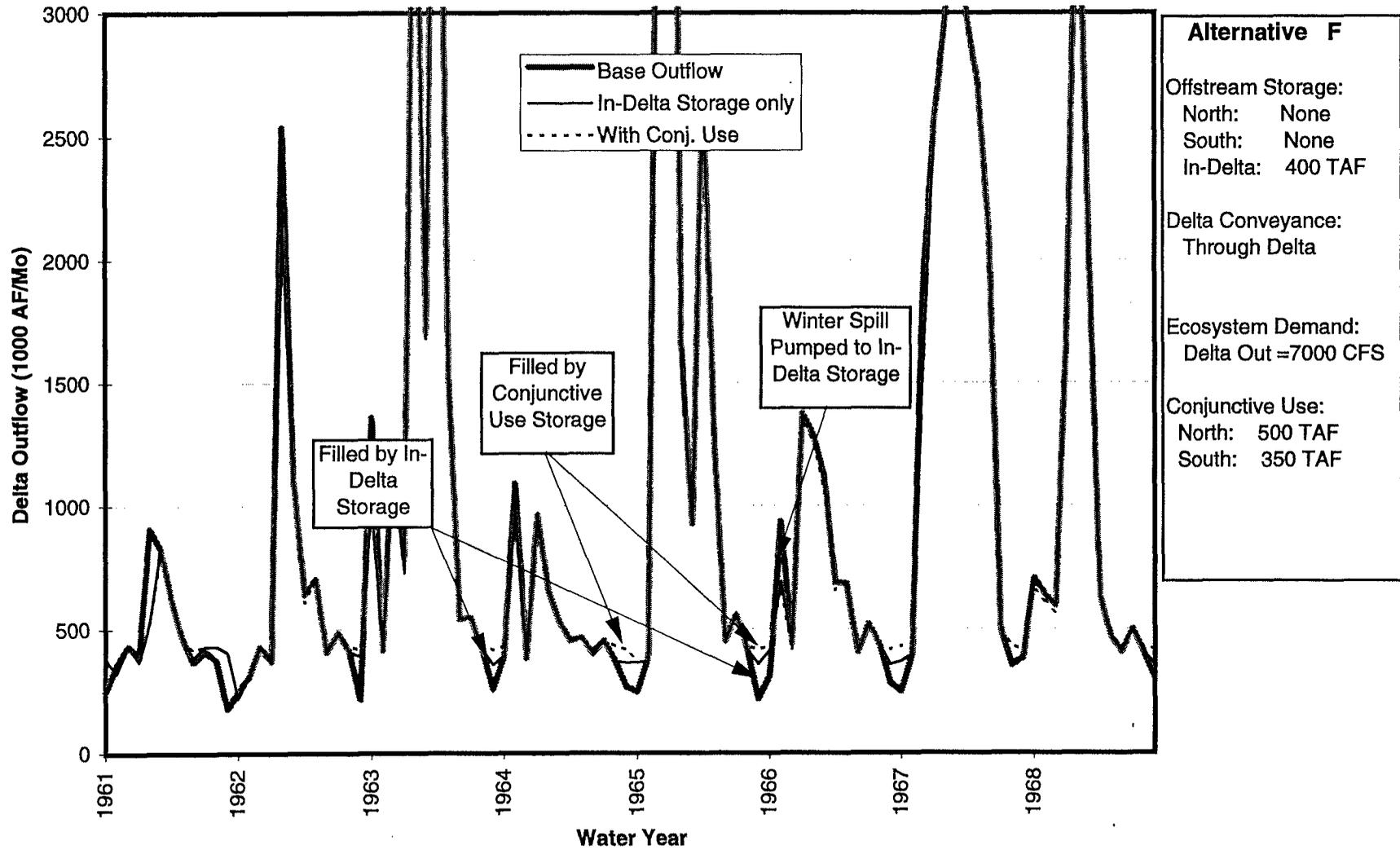
Offstream Storage:
 North: None
 South: None
 In-Delta: 400 TAF

Delta Conveyance:
 Through Delta

Ecosystem Demand:
 Delta Out = 7000 CFS

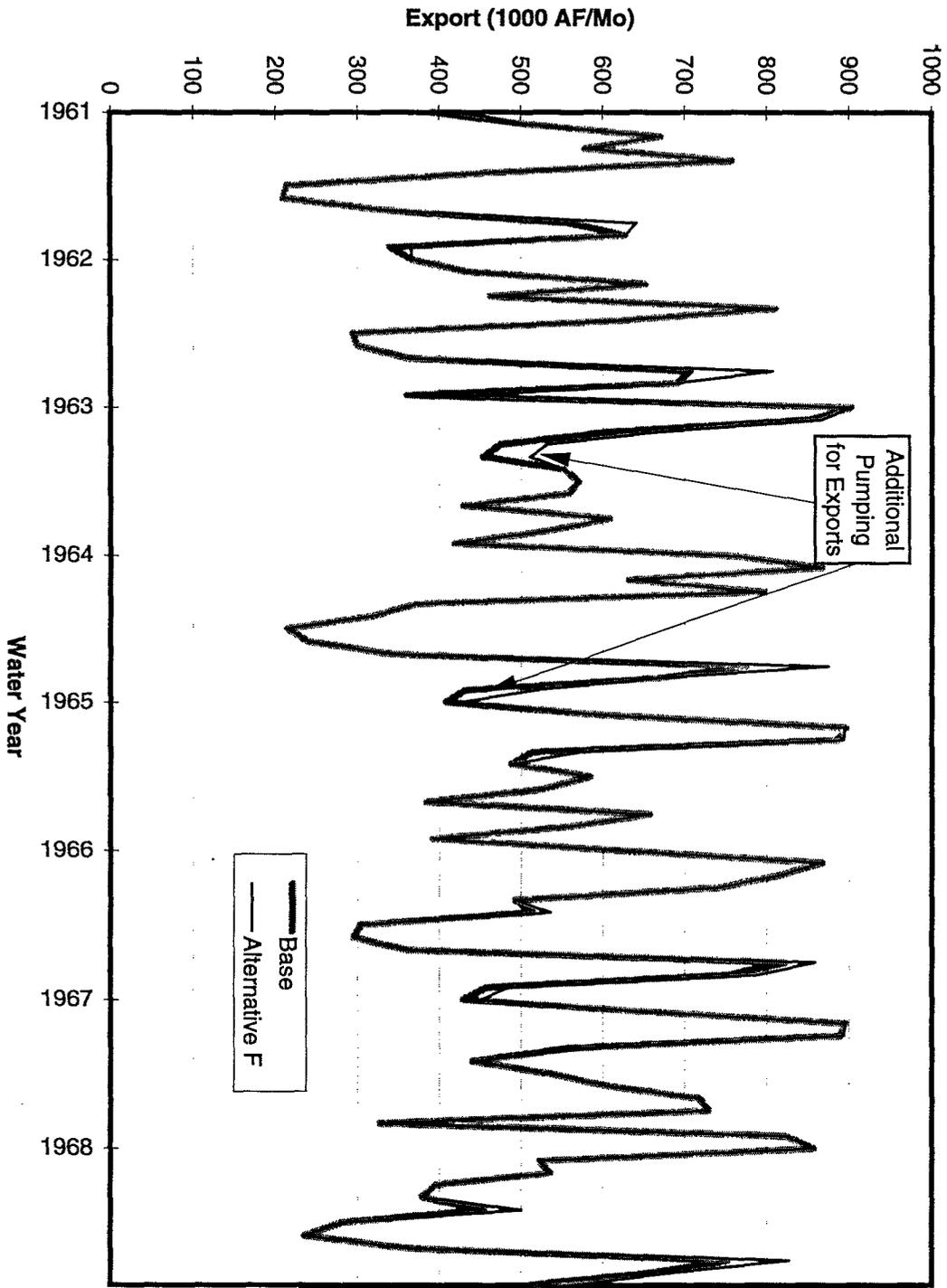
Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

Total Modeled Delta Outflow -- 1961 to 1968 Supplemented by In-Delta Storage and Conjunctive Use



B-005704

Total Modeled South Delta Export -- 1961 to 1968



— Base
 — Alternative F

Alternative F

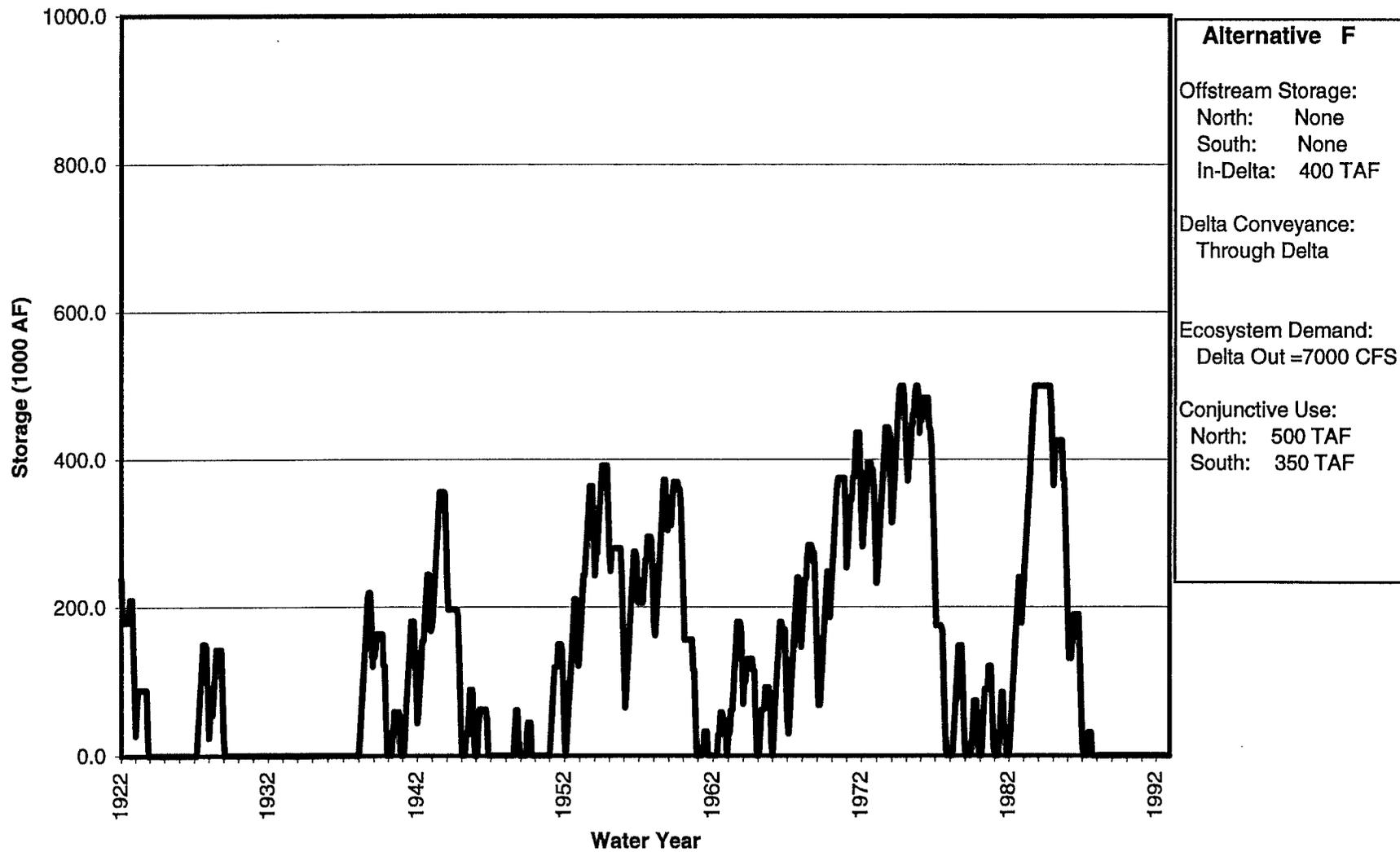
Offstream Storage:
 North: None
 South: None
 In-Delta: 400 TAF

Delta Conveyance:
 Through Delta

Ecosystem Demand:
 Delta Out = 7000 CFS

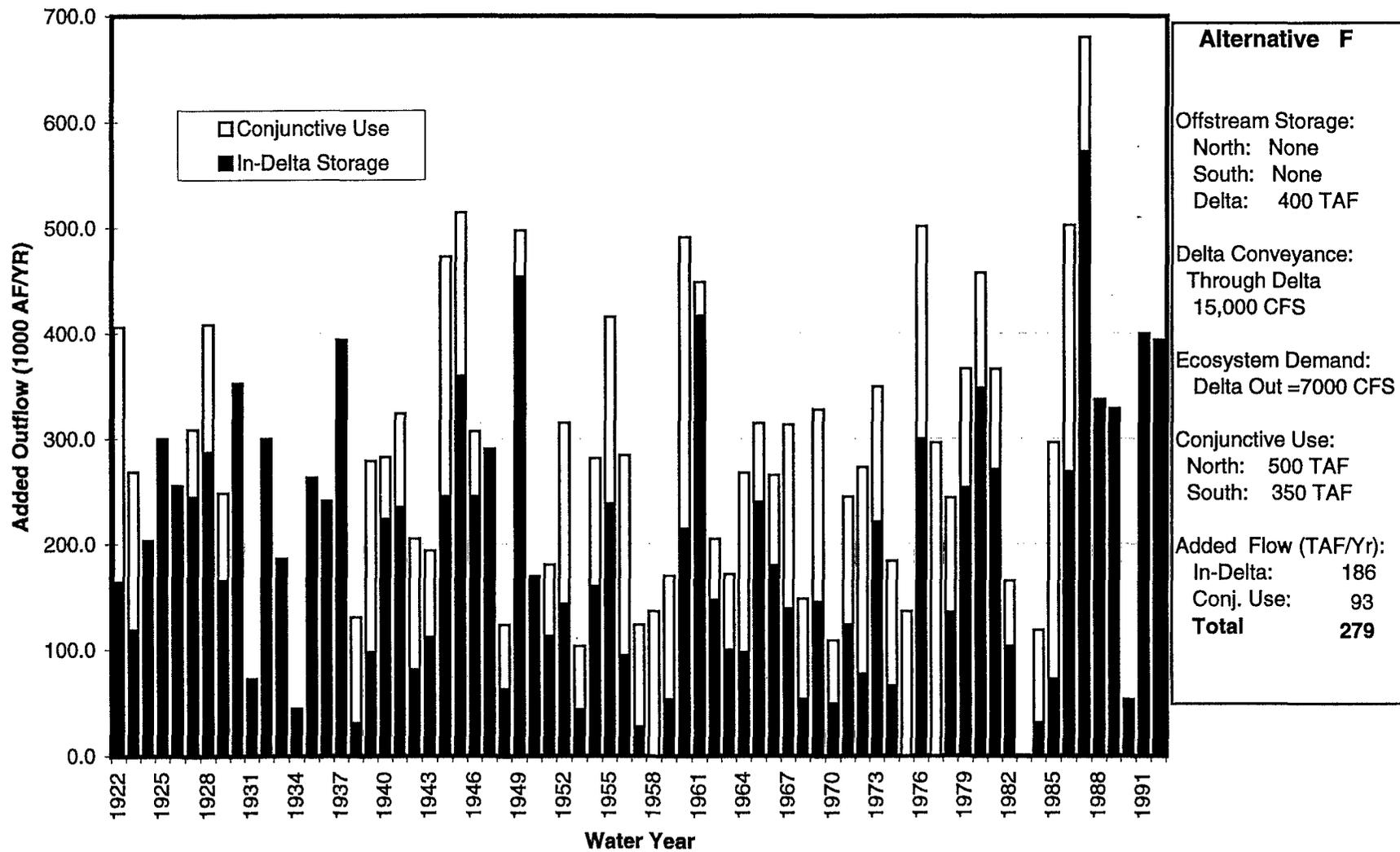
Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

North of Delta Groundwater Operation (Managed for Delta Outflow)



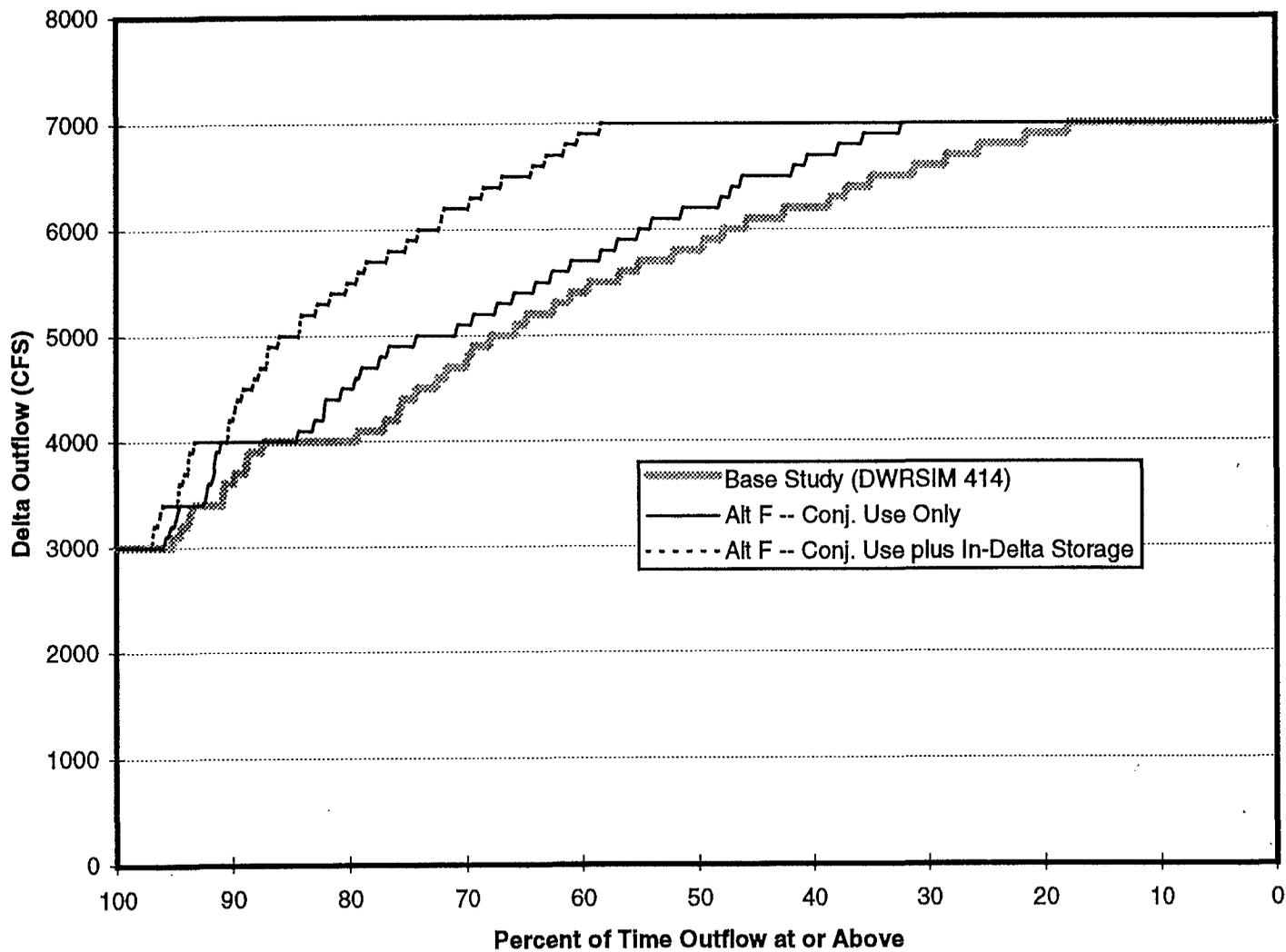
B-005706

Supplemental Delta Outflow from Storage and Conjunctive Use



B-005707

Frequency of Delta Outflow -- Target = 7000 CFS April through September



Alternative F

Offstream Storage:
North: None
South: None
In-Delta: 400 TAF

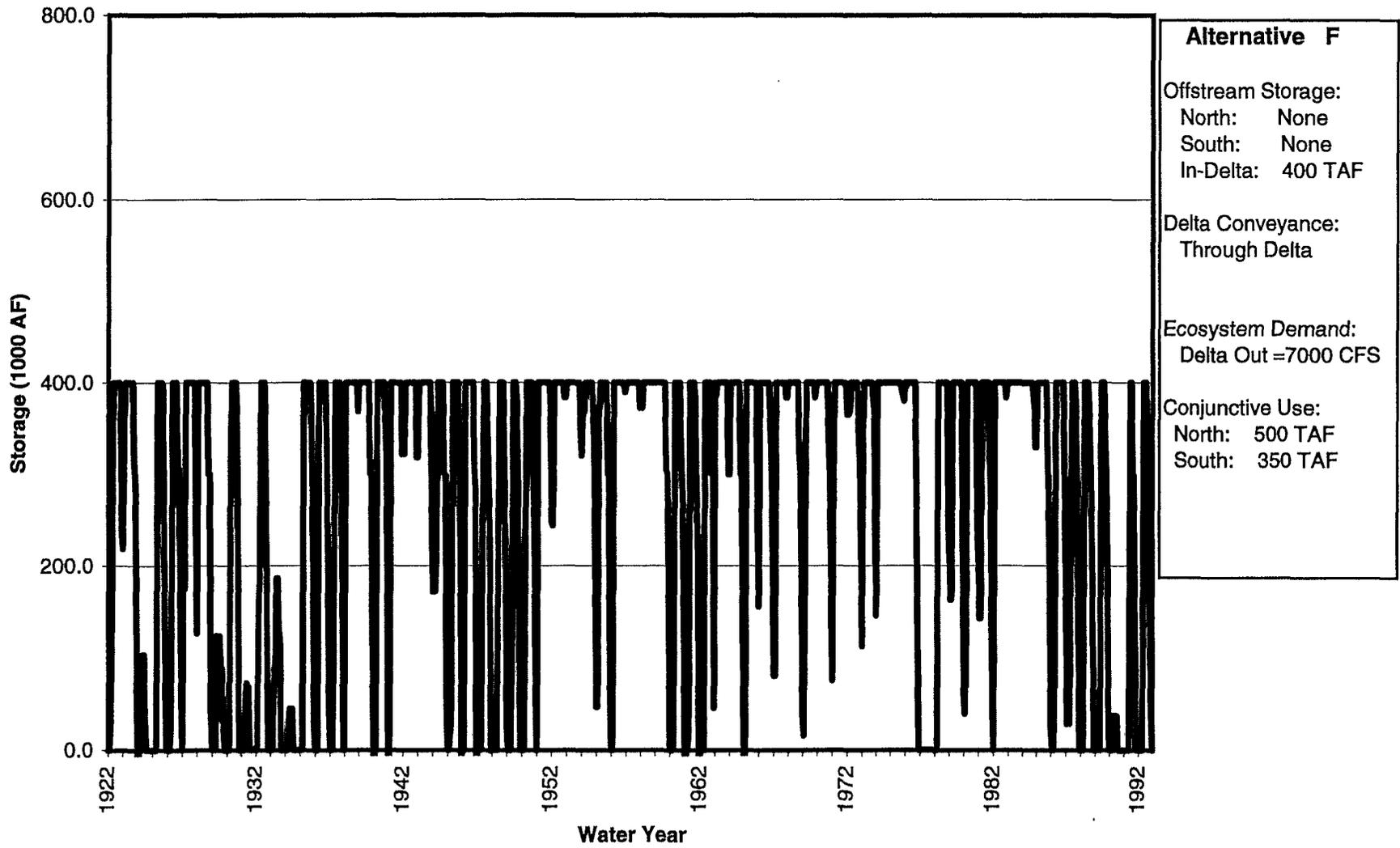
Delta Conveyance:
Through Delta

Ecosystem Demand:
Delta Out = 7000 CFS

Conjunctive Use:
North: 500 TAF
South: 350 TAF

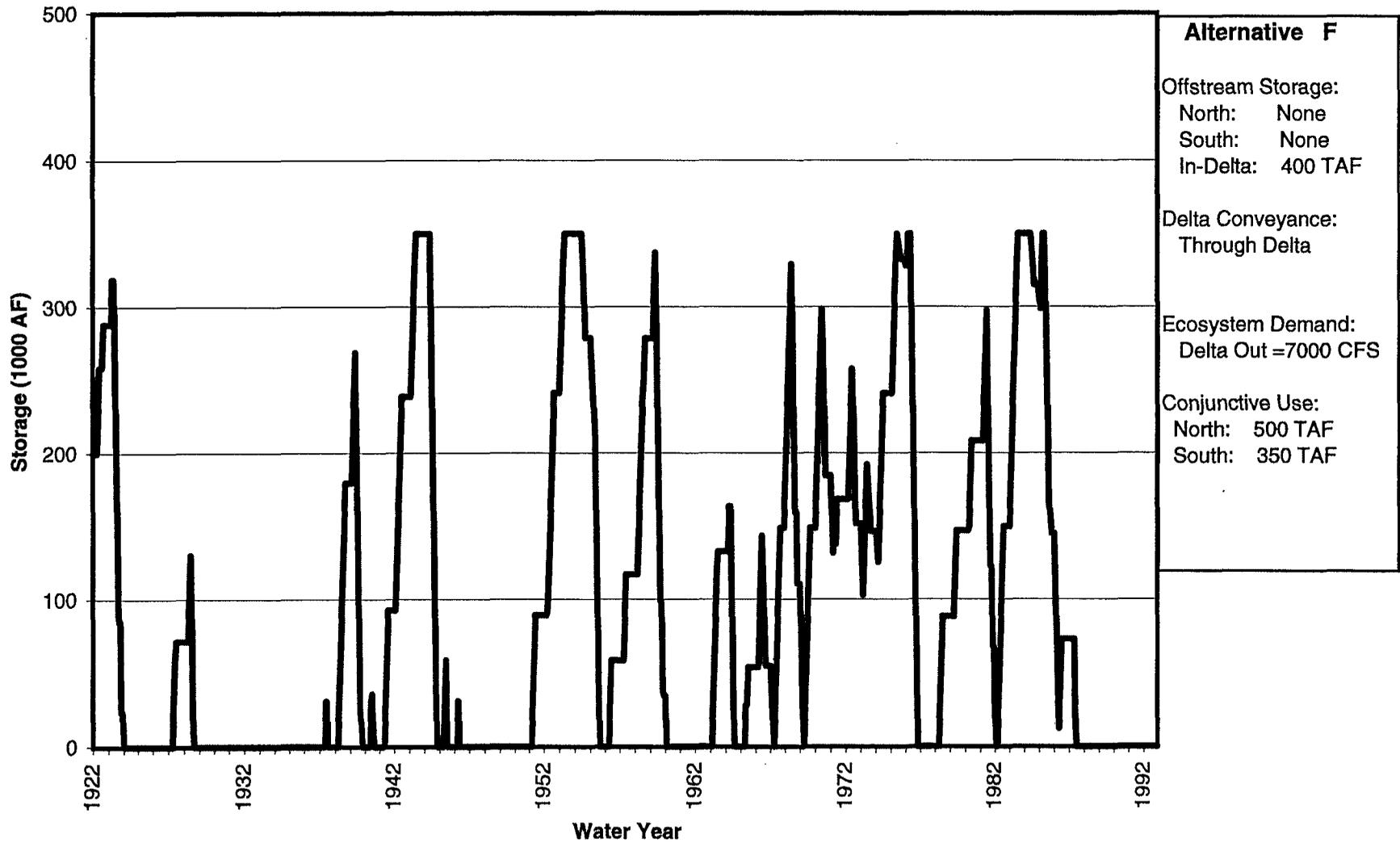
B-005708

In-Delta Storage



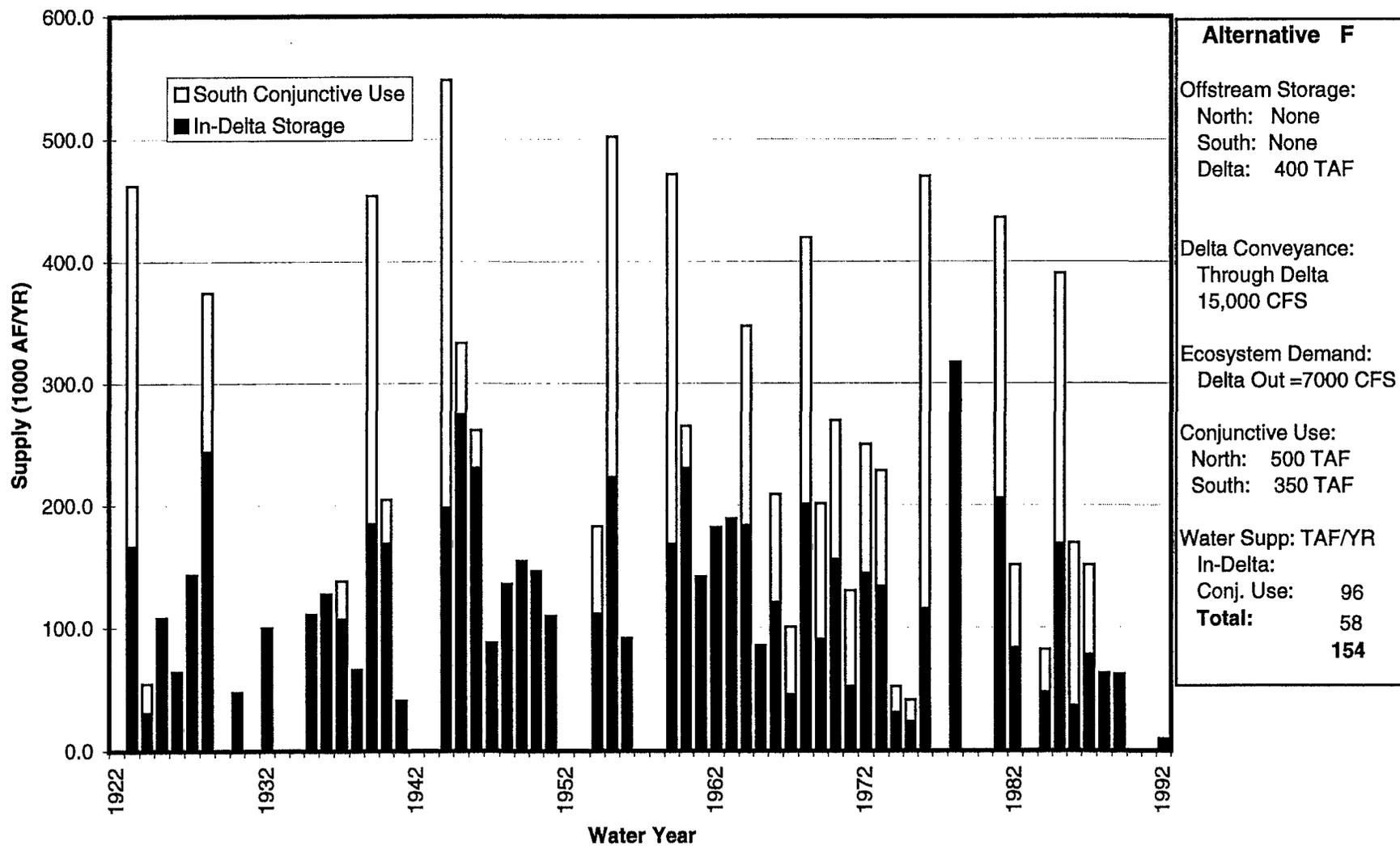
B-005709

South of Delta Storage Groundwater Storage (Managed for Water Supply Opportunities)



B-005710

Water Supply Opportunities from In-Delta Storage plus Conjunctive Use



B-005711

Alternative G



Alternative G

Facilities

North of Delta Storage:	None
South of Delta Storage:	None
In-Delta Storage:	100,000 Acre/Feet
New Melones:	Uses space as available to bank in-lieu deliveries to San Joaquin irrigators.
Delta Conveyance:	Isolated facility -- 7,000 CFS

Additional Criteria Assumptions for New Water Supply Opportunities

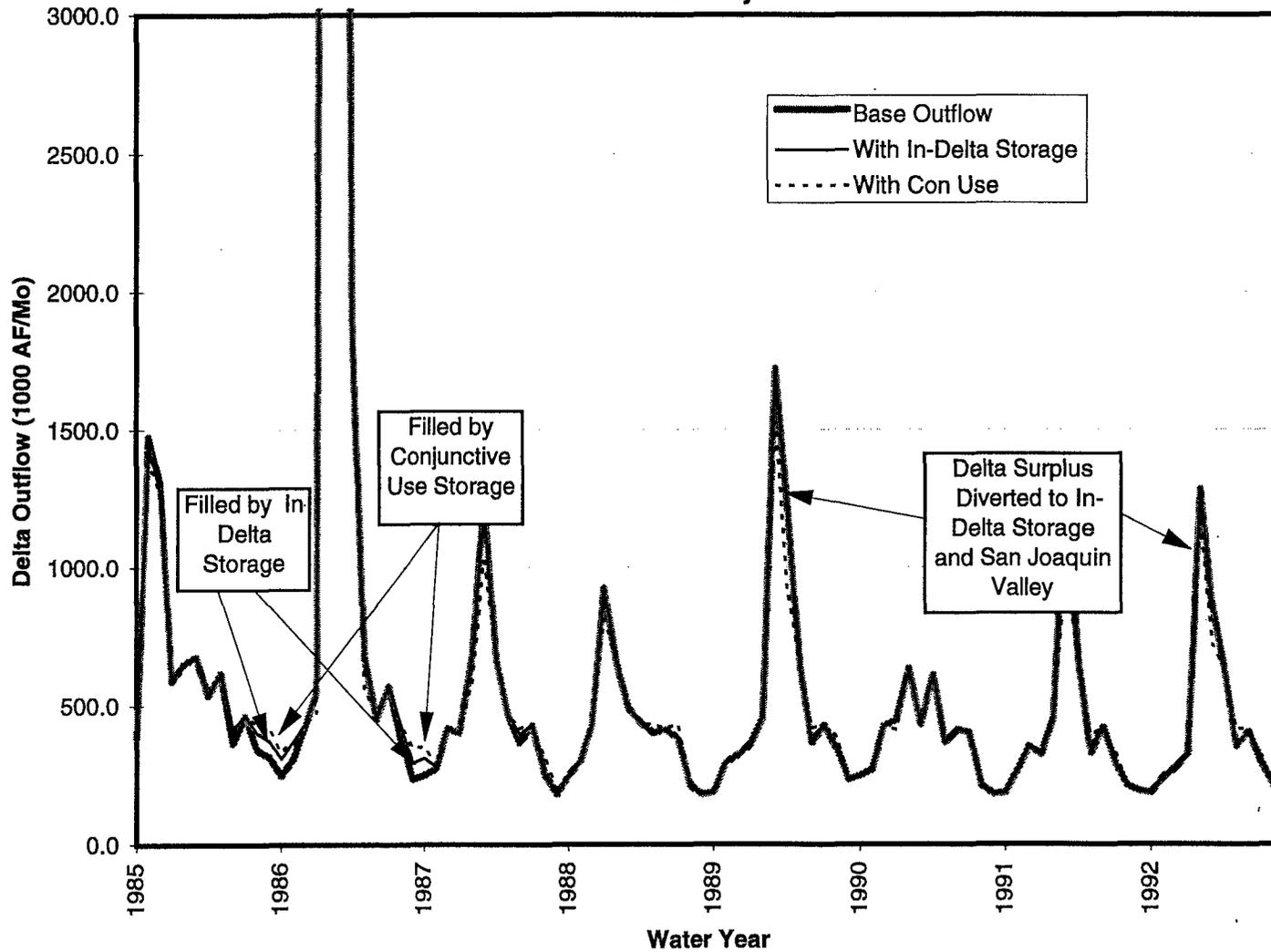
Water Supply Targets: To offset deficits in CVP/SWP demands as determined by base DWRSIM operation simulations to the extent possible. Demands are met on delivery patterns provided by DWR and the Bureau of Reclamation.

Environmental Targets: Provide for no less than 7000 CFS Delta outflow to the extent possible. Meet December 15 Delta criteria for Vernalis and south Delta with banked water from New Melones when available.

Simulation Assumptions

- Operate north of Delta groundwater storage in a conjunctive use mode for environmental opportunities. (To enhance Delta outflow.)
- Divert Sacramento River (Knights Landing) and Feather River (mouth) spills to new east side conveyance. Provide direct delivery to San Joaquin Basin (Stanislaus and Tuolumne River service areas on pattern. Bank in-lieu deliveries in New Melones. (Data was not available for potential Don Pedro storage. This could be done later.)
- Operate in-Delta storage for maximum outflow benefits. Provide incidental supply for exports from late fall in-Delta storage after outflows have been met.
- Meet deliveries to export areas as available.
- Operate south of Delta groundwater storage in a water banking mode for water supply opportunities. (To meet demand deficits.)
- Assumes up to maximum use of Banks PP capacity. The first 7000 CFS is available for export purposes. Remaining pumping tested for Export/Inflow ratio.

Total Modeled Delta Outflow -- 1985 to 1992 Supplemented by In-Delta Storage and Conjunctive Use



Alternative G

Offstream Storage:
North: None
South: None
Delta: 100 TAF

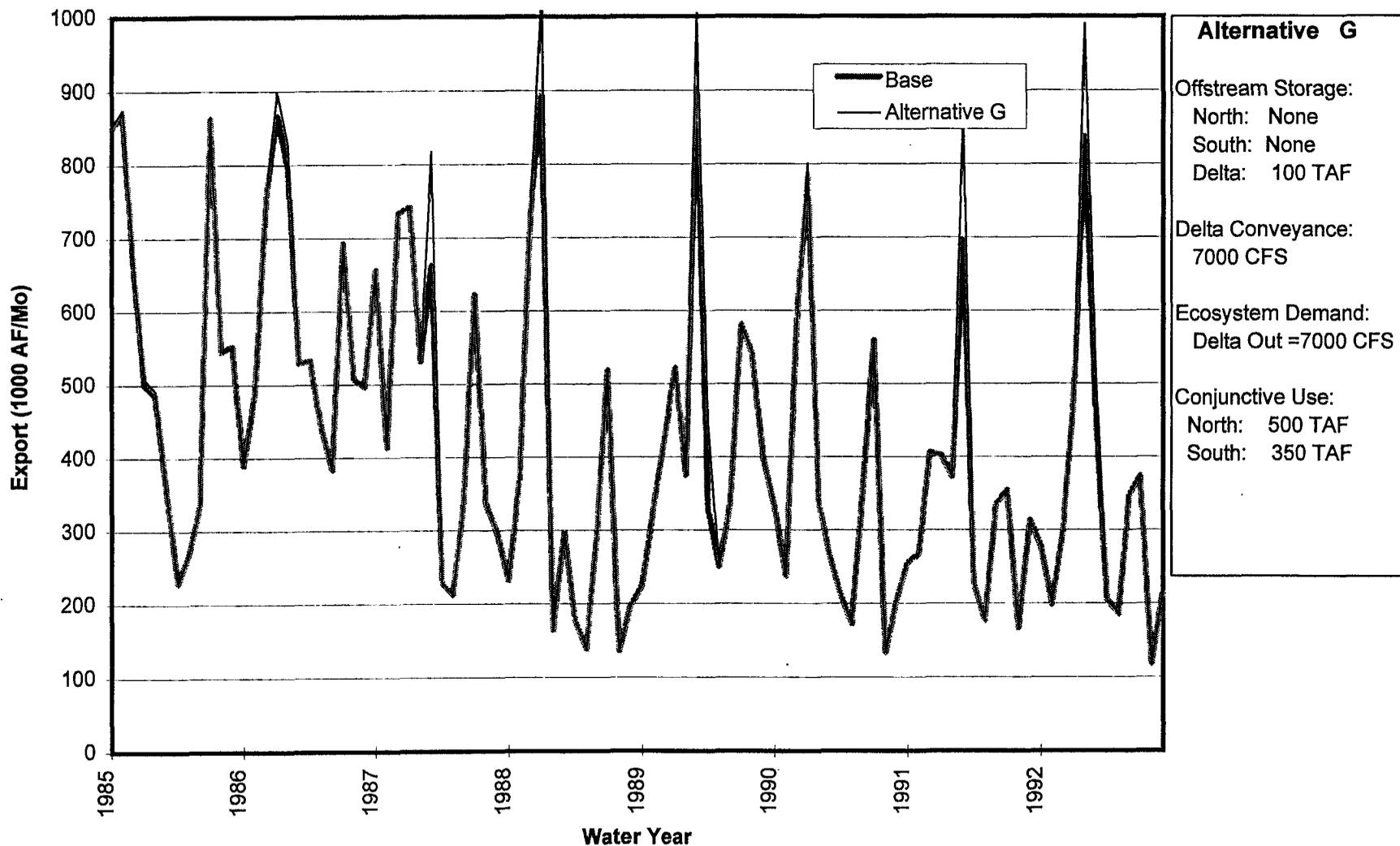
Delta Conveyance:
7000 CFS

Ecosystem Demand:
Delta Out = 7000 CFS

Conjunctive Use:
North: 500 TAF
South: 350 TAF

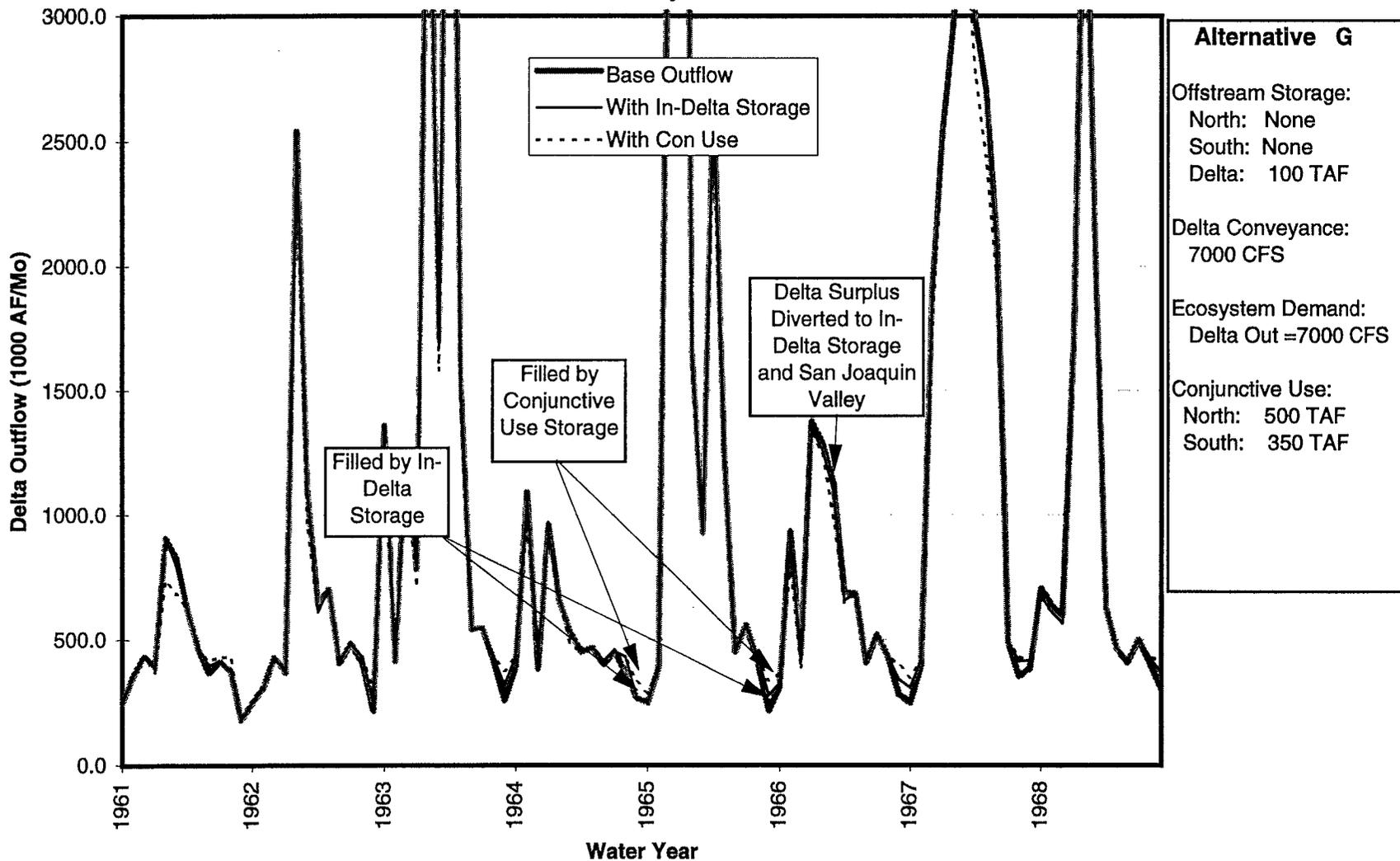
B-005714

Total Modeled South Delta Export -- 1985 to 1992



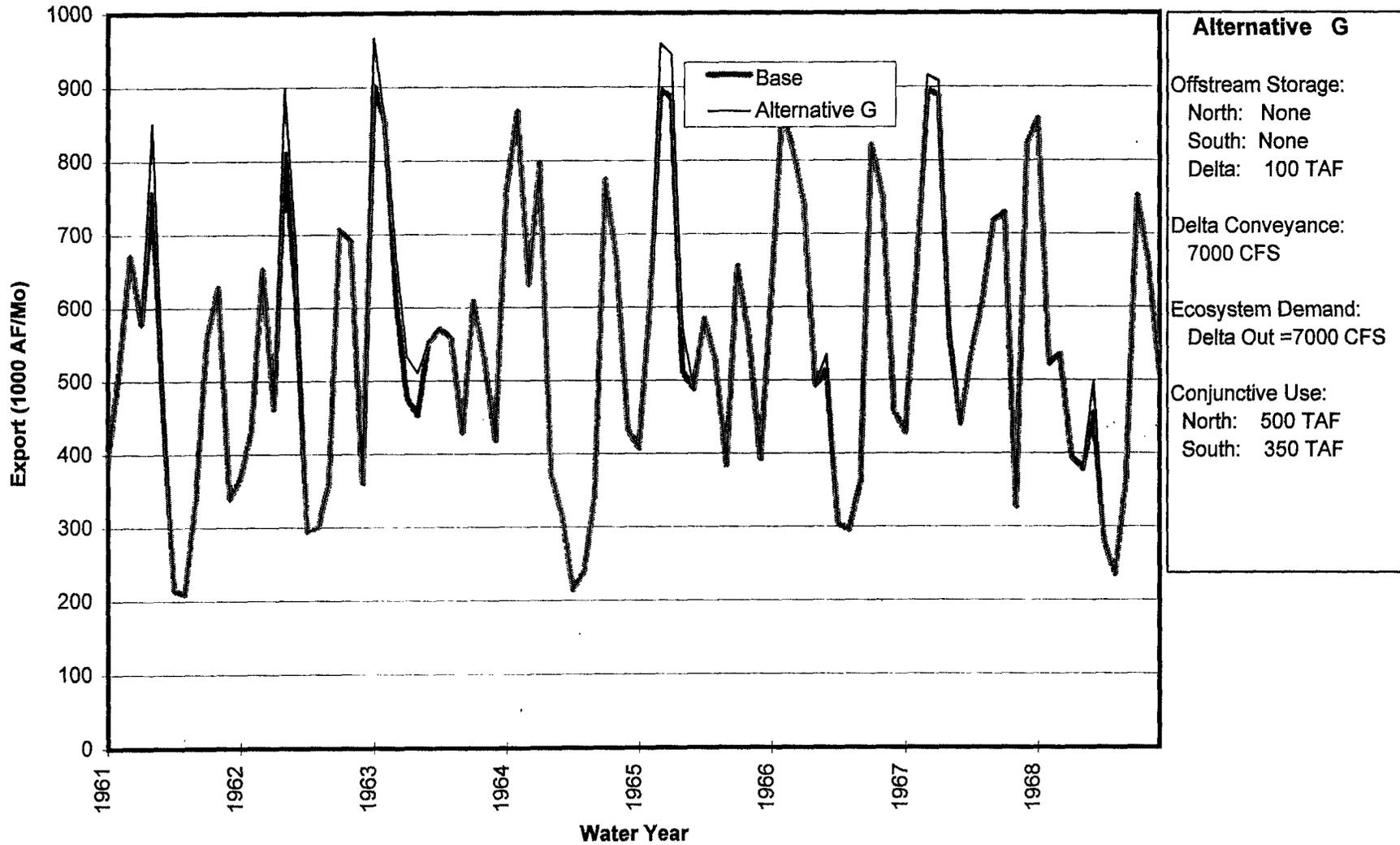
B - 0 0 5 7 1 5

Total Modeled Delta Outflow -- 1961 to 1968 Supplemented by In-Delta Storage and Conjunctive Use



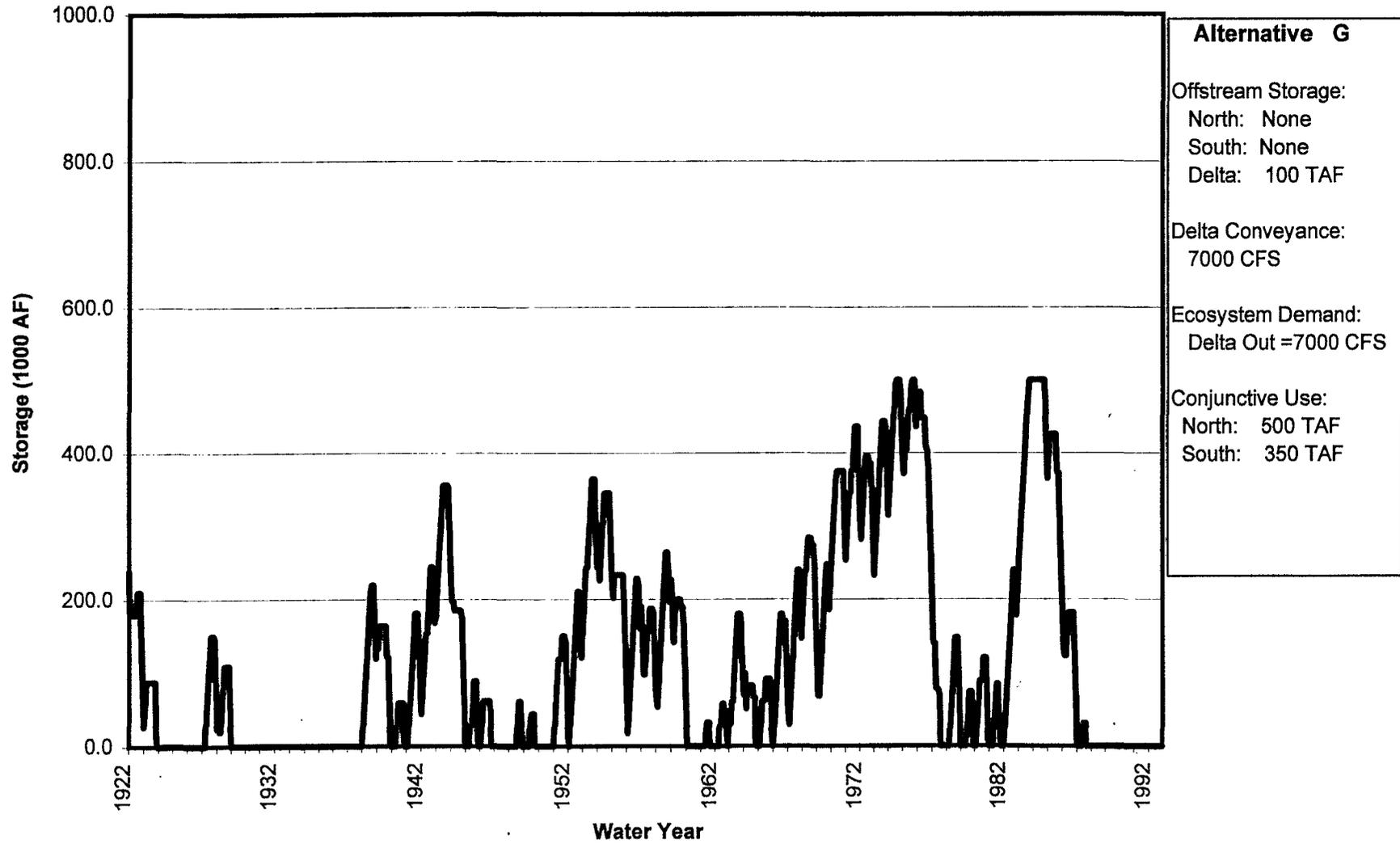
B - 0 0 5 7 1 6

Total Modeled South Delta Export -- 1961 to 1968



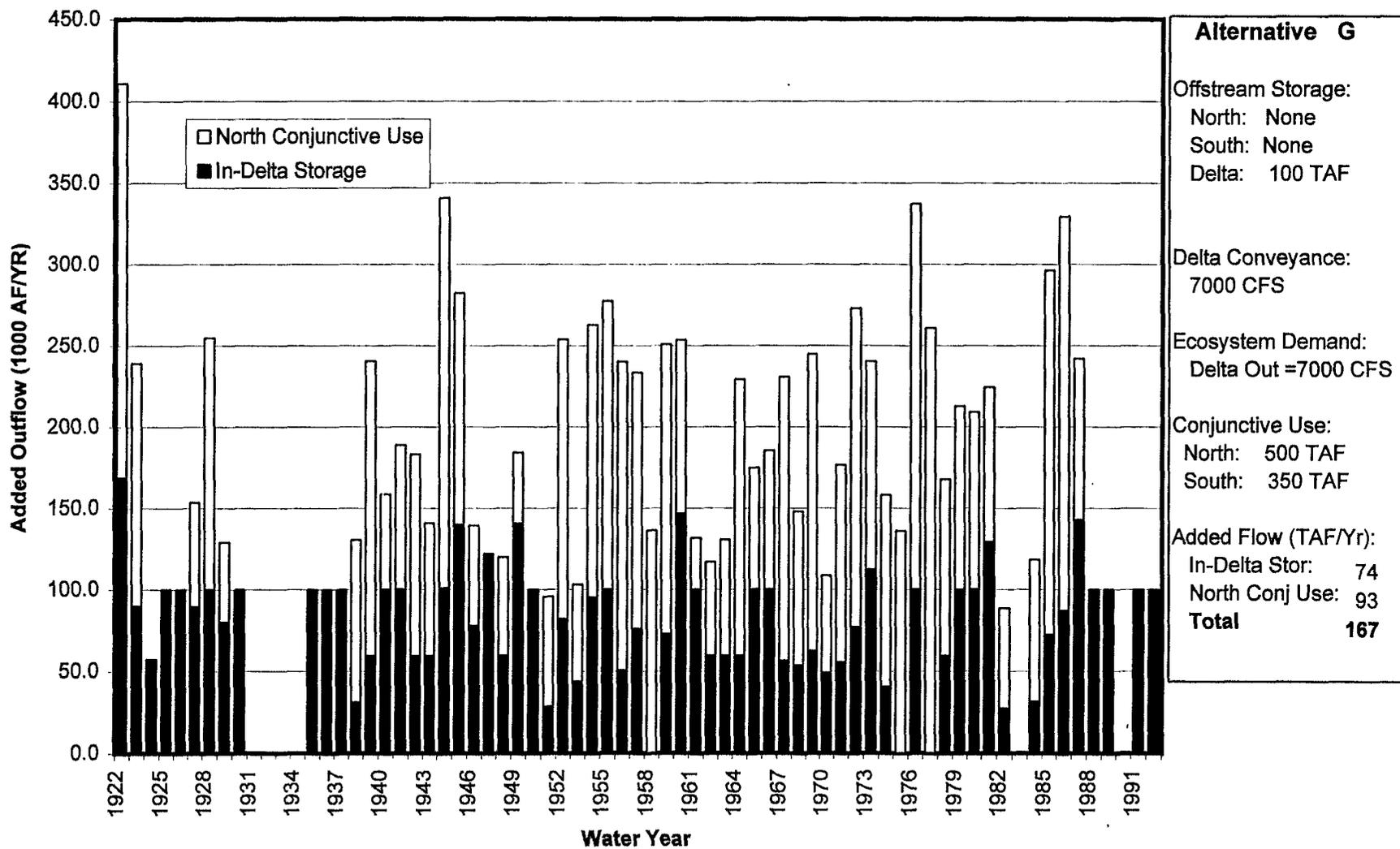
B-005717

North of Delta Groundwater Operation (Managed for Delta Outflow)



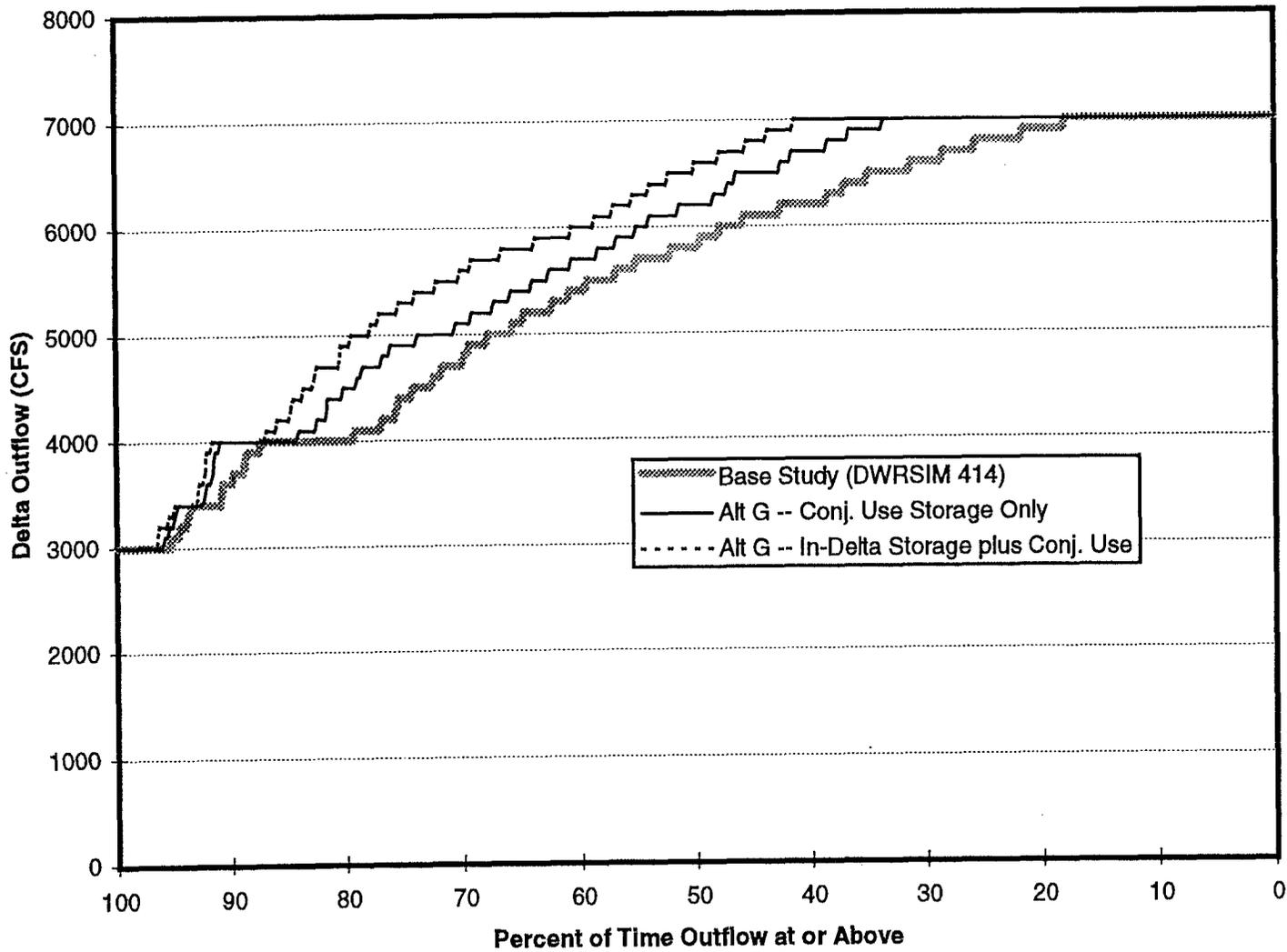
B-005718

Supplemental Delta Outflow from Storage and Conjunctive Use



B-005719

Frequency of Delta Outflow -- Target = 7000 CFS April through September



Alternative G

Offstream Storage:
North: None
South: None
Delta: 100 TAF

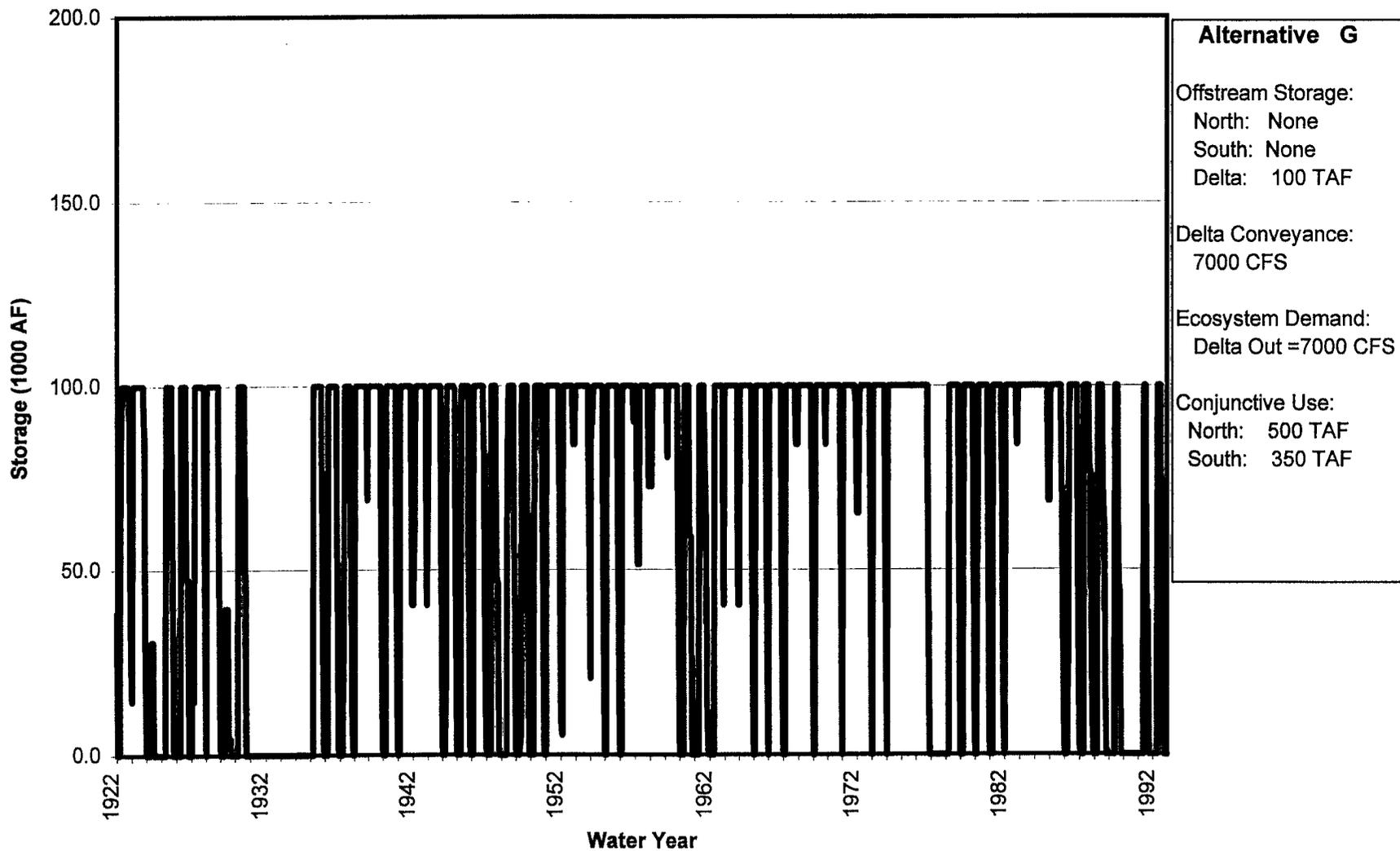
Delta Conveyance:
7000 CFS

Ecosystem Demand:
Delta Out = 7000 CFS

Conjunctive Use:
North: 500 TAF
South: 350 TAF

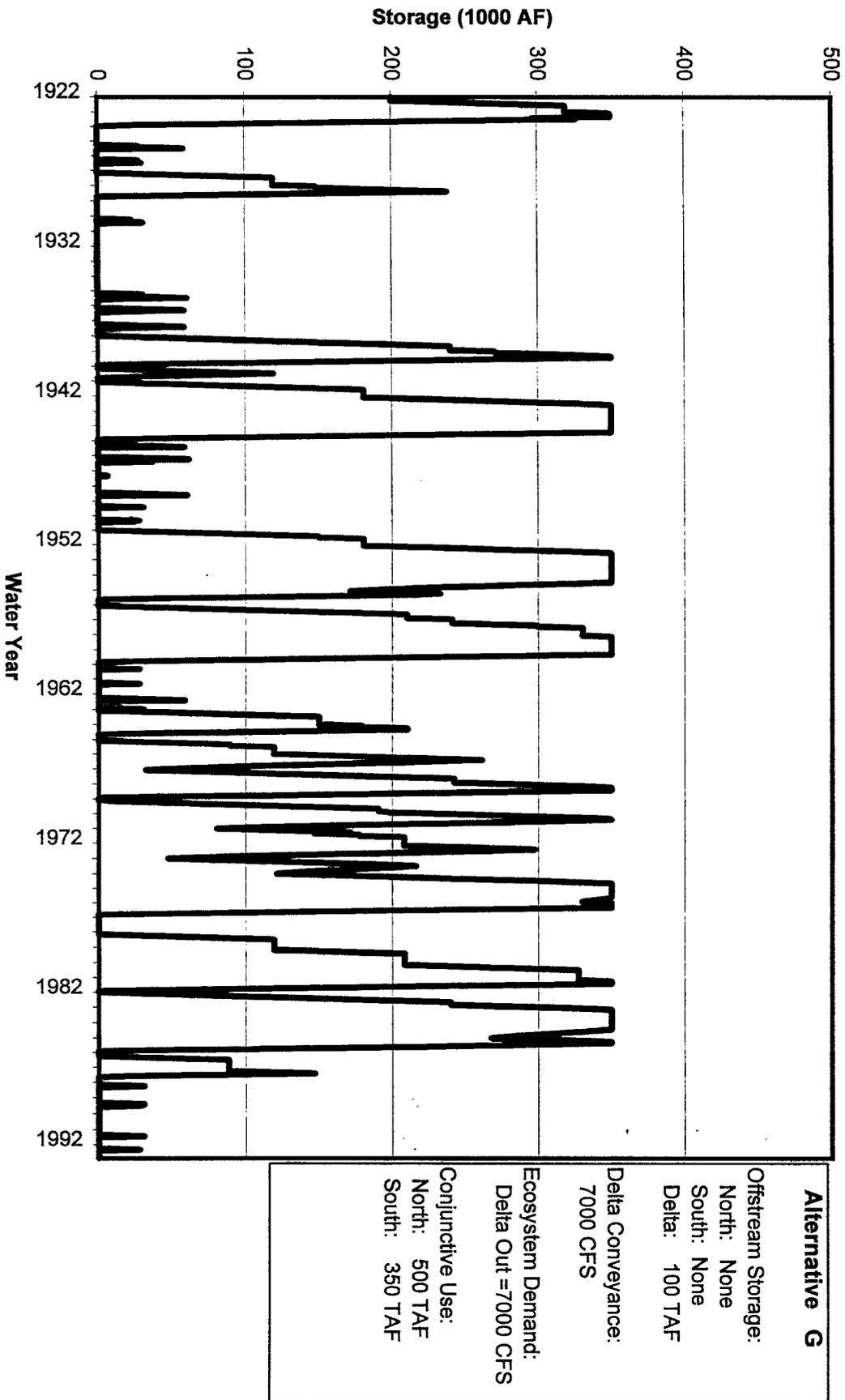
B-005720

In-Delta Storage

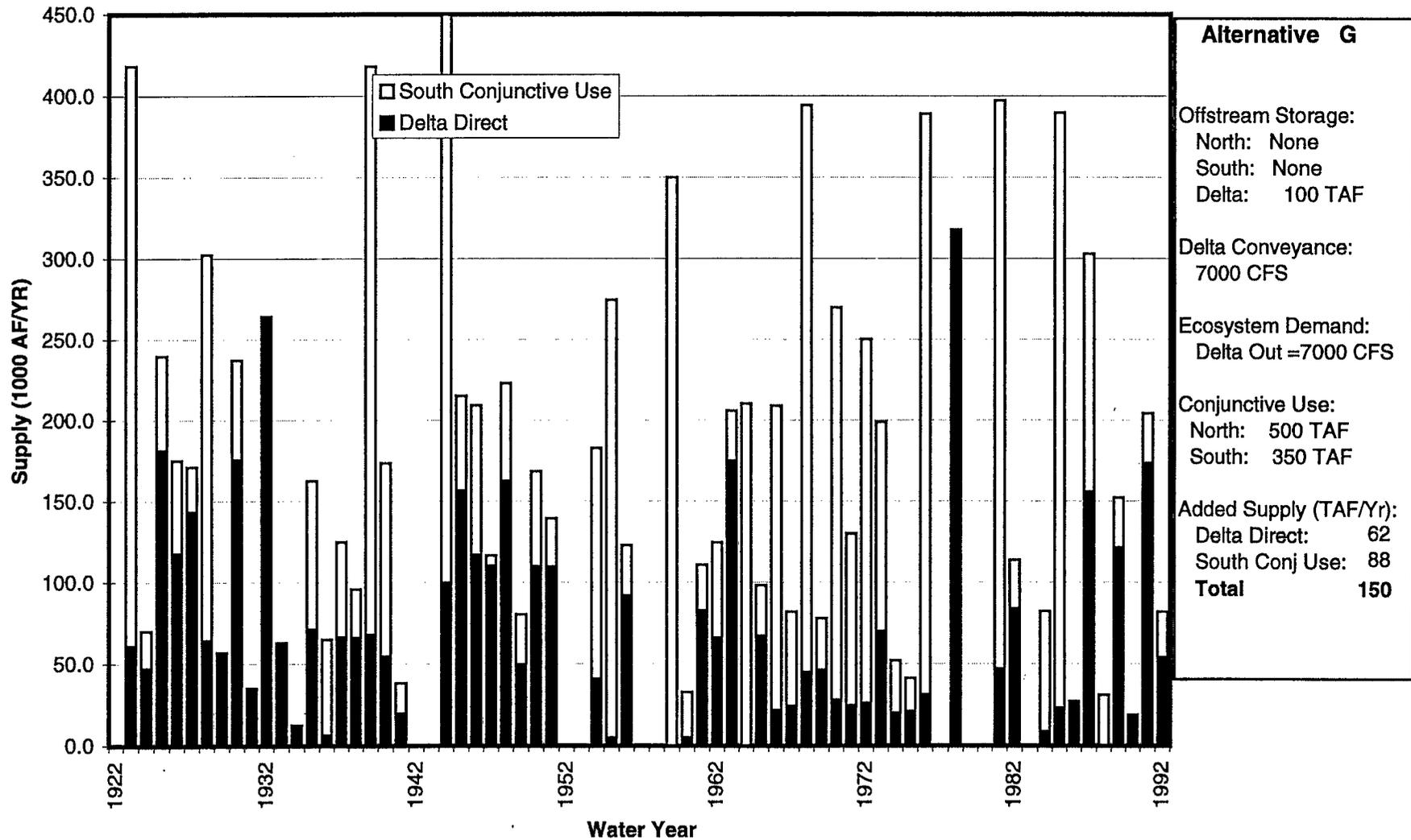


B - 0 0 5 7 2 1

**South of Delta Groundwater Operation
(Managed for Water Supply Opportunities)**

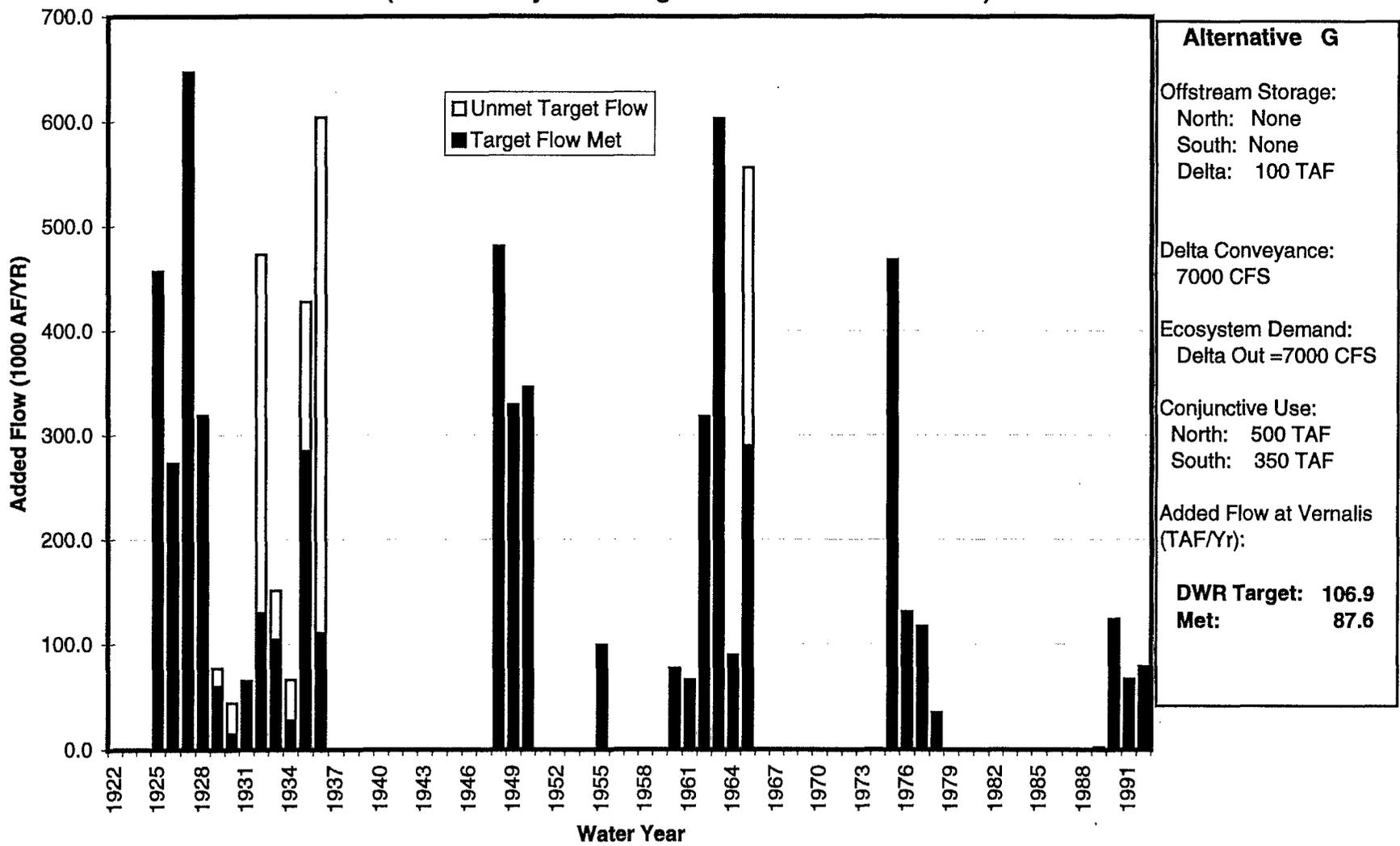


Water Supply Opportunities from Delta Direct plus Conjunctive Use



B-005723

**Supplemental Flow San Joaquin River at Vernalis
 (From Stored San Joaquin Basin Water -- In-Lieu Deliveries)
 (DWR Quality Flow Target vs. Flow Met With Alt. G)**



B-005724

Alternative H



Alternative H

Facilities

North of Delta Storage:	None
South of Delta Storage:	None
In-Delta Storage:	Chain of Lakes -- 600,000 Acre/Feet
Delta Conveyance:	Chain of Lakes

Additional Criteria Assumptions for New Water Supply Opportunities

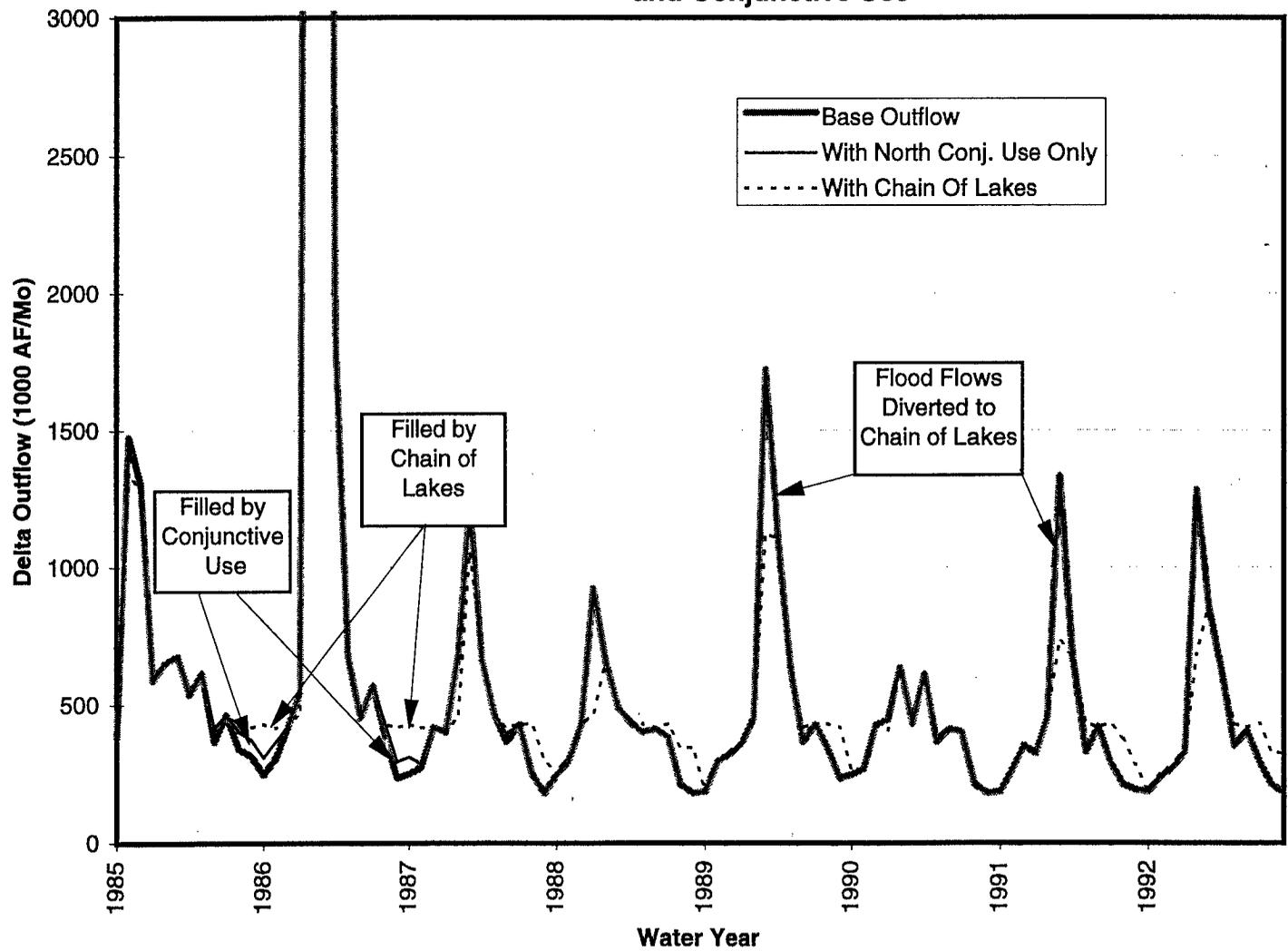
Water Supply Targets: To offset deficits in CVP/SWP demands as determined by base DWRSIM operation simulations to the extent possible. Demands are met on delivery patterns provided by DWR and the Bureau of Reclamation.

Environmental Targets: Provide for no less than 7000 CFS Delta outflow to the extent possible.

Simulation Assumptions

- Operate north of Delta groundwater storage in a conjunctive use mode for environmental opportunities. (To enhance Delta outflow.)
- Operate Chain of Lakes storage for maximum outflow benefits. Provide incidental supply for exports from late fall in-Delta storage after outflows have been met.
- Meet deliveries to export areas as available.
- Operate south of Delta groundwater storage in a water banking mode for water supply opportunities. (To meet demand deficits.)
- Treat as isolated facility. Use maximum available Banks Pumping Plant capacity.

Total Modeled Delta Outflow -- 1985 to 1992 Supplemented by Chain of Lakes Storage and Conjunctive Use



Alternative H

Offstream Storage:
North: None
South: None
Chain: 600 TAF

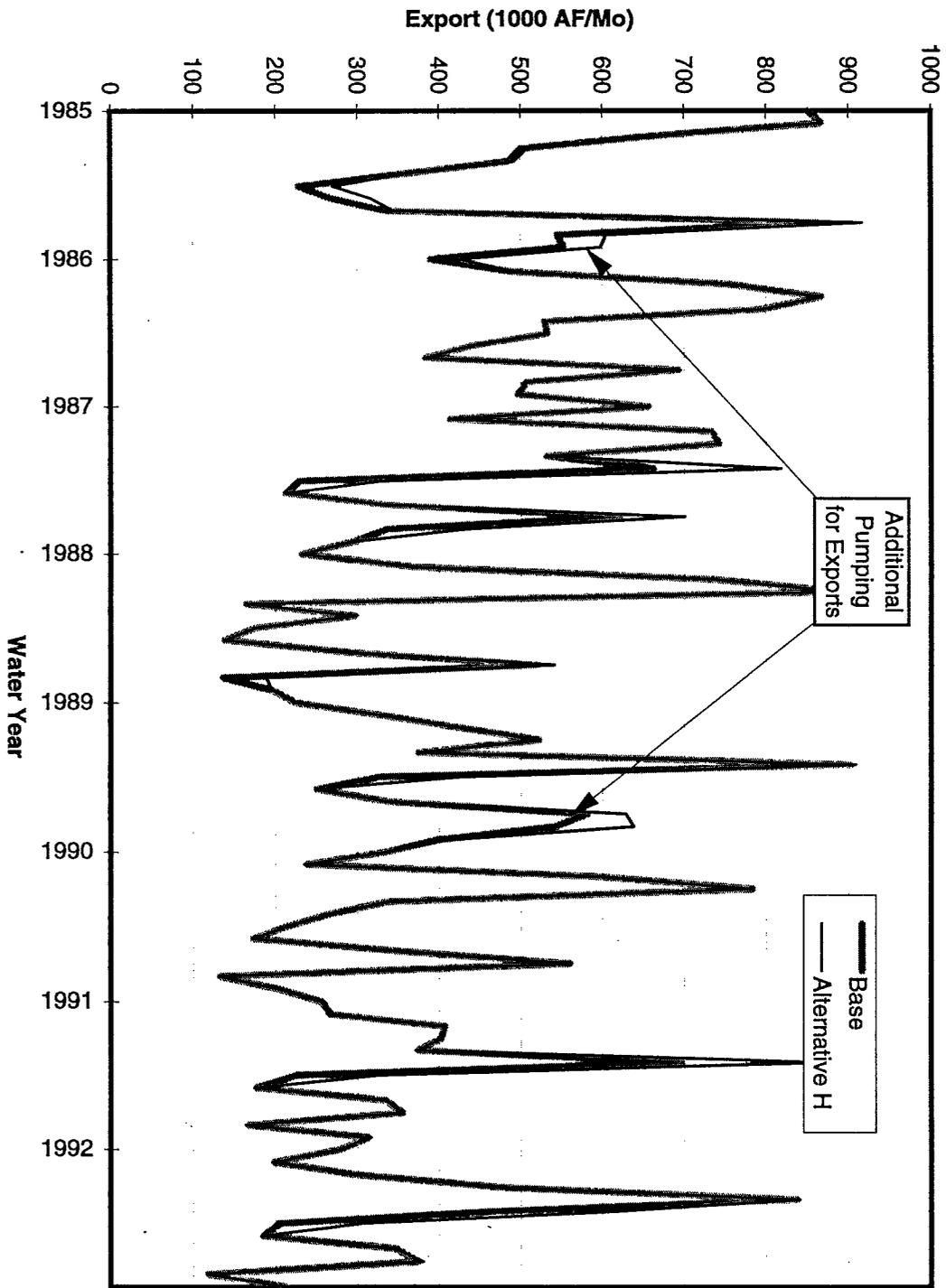
Delta Conveyance:
Chain of Lakes
15,000 CFS

Ecosystem Demand:
Delta Out = 7000 CFS

Conjunctive Use:
North: 500 TAF
South: 350 TAF

B-005727

Total Modeled South Delta Export -- 1985 to 1992



Alternative H

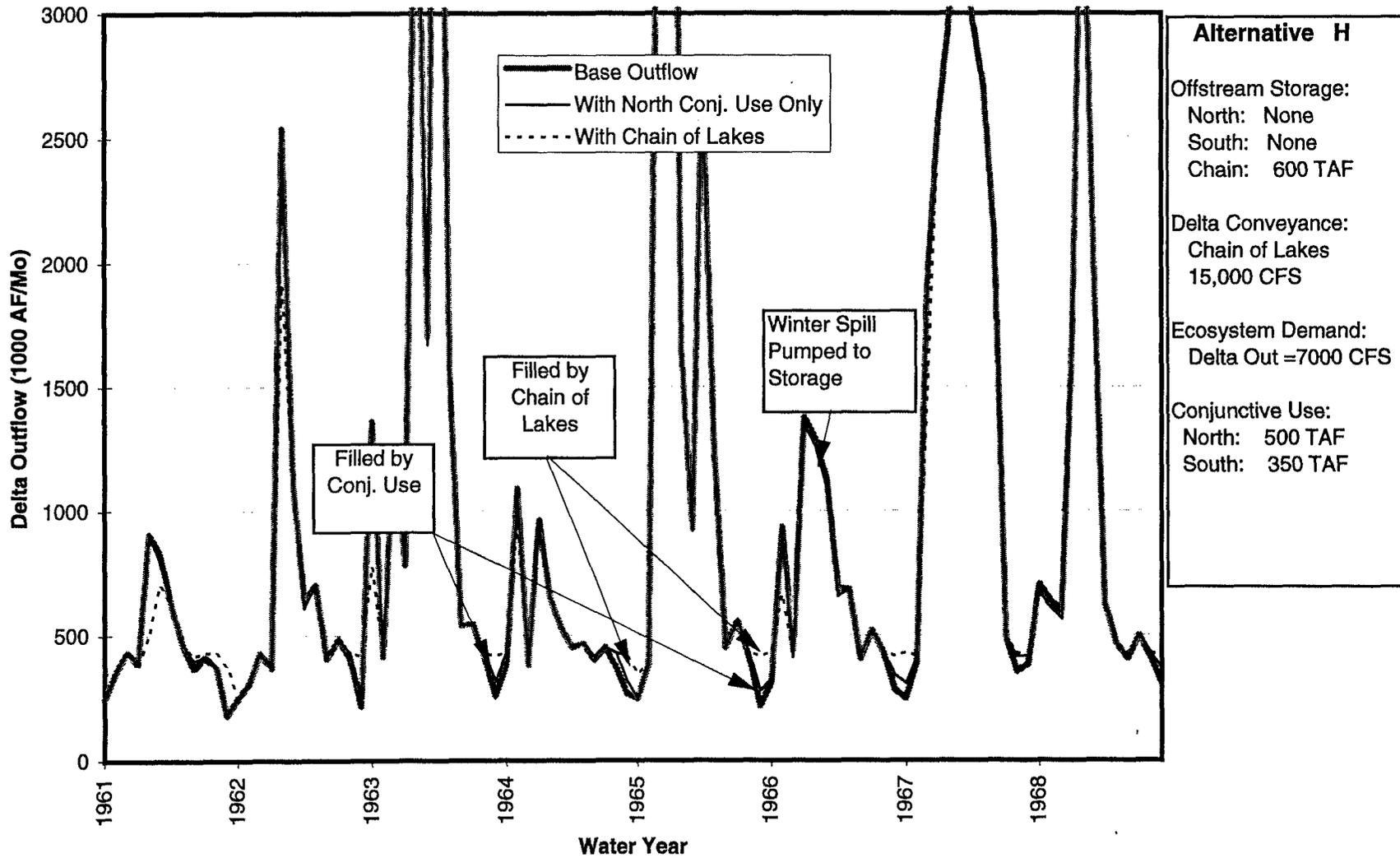
Offstream Storage:
 North: None
 South: None
 Chain: 600 TAF

Delta Conveyance:
 Chain of Lakes
 15,000 CFS

Ecosystem Demand:
 Delta Out = 7000 CFS

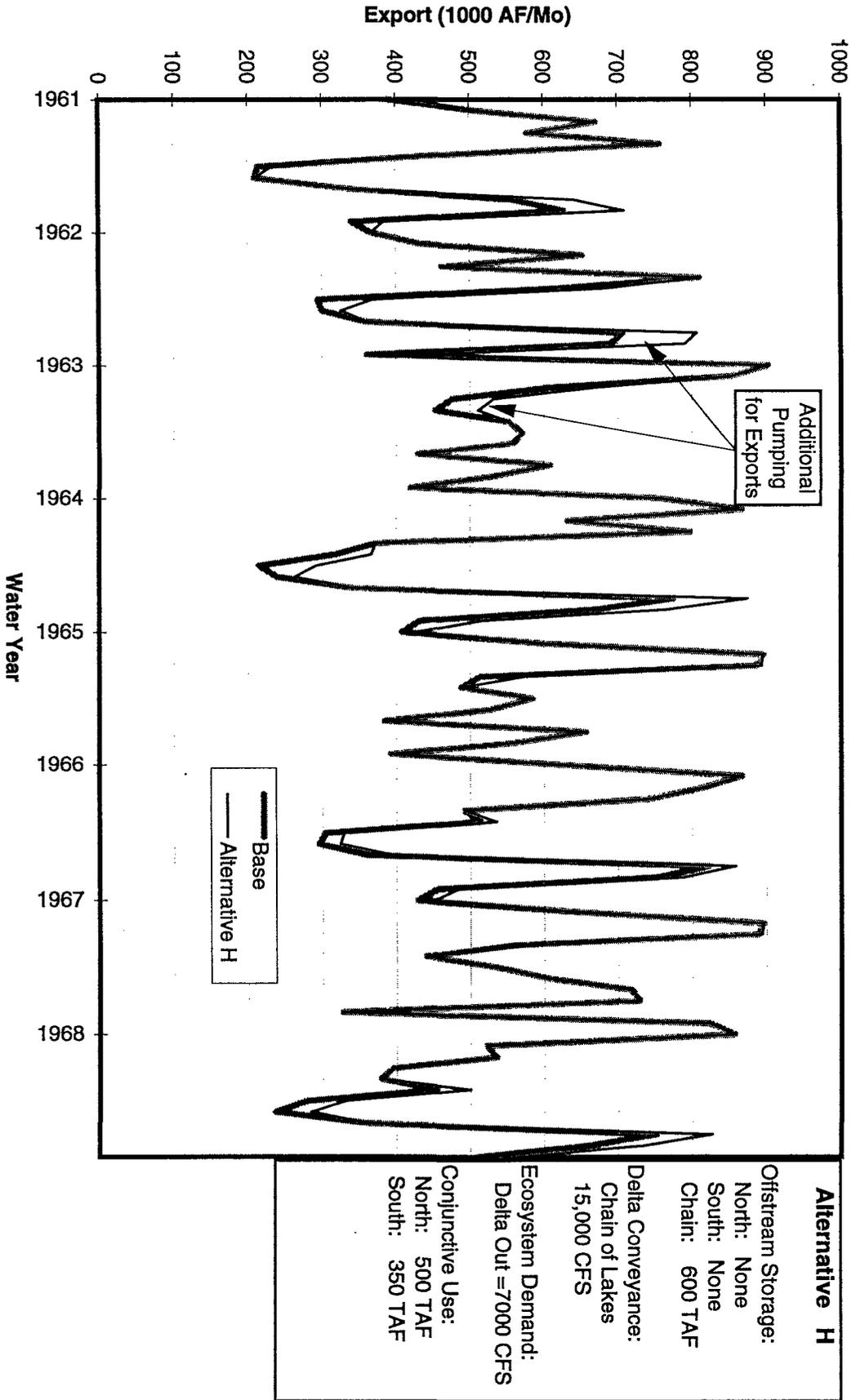
Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

Total Modeled Delta Outflow -- 1961 to 1968 Supplemented by Chain of Lakes Storage and Conjunctive Use



B - 0 0 5 7 2 9

Total Modeled South Delta Export -- 1961 to 1968

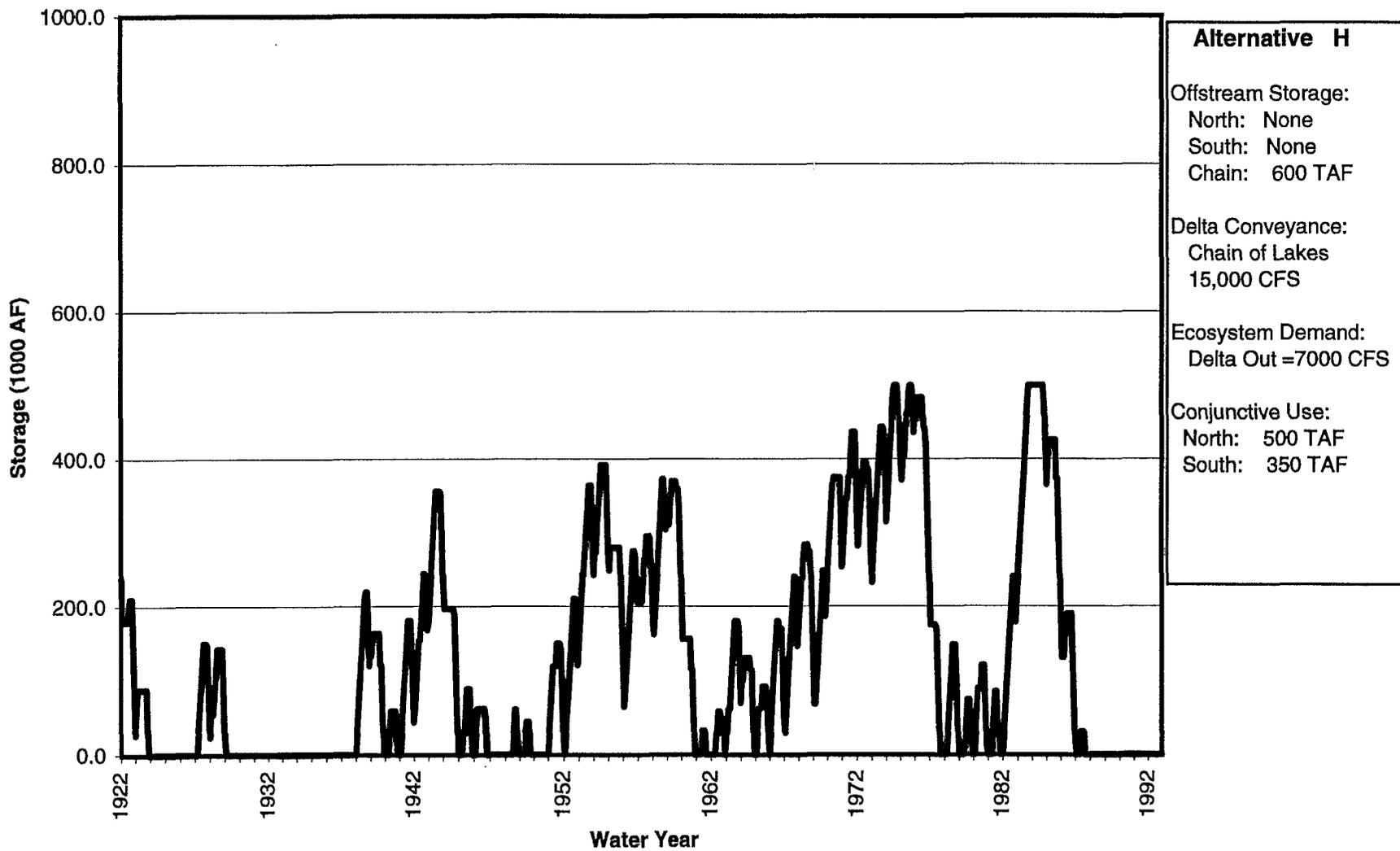


Additional Pumping for Exports

Base
Alternative H

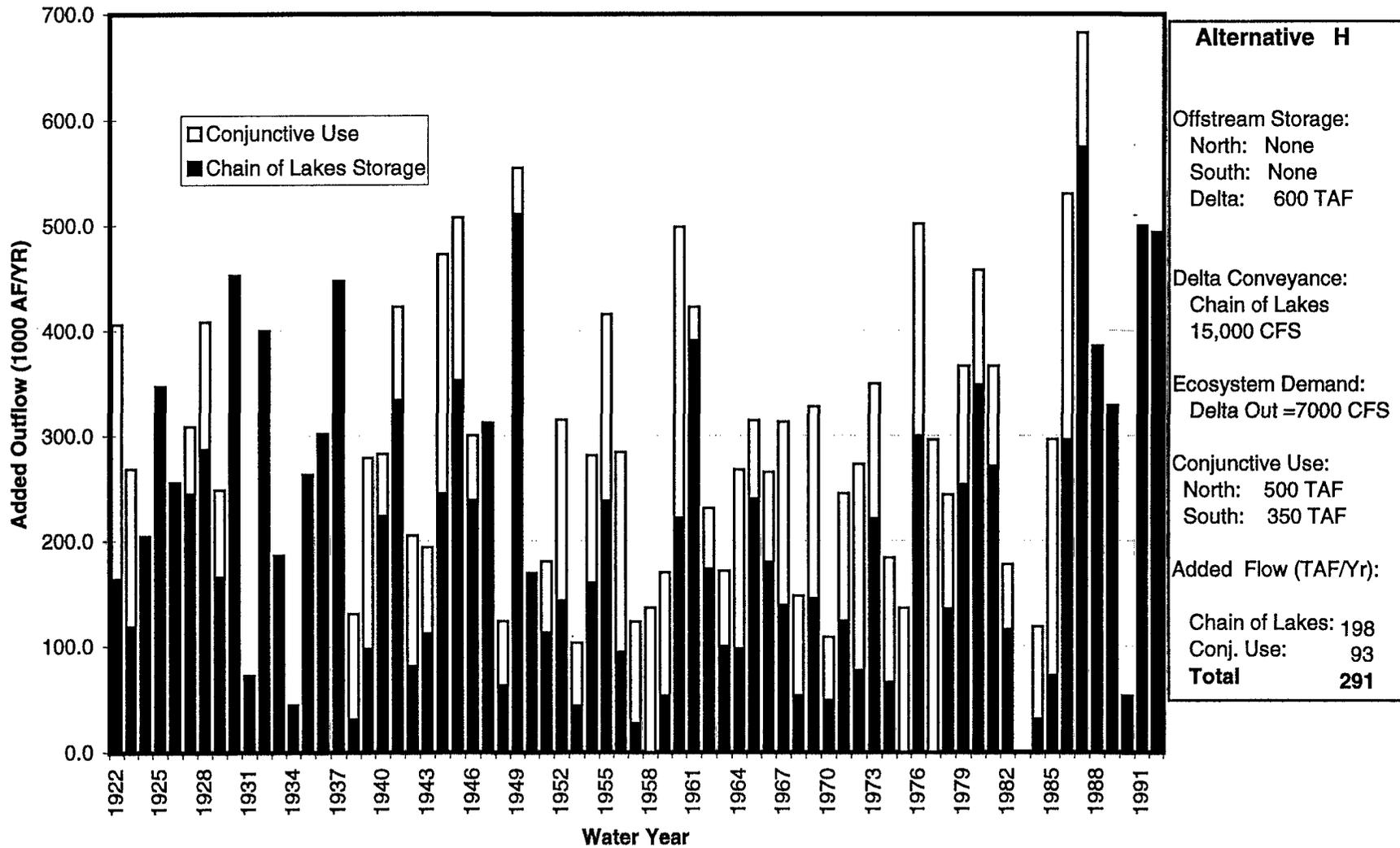
Alternative H
 Offstream Storage:
 North: None
 South: None
 Chain: 600 TAF
 Delta Conveyance:
 Chain of Lakes
 15,000 CFS
 Ecosystem Demand:
 Delta Out = 7000 CFS
 Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

North of Delta Groundwater Operation (Managed for Delta Outflow)



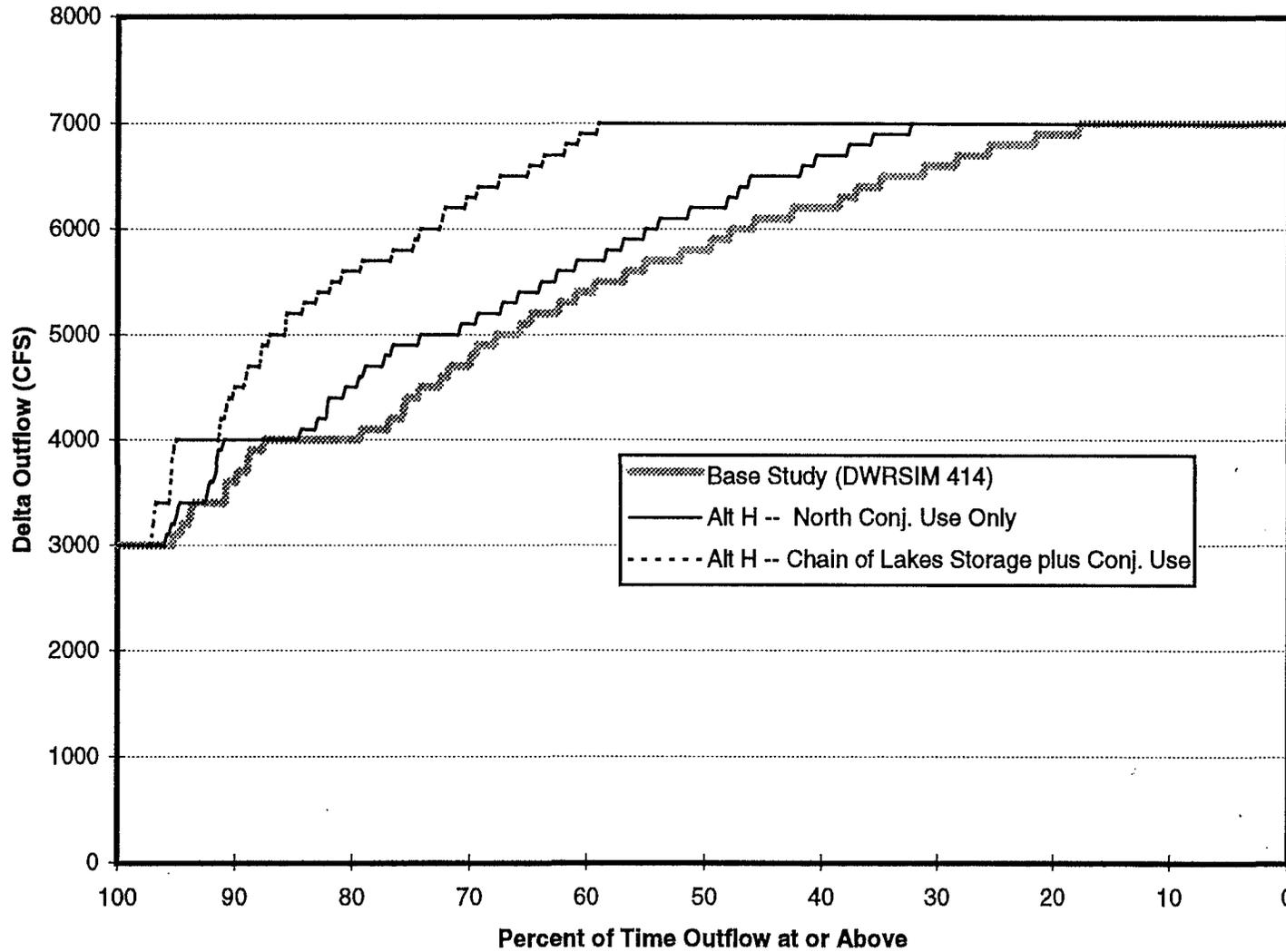
B - 0 0 5 7 3 1

Supplemental Delta Outflow from Storage and Conjunctive Use



B - 0 0 5 7 3 2

Frequency of Delta Outflow -- Target = 7000 CFS April through September



Alternative H

Offstream Storage:
North: None
South: None
Chain: 600 TAF

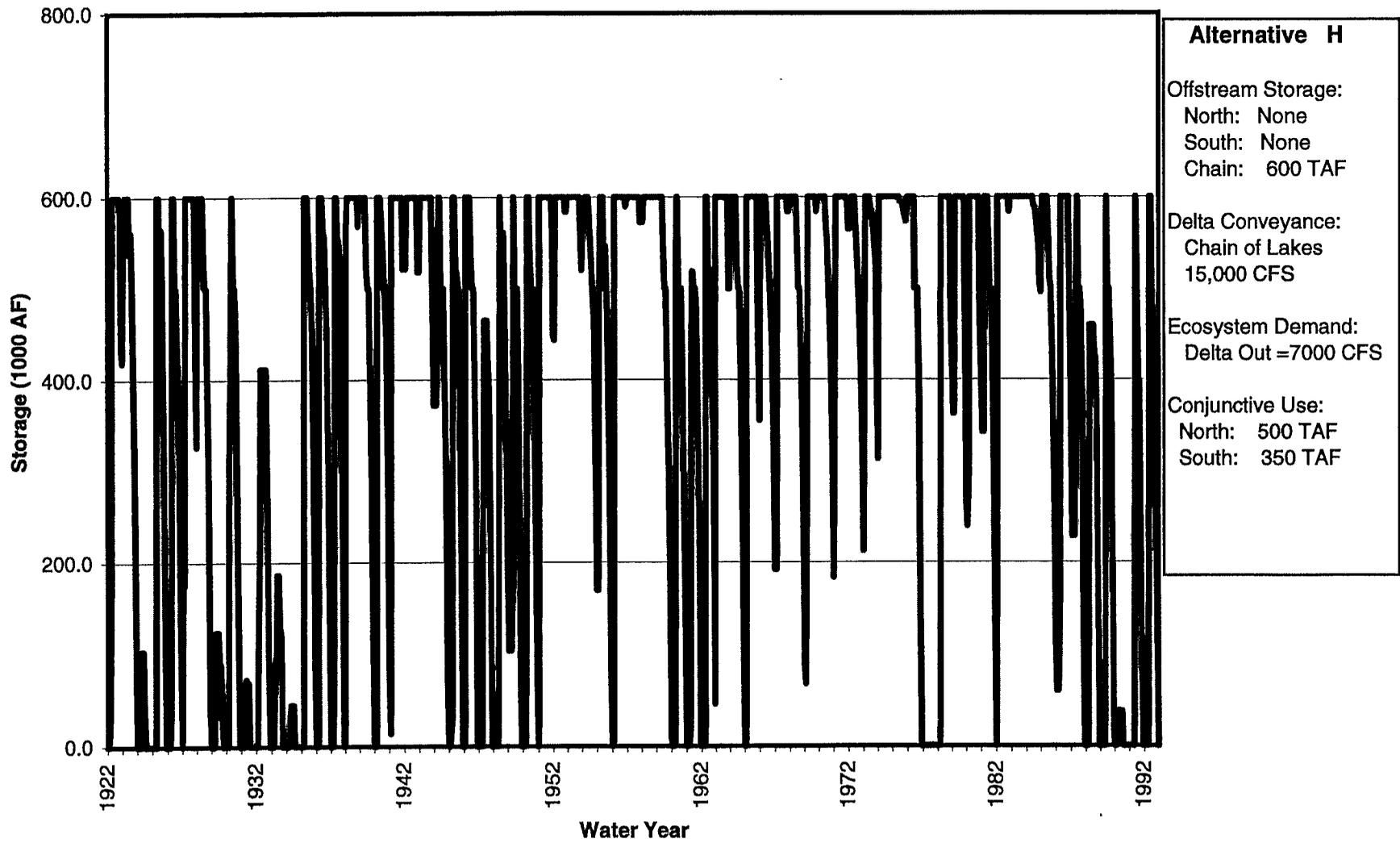
Delta Conveyance:
Chain of Lakes
15,000 CFS

Ecosystem Demand:
Delta Out = 7000 CFS

Conjunctive Use:
North: 500 TAF
South: 350 TAF

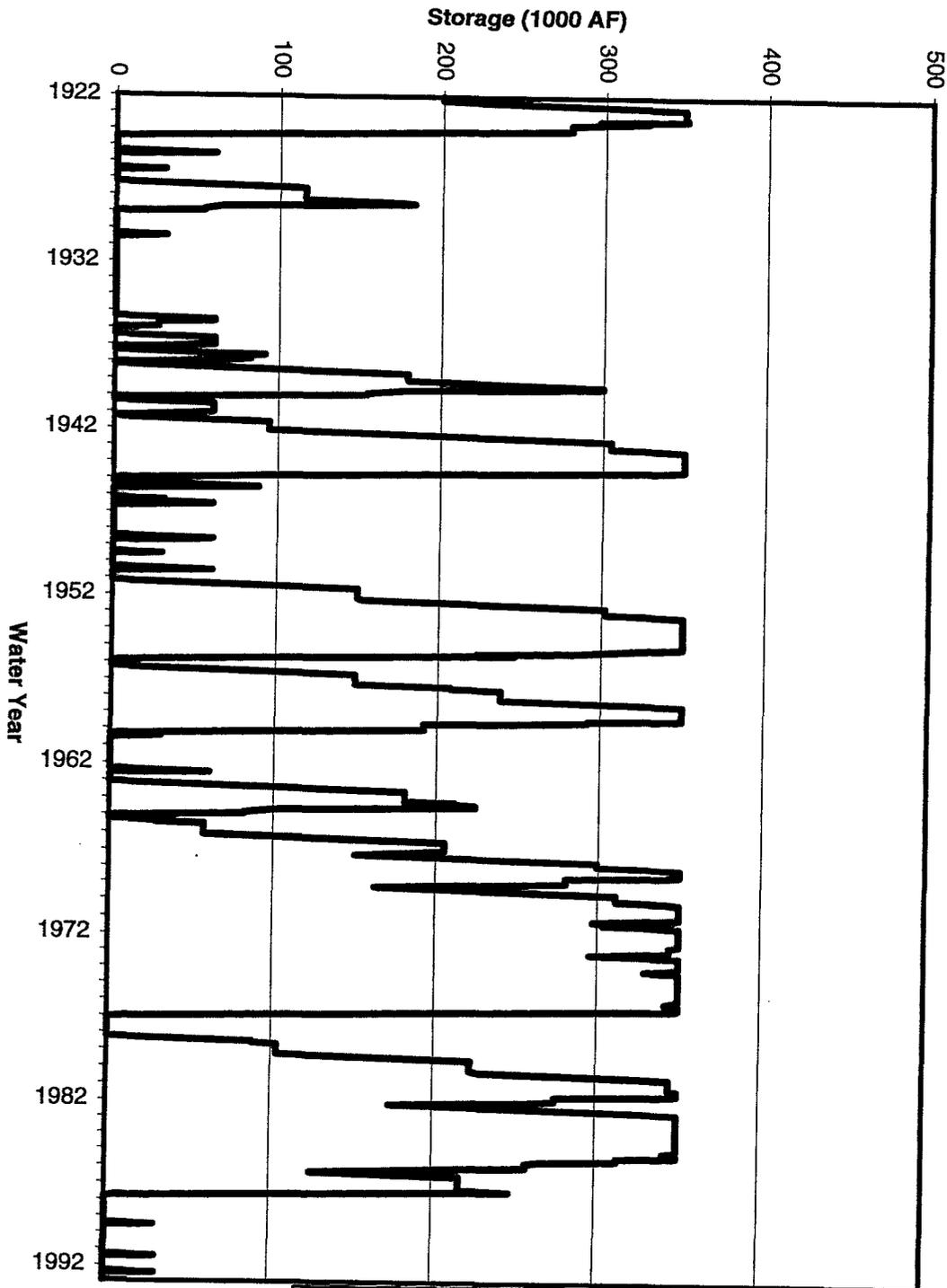
B - 0 0 5 7 3 3

Chain of Lakes Storage



B - 0 0 5 7 3 4

**South of Delta Storage Groundwater Storage
(Managed for Water Supply Opportunities)**



Alternative H

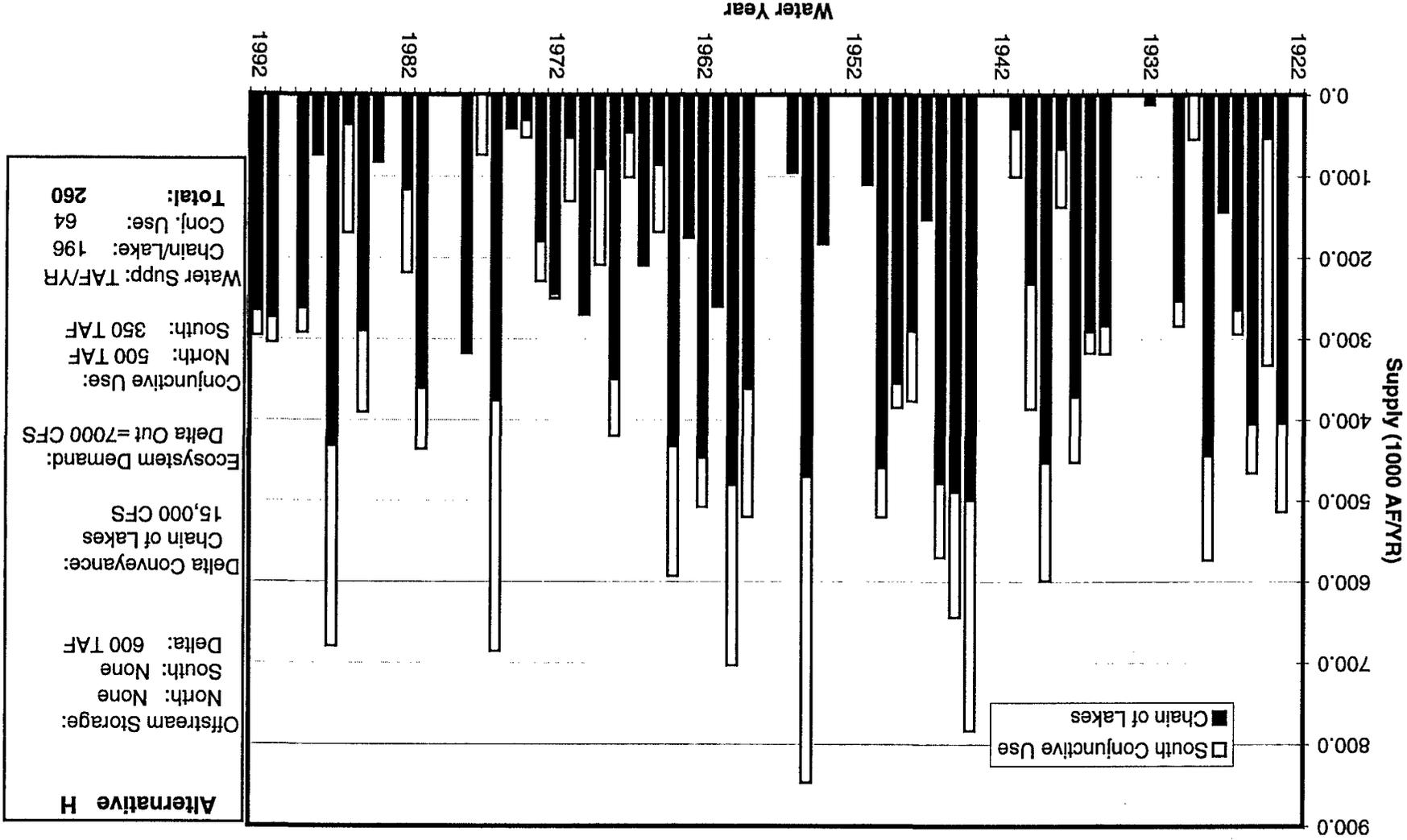
Offstream Storage:
 North: None
 South: None
 Chain: 600 TAF

Delta Conveyance:
 Chain of Lakes
 15,000 CFS

Ecosystem Demand:
 Delta Out = 7000 CFS

Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

Water Supply Opportunities from Chain of Lakes plus Conjunctive Use



Alternative I



B - 0 0 5 7 3 7

B-005737

Alternative I

(Original)

B - 0 0 5 7 3 8

B-005738

Alternative I

Facilities

North of Delta Storage:	6,000,000 Acre/Feet
South of Delta Storage:	None
In-Delta Storage:	None
Delta Conveyance:	Sacramento Valley to the South Delta Pumps

Additional Criteria Assumptions for New Water Supply Opportunities

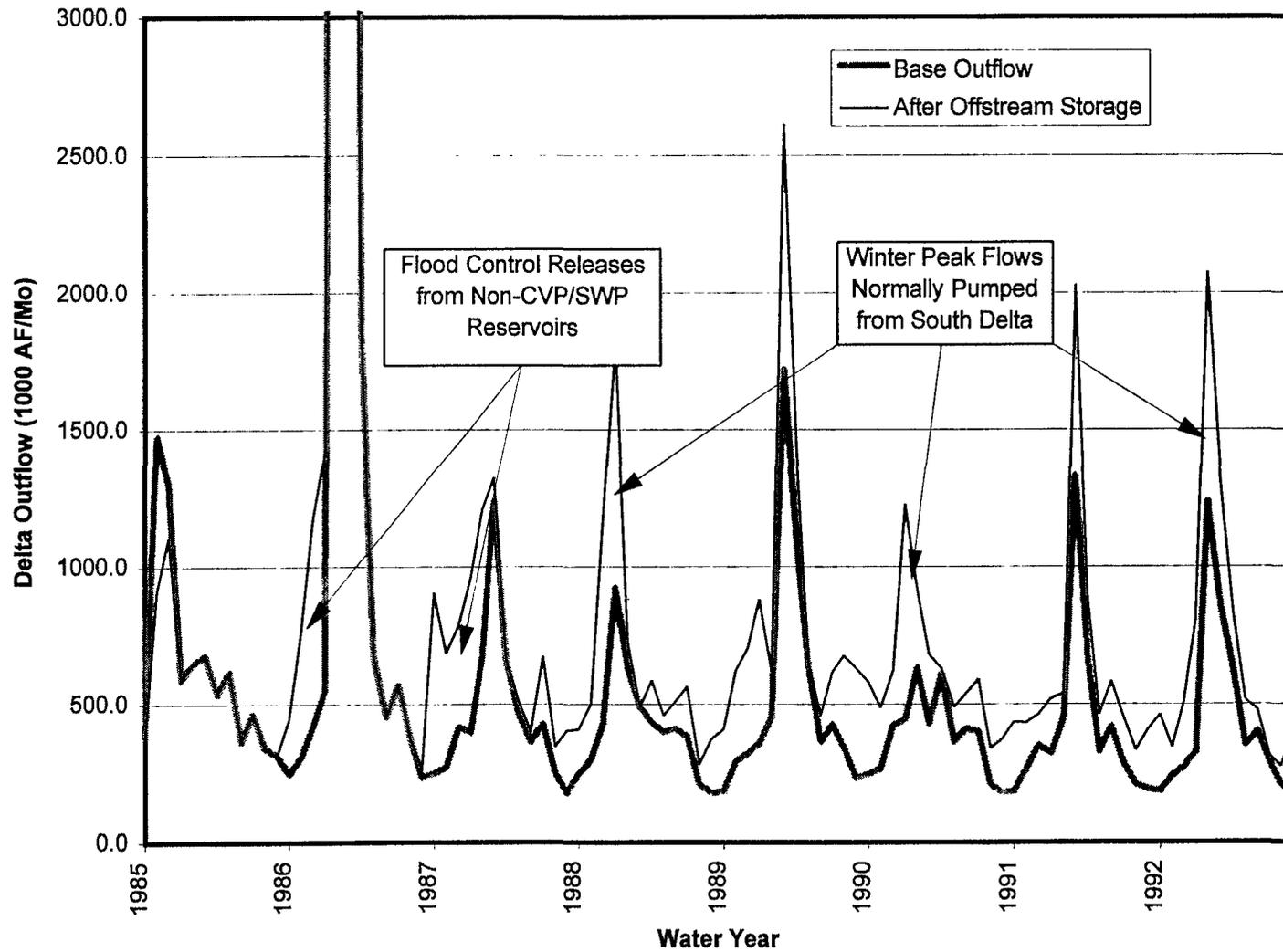
Water Supply Targets: To offset deficits in CVP/SWP demands as determined by base DWRSIM operation simulations to the extent possible. Demands are met on delivery patterns provided by DWR and the Bureau of Reclamation.

Environmental Targets: Provide for no less than 7000 CFS Delta outflow to the extent possible.

Simulation Assumptions

- Operate north of Delta groundwater storage in a conjunctive use mode for environmental opportunities. (To enhance Delta outflow.)
- Divert spill water directly from Oroville and Shasta limited by new canal capacity to new 6 million AF west side Sacramento Valley storage. Route water released from Shasta and Oroville specifically to meet south Delta exports to new storage. Route water released from Shasta to meet GCID, Tehama Colusa, and Corning canals into new storage.
- Meet Sacramento River Canal demand directly from new storage.
- Meet south Delta CVP and SWP exports from new storage to the extent possible.
- Operate south of Delta groundwater storage in a water banking mode for water supply opportunities. (To meet demand deficits.)
- Uses maximum available Banks PP capacity.

Total Modeled Delta Outflow -- 1985 to 1992 After Operation of Upstream Storage



Alternative I

Offstream Storage:
North: 6000 TAF
South:
Res. A: None
Res. B: None

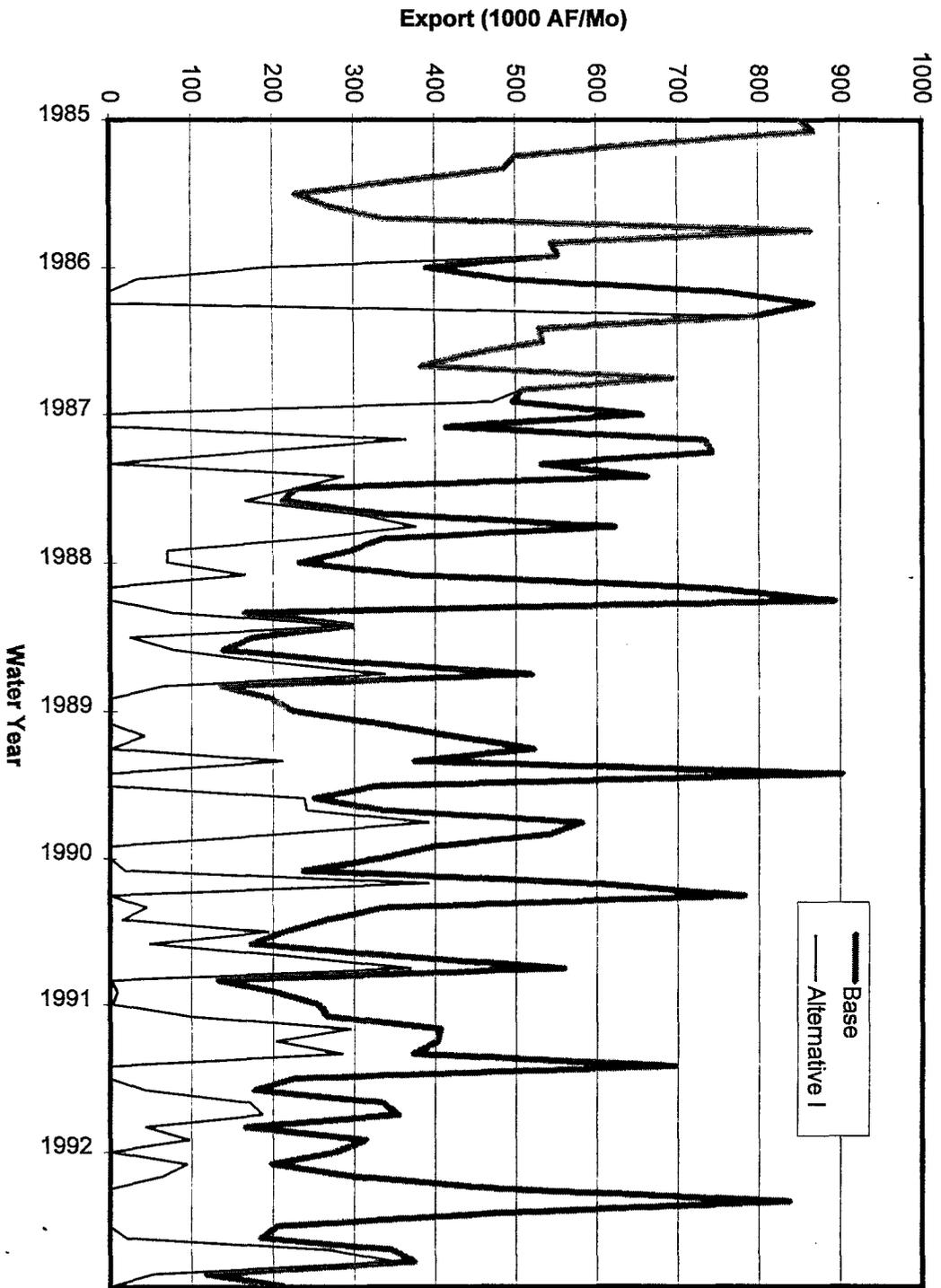
Isolated Facility:
15000 CFS

Conveyance:
Shasta: 15000 CFS
Oroville: 15000 CFS

Conjunctive Use:
North: 500 TAF
South: 350 TAF

B-005740

Total Modeled South Delta Export -- 1985 to 1992



— Base
 — Alternative I

Alternative I

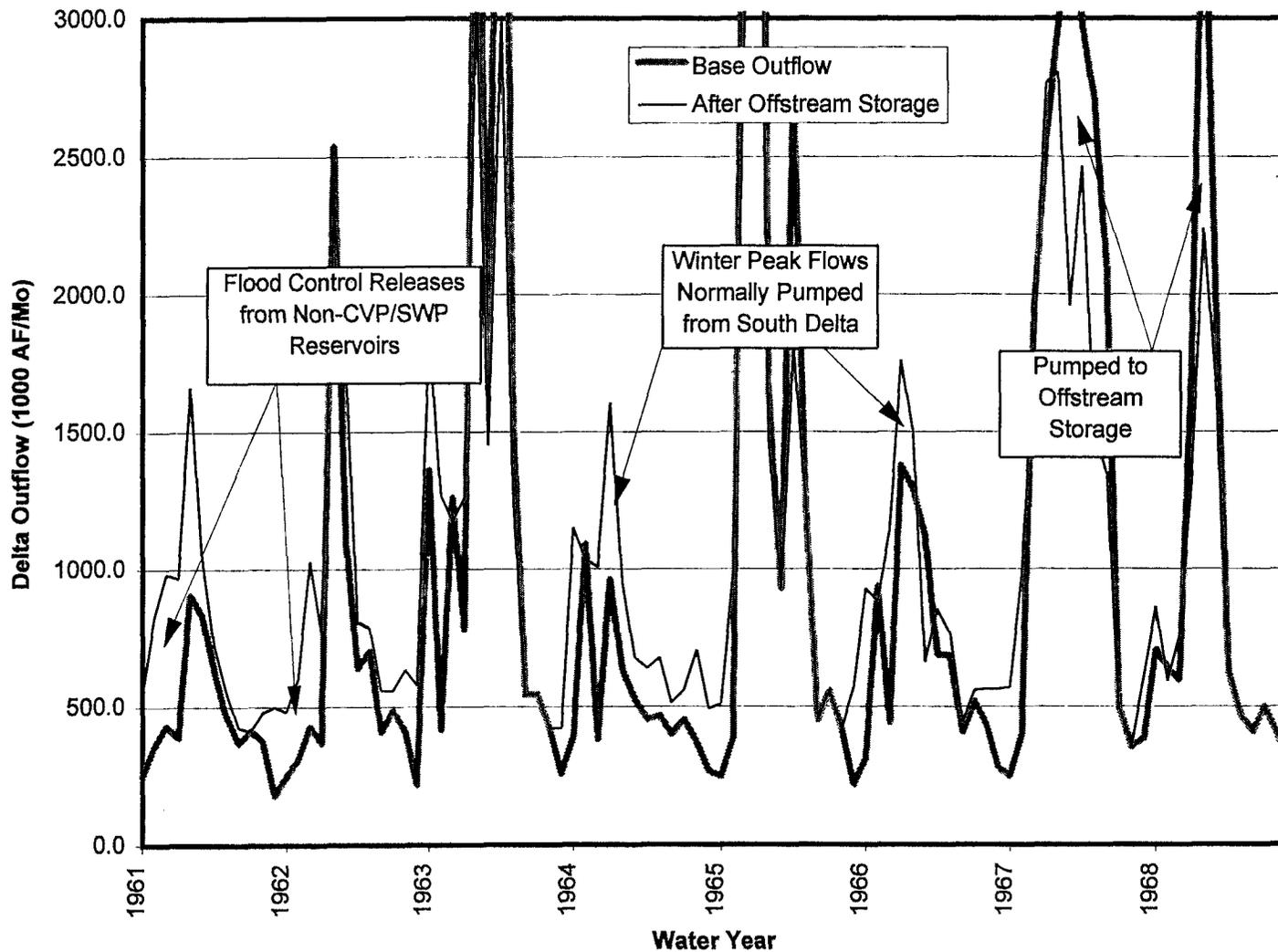
Offstream Storage:
 North: 6000 TAF
 South:
 Res. A: None
 Res. B: None

Isolated Facility:
 15000 CFS

Conveyance:
 Shasta: 15000 CFS
 Oroville: 15000 CFS

Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

Total Modeled Delta Outflow -- 1961 to 1968 After Operation of Upstream Storage



Alternative I

Offstream Storage:
 North: 6000 TAF
 South:

Res. A: None
 Res. B: None

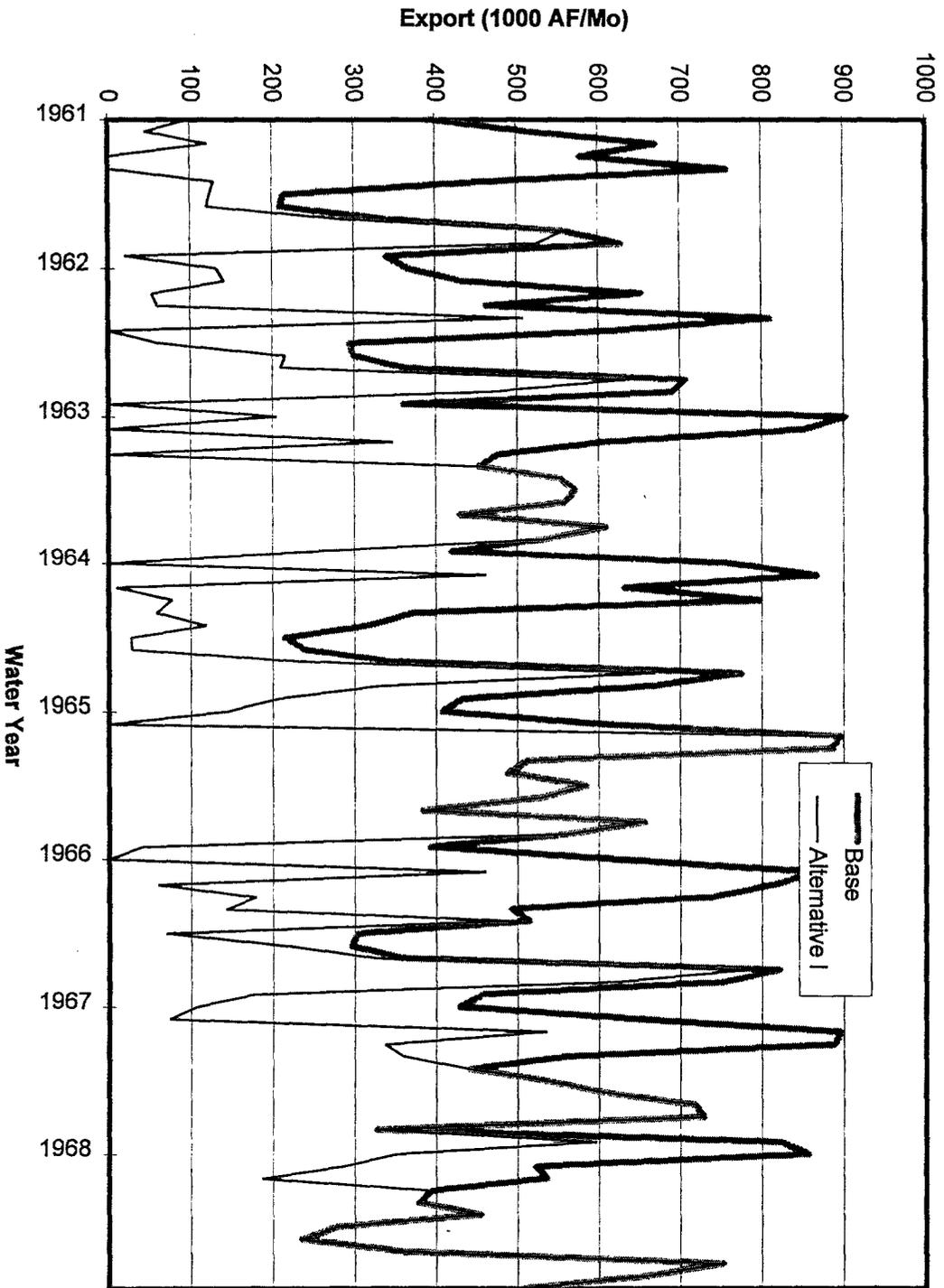
Isolated Facility:
 15,000 CFS

Conveyance:
 Shasta: 15,000 CFS
 Oroville: 15,000 CFS

Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

B-005742

Total Modeled South Delta Export -- 1961 to 1968



Alternative I

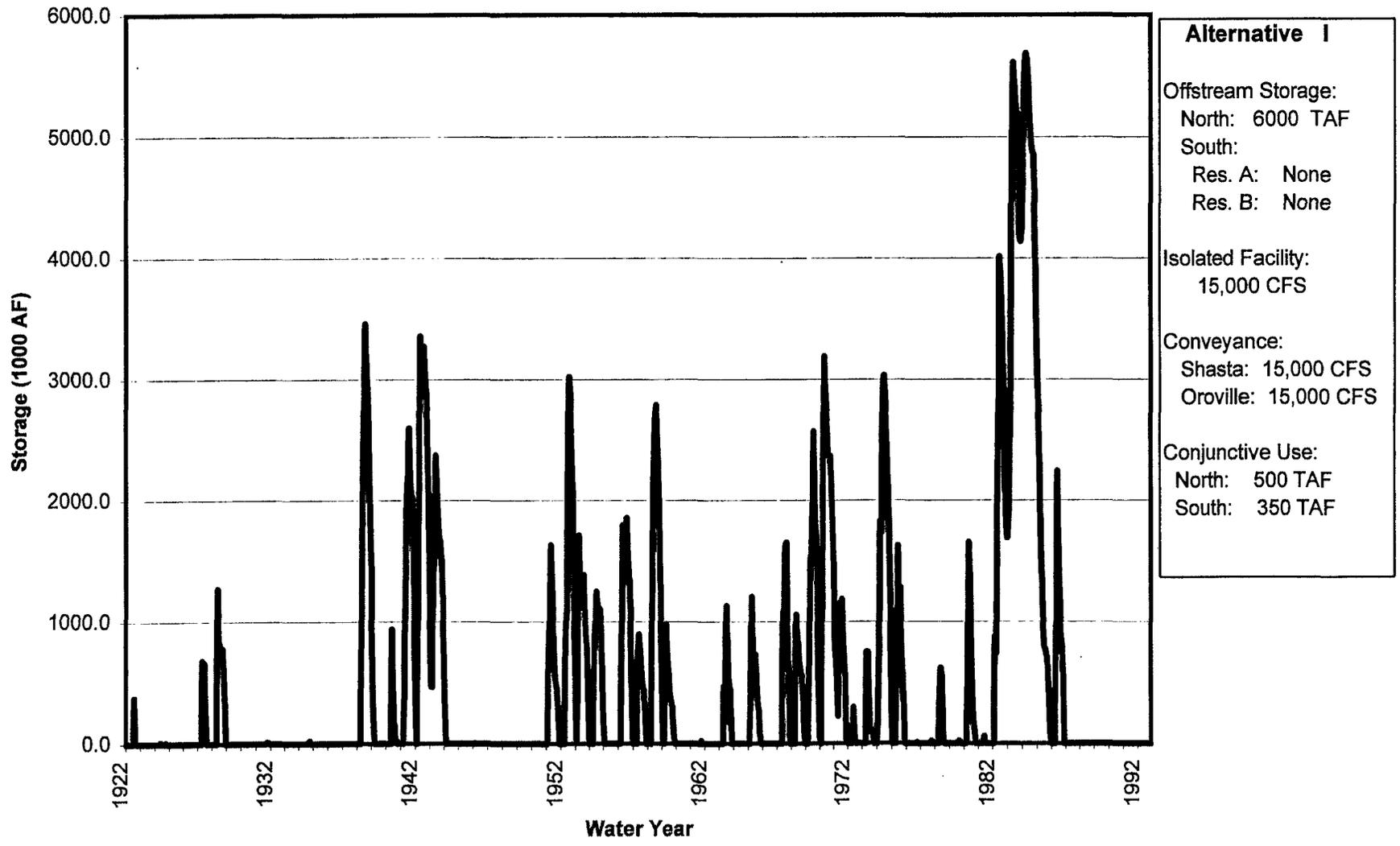
Offstream Storage:
 North: 6000 TAF
 South:
 Res. A: None
 Res. B: None

Isolated Facility:
 15,000 CFS

Conveyance:
 Shasta: 15,000 CFS
 Oroville: 15,000 CFS

Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

Sacramento Valley Westside Offstream Storage



Alternative I

Offstream Storage:
North: 6000 TAF
South:
Res. A: None
Res. B: None

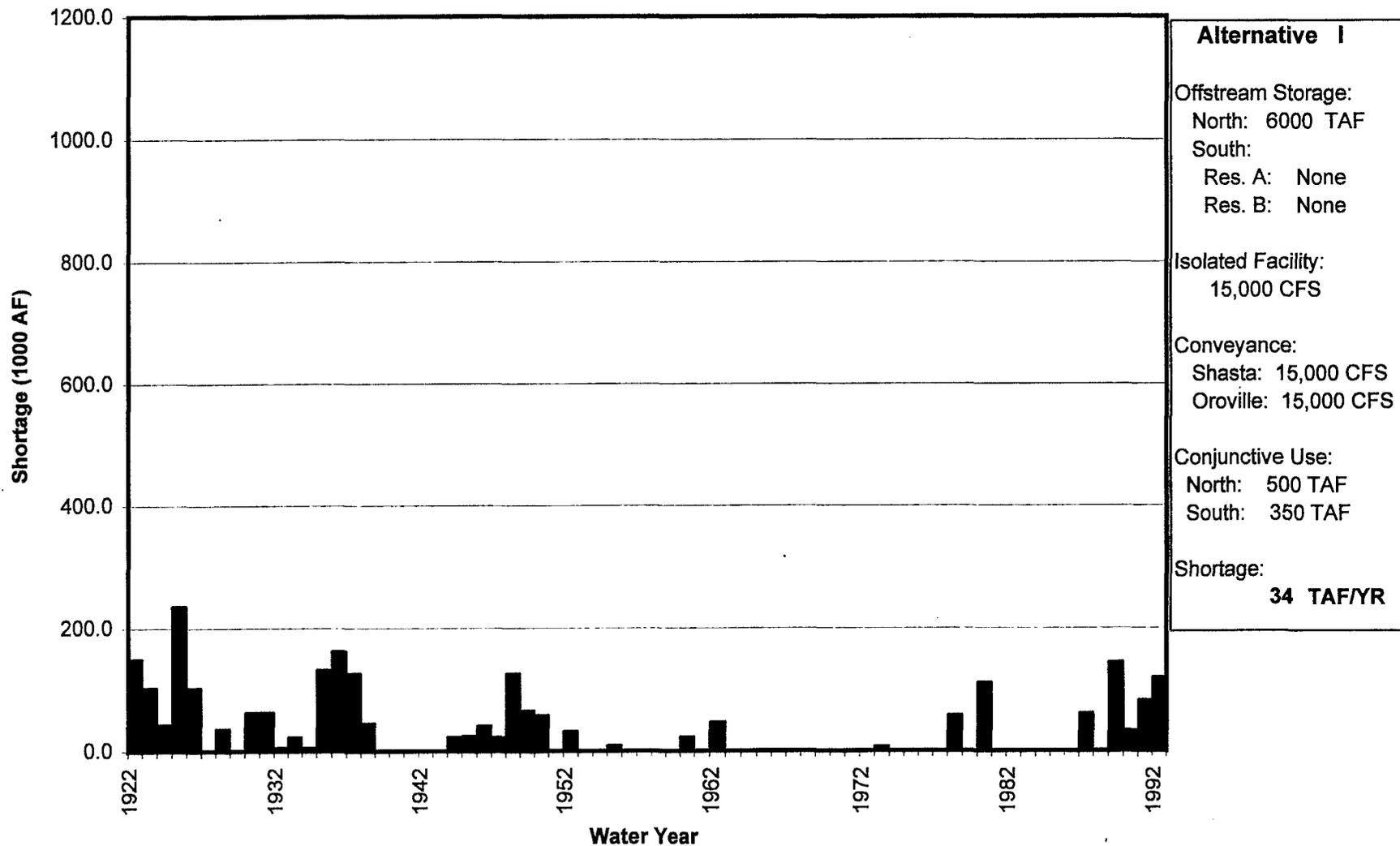
Isolated Facility:
15,000 CFS

Conveyance:
Shasta: 15,000 CFS
Oroville: 15,000 CFS

Conjunctive Use:
North: 500 TAF
South: 350 TAF

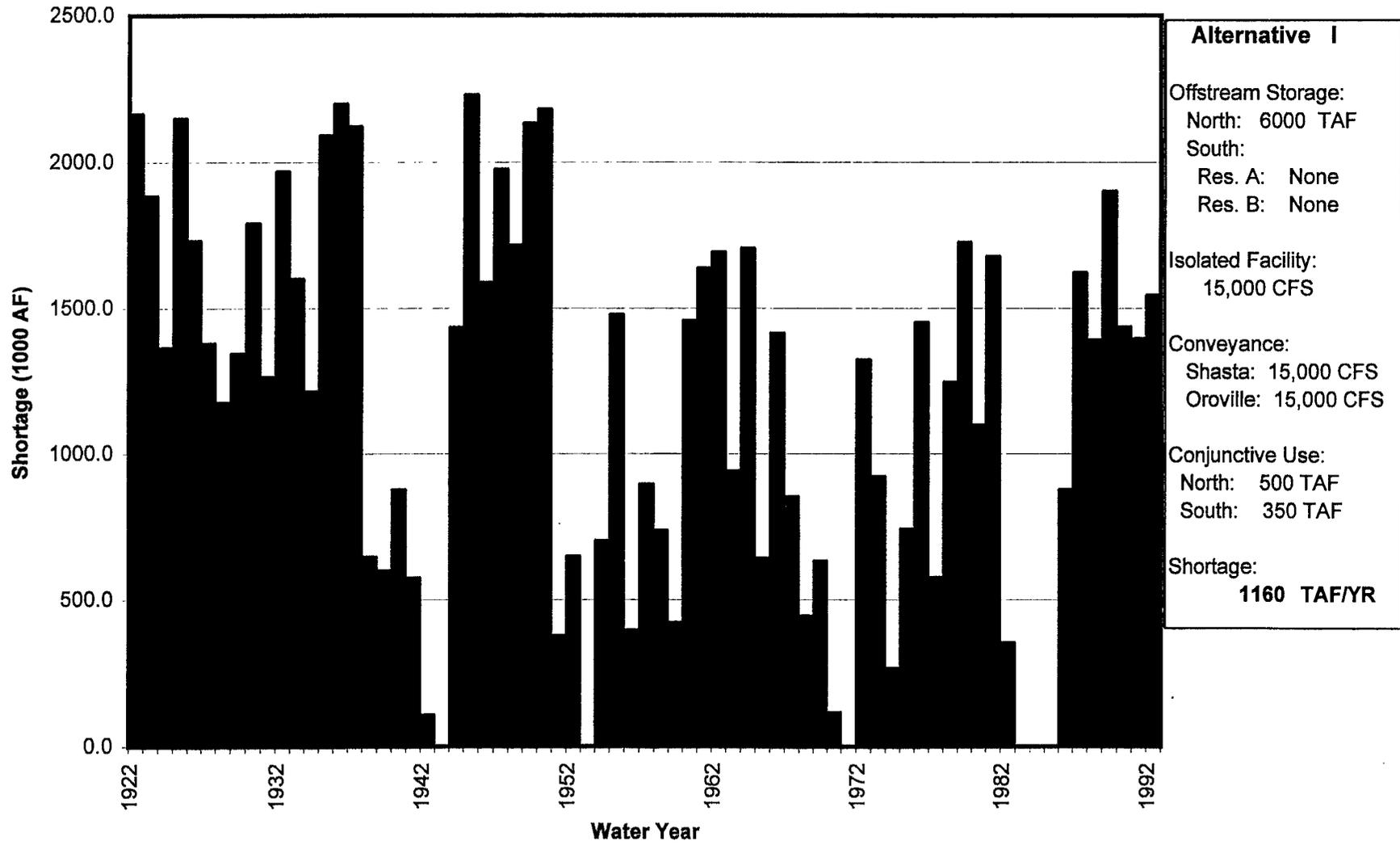
B-005744

Shortages to Corning, Tehama Colusa, and GCID Canals



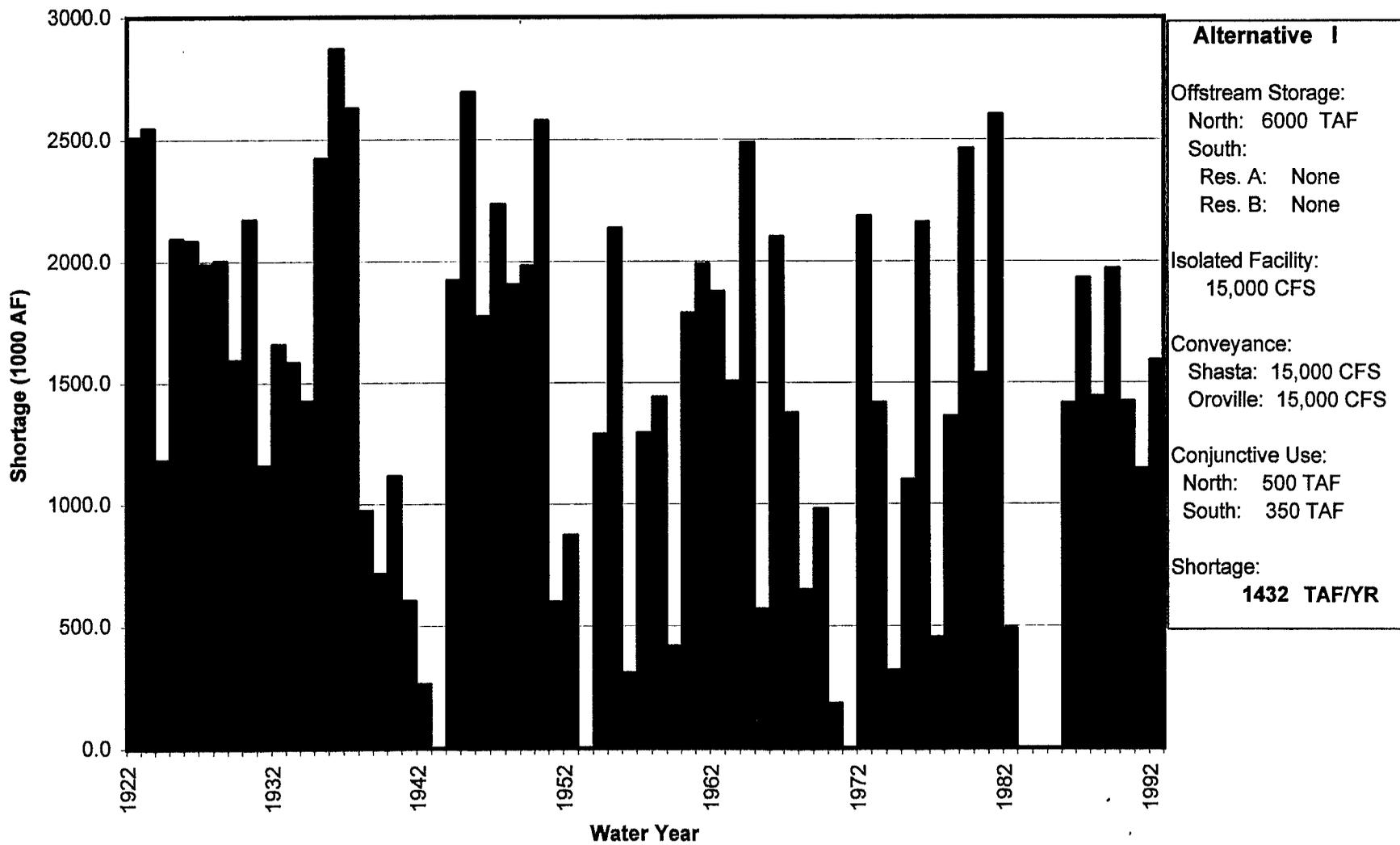
B-005745

Shortages to CVP Exports at Tracy PP



B-005746

Shortages to SWP Exports at Banks PP



B-005747

Alternative I-1

Alternative I-1

Facilities

North of Delta Storage:	3,000,000 Acre/Feet
South of Delta Storage:	None
In-Delta Storage:	None
Delta Conveyance:	Isolated facility -- 7,000 CFS

Additional Criteria Assumptions for New Water Supply Opportunities

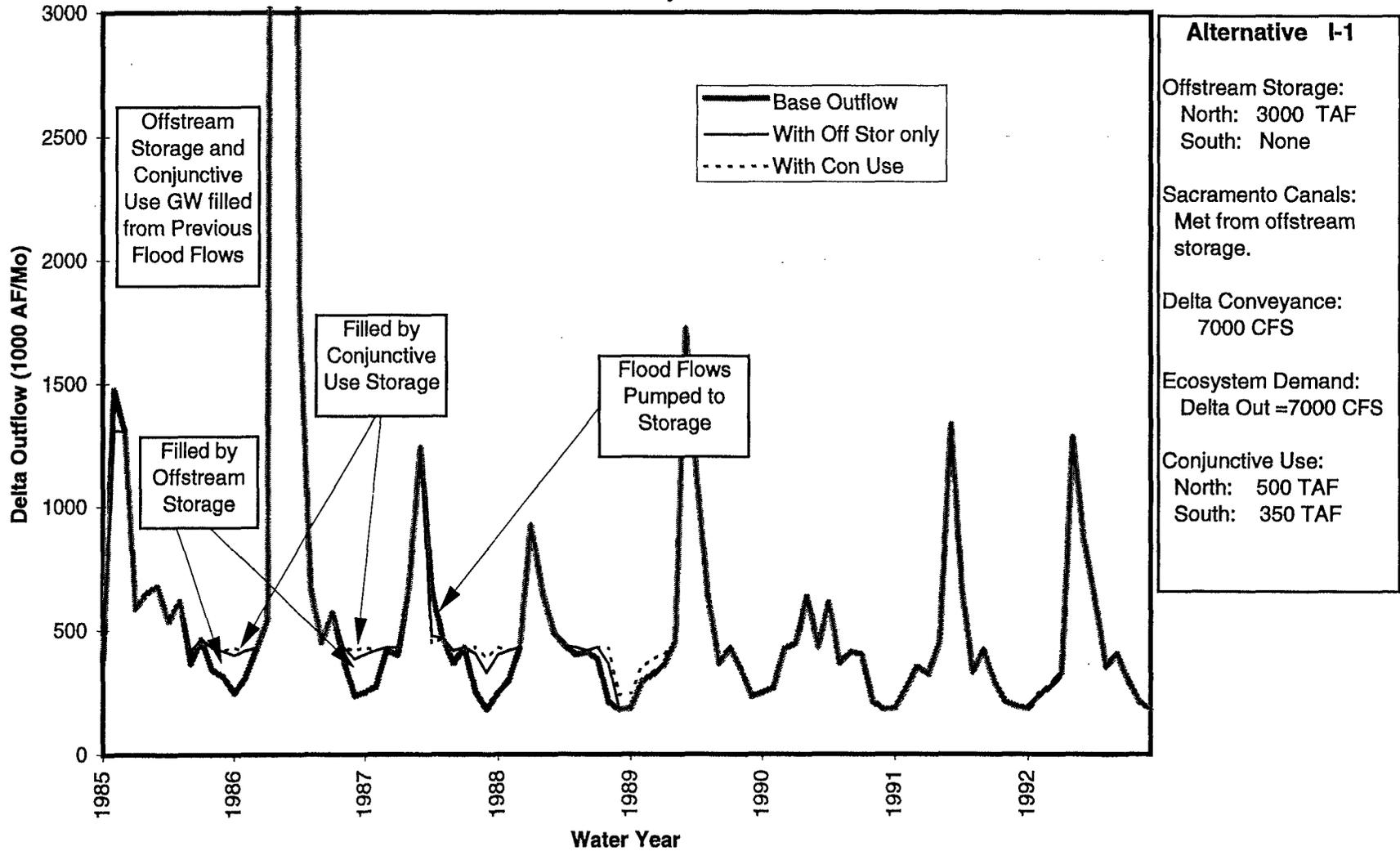
Water Supply Targets: To offset deficits in CVP/SWP demands as determined by base DWRSIM operation simulations to the extent possible. Demands are met on delivery patterns provided by DWR and the Bureau of Reclamation.

Environmental Targets: Provide for no less than 7000 CFS Delta outflow to the extent possible.

Simulation Assumptions

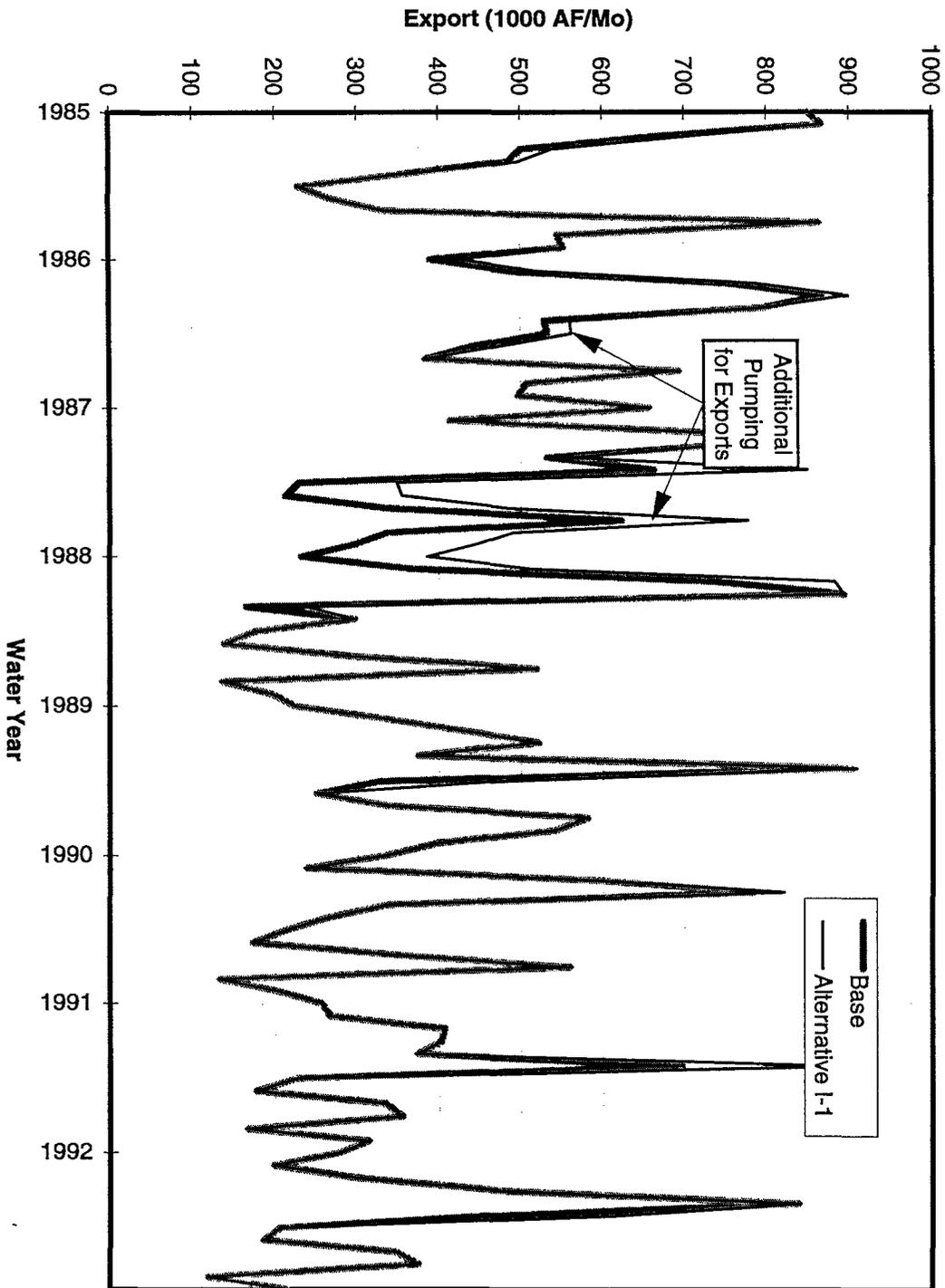
- Operate north of Delta groundwater storage in a conjunctive use mode for environmental opportunities. (To enhance Delta outflow.)
- Divert spill water directly from Shasta limited by new canal capacity to new 3 million AF west side Sacramento Valley storage. Route water released from Shasta to meet GCID, Tehama Colusa, and Corning canals into new storage.
- Meet Sacramento River Canal demand directly from new storage.
- Operate south of Delta groundwater storage in a water banking mode for water supply opportunities. (To meet demand deficits.)
- Assumes up to maximum use of Banks PP capacity. The first 7000 CFS is available for export purposes. Remaining pumping tested for Export/Inflow ratio.

Total Modeled Delta Outflow -- 1985 to 1992 Supplemented by North of Delta Offstream Storage and Conjunctive Use



B-005750

Total Modeled South Delta Export -- 1985 to 1992



Alternative I-1

Offstream Storage:
 North: 3000 TAF
 South: None

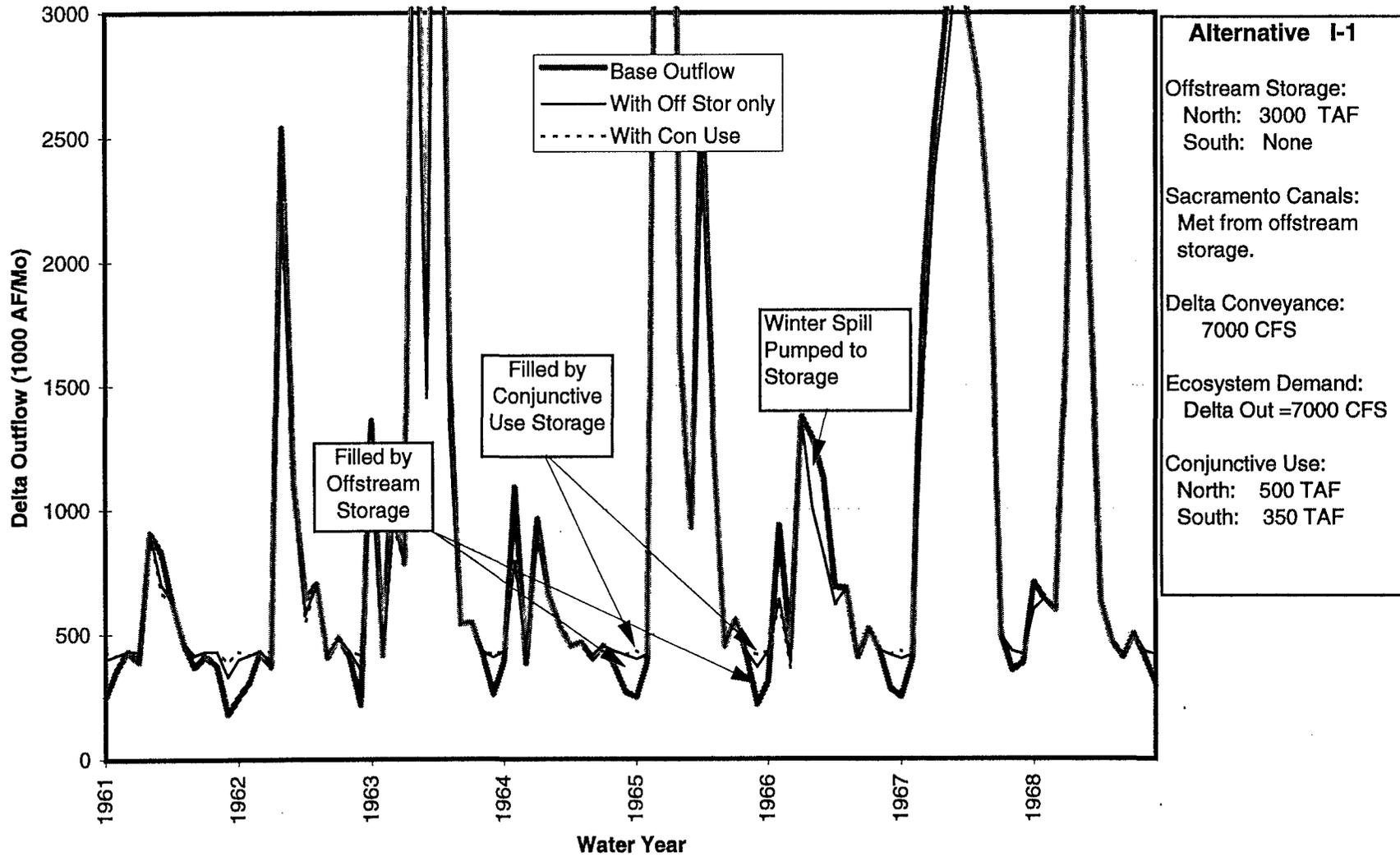
Sacramento Canals:
 Met from offstream storage.

Delta Conveyance:
 7000 CFS

Ecosystem Demand:
 Delta Out = 7000 CFS

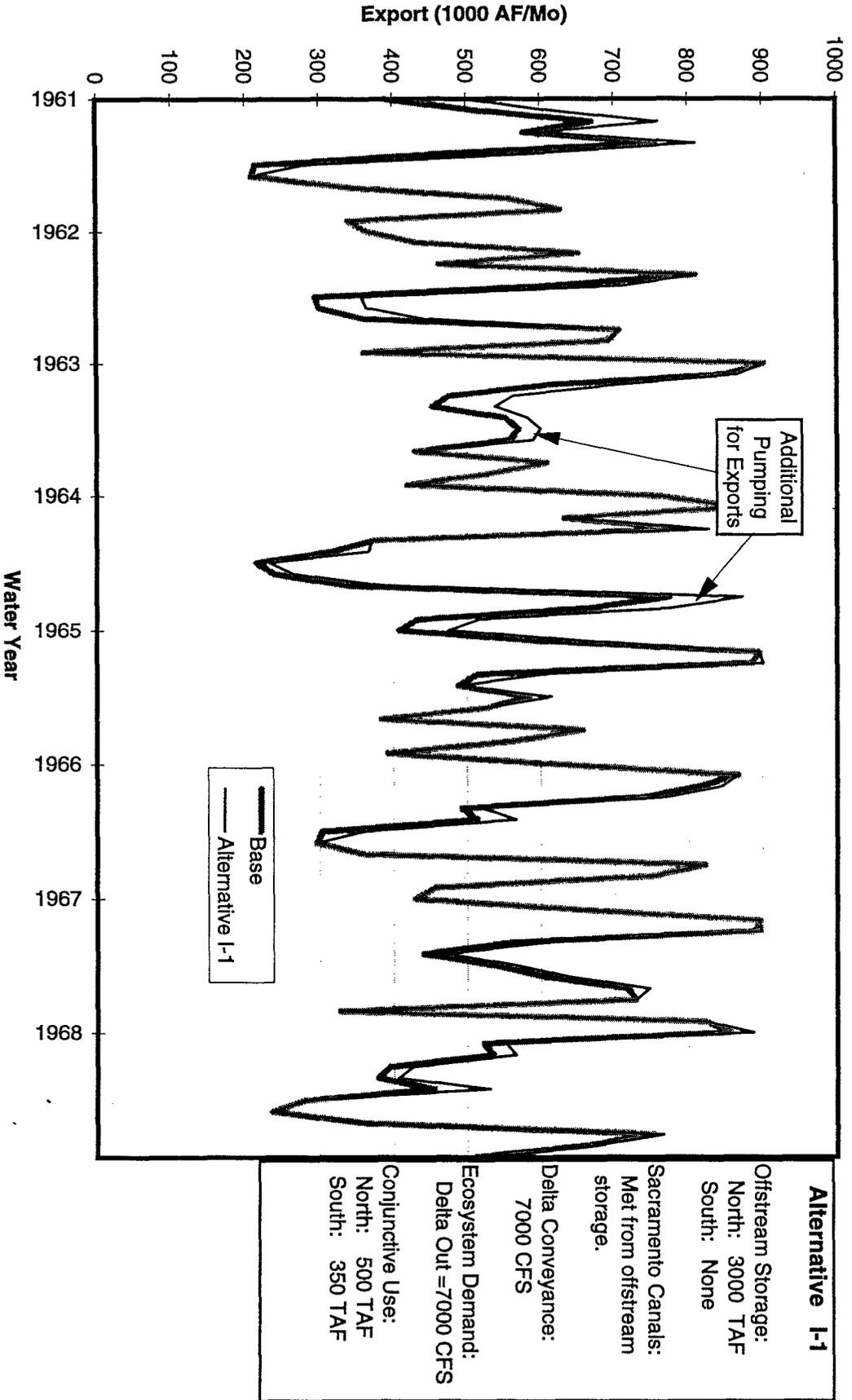
Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

Total Modeled Delta Outflow -- 1961 to 1968 Supplemented by North of Delta Offstream Storage and Conjunctive Use



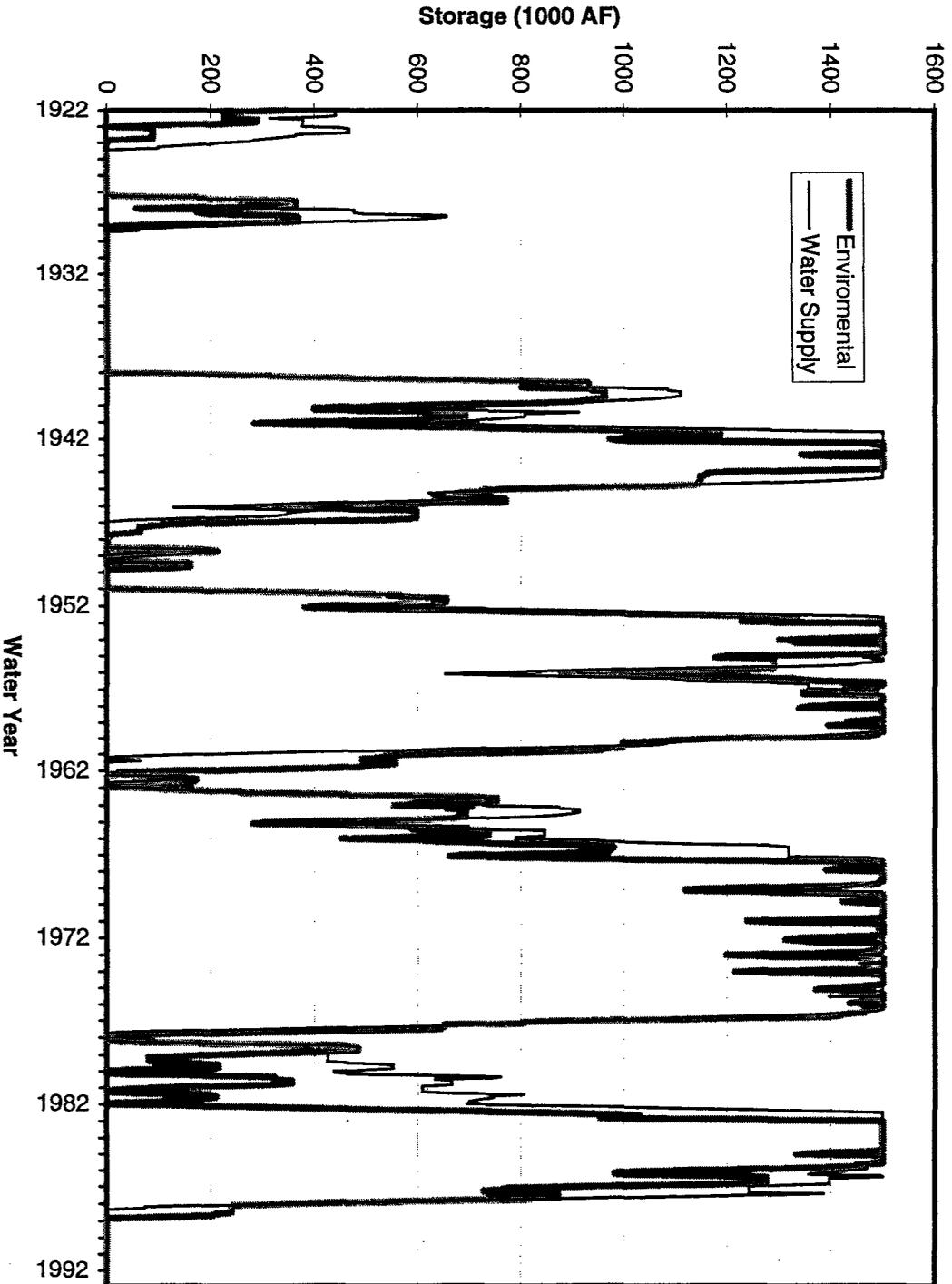
B-005752

Total Modeled South Delta Export -- 1961 to 1968



Alternative I-1
 Offstream Storage:
 North: 3000 TAF
 South: None
 Sacramento Canals:
 Met from offstream storage.
 Delta Conveyance:
 7000 CFS
 Ecosystem Demand:
 Delta Out = 7000 CFS
 Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

Total North of Delta Storage



Alternative I-1

Offstream Storage:
 North: 3000 TAF
 South: None

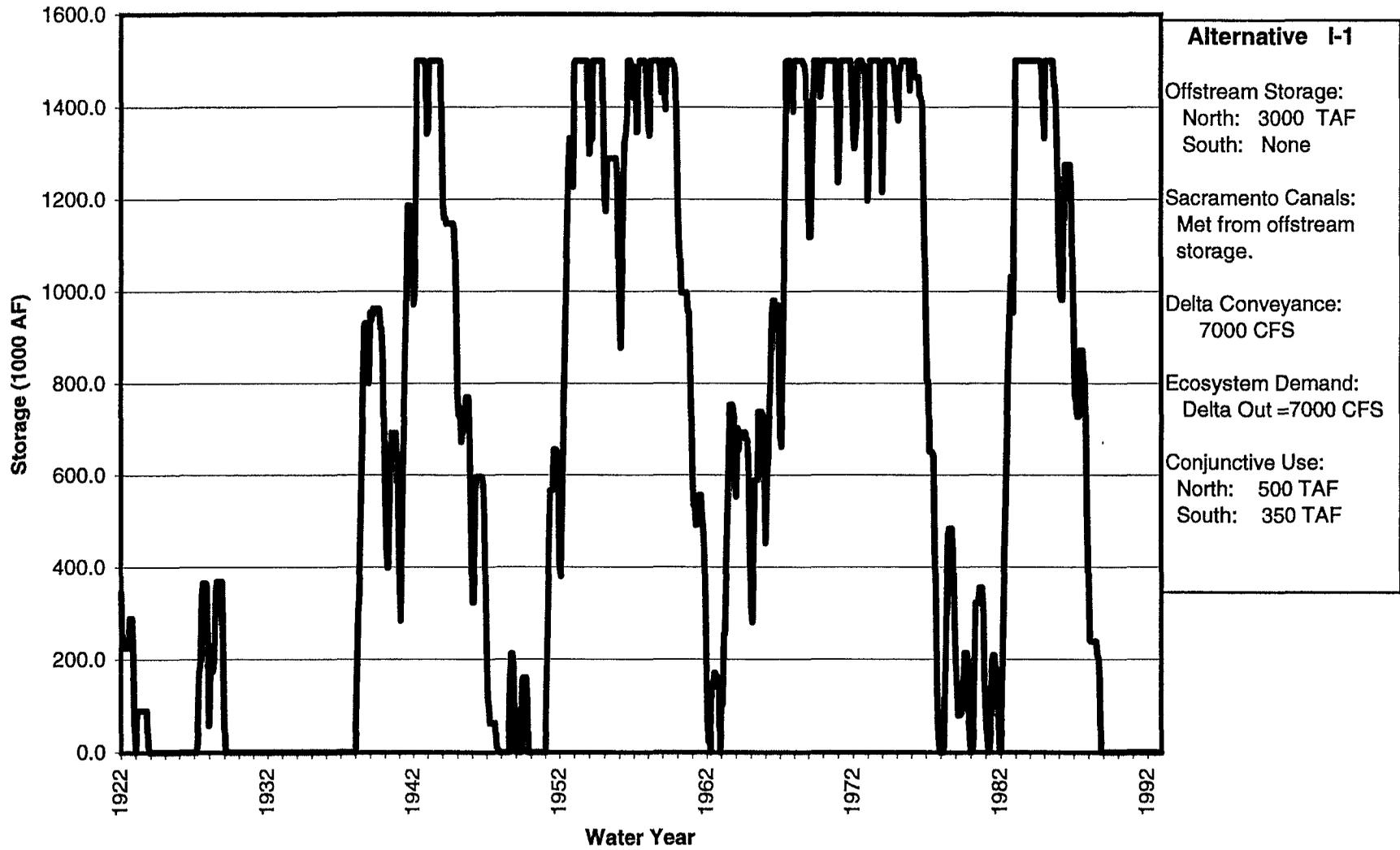
Sacramento Canals:
 Met from offstream storage.

Delta Conveyance:
 7000 CFS

Ecosystem Demand:
 Delta Out = 7000 CFS

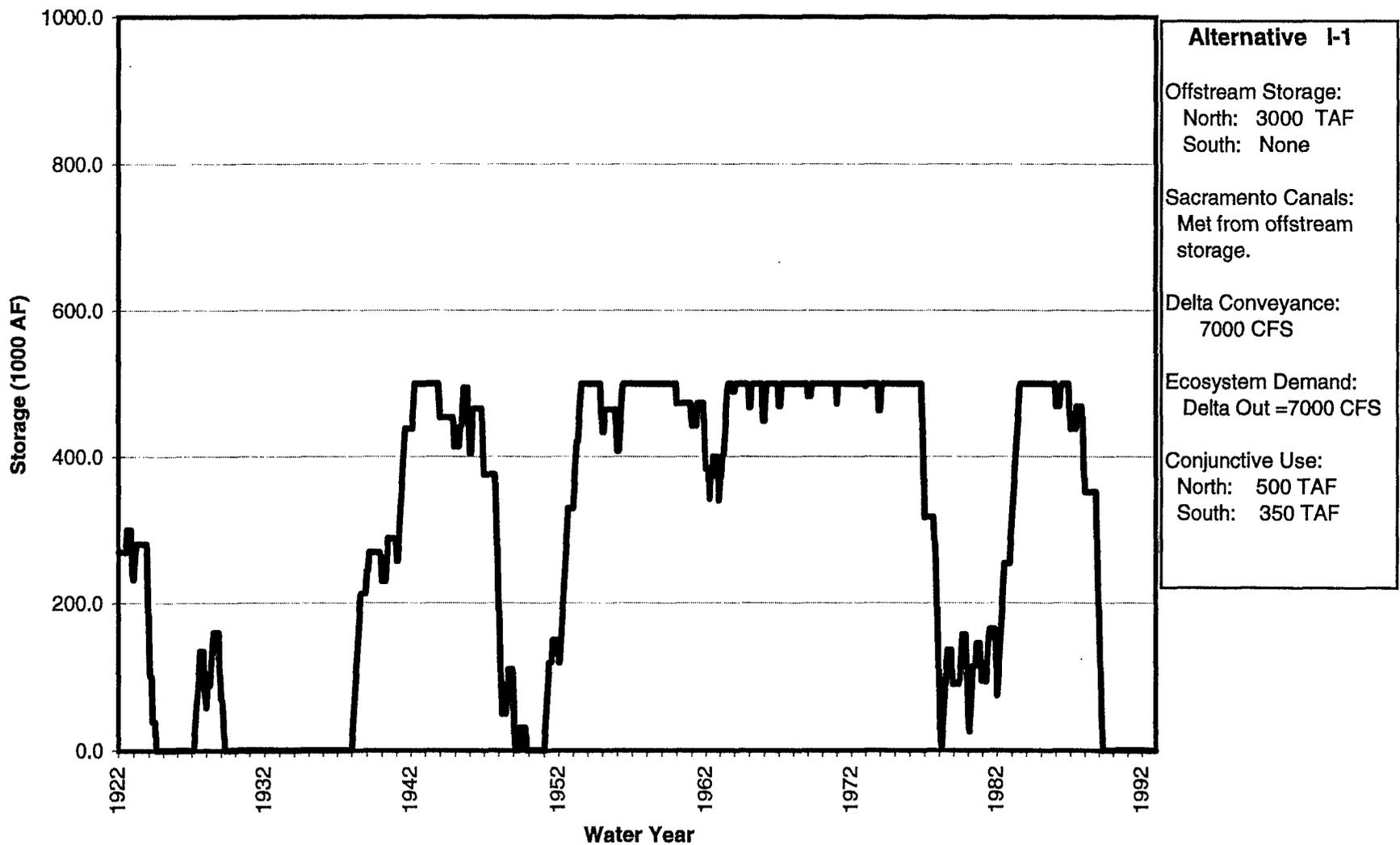
Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

North of Delta Storage Managed for Environmental Needs (Outflow)



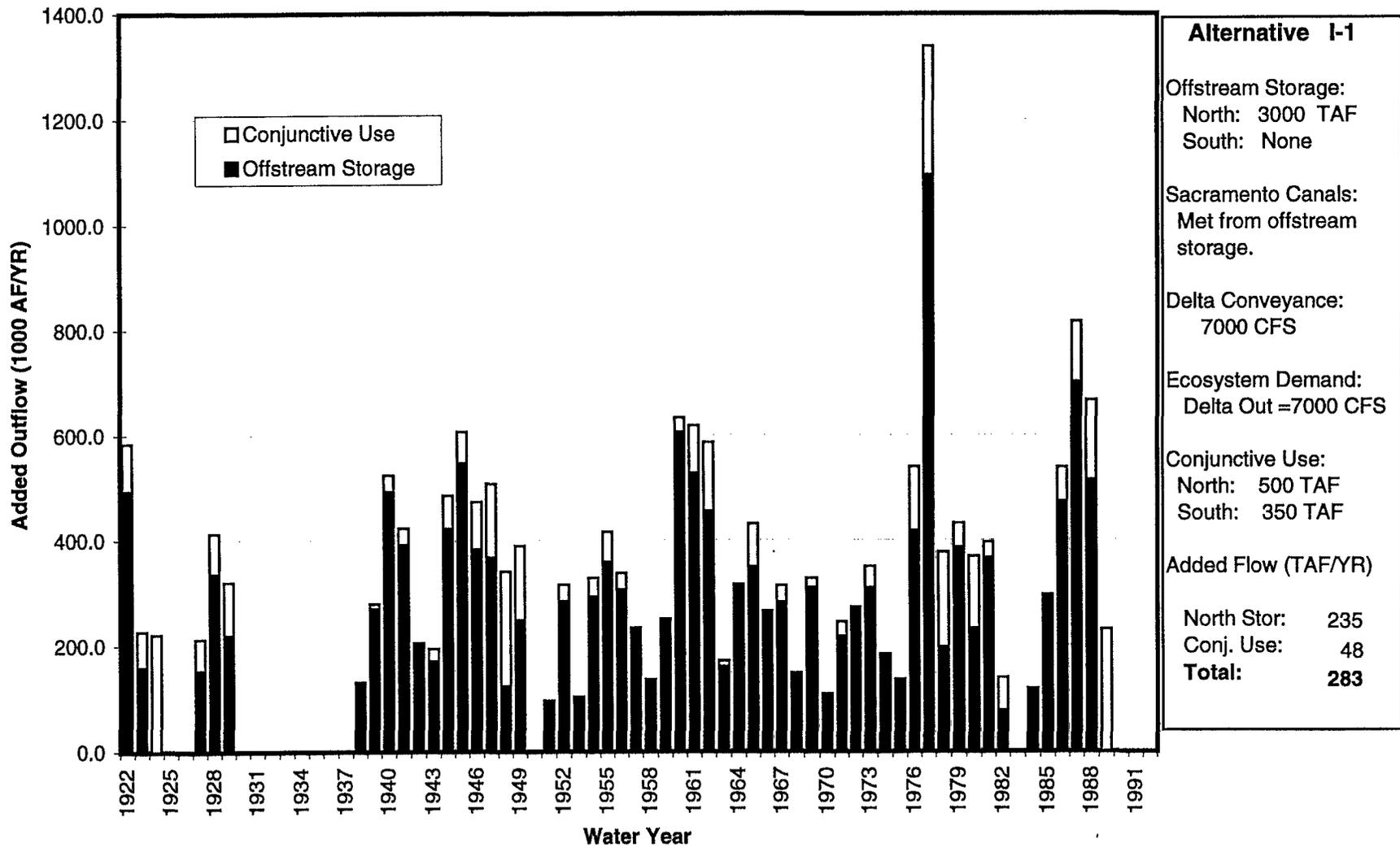
B-005755

North of Delta Groundwater Operation (Managed for Delta Outflow)



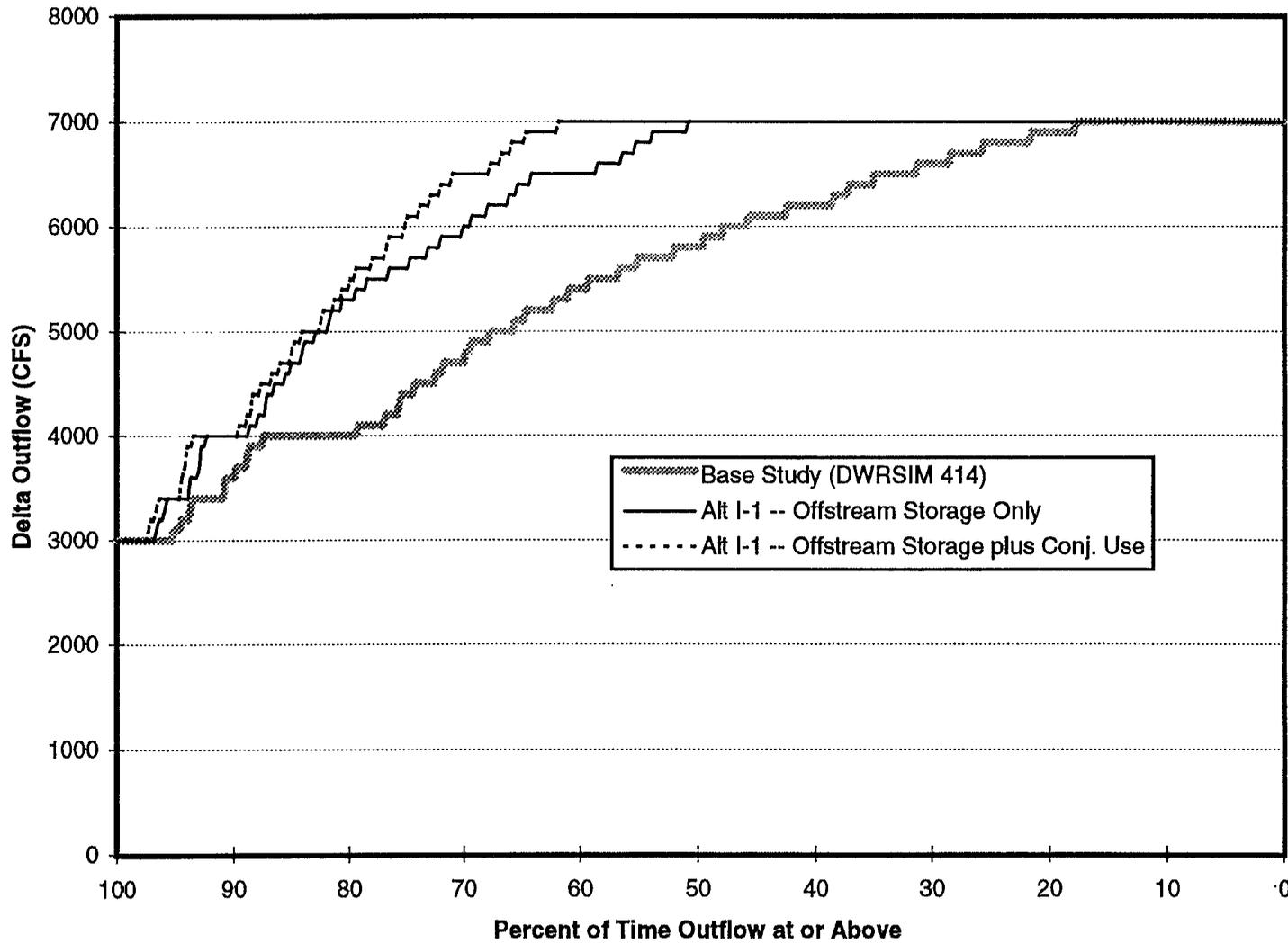
B-005756

Supplemental Delta Outflow from New North Storage and Conjunctive Use



B-005757

Frequency of Delta Outflow -- Target = 7000 CFS April through September



Alternative I-1

Offstream Storage:
North: 3000 TAF
South: None

Sacramento Canals:
Met from offstream storage.

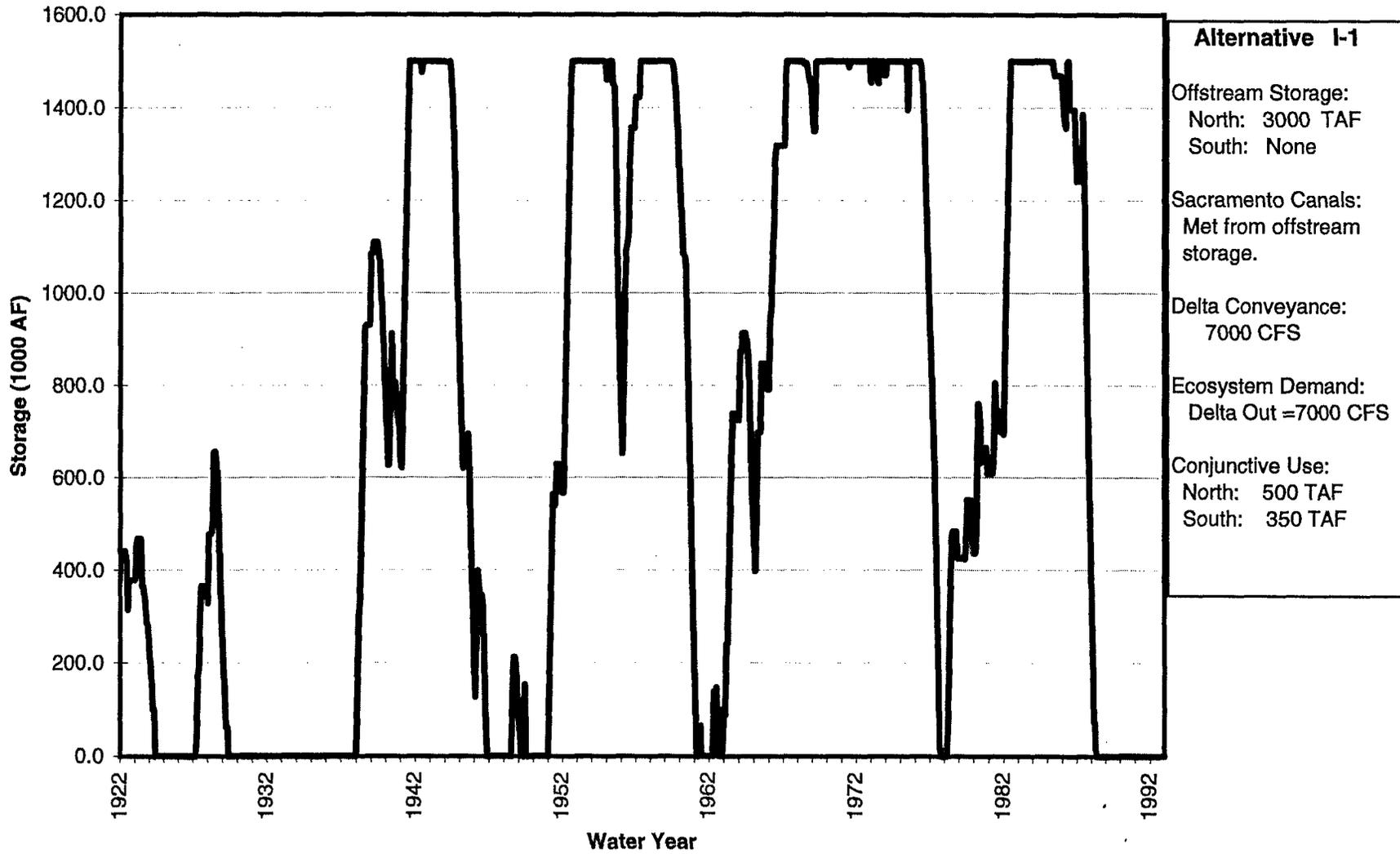
Delta Conveyance:
7000 CFS

Ecosystem Demand:
Delta Out = 7000 CFS

Conjunctive Use:
North: 500 TAF
South: 350 TAF

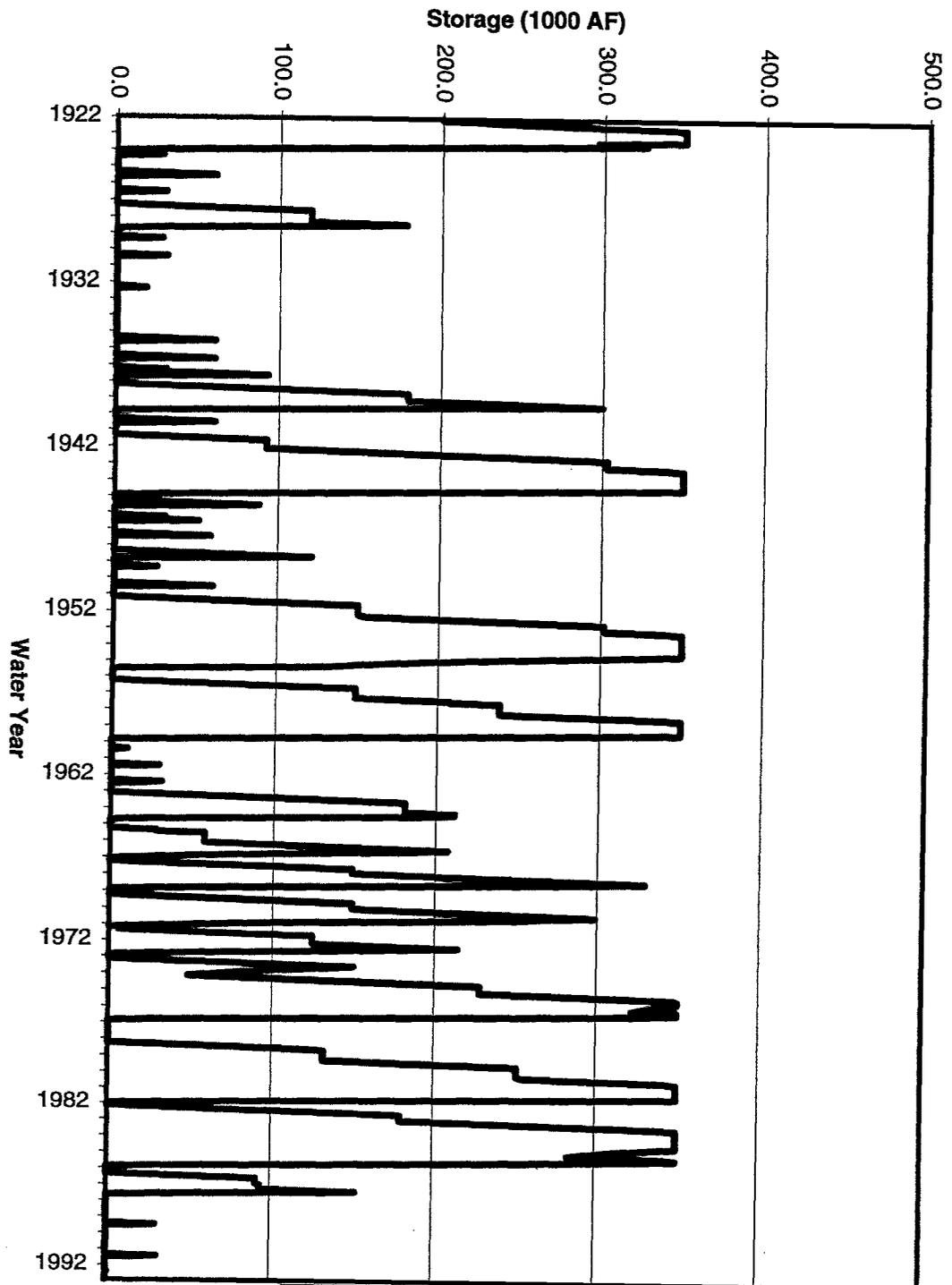
B - 0 0 5 7 5 8

North of Delta Storage Managed for Water Supply Opportunities (Exports)



B - 0 0 5 7 5 9

South of Delta Groundwater Storage (Managed for Water Supply)



Alternative I-1

Offstream Storage:
 North: 3000 TAF
 South: None

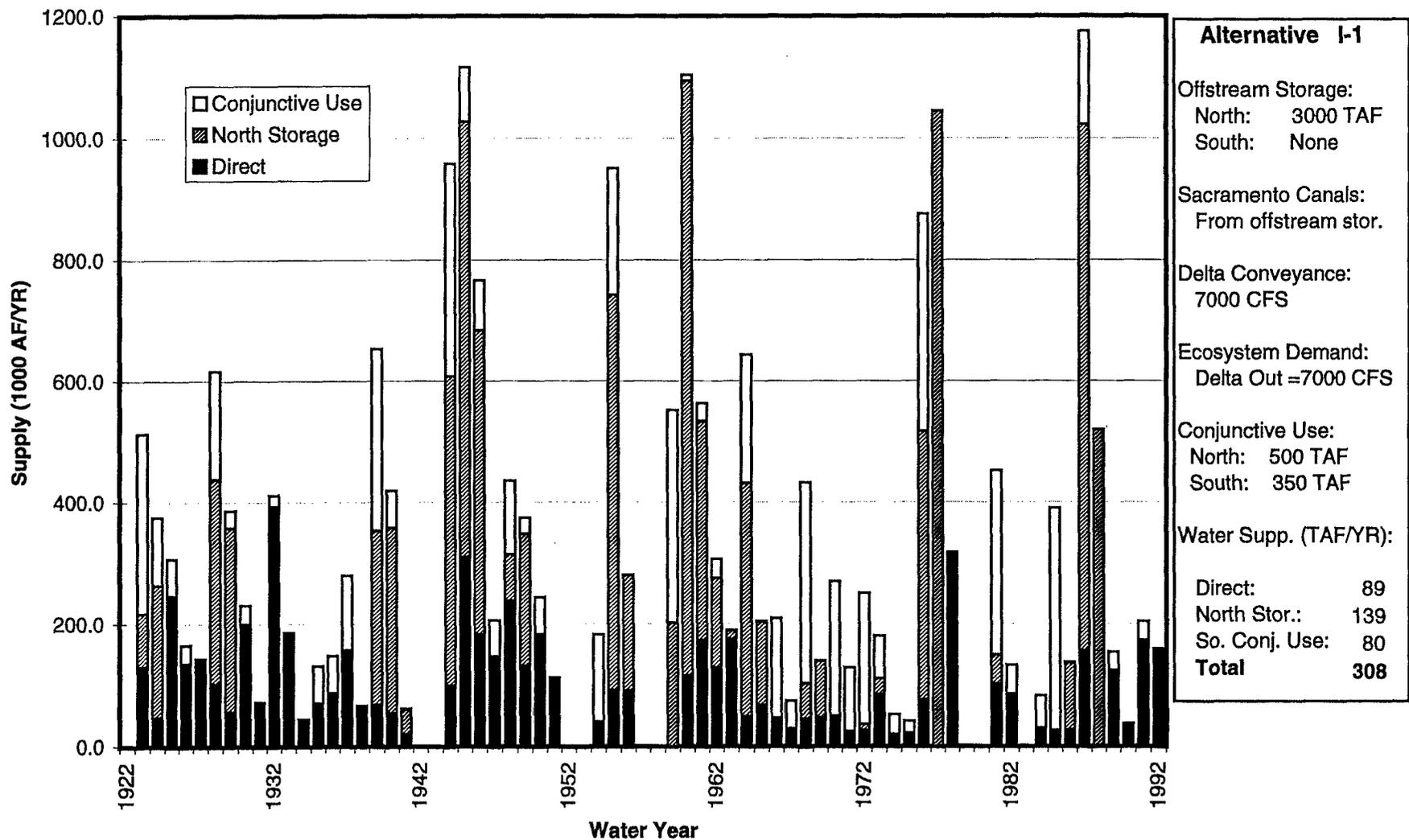
Sacramento Canals:
 Met from offstream storage.

Delta Conveyance:
 7000 CFS

Ecosystem Demand:
 Delta Out = 7000 CFS

Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

Water Supply Opportunities from North Offstream Storage, Direct Delta Diversions, and South Conjunctive Use



B-005761



Alternative J

Alternative J

Facilities

North of Delta Storage:	None
South of Delta Storage:	None
In-Delta Storage:	None
Delta Conveyance:	Isolated facility -- 15,000 CFS

Additional Criteria Assumptions for New Water Supply Opportunities

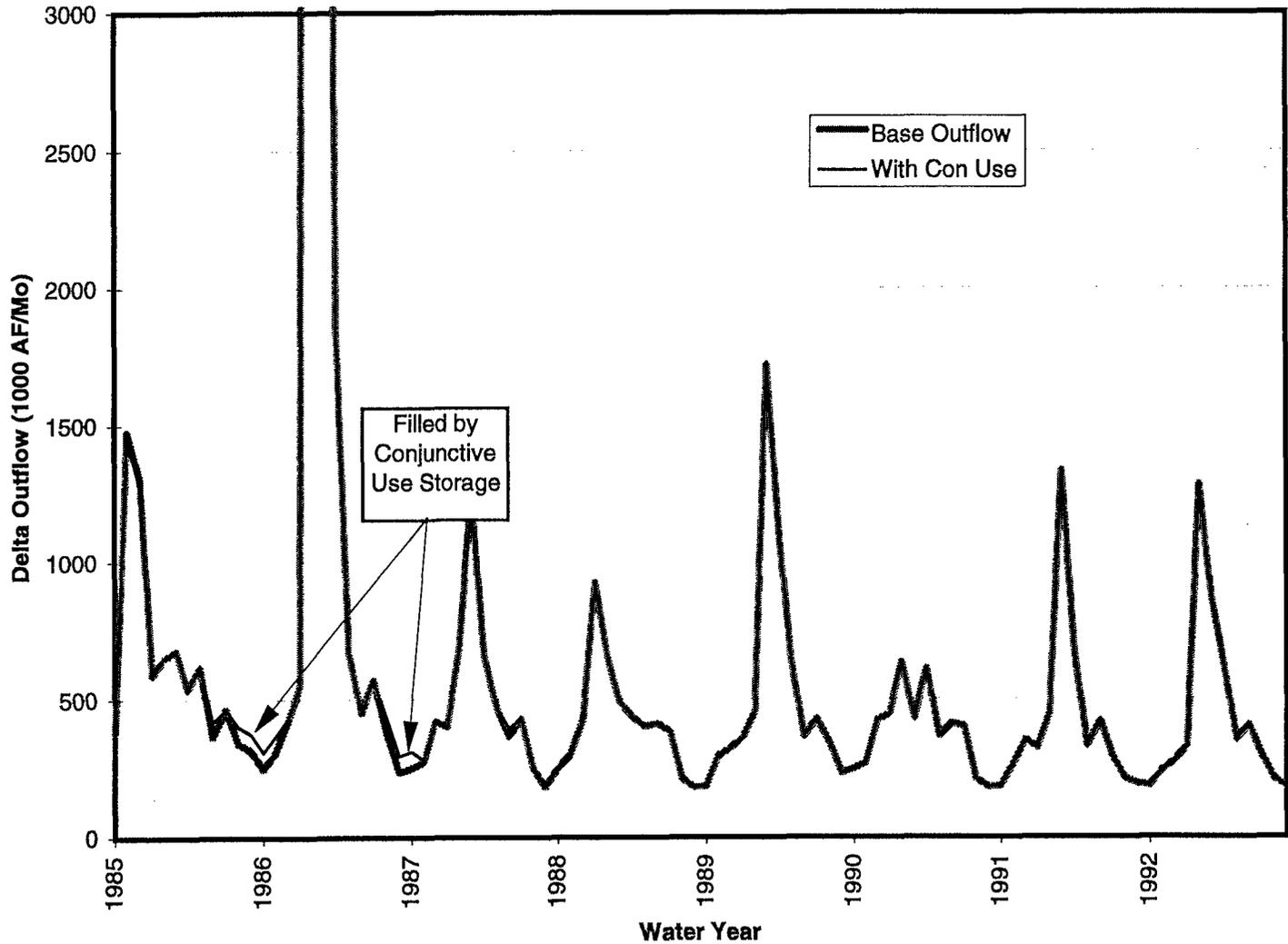
Water Supply Targets: To offset deficits in CVP/SWP demands as determined by base DWRSIM operation simulations to the extent possible. Demands are met on delivery patterns provided by DWR and the Bureau of Reclamation.

Environmental Targets: Provide for no less than 7000 CFS Delta outflow to the extent possible.

Simulation Assumptions

- Operate north of Delta groundwater storage in a conjunctive use mode for environmental opportunities. (To enhance Delta outflow.)
- Operate south of Delta groundwater storage in a water banking mode for water supply opportunities. (To meet demand deficits.)
- Meet CVP/SWP deficient export demands on pattern.
- Uses maximum available Banks PP capacity.

Total Modeled Delta Outflow -- 1985 to 1992 Supplemented by Conjunctive Use



Alternative J

Offstream Storage:
North: None
South:
Res. A: None
Res. B: None

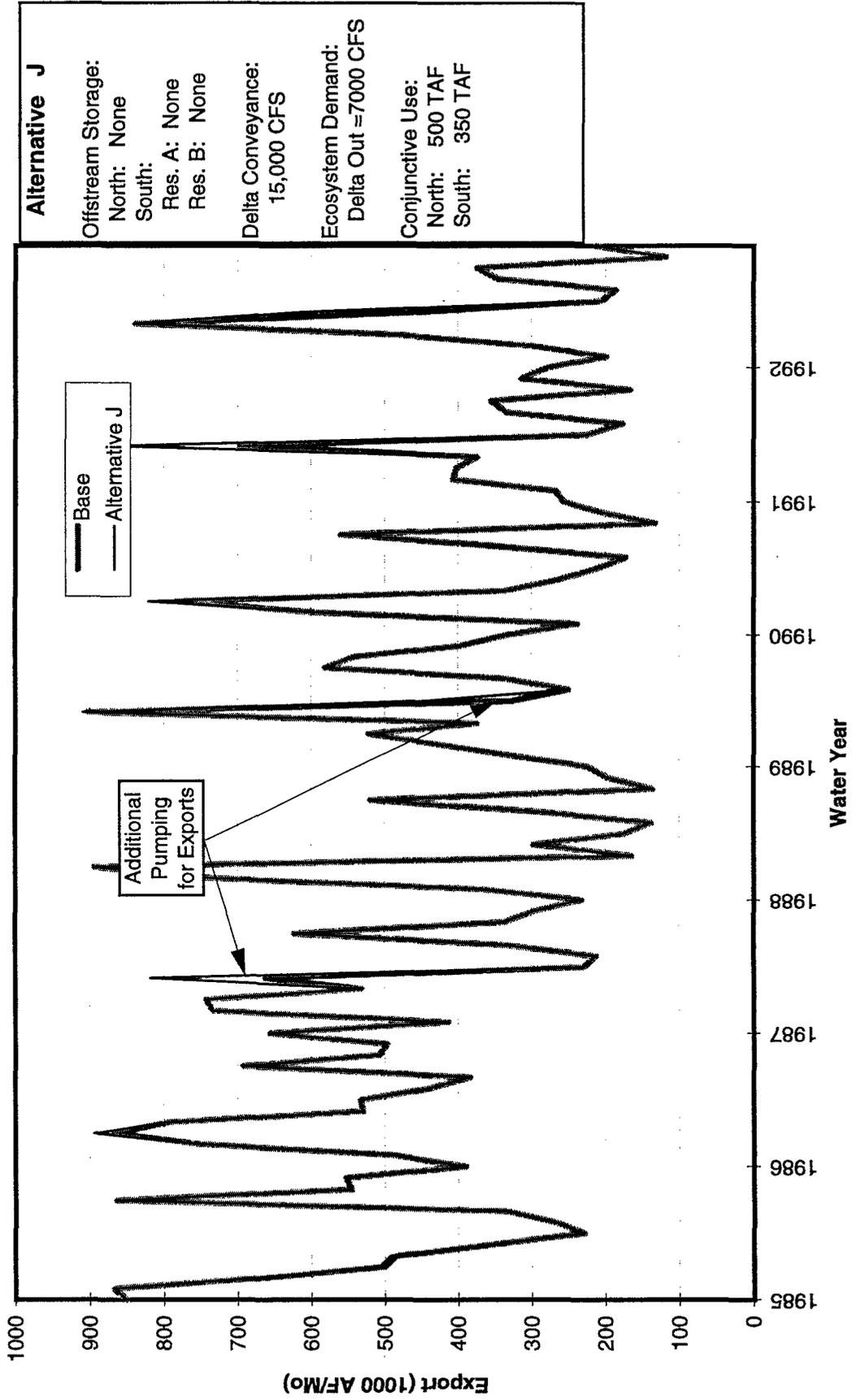
Delta Conveyance:
15,000 CFS

Ecosystem Demand:
Delta Out = 7000 CFS

Conjunctive Use:
North: 500 TAF
South: 350 TAF

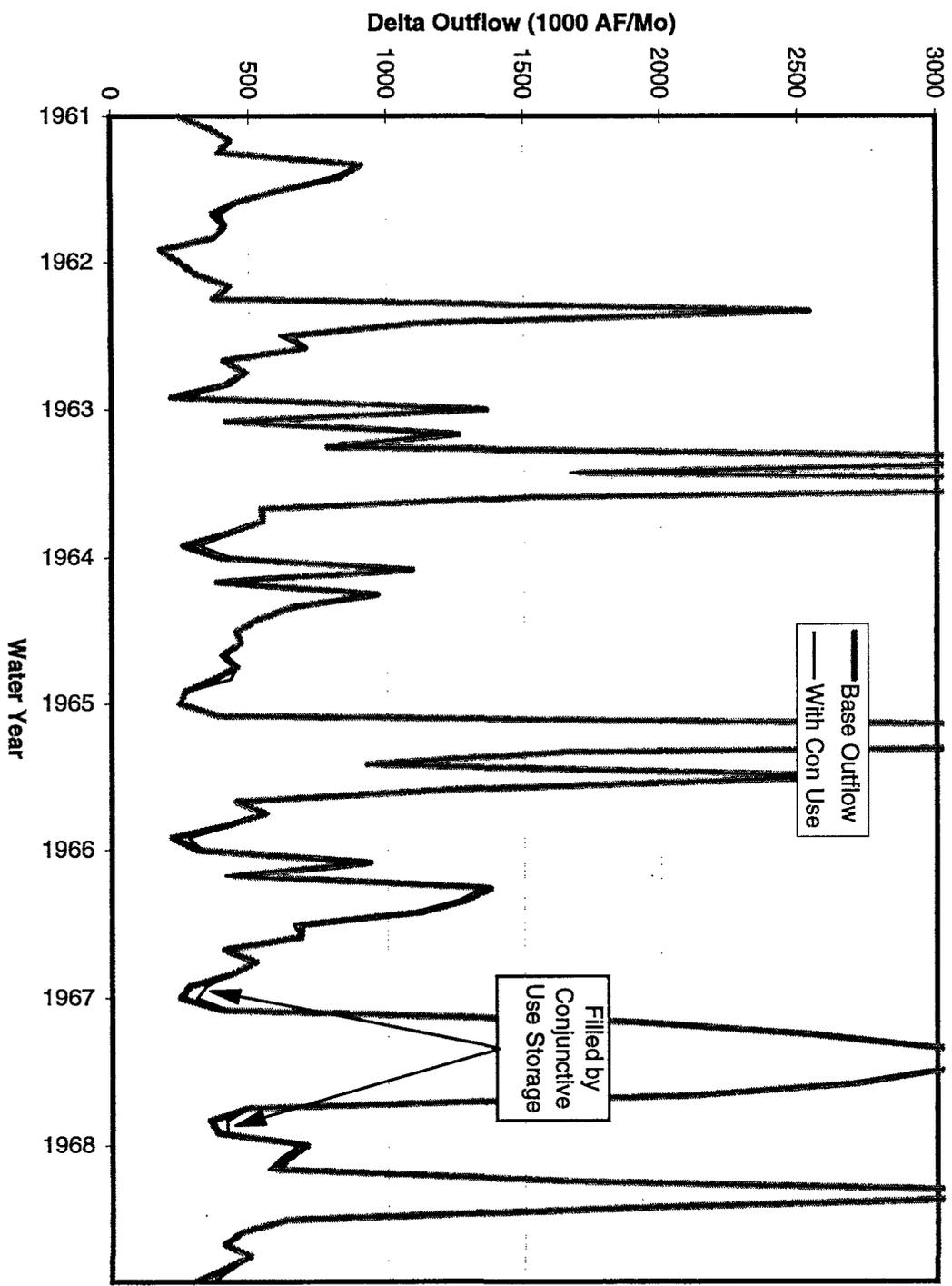
B-005764

Total Modeled South Delta Export -- 1985 to 1992



B - 0 0 5 7 6 5

**Total Modeled Delta Outflow -- 1961 to 1968
Supplemented by Conjunctive Use**



Alternative J

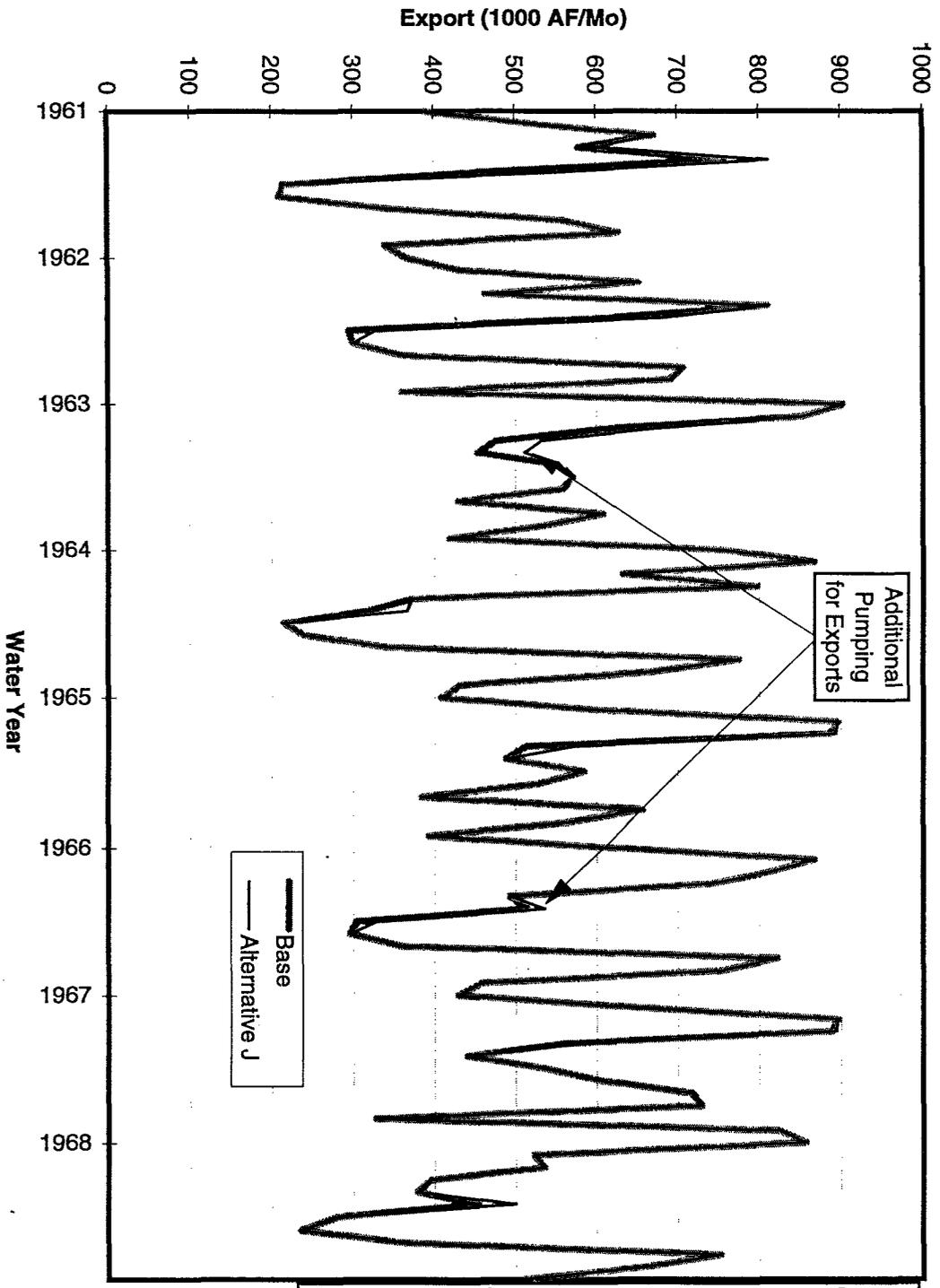
Offstream Storage:
 North: None
 South:
 Res. A: None
 Res. B: None

Delta Conveyance:
 15,000 CFS

Ecosystem Demand:
 Delta Out = 7000 CFS

Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

Total Modeled South Delta Export – 1961 to 1968

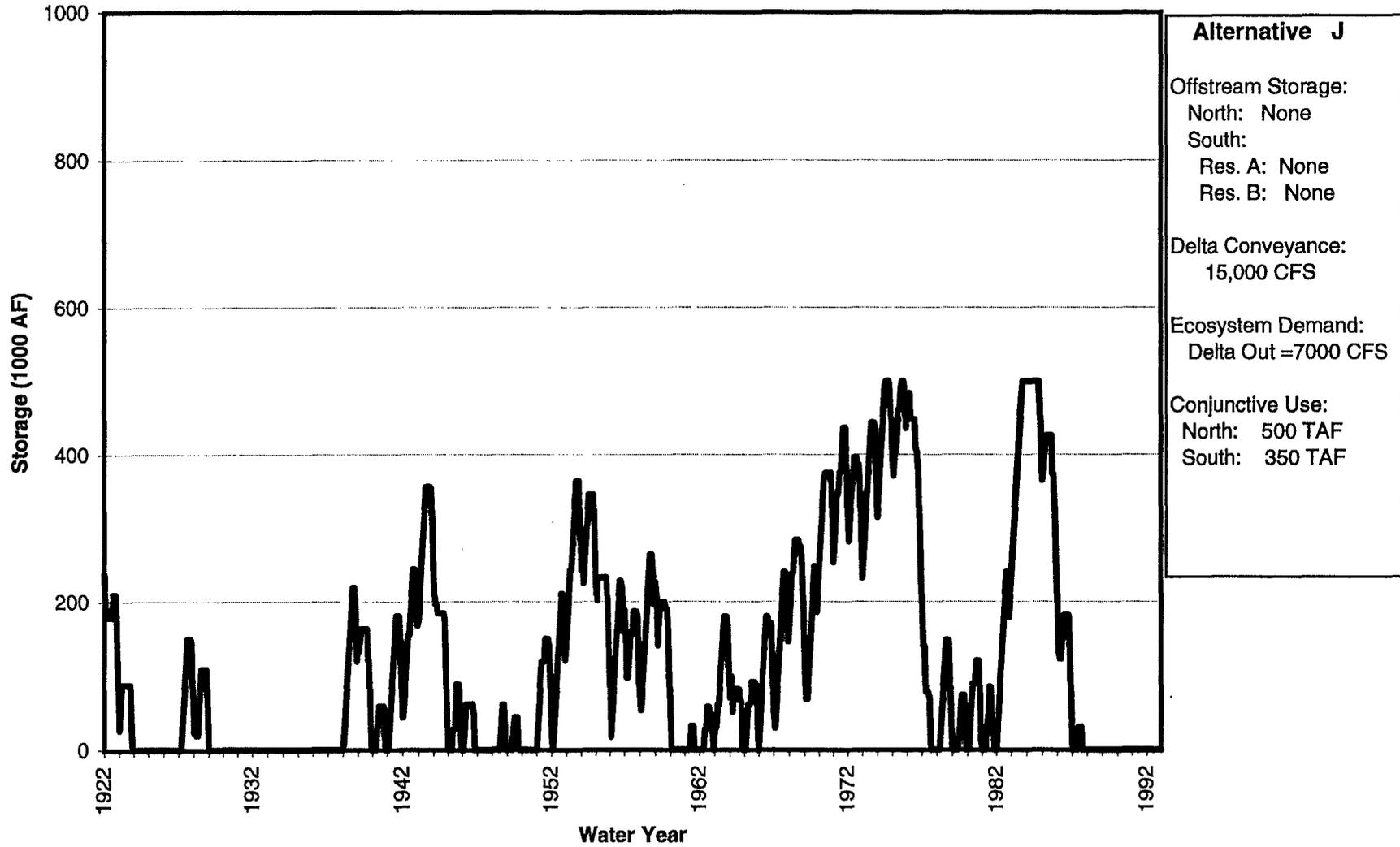


— Base
- - - Alternative J

Additional Pumping for Exports

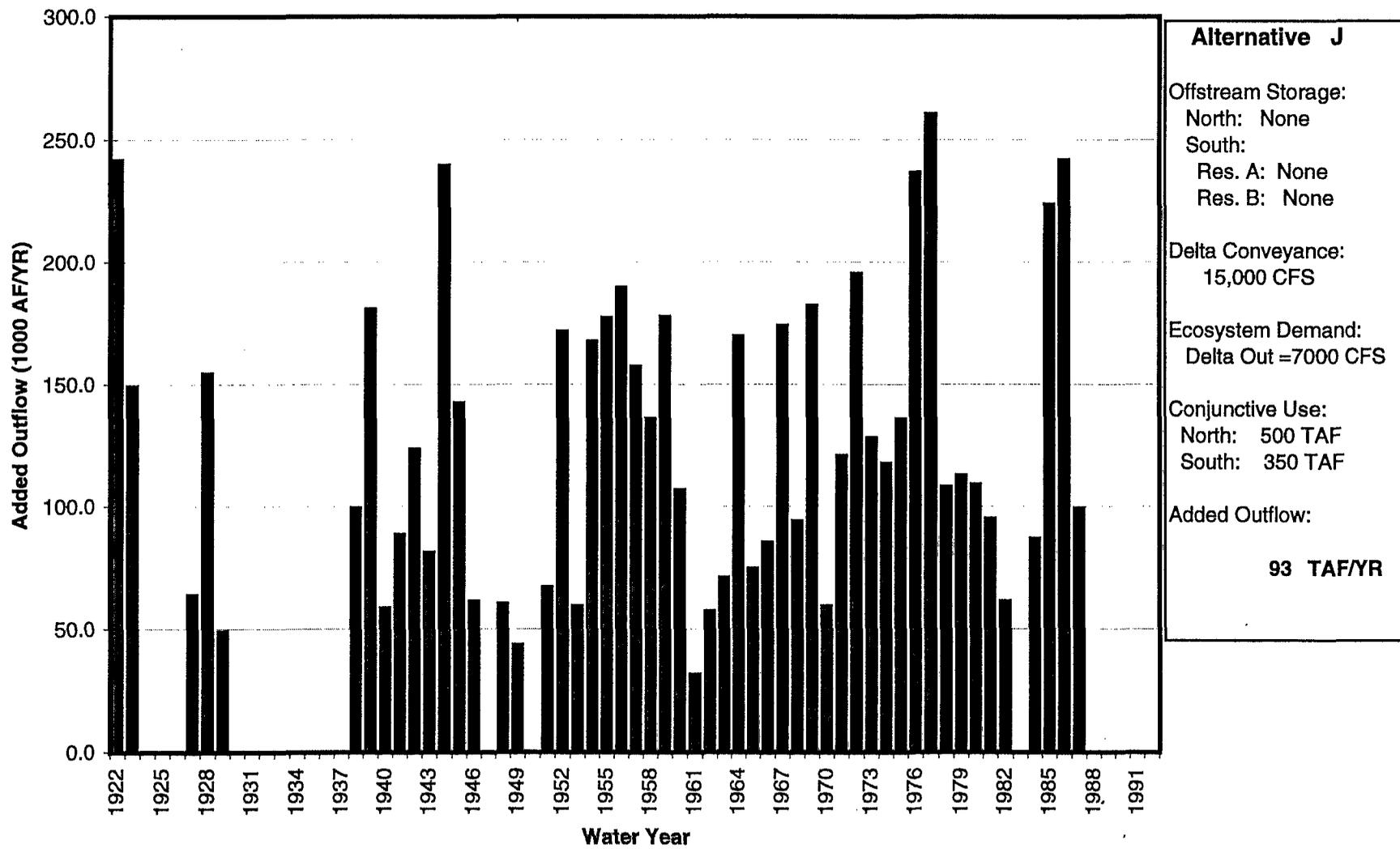
Alternative J
 Offstream Storage:
 North: None
 South:
 Res. A: None
 Res. B: None
 Delta Conveyance:
 15,000 CFS
 Ecosystem Demand:
 Delta Out = 7000 CFS
 Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

North of Delta Groundwater Operation (Managed for Delta Outlow)



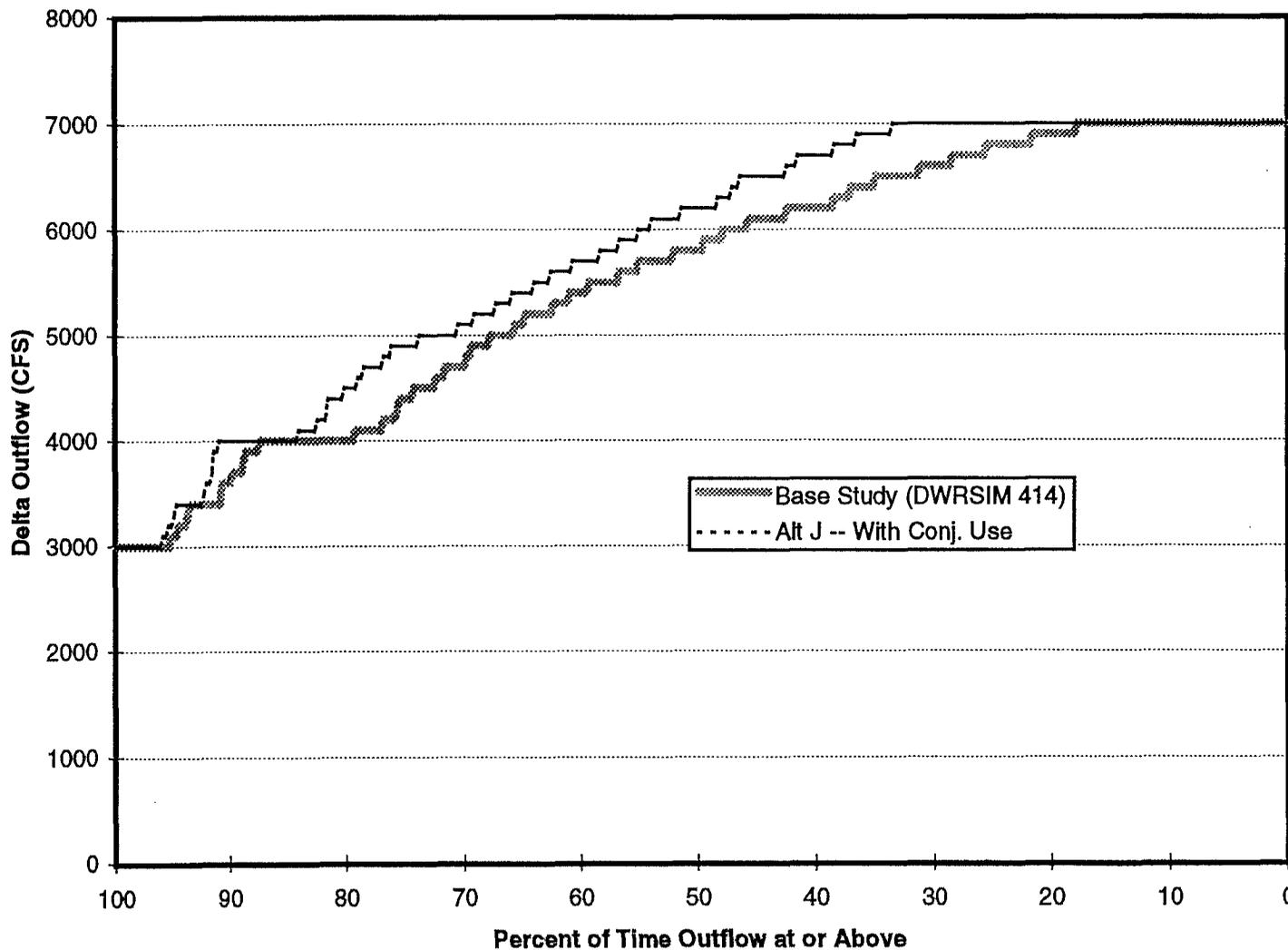
B - 0 0 5 7 6 8

Supplemental Delta Outflow from North Conjunctive Use



B-005769

**Frequency of Delta Outflow -- Target = 7000 CFS
April through September**



Alternative J

Offstream Storage:
 North: None
 South:

Res. A: None
 Res. B: None

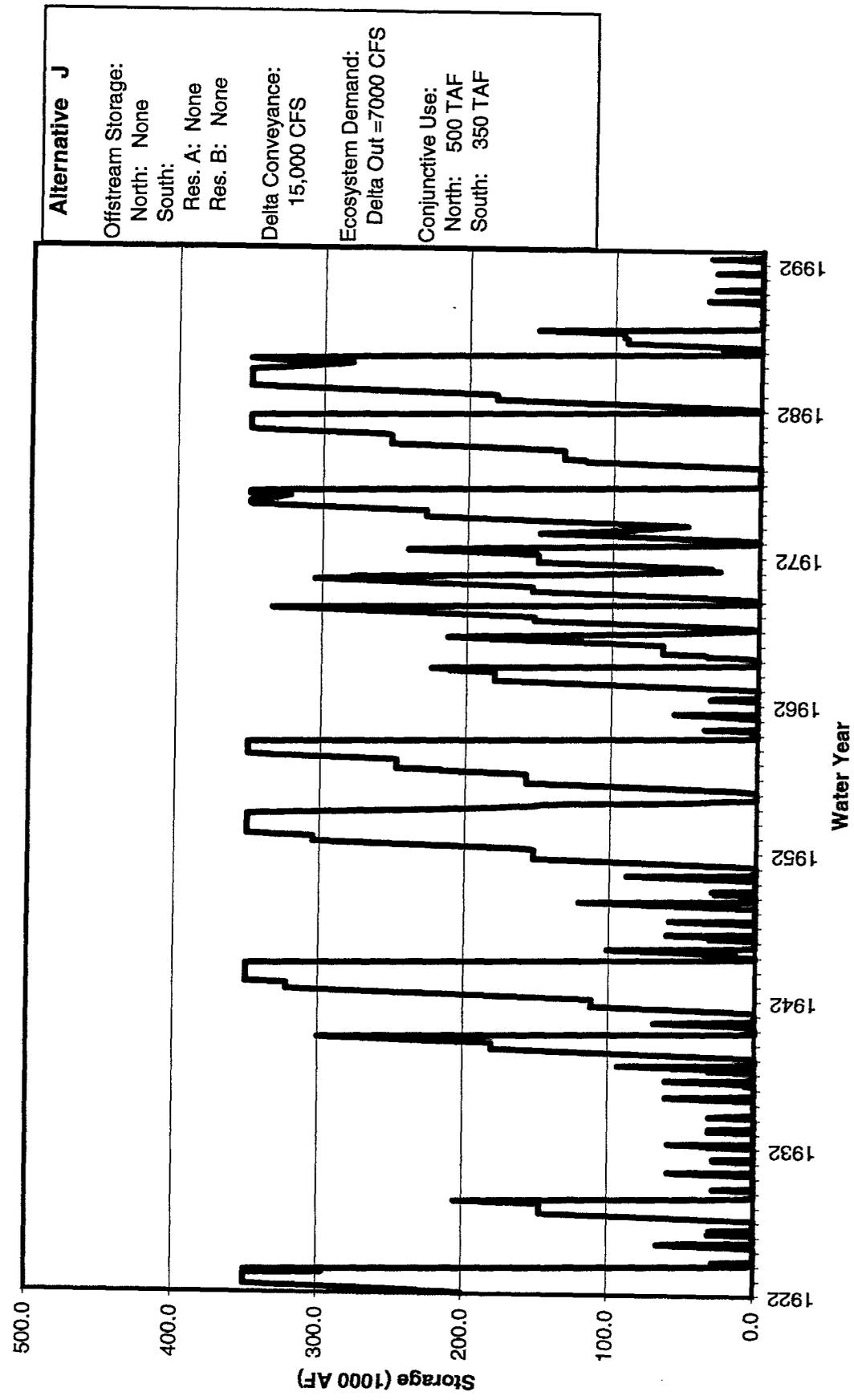
Delta Conveyance:
 15,000 CFS

Ecosystem Demand:
 Delta Out = 7000 CFS

Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

B - 0 0 5 7 7 0

South of Delta Groundwater Storage
(Managed for Water Supply)



Alternative J

Offstream Storage:
 North: None
 South:

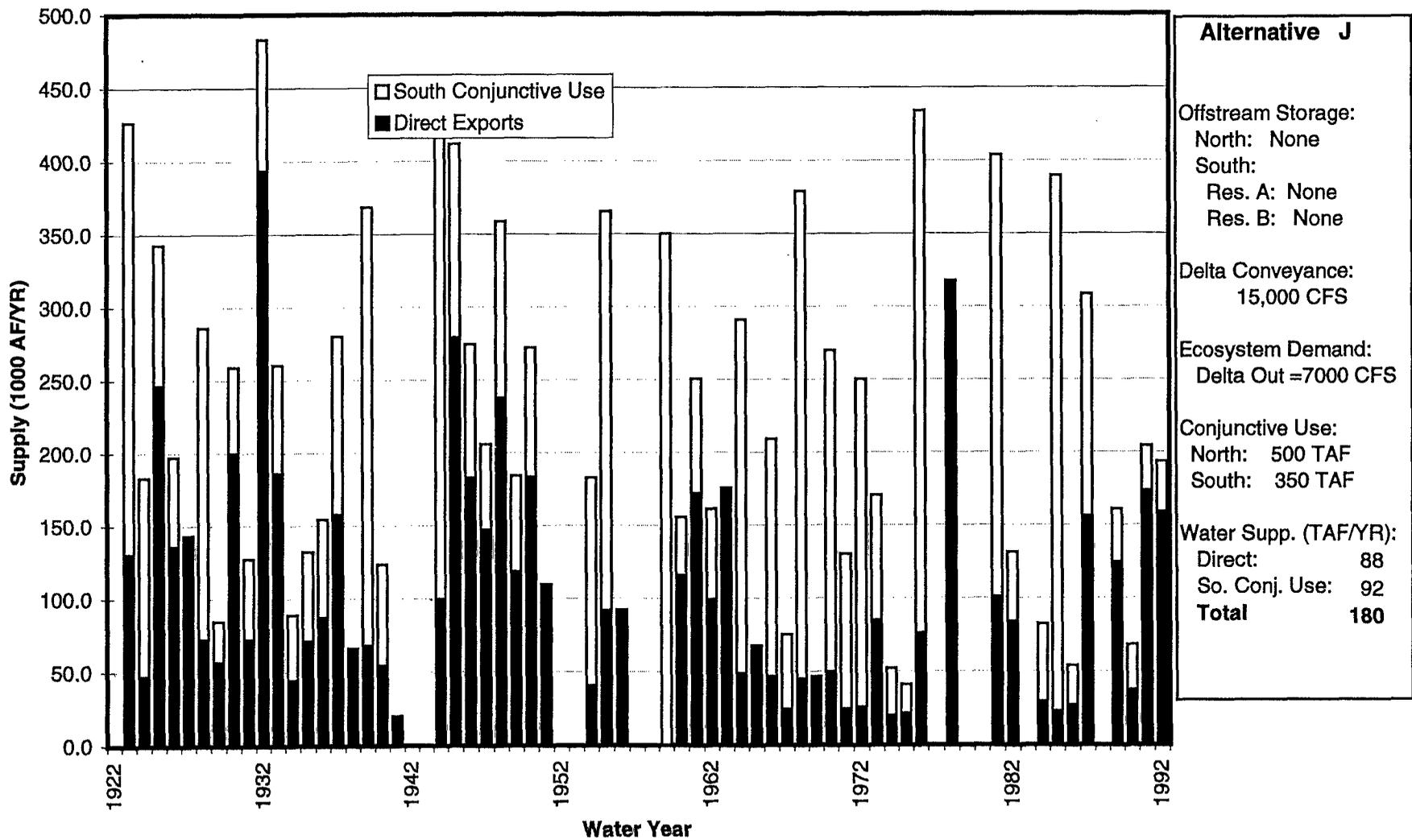
Res. A: None
 Res. B: None

Delta Conveyance:
 15,000 CFS

Ecosystem Demand:
 Delta Out = 7000 CFS

Conjunctive Use:
 North: 500 TAF
 South: 350 TAF

Water Supply Opportunities from Direct Exports plus Conjunctive Use



B-005772