



*Water Resources • Flood Control • Water Rights*

## MEMORANDUM

**DATE:** September 10, 2008

**TO:** L. Ryan Broddrick, Northern California Water Association

**FROM:** Dan Easton

**SUBJECT:** Delta Vision – Evaluation of System Water Demands

In accordance with your request, we have evaluated the potential system water demands of the third draft of the Delta Vision Strategic Plan (Draft Strategic Plan). Several mechanisms for restoring Delta habitat were discussed in the Draft Strategic Plan. The focus of this memorandum is to quantify the water demands above existing operations of three habitat restoration elements. The three elements are:

- 1) “Increase inter-annual inundation frequency on the Yolo Bypass ... [by implementing] the necessary infrastructure and operational modifications to allow the Yolo Bypass to flood at least 60 days continuously between January and April every other year except during critical years.”
- 2) “In the spring ... provide a minimum increase of 10% of unimpaired runoff in most years, with the highest percentage increases in drier years.”
- 3) “In the fall following below normal, above normal, and wet years, the [Delta outflow] requirements should provide two months between August and November with Delta Outflows of 12,000 to 18,000 cubic feet per second.”

Because the Draft Strategic Plan contains few details about these proposals’ implementation, we made several assumptions and evaluated water demand under low and high bookend scenarios for each habitat restoration element. Table 1 summarizes the annual average demand above existing flows by year type classification. It is important to note that the system-wide impacts of meeting the Delta Vision habitat restoration water demands were not quantified in this analysis. However, as will be discussed in the remainder of this document, the timing of the demands – prior to and during droughts – could be significant.

**Table 1 Summary Table of Annual Average Delta Vision Water Demands**

Year Type Classification	Wet	Above Normal	Below Normal	Dry	Critical
<b>Annual Average Yolo Bypass Inundation Demand (acre-feet)</b>					
Scenario A (revised Fremont Weir + pumps)	0	49,000	189,000	260,000	0
Scenario B (current Fremont Weir)	540,000	1,443,000	1,879,000	3,267,000	0
<b>Annual Average Spring Delta Outflow Increase Demand (acre-feet)</b>					
Scenario C (10% all years)	59,000	120,000	130,000	104,000	132,000
Scenario D (10% wet years-25% critical years)	59,000	120,000	203,000	238,000	357,000
<b>Annual Average Fall Delta Outflow Requirement Demand (acre-feet)</b>					
Scenario E (12,000 cfs all years)	497,000	841,000	772,000	0	0
Scenario F (12,000 cfs below normal-18,000 cfs wet)	1,110,000	1,189,000	772,000	0	0

### **Basis of Calculation**

Our evaluation of the restoration demands is based on simulation output from CalSim CACMP Version 9. CalSim is a planning model developed for the Central Valley Project (CVP) and State Water Project (SWP). The model simulates project operations and the underlying hydrology at a monthly time step over an 82 year historical period (1921-2002) with a superimposed level of development. For these calculations, an existing level of development (2005) was assumed.

For each of the elements analyzed, it was first determined whether existing operations as defined by the baseline CalSim results were sufficient to meet the proposed Draft Strategic Plan criteria in any given month of the 82 year simulation. In months that additional upstream releases would be required, the size of those releases – an increase in system demand – was quantified. It is important to note that the additional demand may not result in a direct water supply impact. The cumulative impacts to project operations have not been simulated. It is possible that in some years high flows in following months would refill any storage deficit caused by the Delta Vision criteria prior to a reduction in water supply. It is also possible that the “hole” created by the proposed action may result in less carryover storage and impact water supply availability in subsequent years. Furthermore, the impact of each Delta Vision element was considered separately. There is potential that a release for Yolo Bypass inundation could also meet the increased spring Delta outflow requirements, and that was not considered in this estimate. The Draft Strategic Plan does not provide sufficient detail to determine the extent of the possible overlap. Lastly, no transportation costs such as seepage or evaporation nor potential changes in Delta water quality and how that may effect project operations were considered in this analysis.

## Element 1: Yolo Bypass Inundation

The Draft Strategic Plan does not provide key details for the Yolo Bypass inundation plan necessary for quantification of water demand. For instance, the minimum Yolo Bypass flow necessary for beneficial inundation was not specified. A minimum flow of 5,000 cfs was mentioned in supporting documents.<sup>1</sup> Also, proposed changes in infrastructure for providing the inundation flow were unmentioned. In some work related to the Bay Delta Conservation Plan, scenarios were analyzed where Fremont Weir was modified so that an upstream flow of 35,000 cfs would be sufficient to push 5,000 cfs into the bypass. Currently, upstream flows must exceed 62,000 cfs to initiate spills over Fremont Weir into the Yolo Bypass.

While it was not likely intended by the Delta Vision Task Force, one potential scenario would be to reroute 5,000 cfs of existing Sacramento River flow through the Yolo Bypass. This would require no additional release from upstream reservoirs however it would reduce flows in the Sacramento River between the Fremont Weir and Cache Slough by 5,000 cfs. It is unknown how this would be done, but the reduction to Sacramento River flow downstream of the diversion would at times be a significant fraction of existing flow. Since this was not likely intended by the task force, we will not discuss it further except to mention that it represents the absolute minimum increase in upstream releases.

To address the uncertainty regarding the details of the inundation plan, bookend estimates of the releases necessary for Element 1 are provided. For each estimate, it is assumed that a minimum flow of 5,000 cfs is needed to inundate the bypass. The assumptions common to each estimate are:

- Beneficial inundation requires a minimum of 5,000 cfs flow in the bypass over a two month period from January to April.
- Inundation must occur every other year except critical years as defined by the 40-30-30 Sacramento Basin index.
- In any year that inundation is required, selection of the two month inundation period is made to minimize water supply impacts.

### Scenario A: Low estimate

- Fremont Weir is modified so that spills into the Yolo Bypass start when Sacramento River flows reach 30,000 cfs, rather than 62,000 cfs.
- The minimum inundation flow of 5,000 cfs will spill over Fremont Weir into the Yolo Bypass when Sacramento River flows reach 35,000 cfs.
- If Sacramento River flows are below 30,000 cfs, then 5,000 cfs could be released upstream and diverted into the Yolo Bypass using pumps that currently do not exist.

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<sup>1</sup>The Draft Strategic Plan does not state what flow is considered necessary to inundate the bypass, but its relevant proposal appears to be based on The Bay Institute's proposal, which used 5,000 cfs as the flow necessary for bypass inundation. (See Delta Vision document 2008-ES-14, attachment 1, p. 11.)

## Scenario B: High estimate

- Fremont Weir is not modified and 62,000 cfs of Sacramento River flow is necessary to initiate spilling over the Fremont Weir and 67,000 cfs of upstream flow will provide the minimum 5,000 cfs needed to inundate the Yolo Bypass

Table 2 provides the annual average demand by year classification – wet (W), above normal (AN), below normal (BN), dry (D), and critical (C) – and over the entire 82-year period of analysis (All) in thousand acre-feet (TAF). As shown, there is no inundation demand in the critical years as recommended in the Draft Strategic Plan. For Scenario A, where it is assumed that the Fremont Weir is modified to divert water into the Yolo Bypass when the Sacramento River is flowing at 30,000 cfs instead of the current 62,000 cfs, existing flows are sufficient for inundation of the bypass in wet years. In Scenario B, which assumes the existing Fremont Weir, more than half of a million acre-feet would have to be released on average in wet years alone to maintain the inundation standard. In dry years, the annual average release was 260 TAF and 3,267 TAF in Scenarios A and B, respectively.

**Table 2 Annual Average Yolo Bypass Inundation Demand**

Annual Average Yolo Bypass Inundation Demands		
Year Type	Scenario A (TAF)	Scenario B (TAF)
W	0	540
AN	49	1443
BN	189	1879
D	260	3267
C	0	0
All	96	1420

Figures 1 and 2 compare annual inundation demand with CalSim baseline Lake Shasta carryover storage for Scenarios A and B, respectively. Years in which there is no inundation demand are labeled “P” if there was inundation demand in the previous year, “C” if it was a critical year, and “I” if existing flows were sufficient to inundate the bypass. For Scenario A, no annual inundation demand exceeds 600 TAF because it was assumed that the maximum release necessary to generate inundation would be 5,000 cfs over the two month period. While the demands in Scenario A are generally much smaller than in Scenario B, they are still significant. For instance, in 1930 and 1932, two dry years during the drought of 1929-1934, the Scenario A Yolo Bypass inundation demand estimates were 600 TAF each. As shown in Figure 1, CalSim baseline Shasta carryover storage was drawn down to 650 TAF in September 1931 and 626 TAF in September 1934. Shasta dead pool storage is 550 TAF. During such an historical drought, there would not be sufficient water to meet this additional 1.2 million acre-feet of habitat demand while still meeting other project obligations.

In Scenario B, enough water has to be released to initiate a spill over Fremont Weir and then an additional 5,000 cfs must be released for inundation. (This is a low estimate, since a significant

fraction of the flow exceeding the spill threshold would continue down the Sacramento River.) As shown in Figure 2, the Scenario B inundation demands would be enough to drain Lake Shasta in many years.

### **Element 2: Increase spring Delta outflow**

The Draft Strategic Plan recommends that the State Water Resources Control Board (SWRCB) revise the Bay-Delta Water Quality Control Plan (WQCP) to increase spring Delta outflow in all but the wettest years. Specifically the Draft Plan states that “[I]n the spring, the requirements should provide a minimum increase of 10% of unimpaired runoff in most years, with the highest percentage increases in drier years.”

Increases in Delta spring outflow are intended to push X2 -- the location of the two parts-per-thousand salinity threshold -- downstream. As written in the Draft Strategic Plan, “Delta outflows in February through June have a strong and statistically significant correlation with the abundance and/or survival of numerous estuary-dependent organisms in the Bay-Delta ecosystem.” Currently, from February through June the Delta is operated to maintain X2 at or downstream of specific locations for a number of days dependent on the water year type as specified in the WQCP. The Draft Strategic Plan appears to be intended to build on this standard by increasing spring outflows by at least 10%. As stated in the Draft Strategic Plan, it is not expected that much additional outflow would be required in wet years. (This is true because the X2 Delta outflow requirements are rarely controlling in wet years.) The Draft Strategic Plan specifically calls for the greatest percent increase in spring Delta outflow in the drier years. (Note that there will be overlap between Element 1 and Element 2 and that this analysis is not accounting for the periods when the inundation release might also meet the spring Delta outflow demand. The Draft Strategic Plan does not provide sufficient detail to determine the extent of the overlap.)

#### Scenario C: Low estimate

- Increase X2 Delta outflow requirements in the months of February through June by 10%

#### Scenario D: High estimate

- Increase X2 Delta outflow requirements in the months of February through June by 10% in wet and above normal years, 15% in below normal years, 20% in dry years, and 25% in critical years

Table 3 provides annual average spring Delta outflow demand by year type classification for Scenarios C and D. Annual SWP Table A allocations as compiled from the baseline CalSim results are also listed. From Scenario C to D, there is no change in wet and above normal spring Delta outflow demand since it was assumed that required X2 Delta outflows would be increased by 10% in each. It was in the below normal, dry, and critical years where the requirements were ramped up in Scenario D. As expected in the Draft Strategic Plan, wet year increases in spring Delta outflow were small on average. For dry and critical years, if 20% and 25% increases are

implemented as assumed in Scenario D, the annual average increase in spring outflow demands are 238 TAF to 357 TAF respectively.

**Table 3 Annual average spring Delta outflow demands**

Year Type	Annual Average Spring Delta Outflow Demands		CalSim SWP Annual Allocations (TAF)
	Scenario C (TAF)	Scenario D (TAF)	
W	59	59	3928
AN	120	120	3885
BN	130	203	3333
D	104	238	2472
C	132	357	1481
All	101	175	3142

Figures 3 and 4 show annual spring Delta outflow demands for Scenarios C and D, respectively. Each year is labeled with its year type classification. Note the additional demand placed on the system during droughts such as 1929-1934, 1976-1977, and 1987-1992. These increased Delta outflow requirements during the drier years could significantly affect upstream reservoir storage and Delta export operations.

**Element 3: Increase fall Delta outflow**

The Draft Strategic Plan calls for 12,000 to 18,000 cfs required Delta outflow in at least two months in the period from August to November in wet, above normal, and below normal years. Each year, the two months selected to increase Delta outflow, if necessary, were selected to minimize water demand. As such, the estimates of the increased demand of the proposed Delta outflow requirements may be conservative.

Scenario E: Low estimate

- Maintain a minimum Delta outflow of 12,000 cfs for at least 2 months from August to November in wet, above normal, and below normal years.

Scenario F: High estimate

- Maintain a minimum Delta outflow of 12,000 cfs for at least 2 months from August to November in below normal years
- Maintain a minimum Delta outflow of 15,000 cfs for at least 2 months from August to November in above normal years
- Maintain a minimum Delta outflow of 18,000 cfs for at least 2 months from August to November in wet years


Table 4 summarizes annual average fall Delta outfall demands by year classification for Scenarios E and F. For comparison, annual SWP Table A allocations are also listed. As

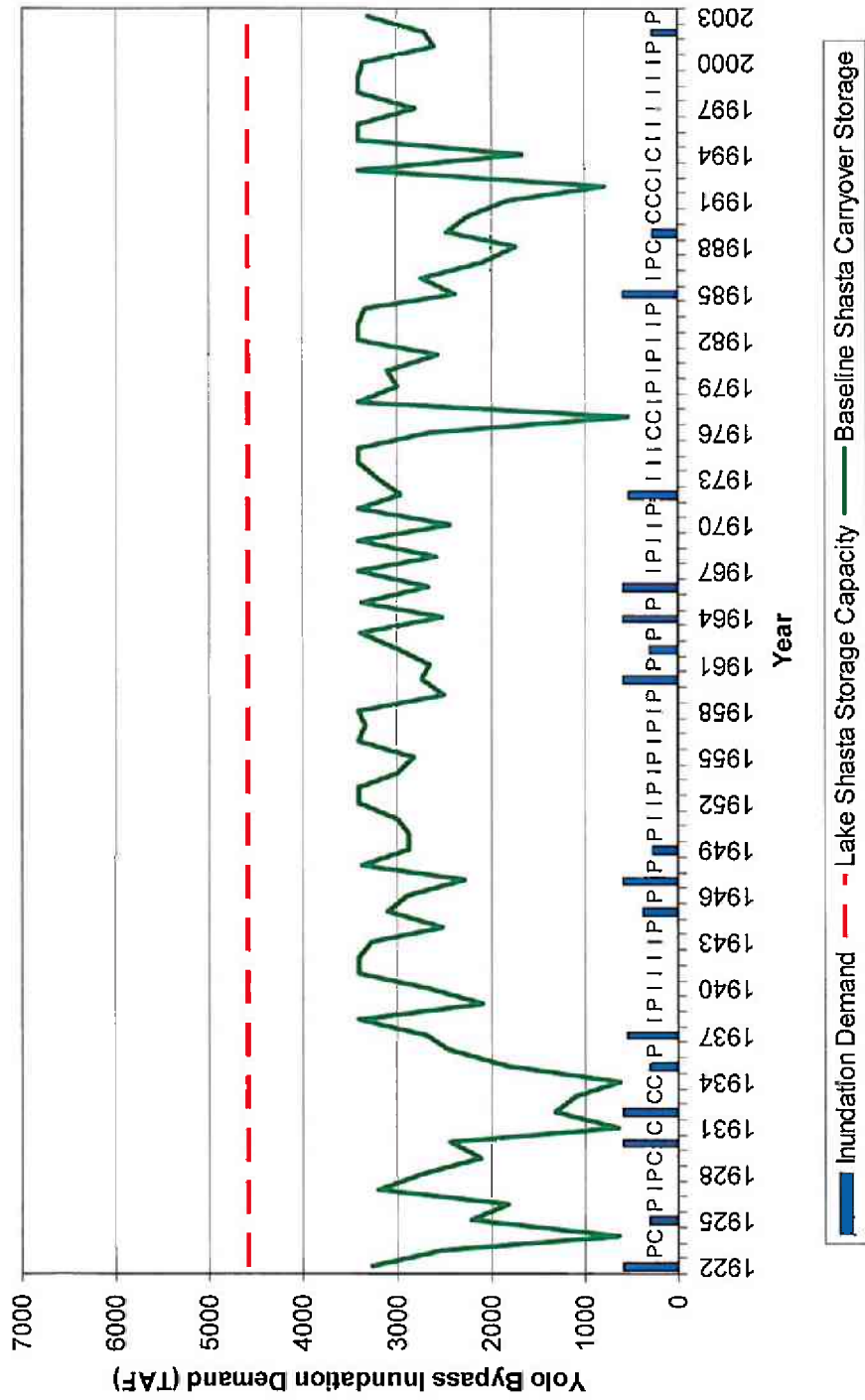
recommended in the Draft Strategic Plan, no additional fall Delta outflow releases were made in dry and critical years. For both Scenarios E and F, the increases in fall Delta outflow are large and could impact project reservoir and Delta export operations.

**Table 4 Annual average fall Delta outflow releases**

Year Type	Annual Average Fall Delta Outflow Demands		CalSim SWP Annual Allocations (TAF)
	Scenario E (TAF)	Scenario F (TAF)	
W	497	1110	3928
AN	841	1189	3885
BN	772	772	3333
D	0	0	2472
C	0	0	1481
All	412	658	3142

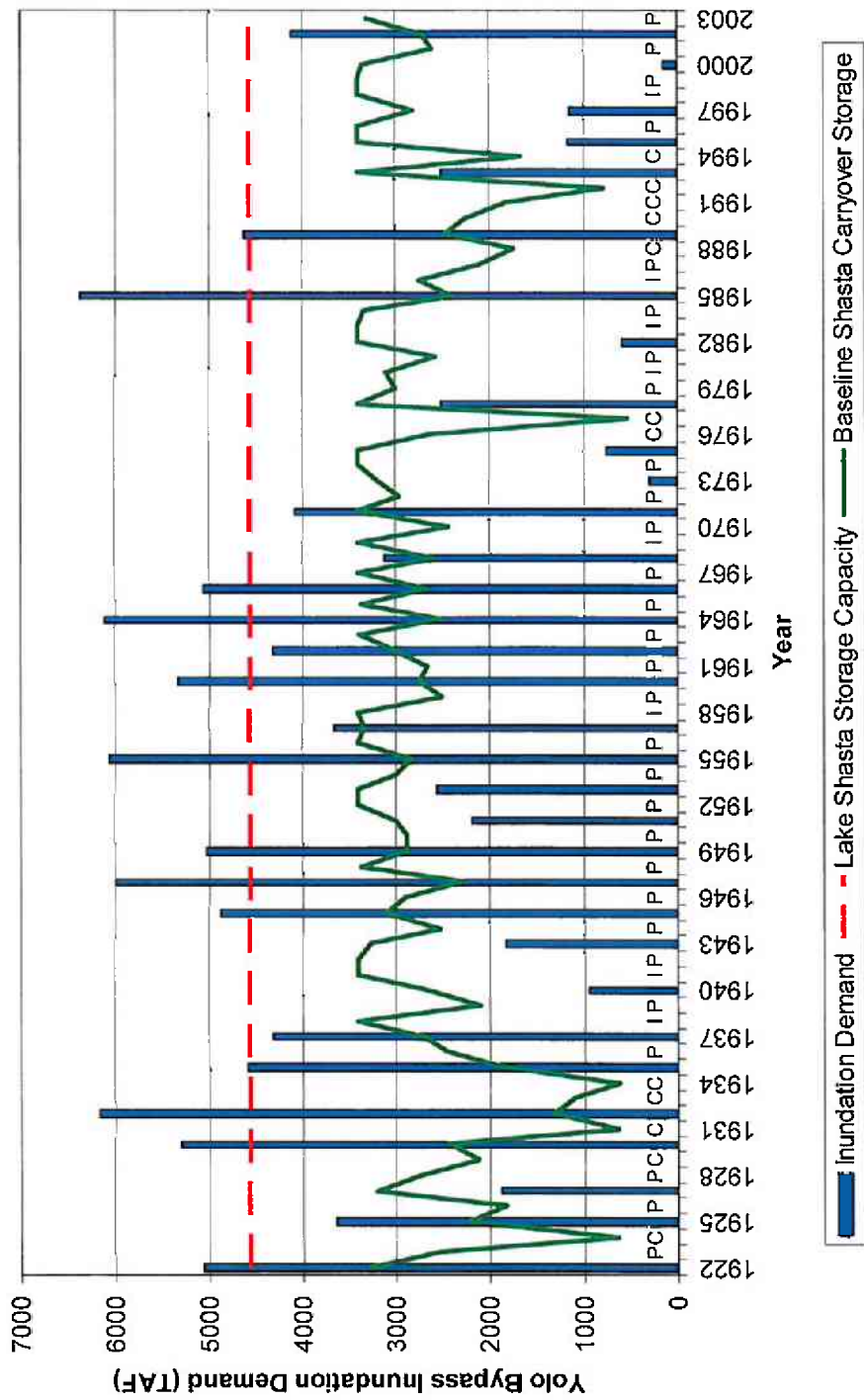
Figures 5 and 6 show annual fall demands in Scenarios E and F. Each year is labeled with the year type classification (wet, above normal, below normal, dry, and critical). Unlike the spring Delta outflow requirement (Element 2), the fall Delta outflow requirement would not impose a large drought demand on the system. However, it could significantly reduce the amount of water in storage in upstream reservoirs heading into the droughts. For Scenario E, it was estimated that an additional 900 TAF would be needed in the fall of 1928 and 1986 heading into the droughts of 1929-1934 and 1987-1992. In Scenario F, the additional water required was approximately 1,300 TAF and 1,600 TAF. In either scenario, meeting the Draft Strategic Plan’s fall Delta outflow demands would have diminished the ability of the upstream reservoirs to provide water during the following dry periods.

  
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**Figure 1 Scenario A annual Yolo Bypass inundation demands as compared to Lake Shasta storage capacity and baseline end-of-September carryover storage**

- P: No demand due to previous year inundation
- C: No demand in critically dry years
- I: No demand because existing flows were sufficient



**Figure 2 Scenario B annual Yolo Bypass inundation demands as compared to Lake Shasta storage capacity and baseline end-of-September carryover storage**

- P: No demand due to previous year inundation
- C: No demand in critically dry years
- I: No demand because existing flows were sufficient



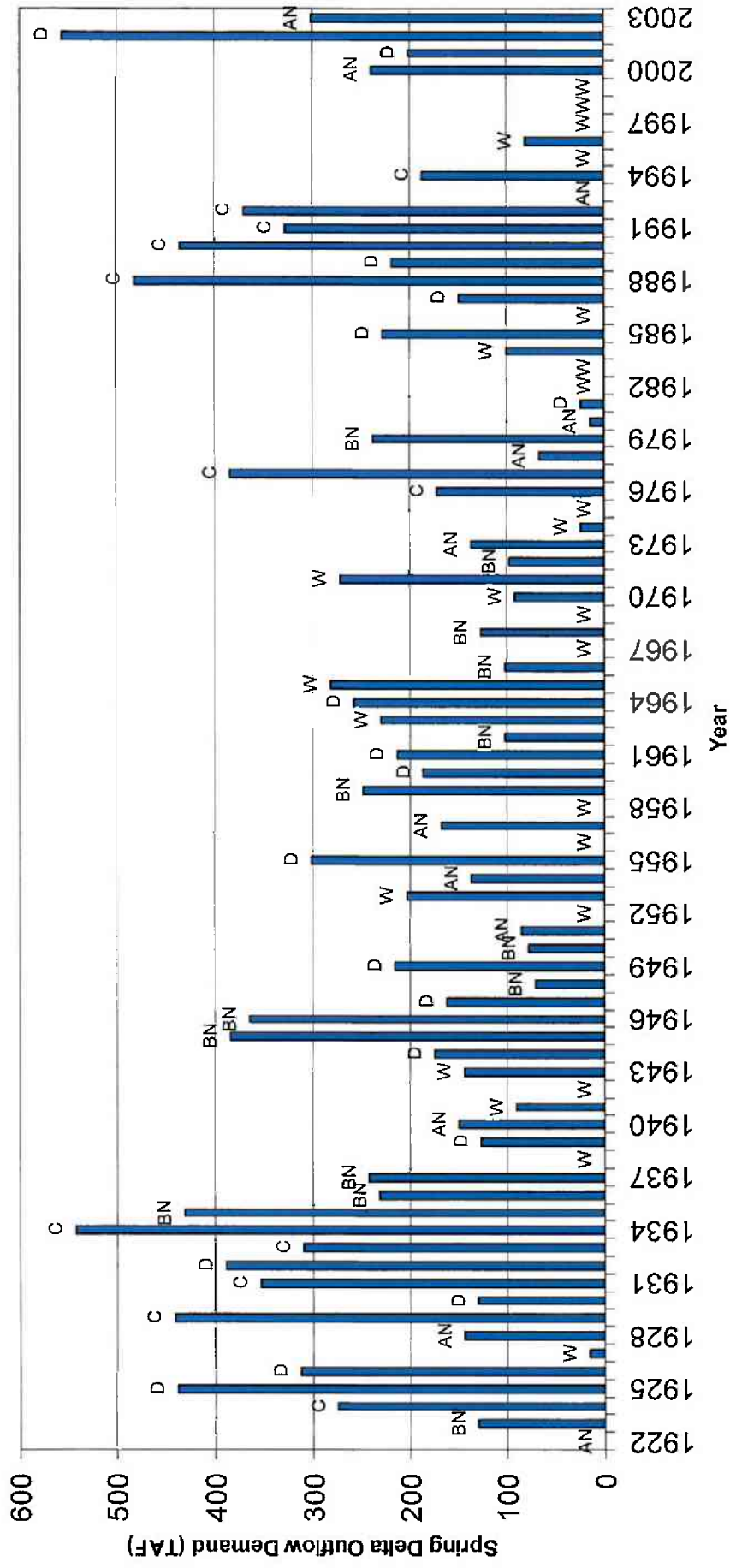


Figure 4 Scenario D annual spring Delta outflow demand



