

**Summary Analysis of Delta
Operations and Hydrodynamics Studies
For CALFED/DEFT Evaluation Scenarios**

September 10, 1998



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- Effects of SWP and CVP on Delta Outflow
- Surplus Delta Flows (Monthly Average)
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- SWP Deliveries and Unmet Demand
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Graphics Set for Delta Operation Studies for CALFED/DEFT Alternatives

- Comparison of X2 Positions (Time Series)
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- Comparison of Total Delta Outflow (Monthly Average)
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- Comparison of Rio Vista Flows (Monthly Average)
- Comparison of Vernalis Flows (Monthly Average)
- Comparison of Hood Flows (Monthly Average)

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- Comparison of Old River @ Bacon Flows (Time Series)
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- Comparison of QWEST Flows (Monthly Average)
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Summary Analysis of Delta Operations and Hydrodynamic Studies For CALFED/DEFT Alternatives

INTRODUCTION

One critical development in Phase II of the CALFED Program has been the formation of the Diversion Effects on Fisheries Team (DEFT) to address the issue of restoring the health of the Delta ecosystem to protect sensitive species. DEFT has been charged with the difficult tasks of developing a set of operational and structural tools to provide increased protection and promote recovery of several sensitive fish species in the Delta.

CALFED has provided technical support to DEFT by post-processing modeling results from NoName/DEFT operation and Delta simulation studies to provide impact comparisons to the current set of base CALFED studies. A series of DWRSIM and DSM-2 modeling studies were conducted in support of the DEFT process. Representative DEFT studies were compared to Existing Conditions and the CALFED alternatives to determine the resulting affects of DEFT actions in the Delta. Graphic comparisons were prepared to show relative differences in flows throughout the Delta as an indication of potential impacts or benefits to the system. The basic operational assumptions for each CALFED and DEFT study are outlined below.

NONAME/DEFT OPERATION STUDIES

A number of operation studies were conducted to describe new operational criteria designed to provide additional protection of fisheries in the Delta.

Existing Conditions for NoName/DEFT Operation Studies (Study 3)

The base case study of Existing Conditions was modeled to include the following operational criteria:

- *1995 Level of Development*
- Analysis of 1994 *Accord* (no minimum flows at Vernalis, including pulse flows, are imposed)
- *Upstream AFRP Flows* (AFRP Upstream Actions 1 through 3) below Keswick, Nimbus and Whiskeytown Dams.
- *AFRP Delta Actions* including:
 1. Delta Action 1: Vernalis Adaptive Management Plan (VAMP)
 2. Delta Action 3: Additional X2 protection
 3. Delta Action 4: Maintain Sacramento River Flow at Freeport
 4. Delta Action 5: Ramping of Delta Exports in May
 5. Delta Action 6: Close Delta Cross Channel gates in October through January
 6. Delta Action 7: July flows and exports

Additional Fishery Protection Operation Studies (DEFT Studies)

The following studies include the operational criteria from the Existing Conditions study and a unique set of additional DEFT fishery operational modifications as described below:

Study 690 (DEFT 2)

- Reduction of E/I ratio to .55 for November
- Reduction of E/I ratio to .45 for December and January

Study 691 (DEFT 3)

- Reduction of E/I ratio to .25 E/I from February through June

Study 692 (DEFT 4)

- Extension of VAMP export constraints to 61 days (April 1 through May 31)

Study 661 (Study 5)

- Reduction of E/I ratio to .55 for November
- Reduction of E/I ratio to .45 for December and January
- Reduction of E/I ratio to .25 E/I from February through June
- Extension of VAMP export constraints to 61 days (April 1 through May 31)
- Extension of VAMP upstream flows to 61 days (April 1 through May 31)
- Habitat Protection Outflow (X2) to 1962 LOD @ Chipps Island from February through June

Additional Water Supply Benefit Operation Studies (NONAME Studies)

The following studies include the operational criteria from the Existing Conditions study and a unique set of additional NoName Delta conveyance or facility components as described below:

Study 663 (Study 4)

- ***ISDP:*** Assume Banks P.P. capacity at 10,300-cfs
- ***JPOD:*** Assume full and unlimited joint point of diversion. SWP wheels for the CVP whenever unused capacity at Banks is available
- ***DMC/California Aqueduct 400-cfs Intertie:*** Modeled as an increase to capacity in the upper Delta Mendota Canal to 4,600-cfs

Study 665 (Study 4A)

- ***ISDP:*** Assume Banks P.P. capacity at 10,300-cfs
- ***JPOD:*** Assume full and unlimited joint point of diversion. SWP wheels for the CVP whenever unused capacity at Banks is available
- ***DMC/California Aqueduct 400-cfs Intertie:*** For modeling convenience, increase the capacity in the upper Delta Mendota Canal to 4,600-cfs
- ***Madera Ranch Groundwater Storage:*** located south of the Delta and modeled as a CVP facility.

Study 669 (Study 4B)

- **ISDP:** Assume Banks P.P. capacity at 10,300-cfs
- **JPOD:** Assume full and unlimited joint point of diversion. SWP wheels for the CVP whenever unused capacity at Banks is available
- **DMC/California Aqueduct 400-cfs Intertie:** For modeling convenience, increase the capacity in the upper Delta Mendota Canal to 4,600-cfs
- **Enlarged Shasta Lake** (400 TAF - height increased by 6.5 feet)

Additional Fishery Protection & Water Supply Benefits Operation Studies (NONAME/DEFT)

The following study includes the operational criteria from the Existing Conditions study and a unique set of additional NoName and DEFT Delta conveyance, facility components and operation criteria as described below:

Study 664 (Study 6)

NoName Delta conveyance or facility components:

- **ISDP:** Assume Banks P.P. capacity at 10,300-cfs
- **JPOD:** Assume full and unlimited joint point of diversion. SWP wheels for the CVP whenever unused capacity at Banks is available
- **DMC/California Aqueduct 400-cfs Intertie:** Modeled as an increase to capacity in the upper Delta Mendota Canal to 4,600-cfs

DEFT fishery operational modifications:

- Reduction of E/I ratio to .55 for November
- Reduction of E/I ratio to .45 for December and January
- Reduction of E/I ratio to .25 E/I from February through June
- Extension of VAMP export constraints to 61 days (April 1 through May 31)
- Extension of VAMP upstream flows to 61 days (April 1 through May 31)
- Habitat Protection Outflow (X2) to 1962 LOD @ Chipps Island from February through June

Summary Results for NoName & DEFT Operation Studies

Preliminary results from Study 6 (NoName + full DEFT actions) were compared to the base case study of Existing Conditions. A set of summary graphs is provided at the end of this report under the section heading *Graphics Set for Operation Studies with NoName + Full DEFT Actions* and includes the following graphics:

- Comparison of Total Delta Exports (Monthly Average)
- Effects of SWP and CVP on Delta Outflow

- Surplus Delta Flows (Monthly Average)
- Flow at Qwest (Monthly Average)
- SWP Deliveries and Unmet Demand
- CVP Deliveries and Unmet Demand

Each set of flow results was evaluated over the following water periods:

- 73-year long-term average (1922 – 1993)
- Dry and critical water years
- Above normal and wet water years

COMPARISON OF CALFED ALTERNATIVES WITH NONAME/DEFT OPERATION STUDIES

In support of the DEFT process, DEFT alternative operation studies were conducted utilizing the DWRSIM model, and results were compared to the core CALFED alternatives of Existing Conditions, No Action and Alternatives 1C, 2B, and 3 with storage. The following Delta operation studies were used to depict the CALFED alternatives:

<u>DWRSIM Study</u>	<u>Description</u>
558	Existing Conditions (1995 LOD)
516	No Action (2020 LOD)
532a	Alternative 1 and 2 (2020 LOD)
636	Alternative 3 - 10k I.F. (2020 LOD)

CALFED Alternatives Study Descriptions/Assumptions

The core CALFED alternatives of Existing Conditions, No Action and Alternatives 1C, 2B, and 3X with storage were utilized in the DEFT process and include the following operational criteria:

Study 558 (CALFED Existing Conditions) meets requirements established by the 1995 WQCP Delta Standards and incorporates 1995-Level hydrology. Total SWP demand varies from 2.6 MAF to 3.6 MAF/year and Total CVP demand is 3.3 MAF/year. Stanislaus River required minimum fish flows below New Melones Reservoir range from 98 TAF/year up to 467 TAF/year. The actual minimum fish flow for each year is based on the water supply available for that year. CVP contract demands above Goodwin Dam are met as a function of New Melones Reservoir storage and inflow per interim Operations Plan provided by the USBR. Additional CVPIA (b)(2) AFRP flow action on the Stanislaus River below Goodwin Dam and additional CVPIA (b)(2) water management Delta actions are also included, which provide operation criteria at Vernalis. The Vernalis Adaptive Management Plan (VAMP) increases the flow at Vernalis to meet the target flow conditions during April 15-May 15 and sets Delta exports as described in the July 9th VAMP framework document. Additional water needed to meet the target flow at Vernalis during April 15 - May 15 is provided from the San Joaquin River upstream of its confluence with the Stanislaus River. Additional water requirements are shared between the Tuolumne (New Don Pedro Reservoir) and Merced (Lake McClure) River basins. The additional water is capped at 100 TAF/year.

Study 516 (CALFED No Action) satisfies requirements under benchmark Study 514 which meets SWRCB'S May 1995 Water Quality Control Plan and includes selected upstream ESA requirements and CVPIA AFRP flow prescriptions. This Study also incorporates 2020 level of hydrology, 2020 level of South-of-Delta SWP variable demands, and the current Stanislaus Operation. In addition, Study 516 includes CVPIA (b)(2) AFRP flow action on the Stanislaus River below Goodwin Dam and additional CVPIA (b)(2) water management Delta actions. CVPIA (b)(2) water management Delta actions from the CVPIA PEIS Administrative Draft Report indicates that total CVP/SWP exports are restricted during the 30-day pulse flow period from April 15 through May 15. Exports are restricted according to the following ratios of total export to flow at Vernalis for the following year types: 1) 1:3 below normal, dry, and critical years, 2) 1:4 above normal years and 1:5 wet years. Delta Cross Channel is closed during the period from November through June, and is open during the period from July through October. Additional Chipps Island X2 days required to approximate a 1962 Level of Development are assumed.

Study 532a (CALFED Alternative 1 and 2 with Storage) meets requirements under Study 518 with additional modifications. Facilities are required to operate Banks Pumping Plant at a capacity of 10,300-cfs. Additional storage of 5.75 MAF is also included, composed of 3.0 MAF North of Delta Surface Storage, 2.0 MAF South of Delta surface Storage, 0.25 MAF North of Delta Groundwater Storage, and 0.50 MAF South of Delta Groundwater Storage. 4.75 MAF of the additional storage is designated as CVP/SWP Storage and 1.0 MAF is allocated for environmental purposes. There is no geomorphologic flow trigger for Sacramento River diversion into North of Delta Surface Storage (NDSS) and North of Delta Environmental Storage (NDES).

Study 636 (CALFED Alternative 3 with 10K IF and with Storage) Export Limits are based on the WQCP with Export/Inflow Ratios of 35% during October through January, 35%-45% during February, 35% for March through June, and 65% for July through September. Flows at Vernalis are based on CVPIA (b)(2) water management Delta actions indicating that total CVP/SWP exports are restricted during the 30-day pulse flow period from April 15 through May 15. Exports are restricted according to the following ratios of total export to flow at Vernalis for the following year types: 1) 1,500 cfs or 1:3 for below normal, dry, and critical years, 2) 1:4 for above normal years, and 1:5 for wet years. X2 position is based on CVPIA (b)(2) action, and additional Chipps Island X2 days in May and June are required to approximate a 1962 Level of Development as described in Table III-14 (Page III-29) PEIS Administrative Draft. Minimum outflow requirements are based on the WQCP and NDOI (cfs) are set at 3,000-4,000 cfs in October, 3,500-4,500 cfs from November through December, 4,500-cfs in January, 4,000-8,000 cfs in July, 3,000-4,000 cfs in August, and 3,000-cfs in September.

Facilities can operate Banks Pumping Plant at a capacity of 10,300-cfs. Additional storage of 6.2 MAF is also included, composed of 3.0 MAF North of Delta surface storage, 2.0 MAF South of Delta surface storage, and 0.25 MAF San Joaquin surface storage, 0.25 MAF North of Delta groundwater storage, and 0.50 MAF South of Delta groundwater storage. 4.75 MAF of the additional storage is designated as CVP/SWP storage and 1.0 MAF is allocated for environmental purposes. There is no geomorphologic flow trigger for Sacramento River diversion into North of Delta Surface storage and North of Delta environmental storage.

Summary Results of CALFED Alternatives with NoName/DEFT Operation Studies

Preliminary results from operation studies conducted for the NoName/DEFT alternatives and the CALFED alternatives of Existing Conditions, No Action, and Alternatives 1C, 2B, and 3X were graphed to provide relative impacts between the alternative operations. A set of summary graphs is provided at the end of this report under the section heading *Graphics Set for Delta Operation Studies for CALFED/DEFT Alternatives* and includes the following graphics:

- Comparison of X2 Positions (Time Series)
- Comparison of X2 Positions (Monthly Average)
- Comparison of Total Delta Outflow (Monthly Average)
- Comparison of Total Delta Exports (Monthly Average)
- Comparison of South of Delta Exports (Monthly Average)
- Comparison of Rio Vista Flows (Monthly Average)
- Comparison of Vernalis Flows (Monthly Average)
- Comparison of Hood Flows (Monthly Average)

Flow results were evaluated over the following water periods:

- 73-year long-term average (1922 – 1993)
- Dry and critical water years
- Above normal and wet water years

NONAME/DEFT DELTA SIMULATION STUDY

DEFT alternative analysis assumes the existing Delta geometry with the following structural and operational changes:

- ♦ Permanent flow control structures are installed in Old River, Middle River and Grant Line Canal.
- ♦ Permanent fish control structure is installed at the head of Old River.
- ♦ Tracy Pumping is *NOT* connected to Clifton Court Forebay through an intertie.
- ♦ A new Forebay intake structure with a 10,300-cfs capacity (full Banks capacity) installed in the Northeast section
- ♦ Delta-cross channel closed in October through June in all water year types.

Hydrology used for the above DSM Study was based on results from DWRSIM Study 664.

COMPARISON OF CALFED ALTERNATIVES WITH NONAME/DEFT DELTA SIMULATION STUDY

Delta simulation studies were also conducted for the DEFT alternatives and results were compared to CALFED alternatives. The following Delta simulation studies were used to describe the CALFED alternatives:

<u>DSM2 Study</u>	<u>Description</u>
1EX	Existing Conditions
1A	No Action
1C	Alternative 1C (with Storage)
2B	Alternative 2B (with Storage)
3X	Alternative 3X (10,000 I.F. with Storage)

Hydrology used for the above DSM Studies was based on results from DWRSIM Studies 558, 516, 532a, 532a, and 636, respectively.

CALFED Alternatives Study Descriptions/Assumptions

Alternative 1A (CALFED No Action) assumes the existing Delta geometry with no change to any Delta channels or structures. No temporary structures in the south Delta or fish control structure at the head of Old River are installed. The hydrology used for evaluating Delta impacts for this study came from DWRSIM Study 516 (described above).

Alternative 1C assumes Delta changes consistent with the preferred alternative for the Interim South Delta Program Draft Environmental Statement / Environmental Report, July 1996. A new forebay intake structure with 30,000-cfs capacity is installed in the northeast section of the forebay. Old River from Victoria Canal to Woodward Canal is dredged. Permanent flow control structures are installed in Old River, Middle River, and Grant Line Canal. A permanent fish control structure is installed at the head of Old River. The Tracy Pumping Plant is connected to Clifton Court Forebay through an intertie. The hydrology used for evaluating Delta impacts for this study came from DWRSIM Study 532a.

Alternative 2B includes the development of North Delta improvements, a 10,000-cfs screened Hood intake, and South Delta improvements. It assumes the same changes in the south Delta as described under Alternative 1C. In addition, up to 10,000-cfs of Sacramento River water is diverted from Hood to Snodgrass Slough while McCormack-Williamson Tract is flooded and channels in the Mokelumne River system are enlarged to accommodate the increased cross-Delta flow.

A 10,000-cfs pumping plant at Hood and a 10,000-cfs open channel from Hood to Lambert Road are assumed. Snodgrass Slough is enlarged by a 1,000-foot levee setback in the southwest corner of Glanville Tract. The flow down Snodgrass Slough is then allowed to pass through a flooded McCormack-Williamson Tract at levee openings in the northwest, the southwest, and the northeast corners of the island.

The Mokelumne River is widened 500 feet by levee setback in three reaches: from I-5 to New Hope Landing, the North Fork of the Mokelumne River from New Hope Landing to the south end of Tyler Island, and the lower Mokelumne River on the western portion of Bouldin Island.

The hydrology used for evaluating Delta impacts under Alternative 2B came from DWRSIM Study 532a.

Alternative 3X includes a 10,000-cfs isolated facility with a diversion pump on the Sacramento River near Hood. Channel enlargements in the Mokelumne system and Clifton Court Forebay improvements are the same as in Alternatives 2B and 3E. In addition, Alternative 3X uses Bacon, Woodward, and Victoria islands as an in-Delta storage component. The islands are used as reservoirs, storing water pumped into Bacon Island at its northeast corner. In-Delta storage is later released to Clifton Court Forebay directly to help meet Banks and Tracy pumping demands. Delta water is also diverted into Clifton Court Forebay through new intake gates located on the northeast corner of the forebay. Alternative 3X also includes the south Delta flow control and fish control structures described in 1C and 2B. The hydrology used for evaluating Delta impacts came from DWRSIM Study 636.

Summary Results of CALFED Alternatives with NoName/DEFT Delta Simulation Study

Results from preliminary Delta simulation studies for the NoName/DEFT alternatives were compared to the CALFED alternatives of Existing Conditions, No Action, and Alternatives 1C, 2B, and 3X. A set of summary graphs is provided at the end of this report under the section heading *Graphics Set for Delta Hydrodynamic Studies for CALFED/DEFT Alternatives* and includes the following graphics:

- Comparison of Old River @ Bacon Flows (Time Series)
- Comparison of Old River @ Bacon Flows (Monthly Average)
- Comparison of Cross Delta Flows (Monthly Average)
- Comparison of QWEST Flows (Monthly Average)
- Comparison of San Joaquin River @ Antioch Flows (Monthly Average)
- Comparison of Clifton Court Water Quality (Monthly Average)
- Comparison of Rock Slough Water Quality (Monthly Average)
- Comparison of San Joaquin River @ Jersey Point Water Quality (Monthly Average)
- Comparison of San Joaquin River @ Prisoners Point Water Quality (Monthly Average)

Results were evaluated for the following hydrologic time periods:

- 73-year long-term average (1922 – 1994)
- Dry and critical water years
- Above normal and wet water years

A summary of the operational criteria and preliminary water supply impacts for each of the NoName, DEFT, and CALFED studies is provided in Table 1.

Graphics Set for Operation Studies With NoName + Full DEFT Actions

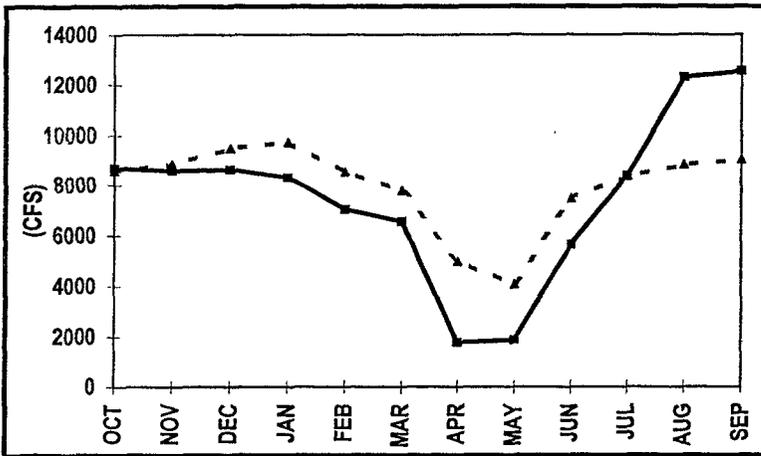
- **Comparison of Total Delta Exports (Monthly Average)**
- **Effects of SWP and CVP On Delta Outflow**
- **Surplus Delta Flows (Monthly Average)**
- **Flow at Qwest (Monthly Average)**
- **CVP Deliveries and Unmet Demand**
- **SWP Deliveries and Unmet Demand**



Comparison of Total Delta Exports

Monthly Average

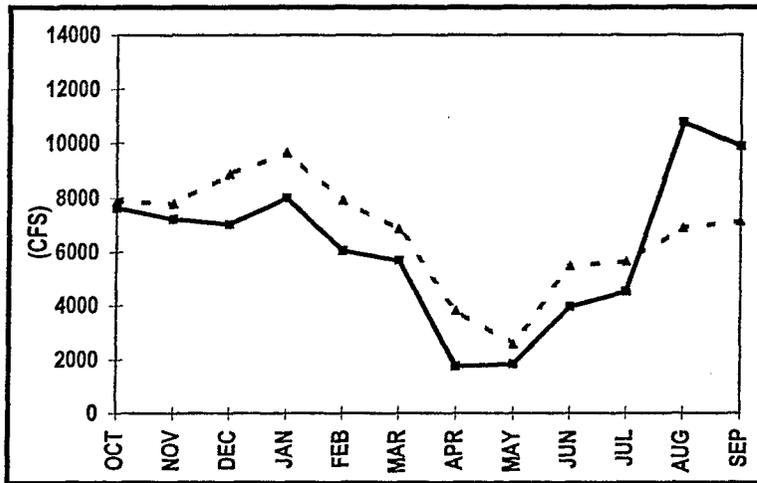
LONG TERM (73 YR AVG)



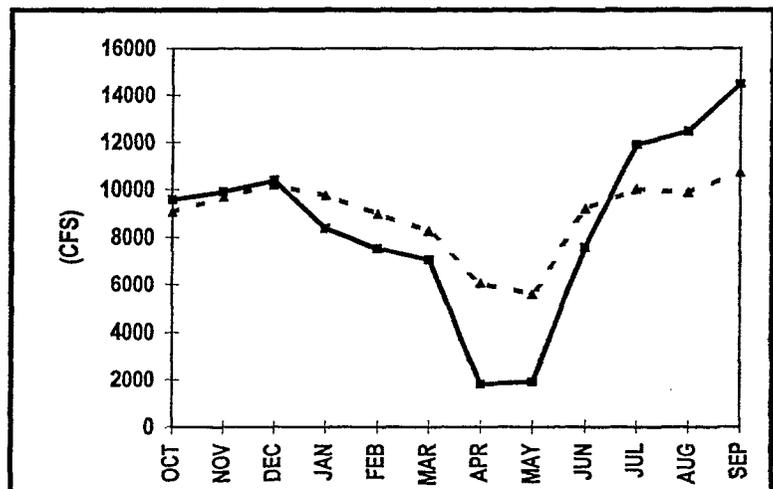
* Base Study
(1995 Level of Demand)

** With NONAME & DEFT Actions

DRY AND CRITICAL YEARS



ABOVE NORMAL AND WET YEARS

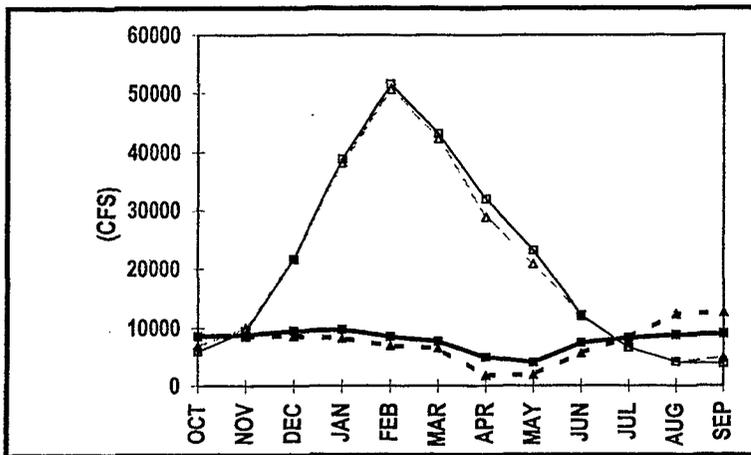


* Accord + Upstream AFRP Flows + AFRP Delta Actions
(1995 Level of Demand)

** Base + NoName (Full Joint Point + 400 cfs Intertie
+ Madera Ranch Groundwater Storage + ISDP)
+ Full Deft (61 Days VAMP + Feb X 2 Days + .25 E/I (Feb-Jun)
+ .55 E/I (Nov), .45 E/I (Dec & Jan) + .75 E/I (Aug & Sep)

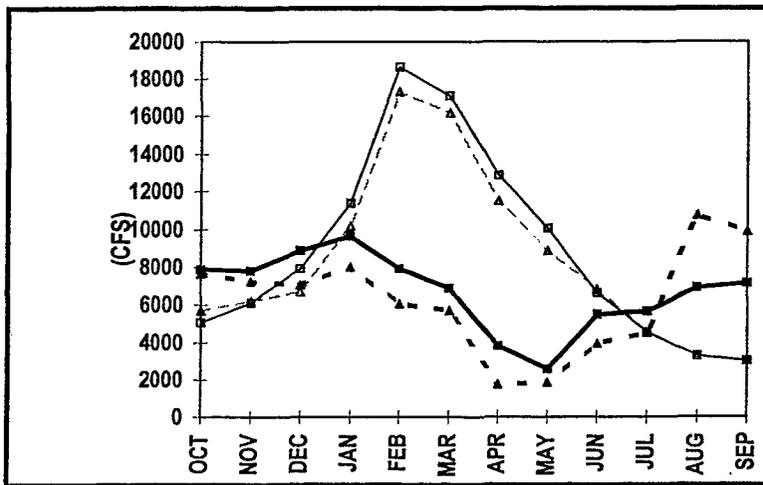
Effects of SWP and CVP On Delta Outflow

LONG TERM (73 YR AVG)

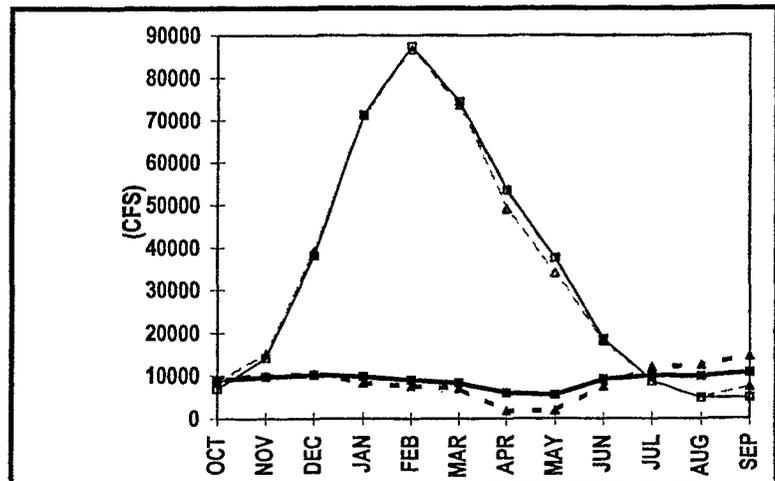


- ▲ - Total Delta Exports (* Base Study)
- ■ - Total Delta Exports (with ** NONAME&DEFT Actions)
- ▲ - Total Delta Outflow (* Base Study)
- □ - Total Delta Outflow (with ** NO NAME&DEFT Actions)

DRY AND CRITICAL YEARS



ABOVE NORMAL AND WET YEARS



*Accord + Upstream AFRP Flows + AFRP Delta Actions
(1995 Level of Demand)

**Base + NoName(Full Joint Point + 400 cfs Intertie

+ Madera Ranch Groundwater Storage + ISDP)

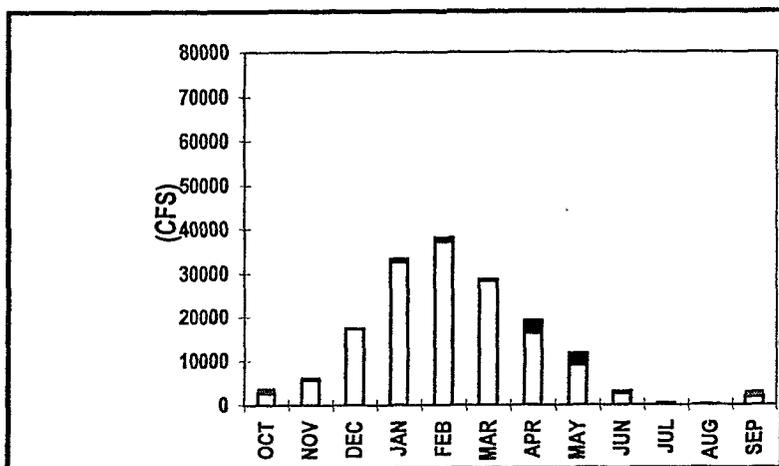
+ Full Deft (61 Days VAMP+FebX2Days+.25E/I (Feb-Jun)

+.55 E/I (Nov), .45 E/I (Dec&Jan)+.75E/I(Aug&Sep)

Surplus Delta Flows

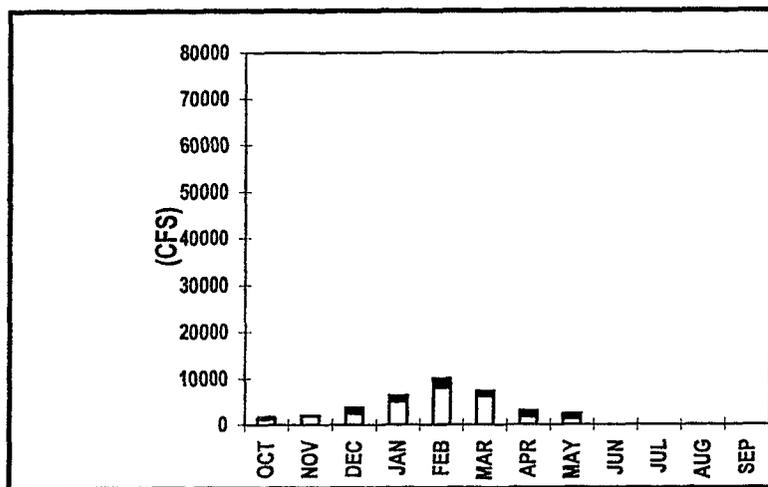
Monthly Average

LONG TERM (73 YR AVG)

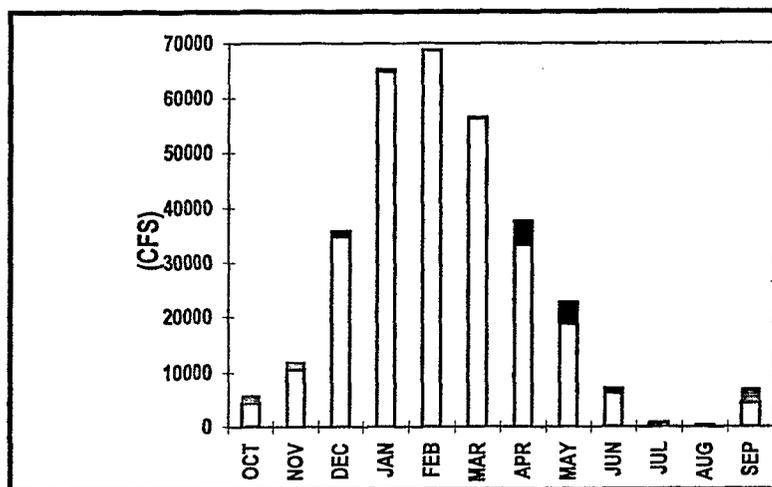


- *Base Study
(1995 Level of Demand)
- ** Increase in Delta Surplus
with NONAME & DEFT Actions
- **Decrease in Delta Surplus
with NONAME & DEFT Actions

DRY AND CRITICAL YEARS



ABOVE NORMAL AND WET YEARS

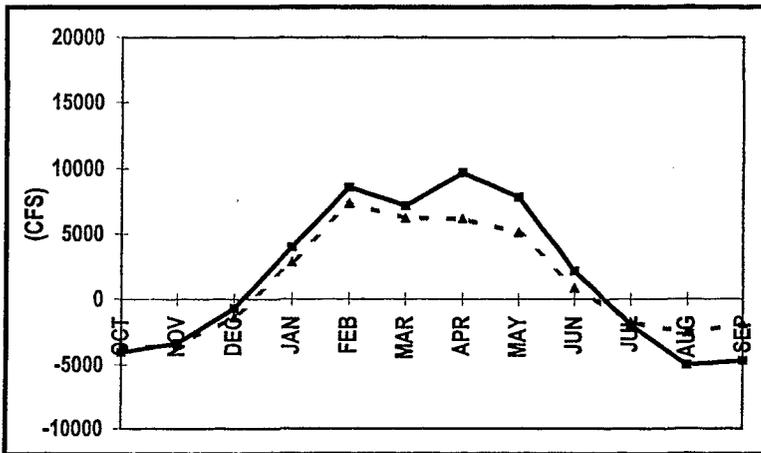


*Accord + Upstream AFRP Flows + AFRP Delta Actions
(1995 Level of Demand)

**Base + NoName(Full Joint Point + 400 cfs Intertie
+ Madera Ranch Groundwater Storage + ISDP)
+ Full Deft (61 Days VAMP+FebX2Days+.25E/I (Feb-Jun)
+.55 E/I (nov),.45 E/I (Dec&Jan)+.75E/I(Aug&Sep)

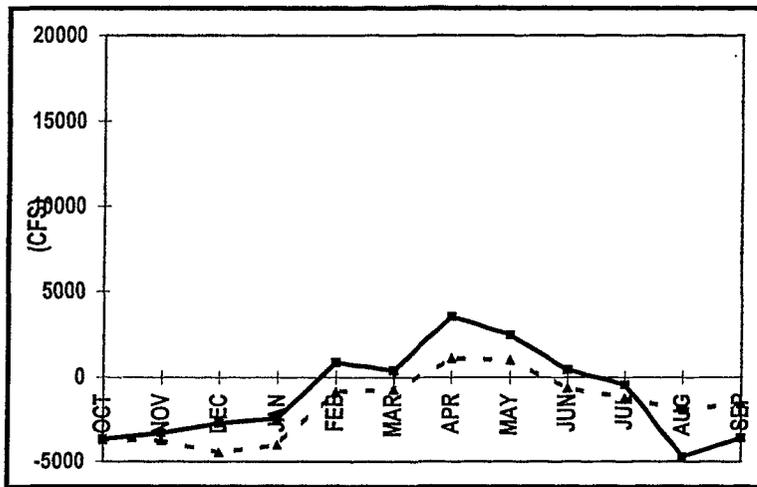
Flow at Qwest Monthly Average

LONG TERM (73 YR AVG)

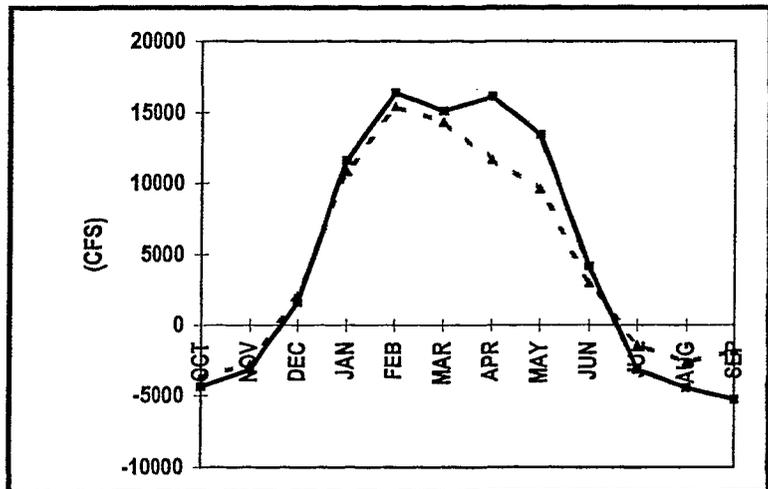


* Base Study
 (1995 Level of Demand)
 ** With NONAME & DEFT Actions

DRY AND CRITICAL YEARS



ABOVE NORMAL AND WET YEARS



* Accord + Upstream AFRP Flows + AFRP Delta Actions
 (1995 Level of Demand)

** Base + NoName (Full Joint Point + 400 cfs Intertie)

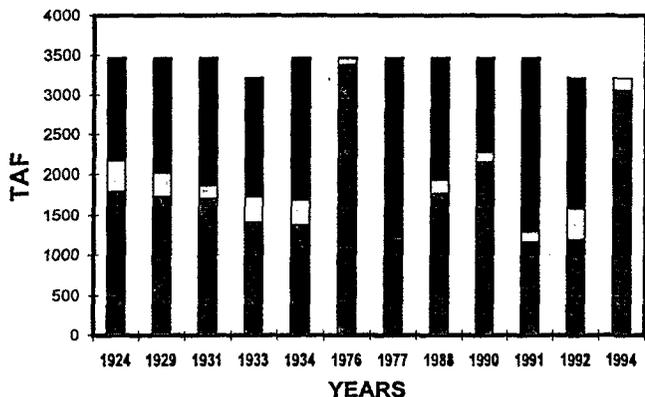
+ Madera Ranch Groundwater Storage + ISDP)

+ Full Deft (61 Days VAMP + Feb X 2 Days + .25 E/I (Feb-Jun)

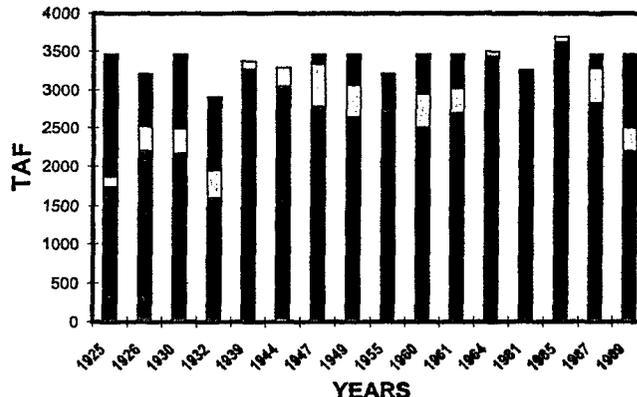
+ .55 E/I (Nov), .45 E/I (Dec & Jan) + .75 E/I (Aug & Sep)

SWP Deliveries and Unmet Demands

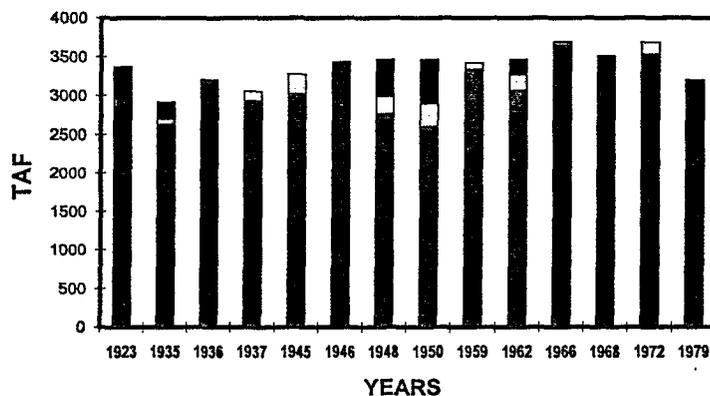
CRITICAL YEARS



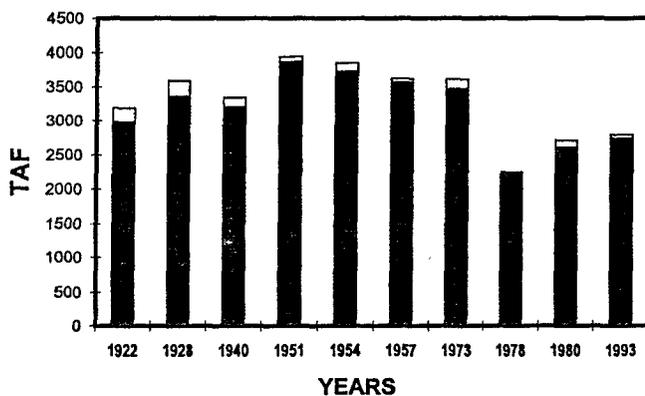
DRY YEARS



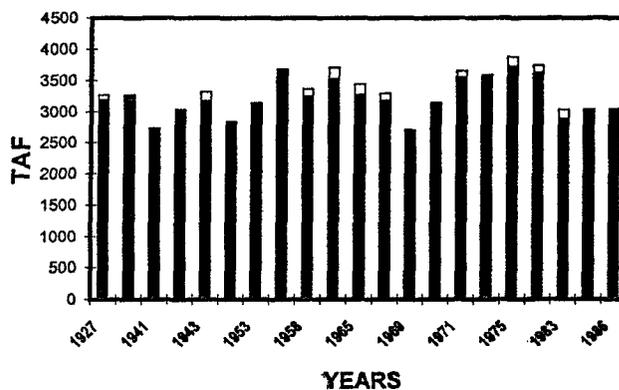
BELOW NORMAL YEARS



ABOVE NORMAL YEARS



WET YEARS



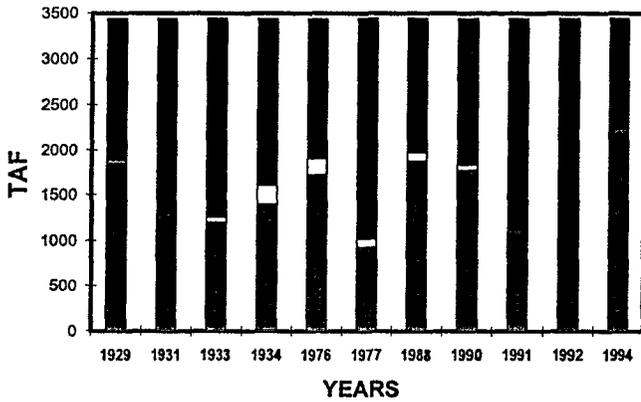
- Deliveries
- Increased Deliveries by **NO NAME + DEFT
- Decreased Deliveries by **NO NAME + DEFT
- Unmet Demand

**Base + NONAME + DEFT Actions

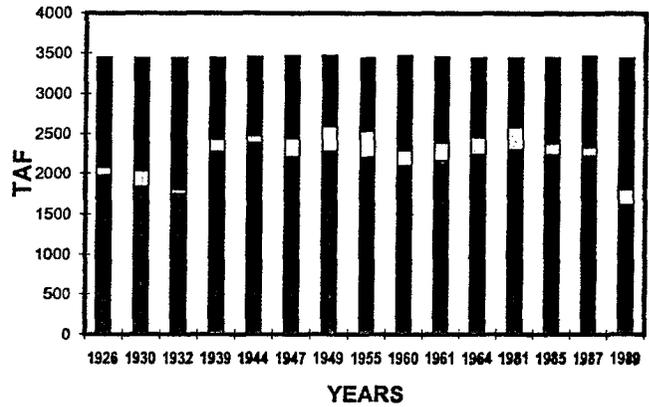
NOTE: Base Study includes Accord + Upstream AFRP Flows + AFRP Delta Actions (1995 Level of Demand)

CVP Deliveries and Unmet Demands

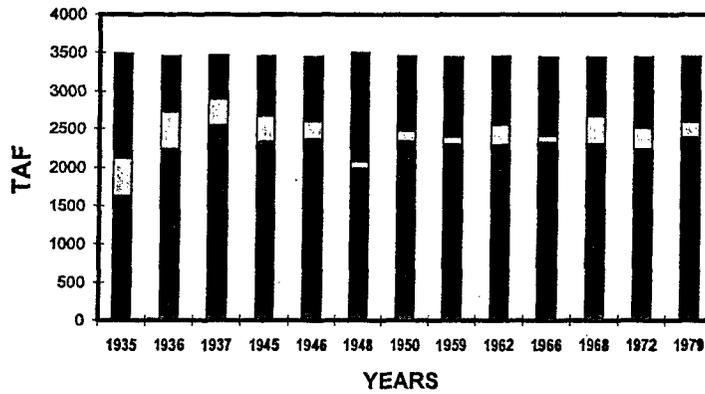
CRITICAL YEARS



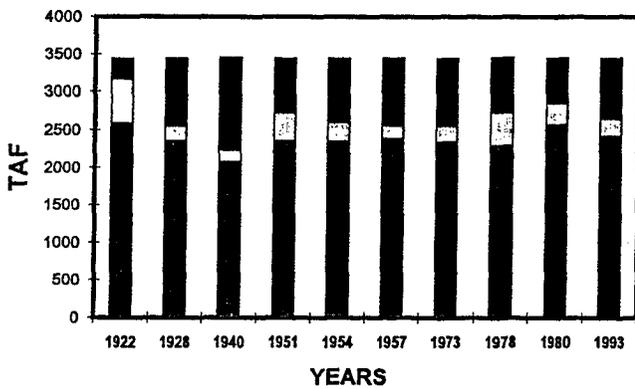
DRY YEARS



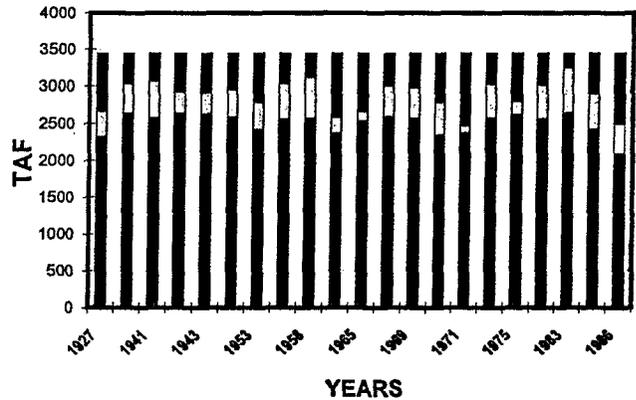
BELOW NORMAL YEARS



ABOVE NORMAL YEARS



WET YEARS



■ Deliveries

□ Decreased Deliveries by **NO NAME + DEFT

□ Increased Deliveries by **NO NAME + DEFT

■ Unmet Demand

**Base + NONAME+ DEFT Actions

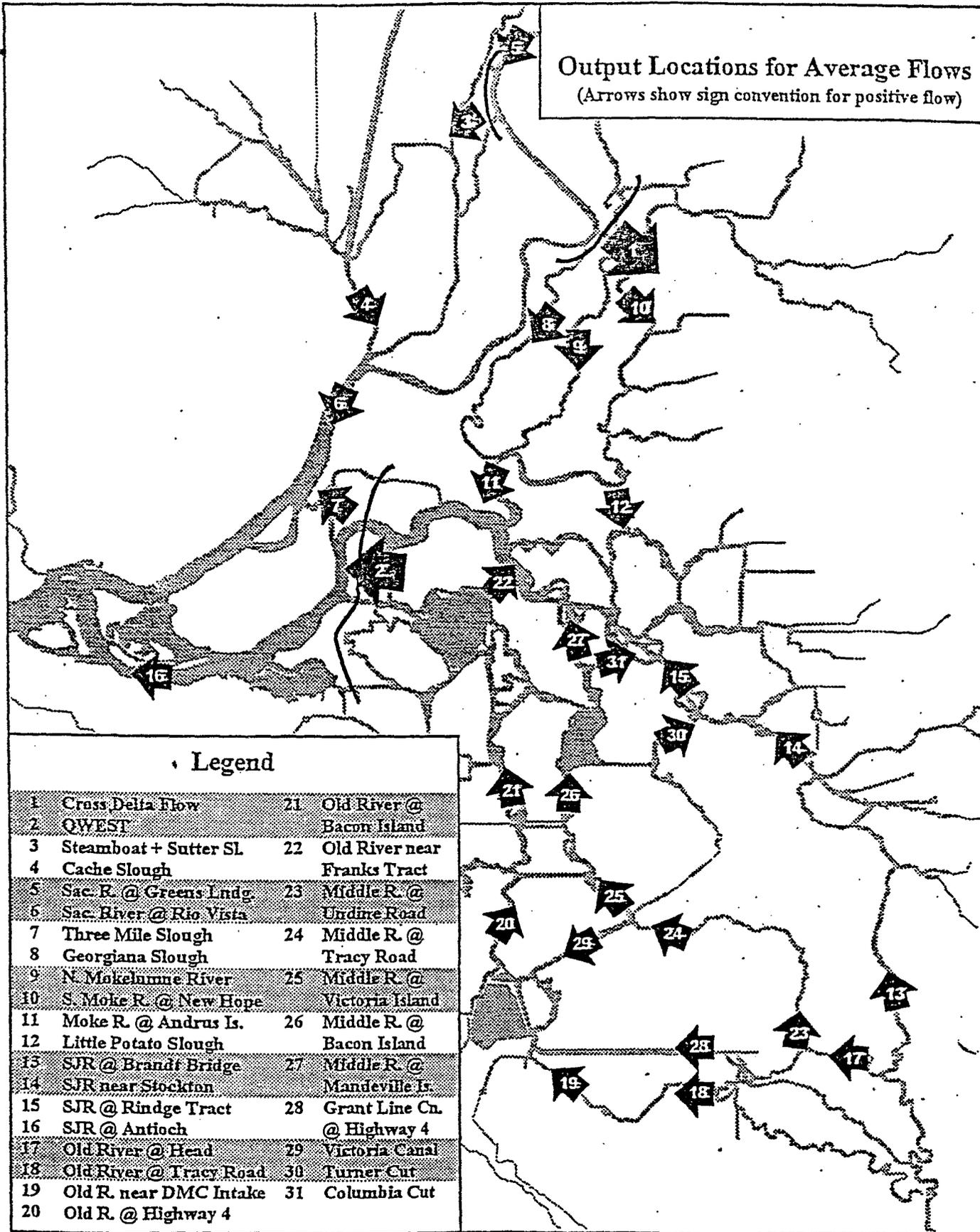
NOTE: Base Study includes Accord + Upstream AFRP Flows + AFRP Delta Actions (1995 Level of Demand)

Graphics Set for Delta Operation Studies for CALFED/DEFT Alternatives

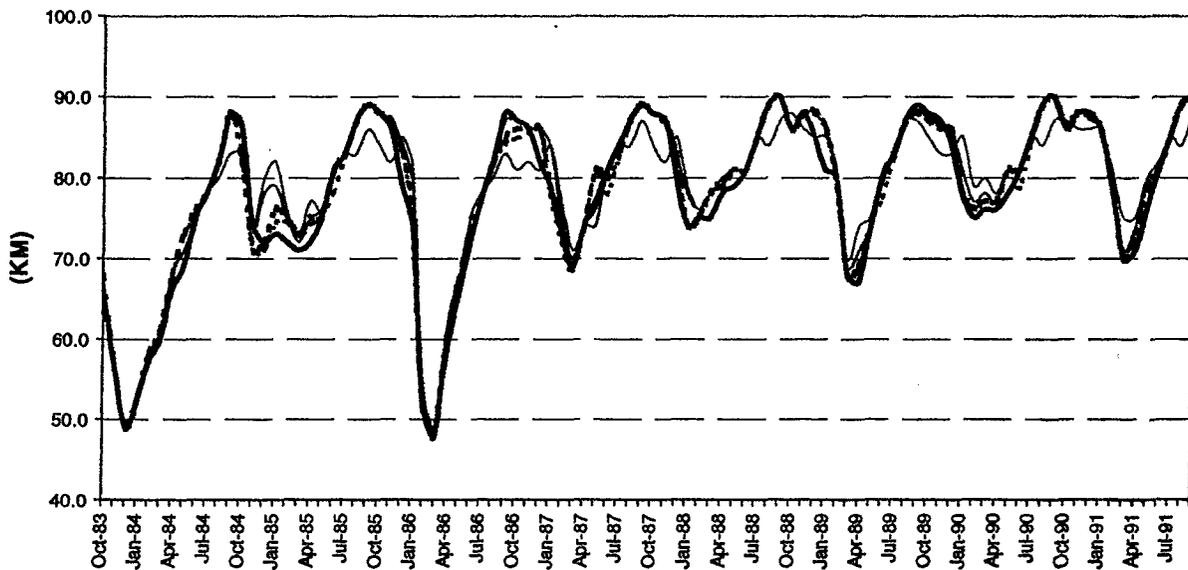
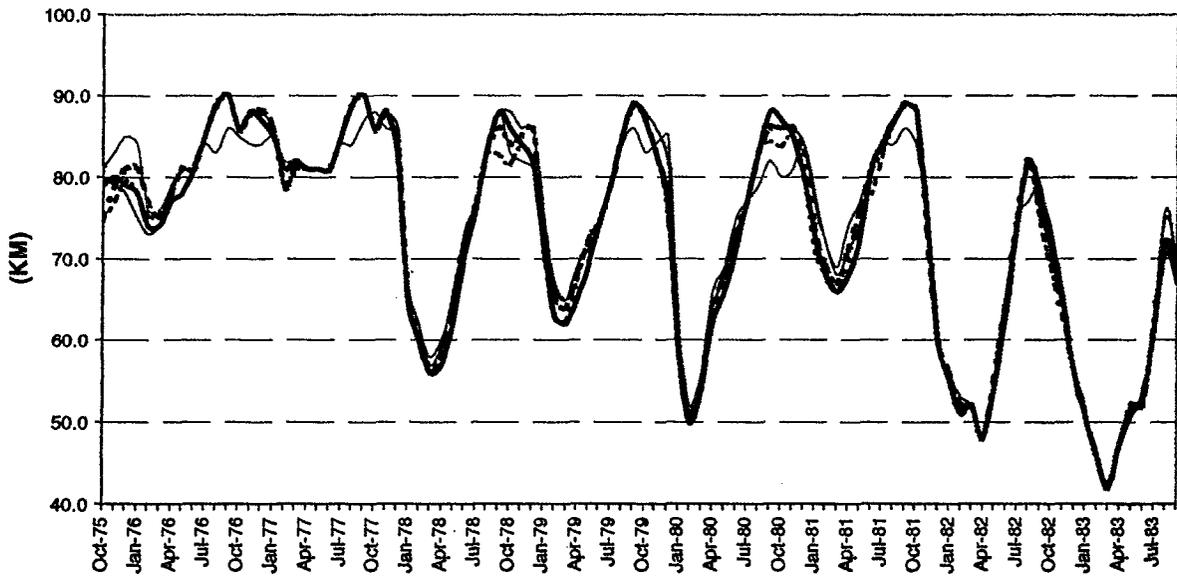
- **Location Map for Average Flows**
- **Comparison of X2 Positions (Time Series)**
- **Comparison of X2 Positions (Monthly Average)**
- **Comparison of Total Delta Outflow (Monthly Average)**
- **Comparison of Total Delta Exports (Monthly Average)**
- **Comparison of South of Delta Exports (Monthly Average)**
- **Comparison of Rio Vista Flows (Monthly Average)**
- **Comparison of Vernalis Flows (Monthly Average)**
- **Comparison of Hood Flows (Monthly Average)**



Output Locations for Average Flows
 (Arrows show sign convention for positive flow)



X2 Location from Golden Gate

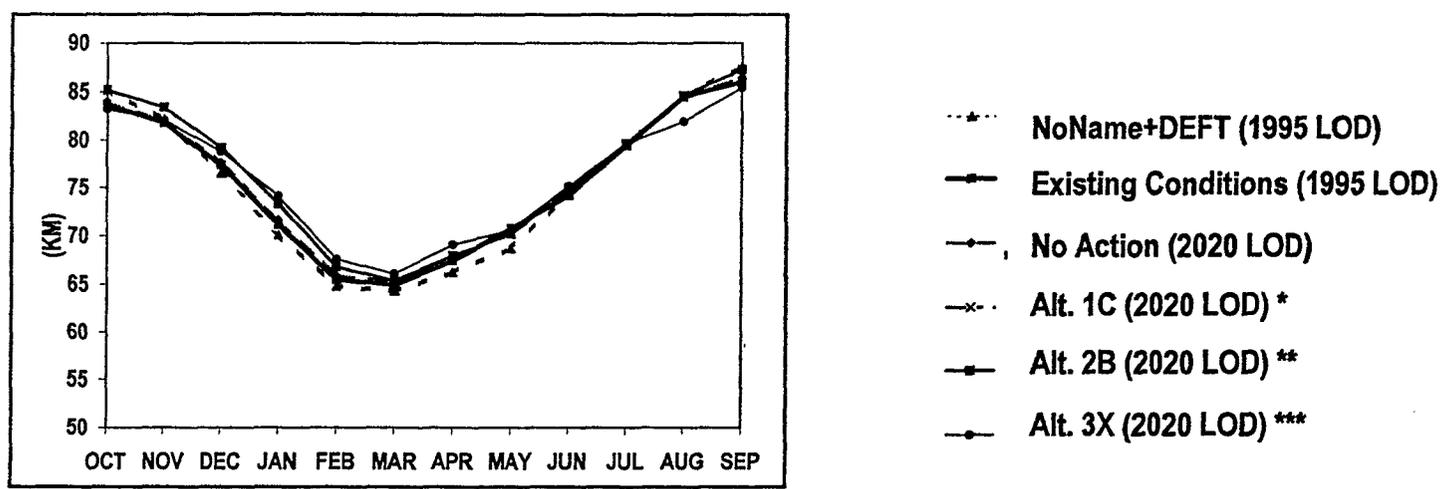


Deft+ NoName
 Existing Condition
 No Action
 Alt 1_Avg
 Alt 2_Avg
 Alt 3_Avg

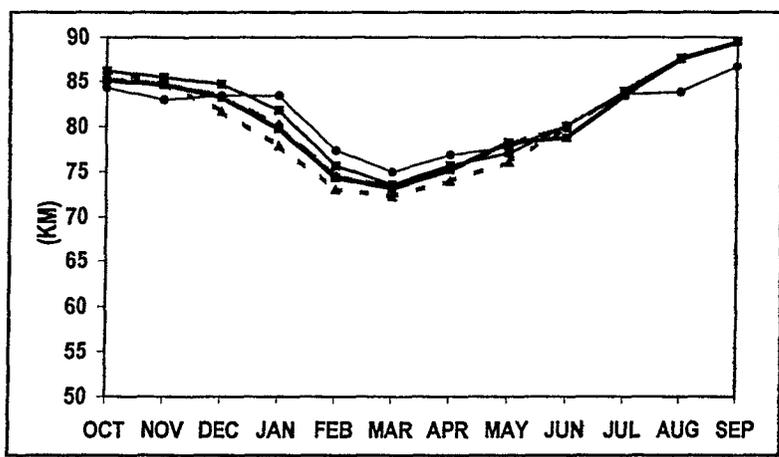
Time Series	Deft+ Noname X2	Existing Condition X2	No Action X2	Alt 1_Avg X2	Alt 2_Avg X2	Alt 3_Avg X2
1976-91 Ave.	75.6	75.8	76.1	76.6	76.6	76.2
1976-91 Max.	90.0	89.9	90.0	90.0	90.0	88.0
1976-91 Min.	45.0	44.8	45.0	45.5	45.5	45.5
1987-91 Ave.	81.6	81.9	82.1	82.5	82.5	81.9
1987-91 Max.	90.0	89.9	90.0	90.0	90.0	88.0
1987-91 Min.	67.0	67.9	68.0	69.0	69.0	70.0

Comparison of X2 Position Monthly Average

LONG TERM (73 YR AVG)



DRY AND CRITICAL YEARS



*** Alternative 1C**

New Northeast Forebay Intake, Old River Dredged, South Delta Salinity Control Structures, Head of Old River Barrier Tracy/Clifton Court Intertie, 10,300 cfs Max. Bank Pumping

**** Alternative 2B**

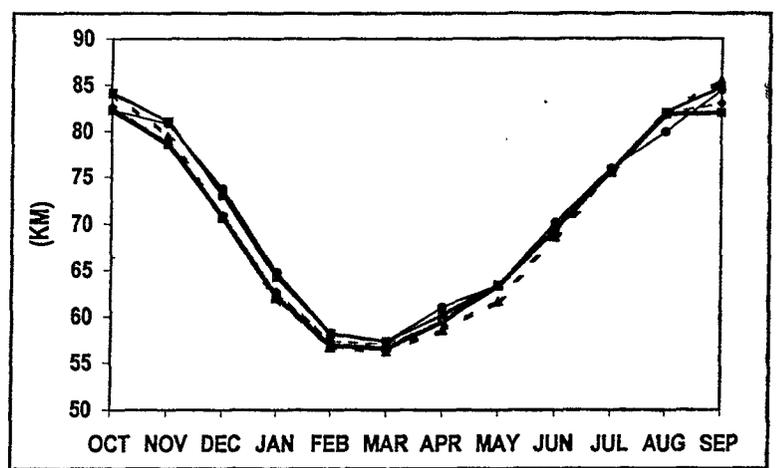
Alt. 1C improvements plus 10,000 cfs Screened Hood Intake Snodgrass Slough & North Fork Mokelumne Enlarged Flooded McCormack-Williamson Tract,*

***** Alternative 3X**

Alt. 1C & 2B** improvements plus 10,000 cfs Screened Isolated Facility Diversion near Hood*

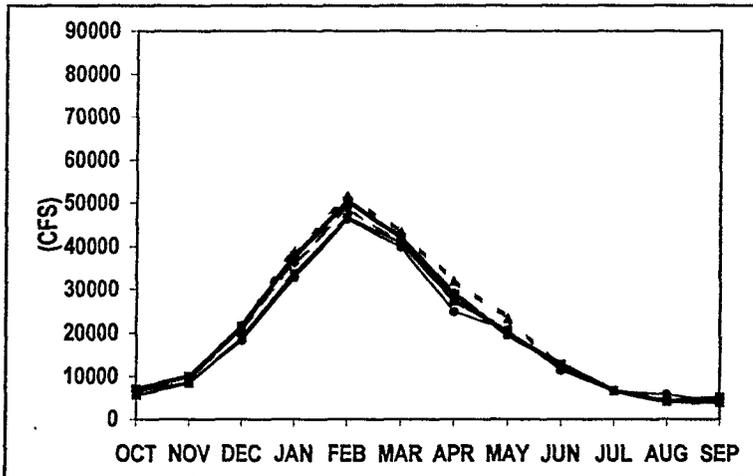
NOTE: All Hydrologies included WQCP & Delta (b)(2) Actions, All Alternative included ERPP Flows, 1.25 MAF Env. Storage, 4.75 MAF Ag/Urban Storage

ABOVE NORMAL AND WET YEARS



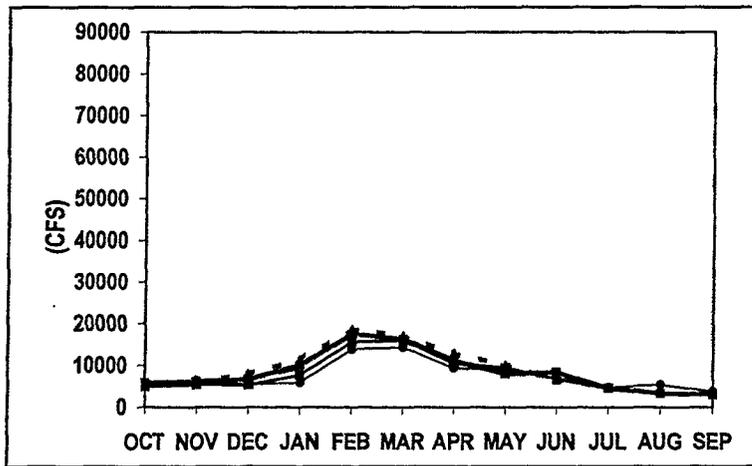
Comparison of Total Delta Outflow Monthly Average

LONG TERM (73 YR AVG)



- ▲--- NoName+DEFT (1995 LOD)
- Existing Conditions (1995 LOD)
- No Action (2020 LOD)
- ×— Alt. 1C (2020 LOD) *
- Alt. 2B (2020 LOD) **
- Alt. 3X (2020 LOD) ***

DRY AND CRITICAL YEARS



* Alternative 1C

New Northeast Forebay Intake, Old River Dredged, South Delta Salinity Control Structures, Head of Old River Barrier Tracy/Clifton Court Intertie, 10,300 cfs Max. Bank Pumping

** Alternative 2B

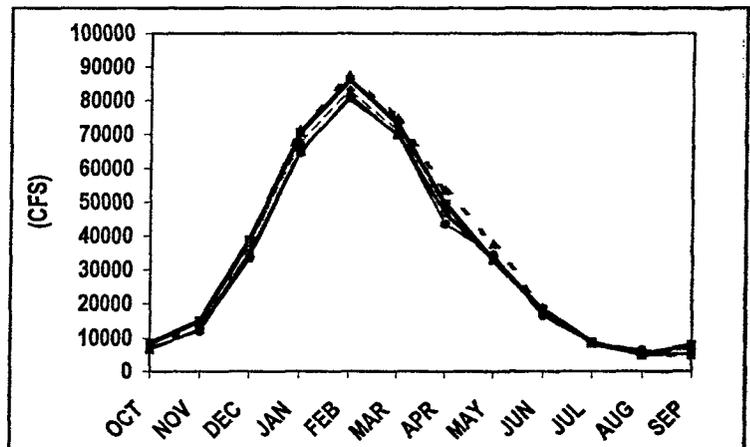
Alt. 1C improvements plus 10,000 cfs Screened Hood Intake Snodgrass Slough & North Fork Mokelumne Enlarged Flooded McCormack-Williamson Tract,*

*** Alternative 3X

Alt. 1C & 2B** improvements plus 10,000 cfs Screened Isolated Facility Diversion near Hood*

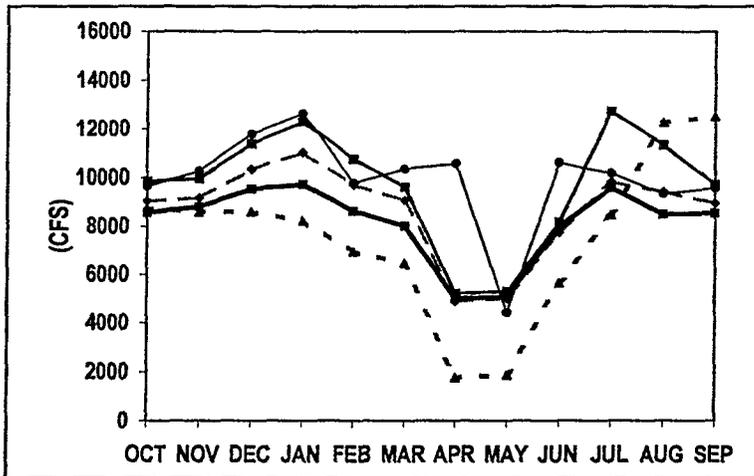
NOTE: All Hydrologies included WQCP & Delta (b)(2) Actions, All Alternative included ERPP Flows, 1.25 MAF Env. Storage, 4.75 MAF Ag/Urban Storage

ABOVE NORMAL AND WET YEARS



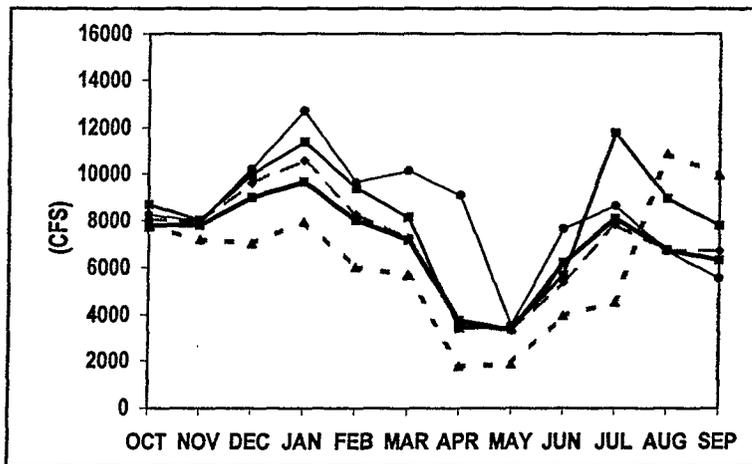
Comparison of Total Delta Exports Monthly Average

LONG TERM (73 YR AVG)



- * NoName+DEFT (1995 LOD)
- Existing Conditions (1995 LOD)
- No Action (2020 LOD)
- × Alt. 1C (2020 LOD) *
- Alt. 2B (2020 LOD) **
- Alt. 3X (2020 LOD) ***

DRY AND CRITICAL YEARS



* Alternative 1C

New Northeast Forebay Intake, Old River Dredged, South Delta Salinity Control Structures, Head of Old River Barrier Tracy/Clifton Court Intertie, 10,300 cfs Max. Bank Pumping

** Alternative 2B

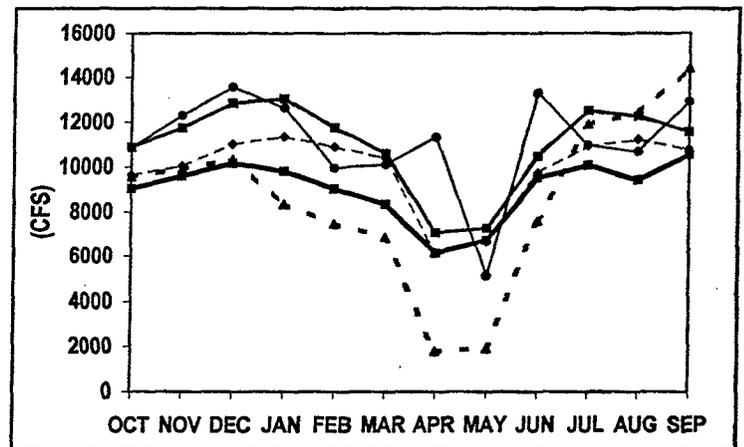
Alt. 1C improvements plus 10,000 cfs Screened Hood Intake Snodgrass Slough & North Fork Mokelumne Enlarged Flooded McCormack-Williamson Tract,*

*** Alternative 3X

Alt. 1C & 2B** improvements plus 10,000 cfs Screened Isolated Facility Diversion near Hood*

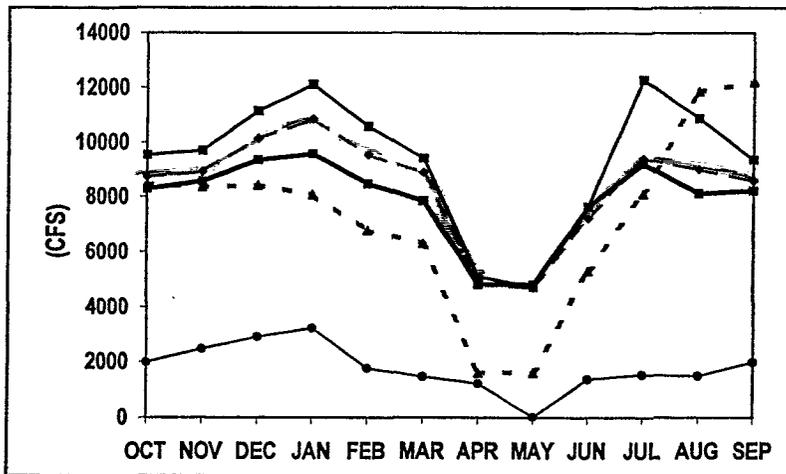
NOTE: All Hydrologies included WQCP & Delta (b)(2) Actions, All Alternative included ERPP Flows, 1.25 MAF Env. Storage, 4.75 MAF Ag/Urban Storage

ABOVE NORMAL AND WET YEARS



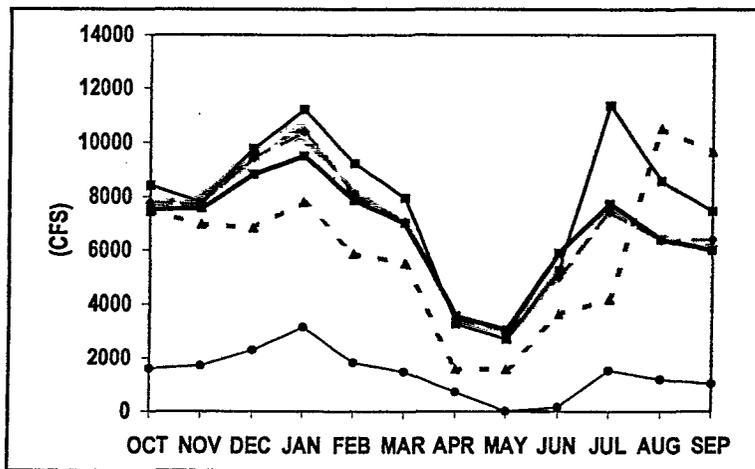
Comparison of South of Delta Exports Monthly Average

LONG TERM (73 YR AVG)



- ▲--- NoName+DEFT (1995 LOD)
- Existing Conditions (1995 LOD)
- No Action (2020 LOD)
- ×— Alt. 1C (2020 LOD) *
- Alt. 2B (2020 LOD) **
- Alt. 3X (2020 LOD) ***

DRY AND CRITICAL YEARS



* Alternative 1C

New Northeast Forebay Intake, Old River Dredged, South Delta Salinity Control Structures, Head of Old River Barrier Tracy/Clifton Court Intertie, 10,300 cfs Max. Bank Pumping

** Alternative 2B

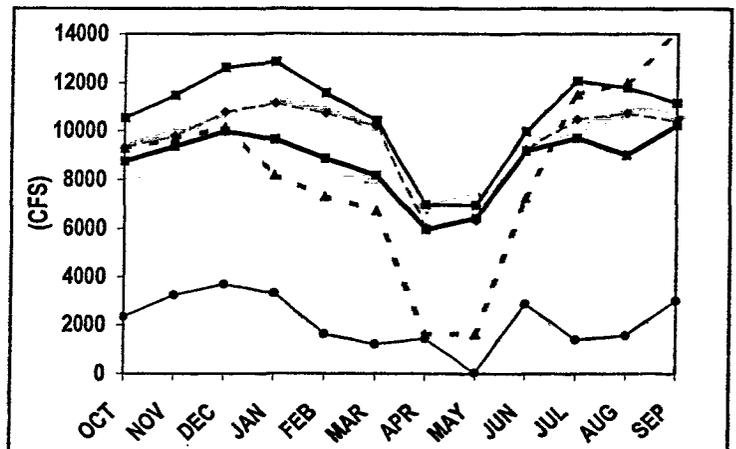
Alt. 1C* improvements plus 10,000 cfs Screened Hood Intake Snodgrass Slough & North Fork Mokelumne Enlarged Flooded McCormack-Williamson Tract,

*** Alternative 3X

Alt. 1C* & 2B** improvements plus 10,000 cfs Screened Isolated Facility Diversion near Hood

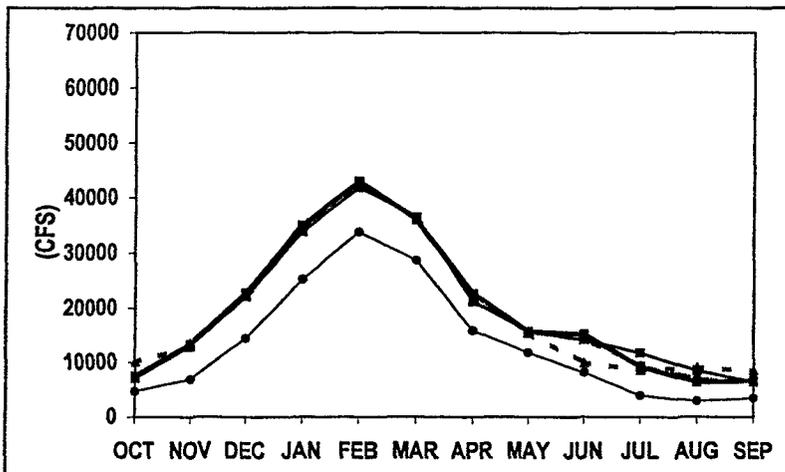
NOTE: All Hydrologies included WQCP & Delta (b)(2) Actions, All Alternative included ERPP Flows, 1.25 MAF Env. Storage, 4.75 MAF Ag/Urban Storage

ABOVE NORMAL AND WET YEARS



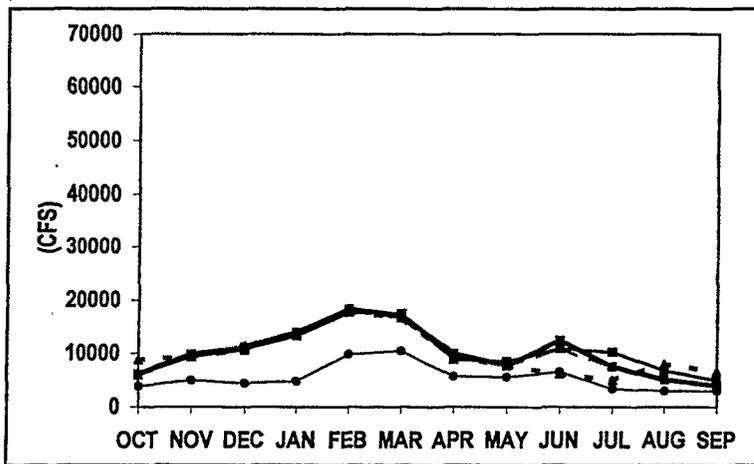
Comparison of Rio Vista Flows Monthly Average

LONG TERM (73 YR AVG)



- * NoName+DEFT (1995 LOD)
- Existing Conditions (1995 LOD)
- No Action (2020 LOD)
- * Alt. 1C (2020 LOD)*
- Alt. 2B (2020 LOD)**
- Alt. 3X (2020 LOD)***

DRY AND CRITICAL YEARS



* Alternative 1C

New Northeast Forebay Intake, Old River Dredged, South Delta Salinity Control Structures, Head of Old River Barrier Tracy/Clifton Court Intertie, 10,300 cfs Max. Bank Pumping

** Alternative 2B

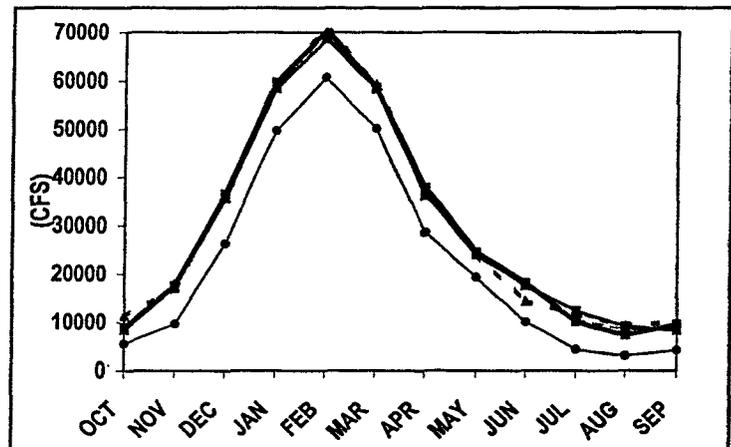
Alt. 1C improvements plus 10,000 cfs Screened Hood Intake Snodgrass Slough & North Fork Mokelumne Enlarged Flooded McCormack-Williamson Tract,*

*** Alternative 3X

Alt. 1C & 2B** improvements plus 10,000 cfs Screened Isolated Facility Diversion near Hood*

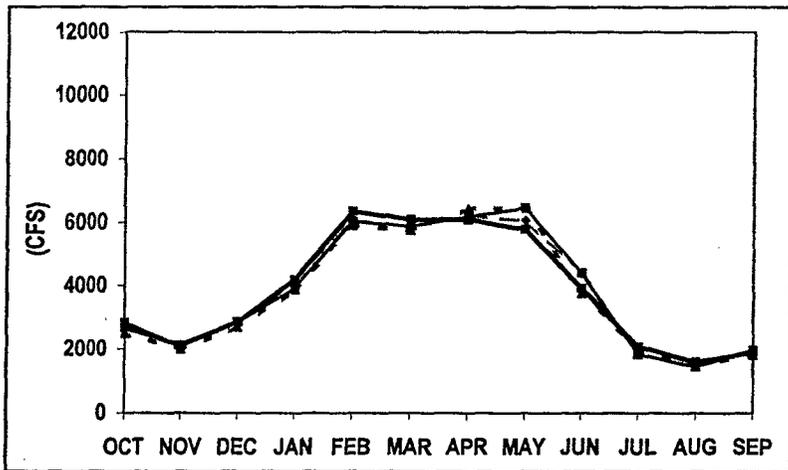
NOTE: All Hydrologies included WQCP & Delta (b)(2) Actions, All Alternative included ERPP Flows, 1.25 MAF Env. Storage, 4.75 MAF Ag/Urban Storage

ABOVE NORMAL AND WET YEARS



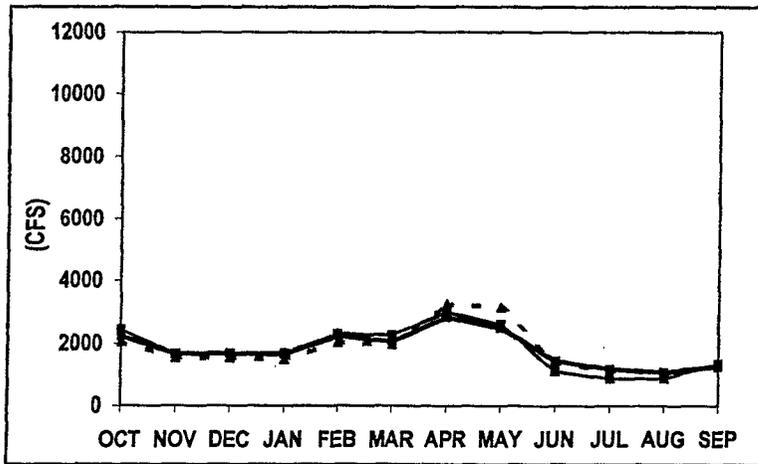
Comparison of Vernalis Flows Monthly Average

LONG TERM (73 YR AVG)



- NoName+DEFT (1995 LOD)
- Existing Conditions (1995 LOD)
- No Action (2020 LOD)
- x- Alt. 1C (2020 LOD) *
- Alt. 2B (2020 LOD) **
- Alt. 3X (2020 LOD) ***

DRY AND CRITICAL YEARS



* Alternative 1C

New Northeast Forebay Intake, Old River Dredged, South Delta Salinity Control Structures, Head of Old River Barrier Tracy/Clifton Court Intertie, 10,300 cfs Max. Bank Pumping

** Alternative 2B

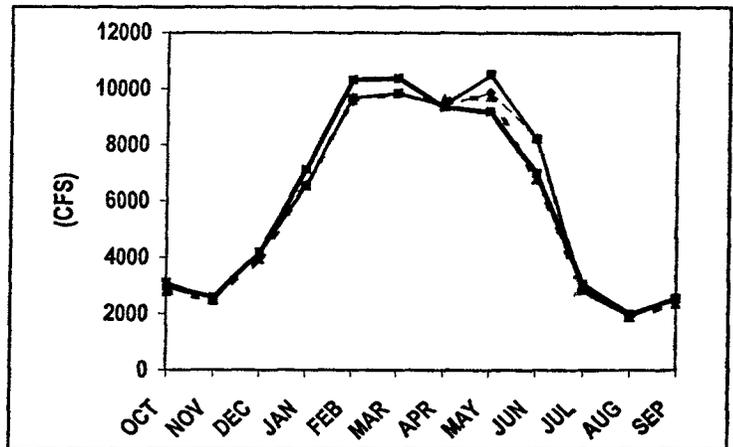
Alt. 1C improvements plus 10,000 cfs Screened Hood Intake Snodgrass Slough & North Fork Mokelumne Enlarged Flooded McCormack-Williamson Tract,*

*** Alternative 3X

Alt. 1C & 2B** improvements plus 10,000 cfs Screened Isolated Facility Diversion near Hood*

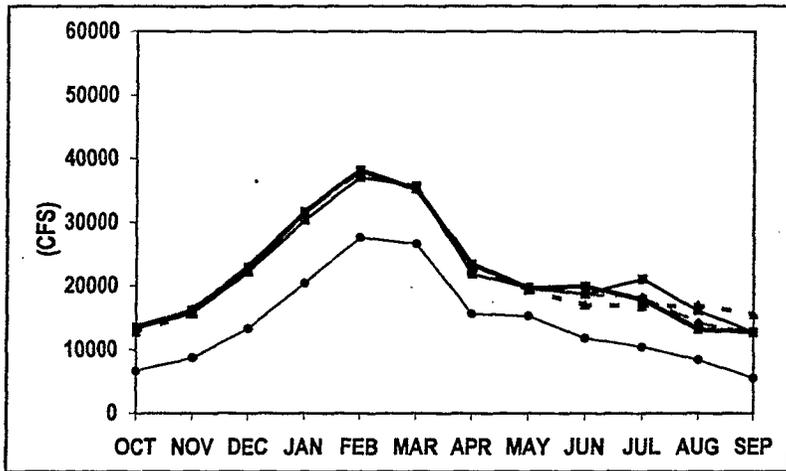
NOTE: All Hydrologies included WQCP & Delta (b)(2) Actions, All Alternative included ERPP Flows, 1.25 MAF Env. Storage, 4.75 MAF Ag/Urban Storage

ABOVE NORMAL AND WET YEARS



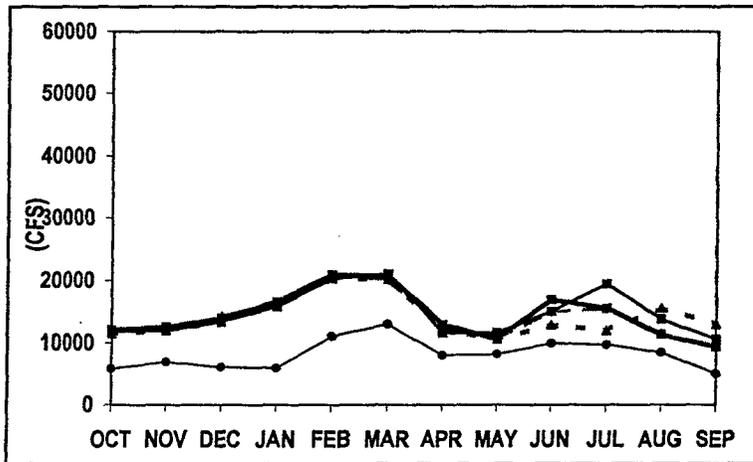
Comparison of Hood Flows Monthly Average

LONG TERM (73 YR AVG)



- NoName+DEFT (1995 LOD)
- Existing Conditions (1995 LOD)
- No Action (2020 LOD)
- x- Alt. 1C (2020 LOD)*
- Alt. 2B (2020 LOD)**
- Alt. 3X (2020 LOD)***

DRY AND CRITICAL YEARS



* Alternative 1C

New Northeast Forebay Intake, Old River Dredged, South Delta Salinity Control Structures, Head of Old River Barrier Tracy/Clifton Court Intertie, 10,300 cfs Max. Bank Pumping

** Alternative 2B

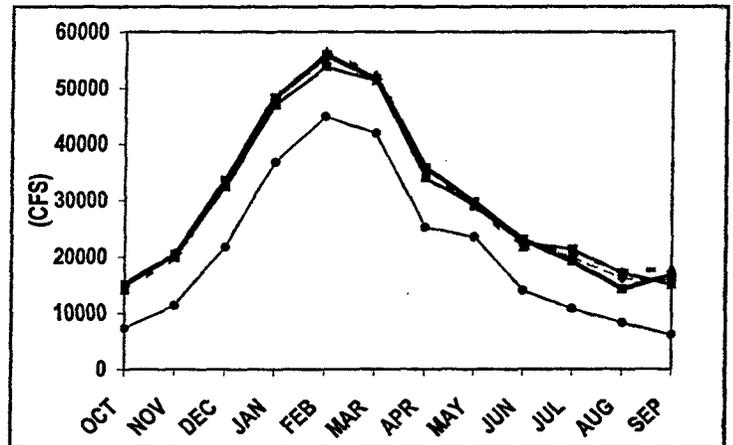
Alt. 1C improvements plus 10,000 cfs Screened Hood Intake Snodgrass Slough & North Fork Mokelumne Enlarged Flooded McCormack-Williamson Tract,*

*** Alternative 3X

Alt. 1C & 2B** improvements plus 10,000 cfs Screened Isolated Facility Diversion near Hood*

NOTE: All Hydrologies included WQCP & Delta (b)(2) Actions, All Alternative included ERPP Flows, 1.25 MAF Env. Storage, 4.75 MAF Ag/Urban Storage

ABOVE NORMAL AND WET YEARS

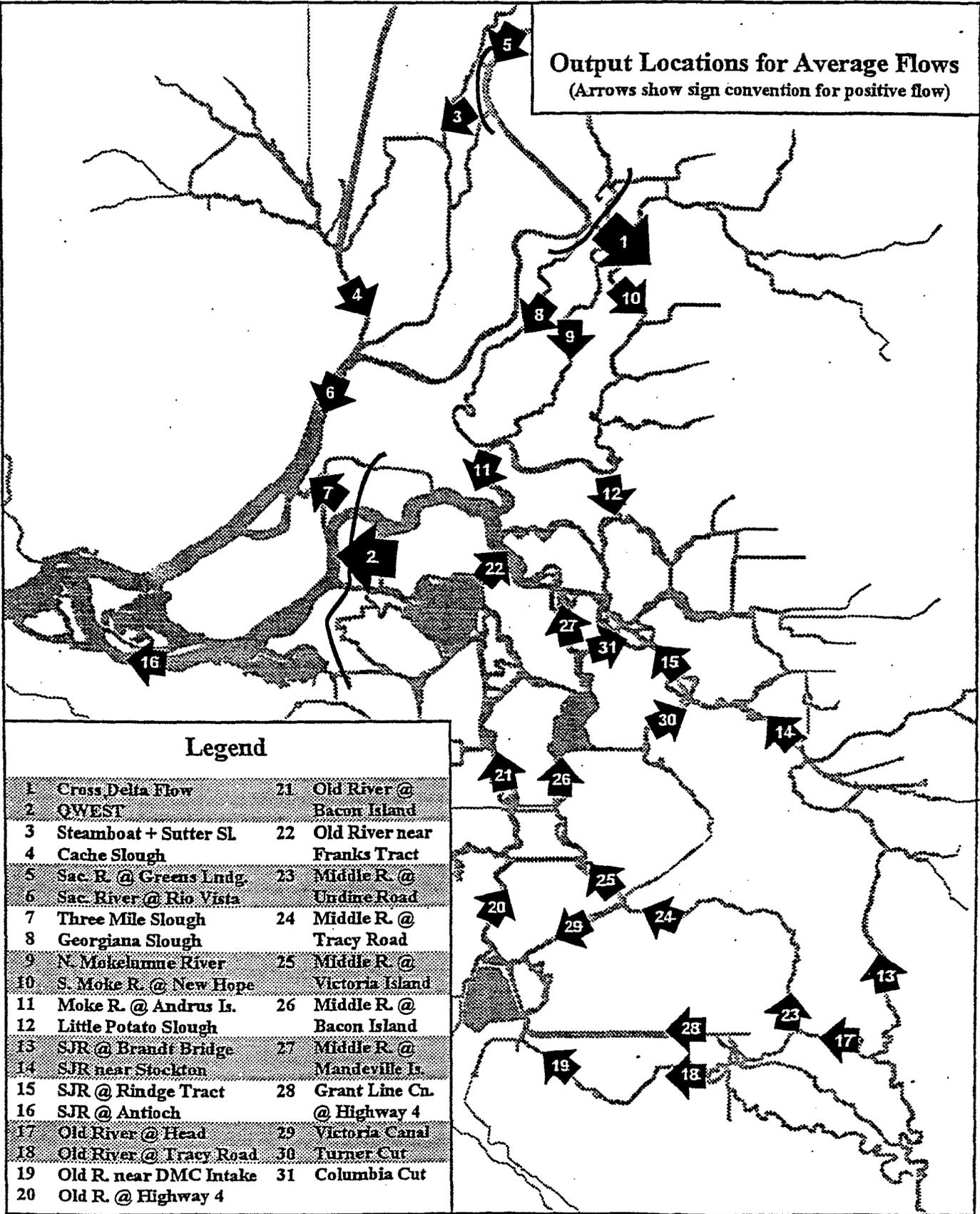


Graphics Set for Delta Hydrodynamic Studies for CALFED/DEFT Alternatives

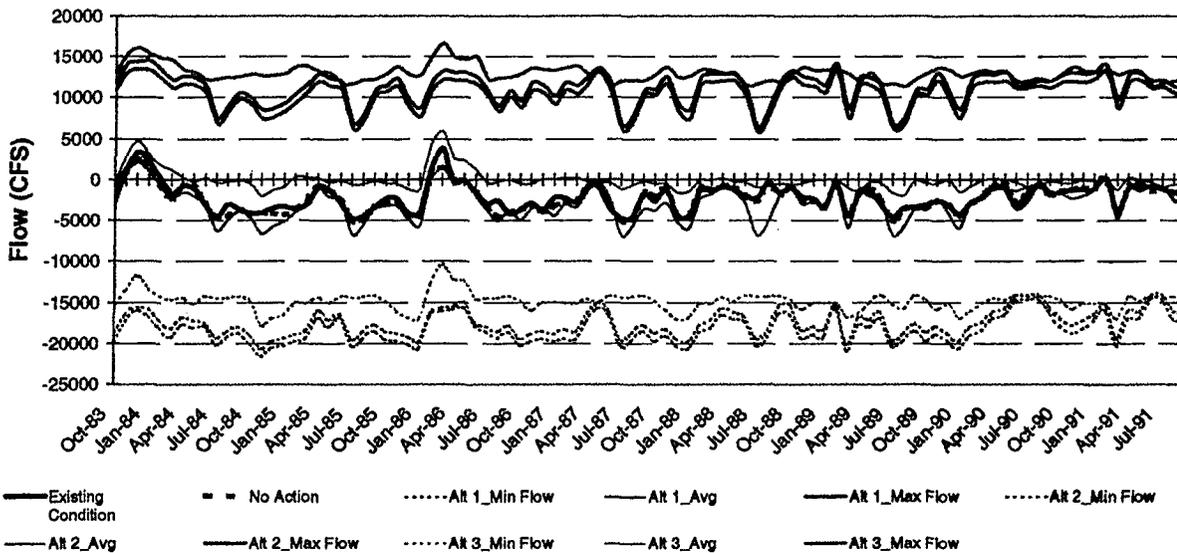
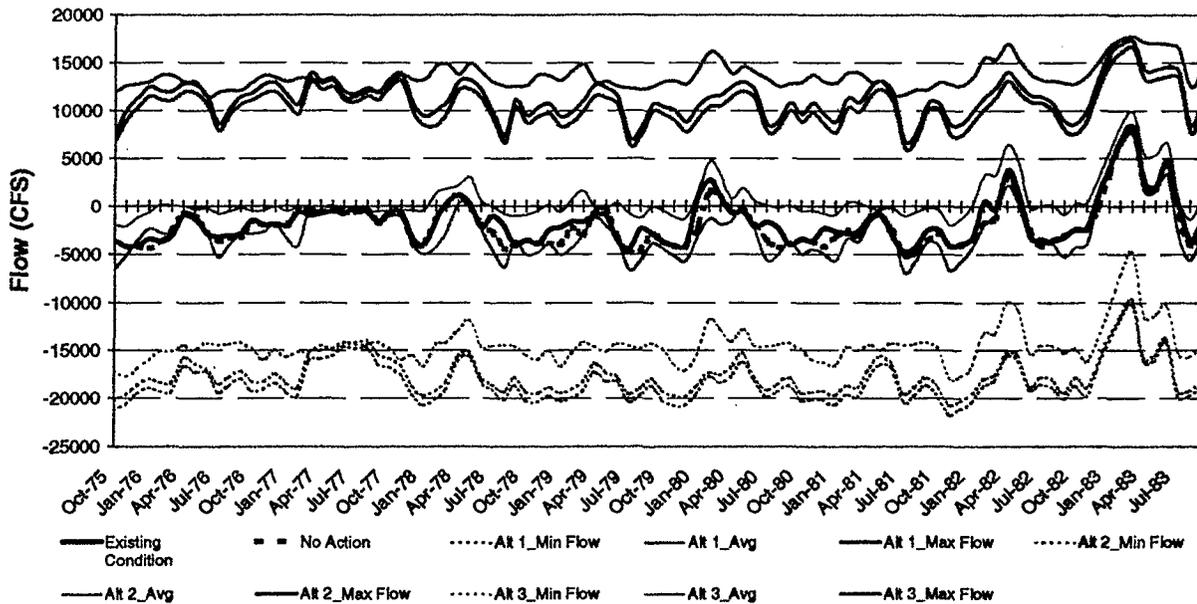
- **Location Map for Average Flows**
- **Comparison of Old River @ Bacon Flows (Time Series)**
- **Comparison of Old River @ Bacon Flows (Monthly Average)**
- **Comparison of Cross Delta Flows (Monthly Average)**
- **Comparison of QWEST Flows (Monthly Average)**
- **Comparison of San Joaquin River @ Antioch Flows (Monthly Average)**
- **Location Map for Average Electrical Conductivity**
- **Comparison of Clifton Court Water Quality (Monthly Average)**
- **Comparison of Rock Slough Water Quality (Monthly Average)**
- **Comparison of San Joaquin River @ Jersey Point Water Quality (Monthly Average)**
- **Comparison of San Joaquin River @ Prisoners Point Water Quality (Monthly Average)**



Output Locations for Average Flows
 (Arrows show sign convention for positive flow)



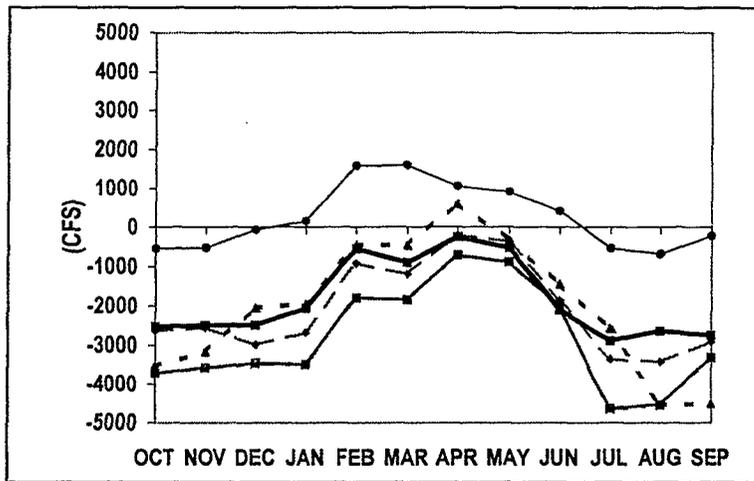
Flows at Old River Near Bacon



Time Series	Existing Condition Flow	No Action Flow	Alt 1_Min Flow	Alt 1_Avg Flow	Alt 1_Max Flow	Alt 2_Min Flow	Alt 2_Avg Flow	Alt 2_Max Flow	Alt 3_Min Flow	Alt 3_Avg Flow	Alt 3_Max Flow
1976-91 Ave	-1851	-2095	-18361	-2845	11288	-17550	-2830	10379	-14672	259	13260
1976-91 Max	6020	5162	-12463	4825	15839	-11929	4788	14955	-7651	7817	17153
1976-91 Min.	-4765	-5057	-21719	-6878	6613	-20720	-6834	5947	-17849	-2038	11366
1987-91 Ave	-2211	-2204	-18149	-2887	11407	-17282	-2869	10525	-15045	-460	12709
1987-91 Max	157	153	-14591	44	14093	-14091	39	13183	-14146	276	13772
1987-91 Min.	-4727	-5036	-21035	-6864	6469	-20064	-6817	5798	-17005	-1962	11346

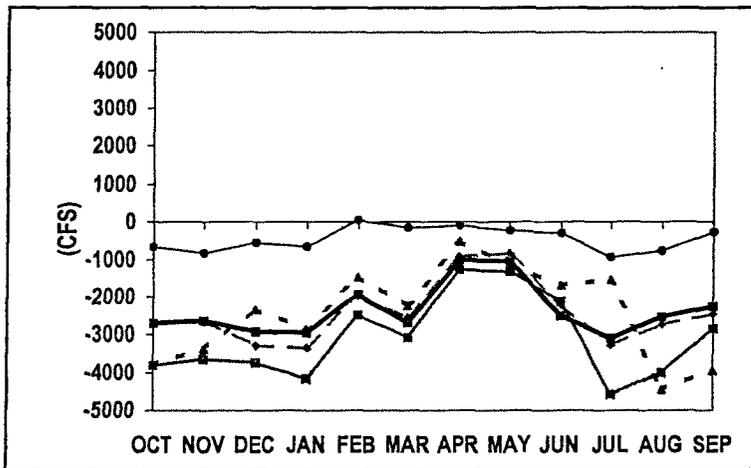
Comparison of Old River @Bacon Monthly Average

LONG TERM (16 YR AVG)

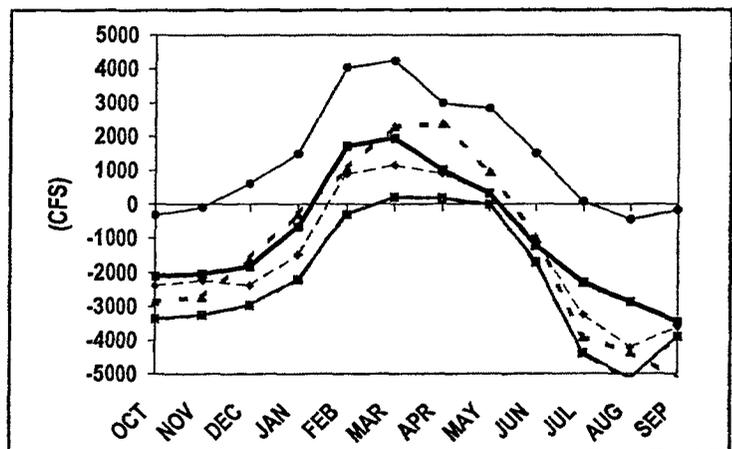


- *--- NoName+DEFT (1995 LOD)
- Existing Conditions (1995 LOD)
- ▲— No Action (2020 LOD)
- x— Alt. 1C (2020 LOD) *
- Alt. 2B (2020 LOD) **
- Alt. 3X (2020 LOD) ***

DRY AND CRITICAL YEARS



ABOVE NORMAL AND WET YEARS



* Alternative 1C

New Northeast Forebay Intake, Old River Dredged, South Delta Salinity Control Structures, Head of Old River Barrier Tracy/Clifton Court Intertie, 10,300 cfs Max. Bank Pumping

** Alternative 2B

Alt. 1C* improvements plus 10,000 cfs Screened Hood Intake Snodgrass Slough & North Fork Mokelumne Enlarged Flooded McCormack-Williamson Tract,

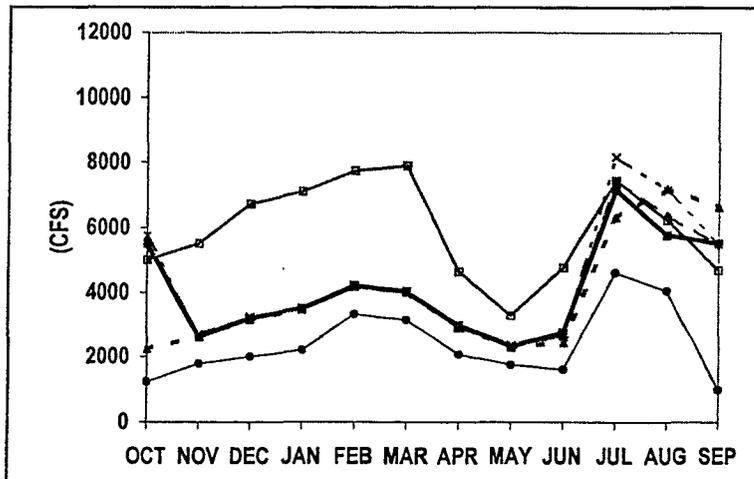
*** Alternative 3X

Alt. 1C* & 2B** improvements plus 10,000 cfs Screened Isolated Facility Diversion near Hood

NOTE: All Hydrologies included WQCP & Delta (b)(2) Actions, All Alternative included ERPP Flows, 1.25 MAF Env. Storage, 4.75 MAF Ag/Urban Storage

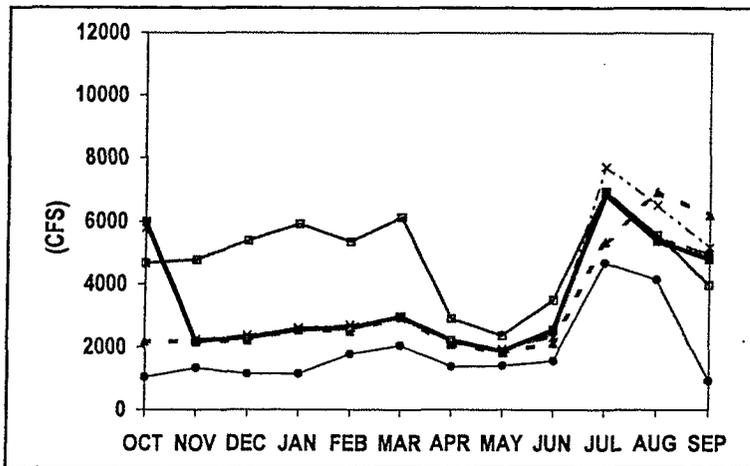
Comparison of Cross Delta Flow Monthly Average

LONG TERM (16 YR AVG)



- ▲--- NoName+DEFT (1995 LOD)
- Existing Conditions (1995 LOD)
- No Action (2020 LOD)
- ×--- Alt. 1C (2020 LOD) *
- Alt. 2B (2020 LOD) **
- Alt. 3X (2020 LOD) ***

DRY AND CRITICAL YEARS



* Alternative 1C

New Northeast Forebay Intake, Old River Dredged, South Delta Salinity Control Structures, Head of Old River Barrier Tracy/Clifton Court Intertie, 10,300 cfs Max. Bank Pumping

** Alternative 2B

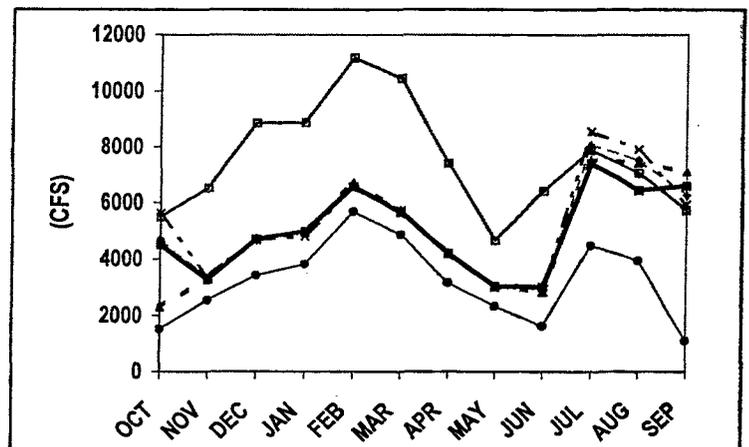
Alt. 1C* improvements plus 10,000 cfs Screened Hood Intake Snodgrass Slough & North Fork Mokelumne Enlarged Flooded McCormack-Williamson Tract,

*** Alternative 3X

Alt. 1C* & 2B** improvements plus 10,000 cfs Screened Isolated Facility Diversion near Hood

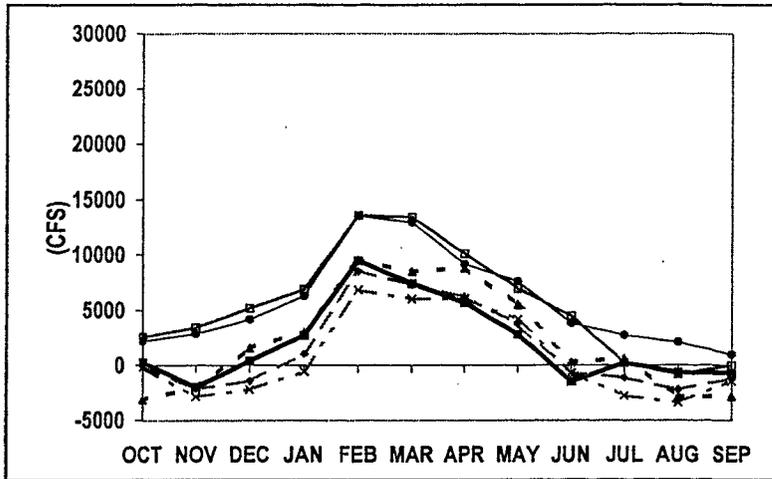
NOTE: All Hydrologies included WQCP & Delta (b)(2) Actions, All Alternative included ERPP Flows, 1.25 MAF Env. Storage, 4.75 MAF Ag/Urban Storage

ABOVE NORMAL AND WET YEARS



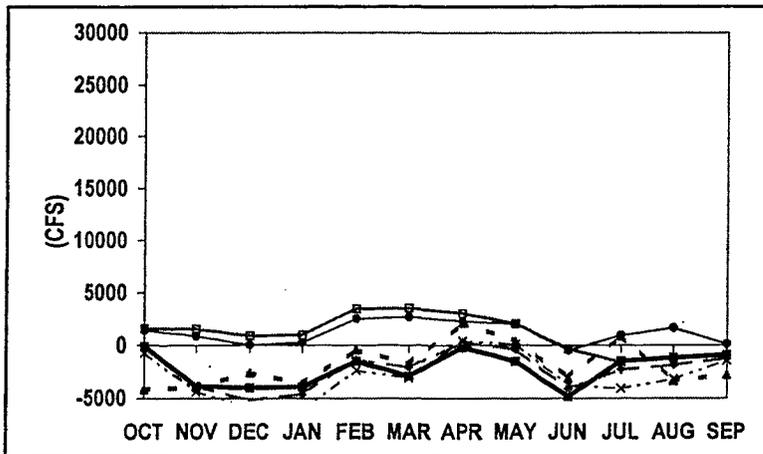
Comparison of QWEST Monthly Average

LONG TERM (16 YR AVG)



- + NoName+DEFT (1995 LOD)
- Existing Conditions (1995 LOD)
- No Action (2020 LOD)
- x Alt. 1C (2020 LOD) *
- Alt. 2B (2020 LOD) **
- Alt. 3X (2020 LOD) ***

DRY AND CRITICAL YEARS



* Alternative 1C

New Northeast Forebay Intake, Old River Dredged, South Delta Salinity Control Structures, Head of Old River Barrier Tracy/Clifton Court Intertie, 10,300 cfs Max. Bank Pumping

** Alternative 2B

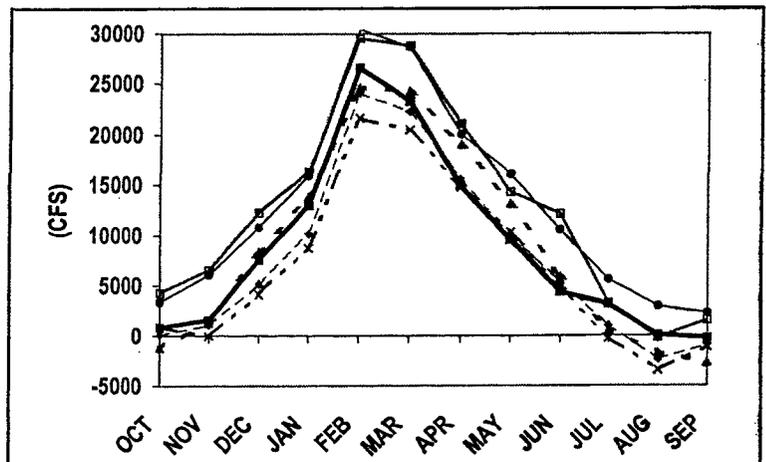
Alt. 1C* improvements plus 10,000 cfs Screened Hood Intake Snodgrass Slough & North Fork Mokelumne Enlarged Flooded McCormack-Williamson Tract,

*** Alternative 3X

Alt. 1C* & 2B** improvements plus 10,000 cfs Screened Isolated Facility Diversion near Hood

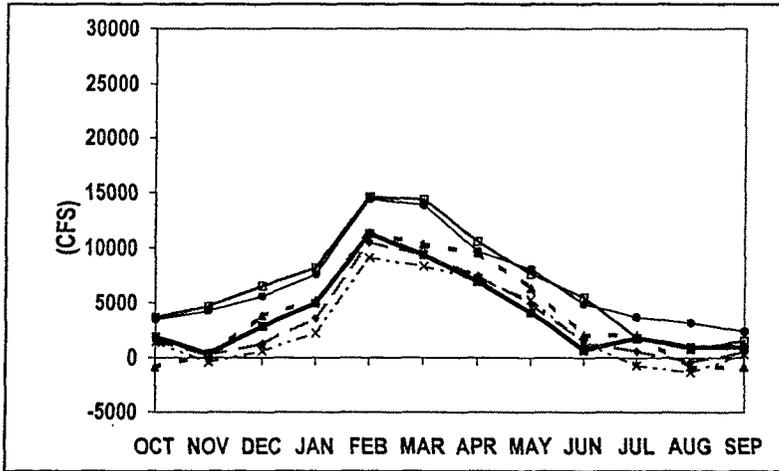
NOTE: All Hydrologies included WQCP & Delta (b)(2) Actions, All Alternative included ERPP Flows, 1.25 MAF Env. Storage, 4.75 MAF Ag/Urban Storage

ABOVE NORMAL AND WET YEARS



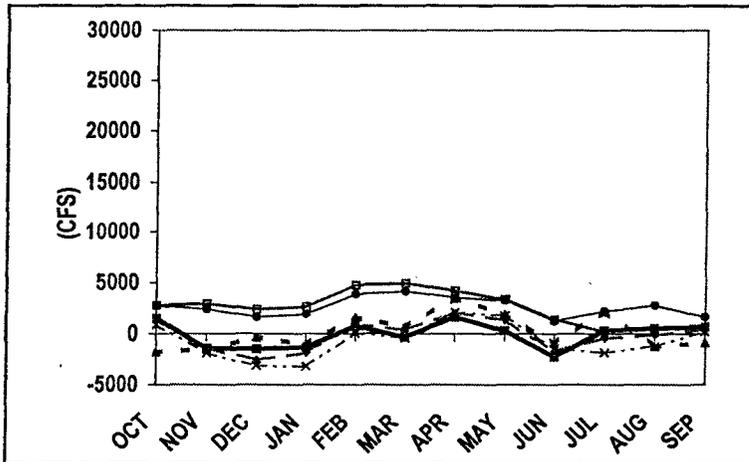
Comparison of San Joaquin River @ Antioch Monthly Average

LONG TERM (16 YR AVG)



- + NoName+DEFT (1995 LOD)
- Existing Conditions (1995 LOD)
- No Action (2020 LOD)
- x Alt. 1C (2020 LOD) *
- Alt. 2B (2020 LOD) **
- Alt. 3X (2020 LOD) ***

DRY AND CRITICAL YEARS



* Alternative 1C

New Northeast Forebay Intake, Old River Dredged, South Delta Salinity Control Structures, Head of Old River Barrier Tracy/Clifton Court Intertie, 10,300 cfs Max. Bank Pumping

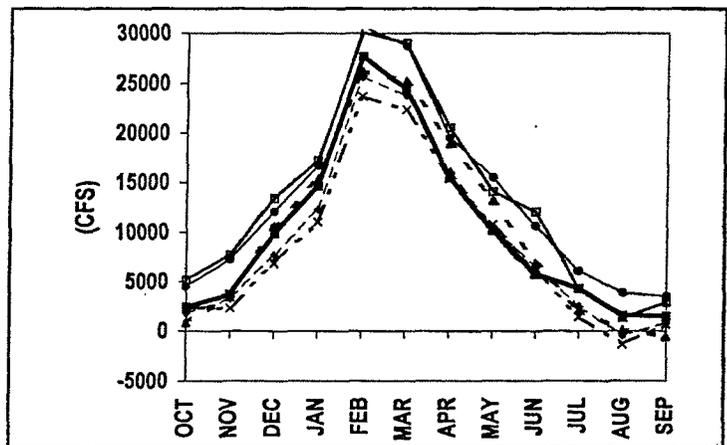
** Alternative 2B

Alt. 1C* improvements plus 10,000 cfs Screened Hood Intake Snodgrass Slough & North Fork Mokelumne Enlarged Flooded McCormack-Williamson Tract,

*** Alternative 3X

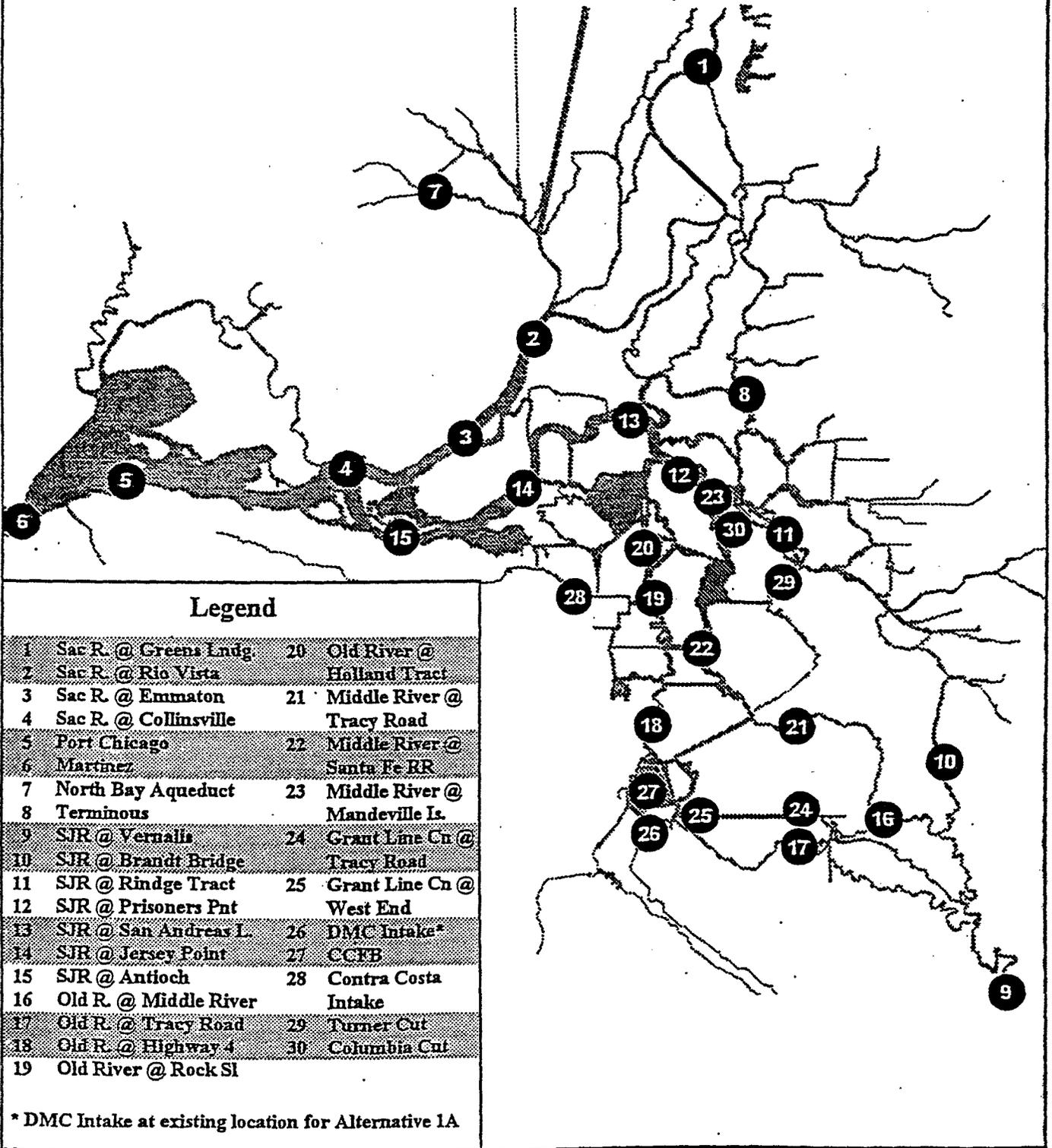
Alt. 1C* & 2B** improvements plus 10,000 cfs Screened Isolated Facility Diversion near Hood

ABOVE NORMAL AND WET YEARS



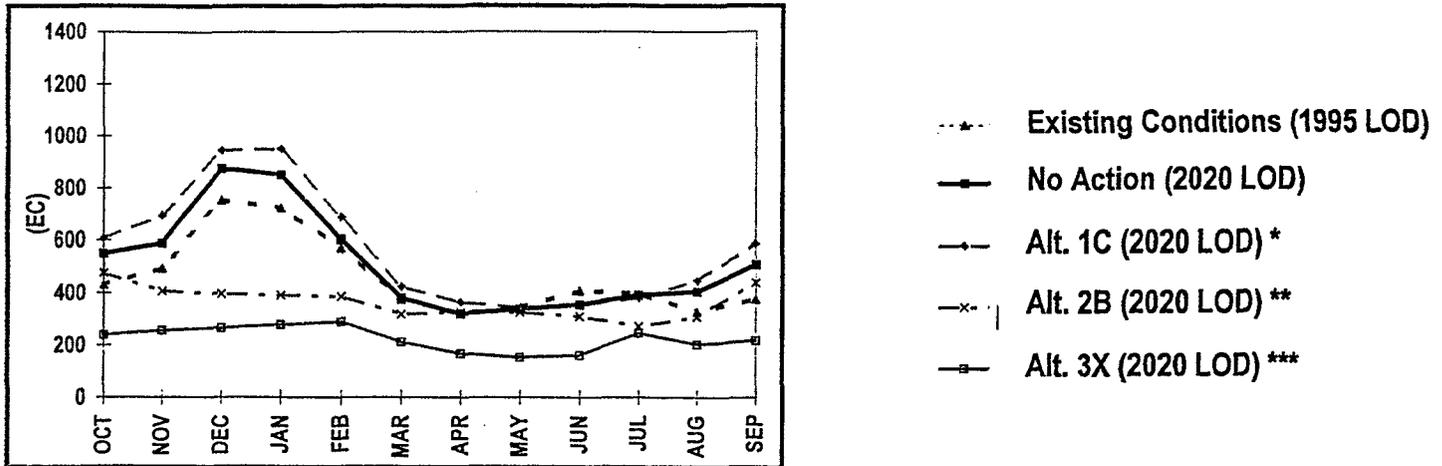
NOTE: All Hydrologies included WQCP & Delta (b)(2) Actions, All Alternative included ERPP Flows, 1.25 MAF Env. Storage, 4.75 MAF Ag/Urban Storage

Output Locations for Monthly Average Electrical Conductivity

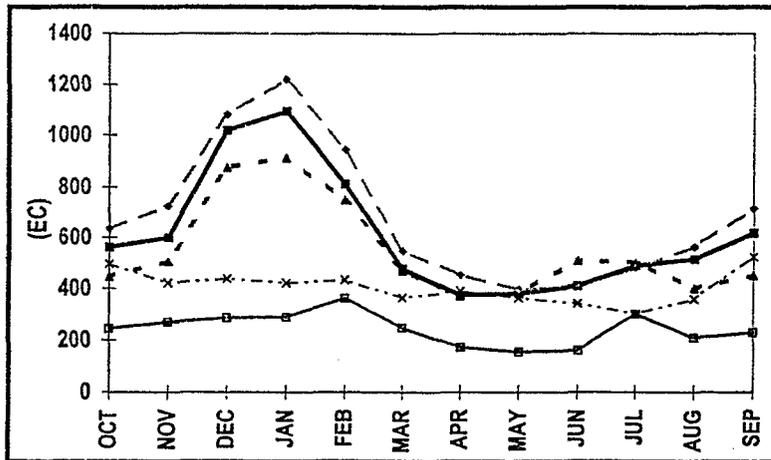


Comparison of Clifton Court Water Quality Monthly Average

LONG TERM (16 YR AVG)



DRY AND CRITICAL YEARS



* Alternative 1C

New Northeast Forebay Intake, Old River Dredged, South Delta Salinity Control Structures, Head of Old River Barrier Tracy/Clifton Court Intertie, 10,300 cfs Max. Bank Pumping

** Alternative 2B

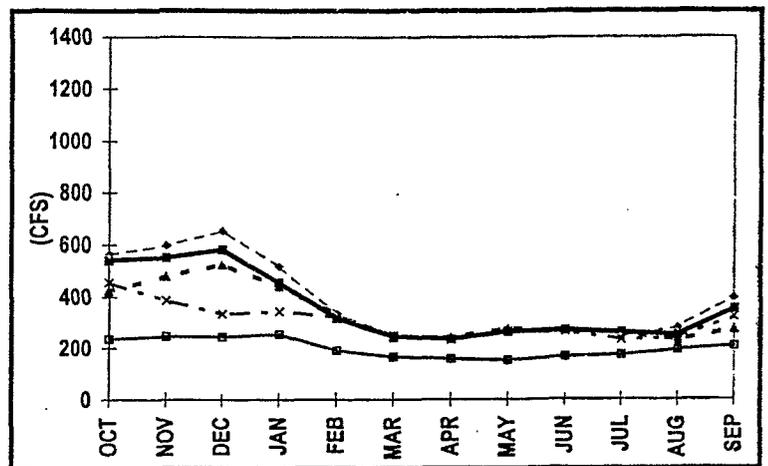
Alt. 1C* improvements plus 10,000 cfs Screened Hood Intake Snodgrass Slough & North Fork Mokelumne Enlarged Flooded McCormack-Williamson Tract,

*** Alternative 3X

Alt. 1C* & 2B** improvements plus 10,000 cfs Screened Isolated Facility Diversion near Hood

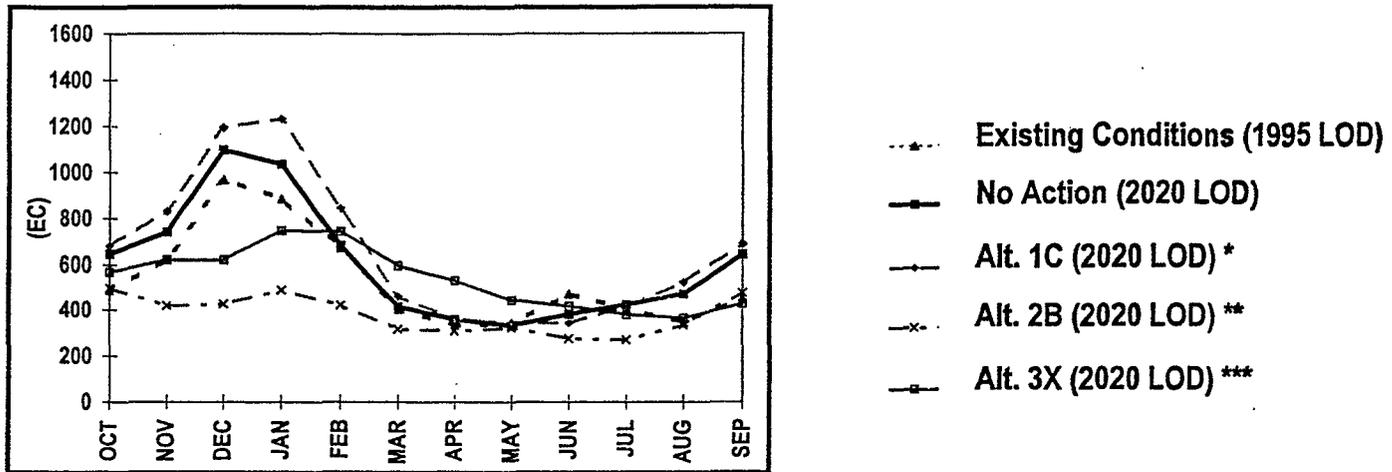
NOTE: All Hydrologies included WQCP & Delta (b)(2) Actions, All Alternative included ERPP Flows, 1.25 MAF Env. Storage, 4.75 MAF Ag/Urban Storage

ABOVE NORMAL AND WET YEARS

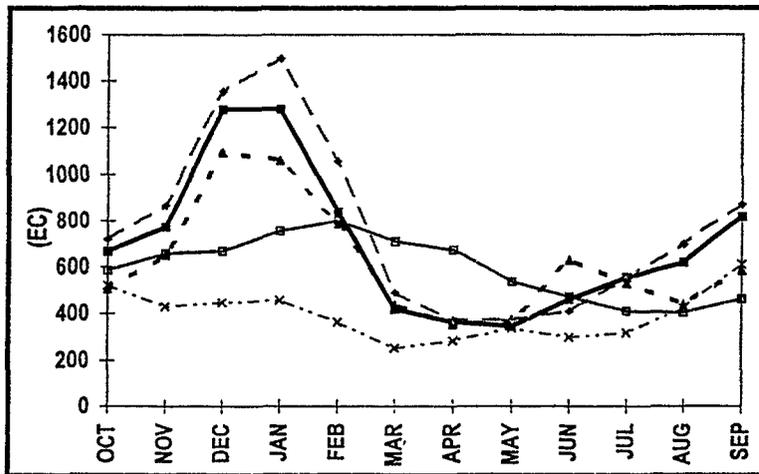


Comparison of Rock Slough Water Quality Monthly Average

LONG TERM (16 YR AVG)



DRY AND CRITICAL YEARS



* Alternative 1C

New Northeast Forebay Intake, Old River Dredged, South Delta Salinity Control Structures, Head of Old River Barrier Tracy/Clifton Court Intertie, 10,300 cfs Max. Bank Pumping

** Alternative 2B

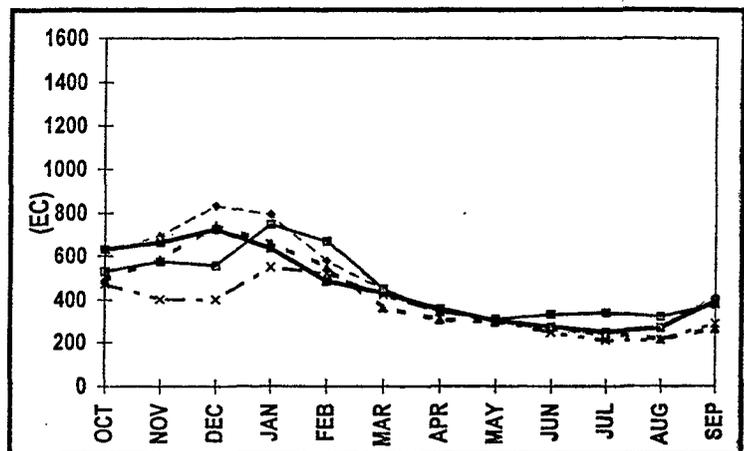
Alt. 1C* improvements plus 10,000 cfs Screened Hood Intake Snodgrass Slough & North Fork Mokelumne Enlarged Flooded McCormack-Williamson Tract,

*** Alternative 3X

Alt. 1C* & 2B** improvements plus 10,000 cfs Screened Isolated Facility Diversion near Hood

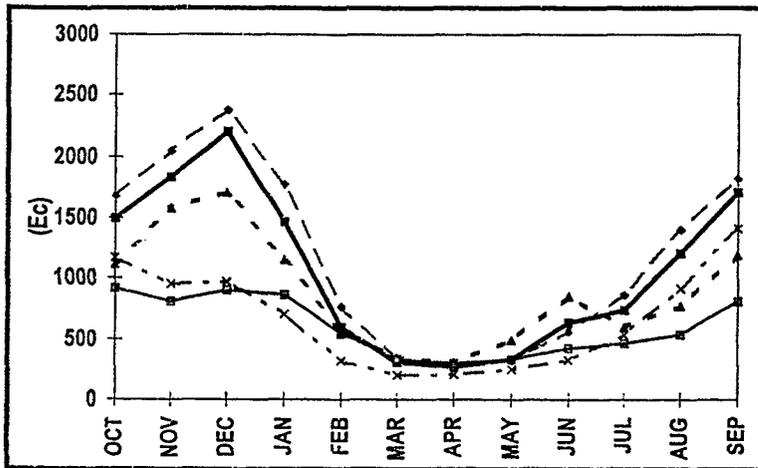
NOTE: All Hydrologies included WQCP & Delta (b)(2) Actions, All Alternative included ERPP Flows, 1.25 MAF Env. Storage, 4.75 MAF Ag/Urban Storage

ABOVE NORMAL AND WET YEARS



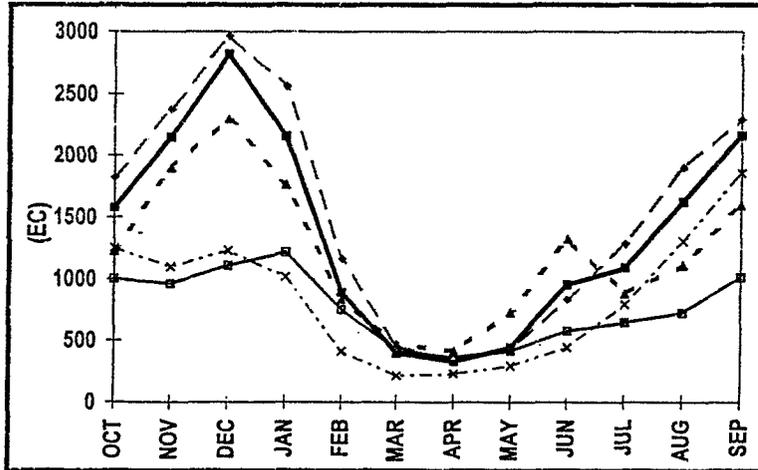
Comparison of San Joaquin River @ Jersey Pt. WQ Monthly Average

LONG TERM (16 YR AVG)



- Existing Conditions (1995 LOD)
- No Action (2020 LOD)
- Alt. 1C (2020 LOD) *
- Alt. 2B (2020 LOD) **
- Alt. 3X (2020 LOD) ***

DRY AND CRITICAL YEARS



* Alternative 1C

New Northeast Forebay Intake, Old River Dredged, South Delta Salinity Control Structures, Head of Old River Barrier Tracy/Clifton Court Intertie, 10,300 cfs Max. Bank Pumping

** Alternative 2B

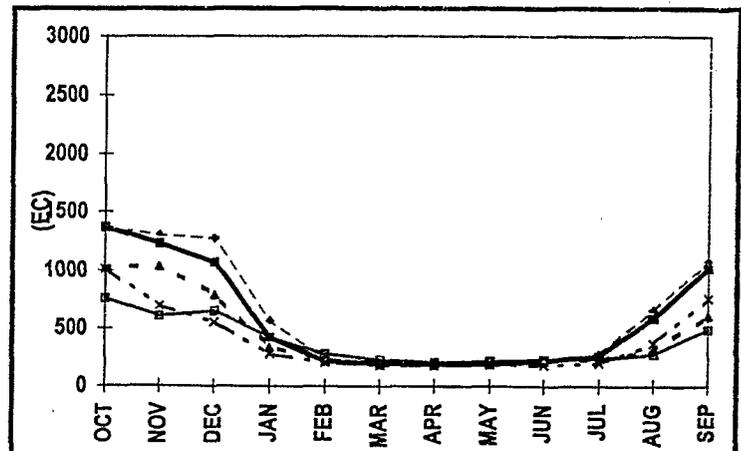
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*** Alternative 3X

Alt. 1C* & 2B** improvements plus 10,000 cfs Screened Isolated Facility Diversion near Hood

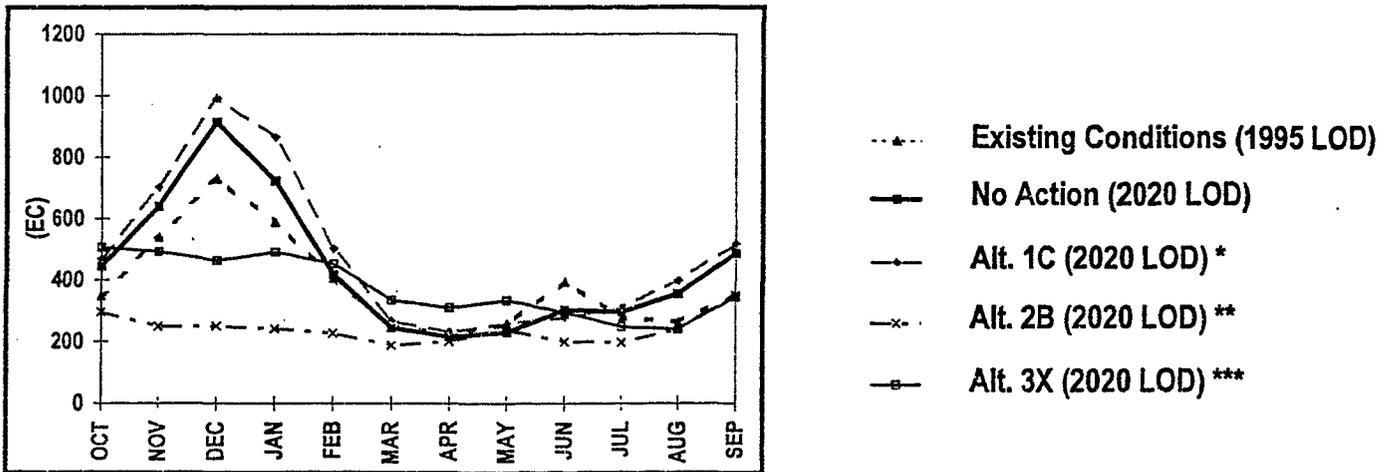
NOTE: All Hydrologies included WQCP & Delta (b)(2) Actions, All Alternative included ERPP Flows, 1.25 MAF Env. Storage, 4.75 MAF Ag/Urban Storage

ABOVE NORMAL AND WET YEARS

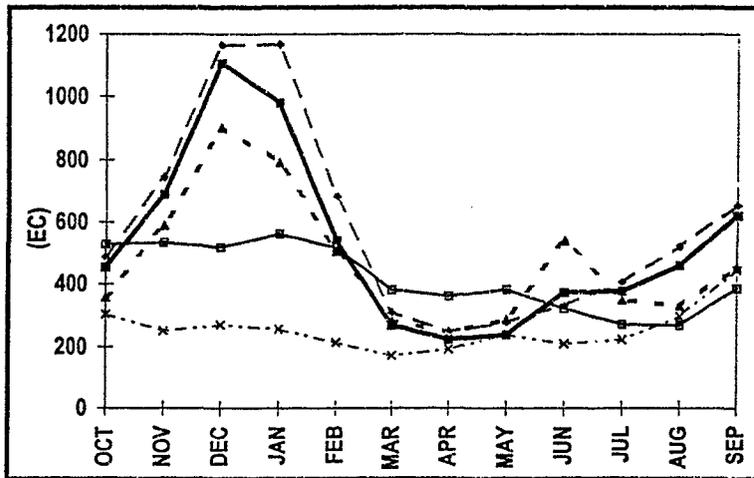


Comparison of San Joaquin River @ Prisoners Pt. WQ Monthly Average

LONG TERM (16 YR AVG)



DRY AND CRITICAL YEARS



* Alternative 1C

New Northeast Forebay Intake, Old River Dredged, South Delta Salinity Control Structures, Head of Old River Barrier Tracy/Clifton Court Intertie, 10,300 cfs Max. Bank Pumping

** Alternative 2B

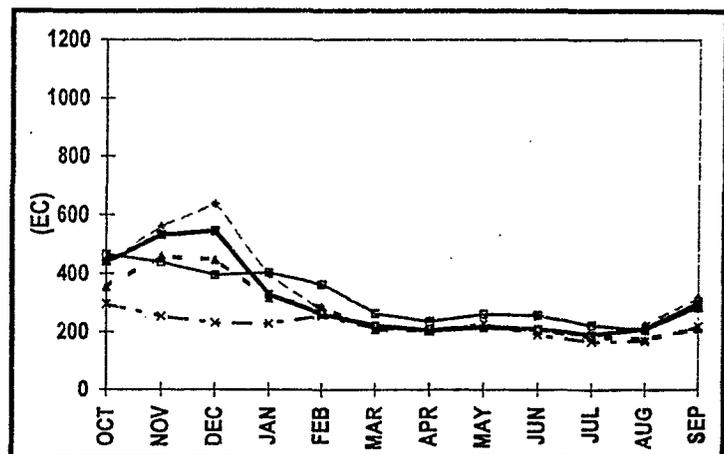
Alt. 1C* improvements plus 10,000 cfs Screened Hood Intake Snodgrass Slough & North Fork Mokelumne Enlarged Flooded McCormack-Williamson Tract,

*** Alternative 3X

Alt. 1C* & 2B** improvements plus 10,000 cfs Screened Isolated Facility Diversion near Hood

NOTE: All Hydrologies included WQCP & Delta (b)(2) Actions, All Alternative included ERPP Flows, 1.25 MAF Env. Storage, 4.75 MAF Ag/Urban Storage

ABOVE NORMAL AND WET YEARS



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