Application for Federal Assistance SF-424

* 1. Type of Submission:
  - [ ] Preapplication
  - [x] Application
  - [ ] Changed/Corrected Application

* 2. Type of Application:
  - [x] New
  - [ ] Continuation
  - [ ] Revision

* If Revision, select appropriate letter(s):

* Other (Specify):

* 3. Date Received: 06/25/2015

4. Applicant Identifier:

5a. Federal Entity Identifier:

5b. Federal Award Identifier:

State Use Only:

6. Date Received by State:

7. State Application Identifier:

8. APPLICANT INFORMATION:

* a. Legal Name: Tule River Tribe of the Tule River Reservation

* b. Employer/Taxpayer Identification Number (EIN/TIN): 94-1728348

* c. Organizational DUNS: 0584028430000

d. Address:

* Street1: 340 North Reservation Road
Street2:
* City: Porterville
County/Parish:
* State: CA: California
Province:
* Country: USA: UNITED STATES
* Zip / Postal Code: 93257-089

e. Organizational Unit:

Department Name: Tule River Administration

Division Name: Planning Department

f. Name and contact information of person to be contacted on matters involving this application:

Prefix:
* First Name: Vernon
Middle Name:
* Last Name: Vera
Suffix:

Title: Director of Planning & Community Development

Organizational Affiliation: Administration

* Telephone Number: (559)853-6066
Fax Number: (559)781-4610

* Email: Vernon.Vera@tulerivertribe-nsn.gov

Application for Federal Assistance SF-424

*** 9. Type of Applicant 1: Select Applicant Type:**

I: Indian/Native American Tribal Government (Federally Recognized)

Type of Applicant 2: Select Applicant Type:

Type of Applicant 3: Select Applicant Type:

* Other (specify):

*** 10. Name of Federal Agency:**

Bureau of Reclamation

11. Catalog of Federal Domestic Assistance Number:

15.514

CFDA Title:

Reclamation States Emergency Drought Relief

*** 12. Funding Opportunity Number:**

R15AS00046

* Title:

WaterSMART: Drought Resiliency Project Grants for Fiscal Year 2015

13. Competition Identification Number:

Title:

14. Areas Affected by Project (Cities, Counties, States, etc.):

Add Attachment | Delete Attachment | View Attachment

*** 15. Descriptive Title of Applicant's Project:**

To improve water storage at Painted Rocks

Attach supporting documents as specified in agency instructions.

Add Attachments | Delete Attachments | View Attachments

Application for Federal Assistance SF-424

16. Congressional Districts Of:

* a. Applicant: CA-020
* b. Program/Project: CA-020

Attach an additional list of Program/Project Congressional Districts if needed.

[Add Attachment] [Delete Attachment] [View Attachment]

17. Proposed Project:

* a. Start Date: 10/01/2015
* b. End Date: 09/30/2017

18. Estimated Funding ($):

* a. Federal	298,918.00
* b. Applicant	129,000.00
* c. State	0.00
* d. Local	0.00
* e. Other	0.00
* f. Program Income	0.00
* g. TOTAL	427,918.00

*** 19. Is Application Subject to Review By State Under Executive Order 12372 Process?**

☐ a. This application was made available to the State under the Executive Order 12372 Process for review on ______.

☐ b. Program is subject to E.O. 12372 but has not been selected by the State for review.

☒ c. Program is not covered by E.O. 12372.

*** 20. Is the Applicant Delinquent On Any Federal Debt? (If "Yes," provide explanation in attachment.)**

☐ Yes ☒ No

If "Yes", provide explanation and attach

[Add Attachment] [Delete Attachment] [View Attachment]

21. *By signing this application, I certify (1) to the statements contained in the list of certifications and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances** and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 218, Section 1001)**

☒ ** I AGREE

** The list of certifications and assurances, or an internet site where you may obtain this list, is contained in the announcement or agency specific instructions.

Authorized Representative:

Prefix:
* First Name: Vernon
Middle Name:
* Last Name: Vera
Suffix:

* Title: Director of Planning & Community Development

* Telephone Number: (559)853-6066
Fax Number: (559)781-4610

* Email: Vernon.Vera@tulerivertribe-nsn.gov

* Signature of Authorized Representative: Vernon Vera
* Date Signed: 06/25/2015

BUDGET INFORMATION - Non-Construction Programs

OMB Number: 4040-0006
Expiration Date: 06/30/2014

SECTION A - BUDGET SUMMARY

	Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds		New or Revised Budget		
			Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1.	WaterSmart Drought Resiliency Grant FY 2015	15.514	$ 298,918.00	$ 129,000.00	$ 0.00	$ 0.00	$ 427,918.00
2.	N/A	0	0.00	0.00	0.00	0.00	0.00
3.	N/A	0	0.00	0.00	0.00	0.00	0.00
4.	N/A	0	0.00	0.00	0.00	0.00	0.00
5.	Totals		$ 298,918.00	$ 129,000.00	$	$	$ 427,918.00

Standard Form 424A (Rev. 7- 97)
Prescribed by OMB (Circular A -102) Page 1

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	GRANT PROGRAM, FUNCTION OR ACTIVITY				Total
	(1)	(2)	(3)	(4)	(5)
	WaterSmart Drought Resiliency Grant FY 2015	N/A	N/A	N/A	
a. Personnel	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$
b. Fringe Benefits	0.00	0.00	0.00	0.00	
c. Travel	0.00	0.00	0.00	0.00	
d. Equipment	0.00	0.00	0.00	0.00	
e. Supplies	135,000.00	0.00	0.00	0.00	135,000.00
f. Contractual	12,000.00	0.00	0.00	0.00	12,000.00
g. Construction	111,000.00				111,000.00
h. Other					
i. Total Direct Charges (sum of 6a-6h)	258,000.00	0.00	0.00	0.00	$ 258,000.00
j. Indirect Charges	40,918.00	0.00	0.00	0.00	$ 40,918.00
k. TOTALS (sum of 6i and 6j)	$ 298,918.00	$ 0.00	$ 0.00	$ 0.00	$ 298,918.00
7. Program Income	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$

Authorized for Local Reproduction

Standard Form 424A (Rev. 7- 97)
Prescribed by OMB (Circular A -102) Page 1A

SECTION C - NON-FEDERAL RESOURCES

(a) Grant Program	(b) Applicant	(c) State	(d) Other Sources	(e)TOTALS
8. WaterSmart Drought Resiliency Grant Program FY 2015	$ 129,000.00	$ 0.00	$ 0.00	$ 129,000.00
9.				
10.				
11.				
12. TOTAL (sum of lines 8-11)	$ 129,000.00	$	$	$ 129,000.00

SECTION D - FORECASTED CASH NEEDS

	Total for 1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
13. Federal	$ 298,918.00	$ 74,729.50	$ 74,729.50	$ 74,729.50	$ 74,729.50
14. Non-Federal	$ 129,000.00	32,250.00	32,250.00	32,250.00	32,250.00
15. TOTAL (sum of lines 13 and 14)	$ 427,918.00	$ 106,979.50	$ 106,979.50	$ 106,979.50	$ 106,979.50

SECTION E - BUDGET ESTIMATES OF FEDERAL FUNDS NEEDED FOR BALANCE OF THE PROJECT

(a) Grant Program	FUTURE FUNDING PERIODS (YEARS)			
	(b)First	(c) Second	(d) Third	(e) Fourth
16. WaterSmart Drought Resiliency Grant Program FY 2015	$	$	$	$
17.				
18.				
19.				
20. TOTAL (sum of lines 16 - 19)	$	$	$	$

SECTION F - OTHER BUDGET INFORMATION

21. Direct Charges:	258000	22. Indirect Charges:	40918
23. Remarks:	none		

Authorized for Local Reproduction

TULE RIVER INDIAN TRIBE OF CALIFORNIA

IN THE MATTER OF:

Approval to submit application to U.S.)	
Department of the Interior, Bureau of)	**RESOLUTION NO. FY2015-142**
Reclamation – Water Smart: Drought)	
Resiliency Project Grants for FY 2015)	

BE IT RESOLVED BY THE COUNCIL OF THE TULE RIVER INDIAN TRIBE:

WHEREAS, the Tule River Indian Tribe is governed under a Constitution and Bylaws duly adopted by the U.S. Secretary of the Interior on January 15, 1936; and

WHEREAS, Article VI, Section 1(a) of the Tribal Constitution authorizes the governing body to enter into negotiations with Federal, State or local agencies on behalf of the Tribe; and

WHEREAS, the Tule River Tribal Council has determined the need to prepare for and address drought conditions on the Reservation; and,

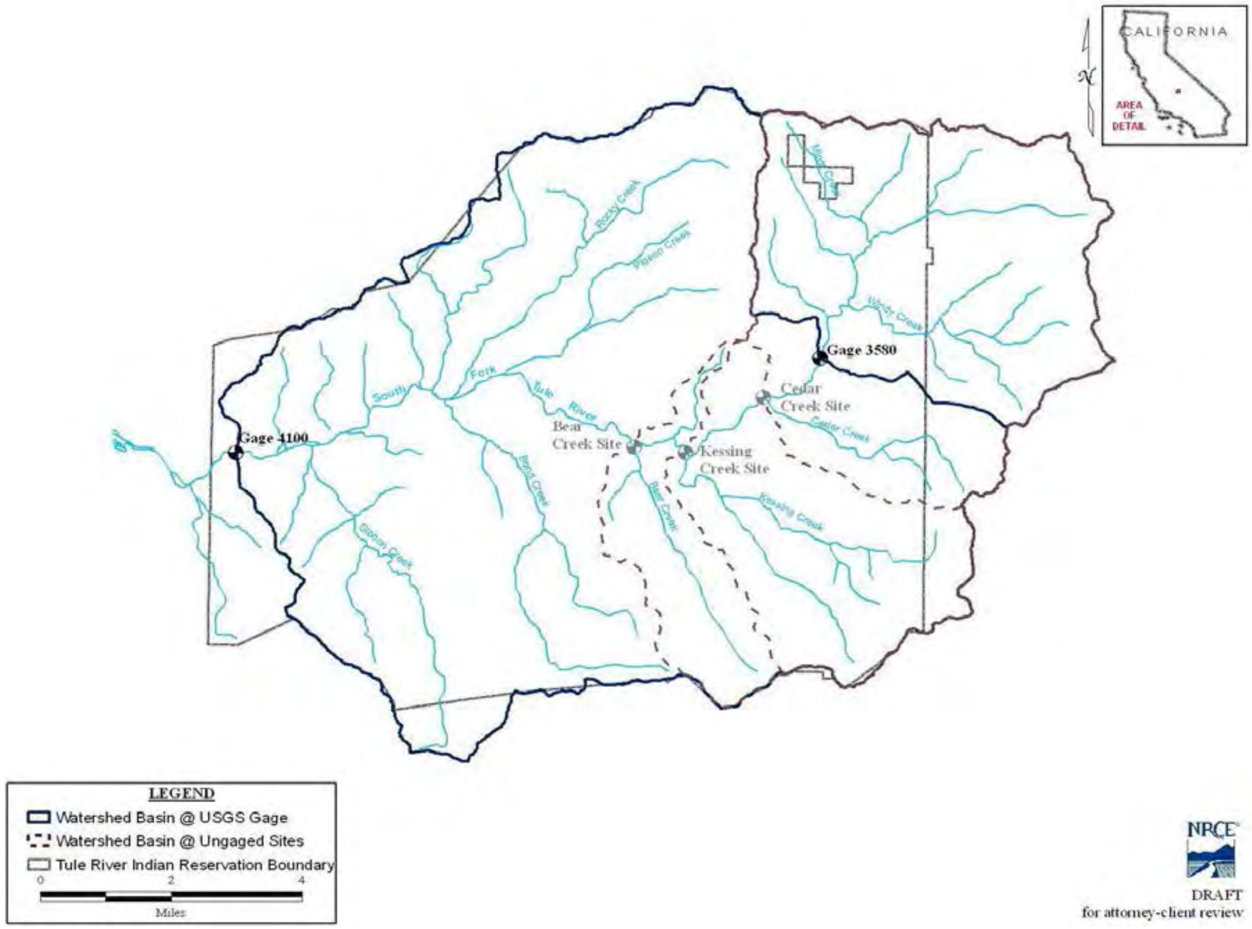
WHEREAS, the U.S. Department of the Interior through the Bureau of Reclamation has issued a Notice of Funding Availability that may be used to increase the reliability of water supply; improve water management; implement systems to mitigate impacts caused by drought; and

WHEREAS, the Tule River Tribal Council wishes to increase water management flexibility, making tribal water supply more resilient, and thereby helping to prepare for and address the impacts of drought and climate change; and the Tribe will work with Reclamation staff to meet established deadlines for entering into a Cooperative Agreement; and

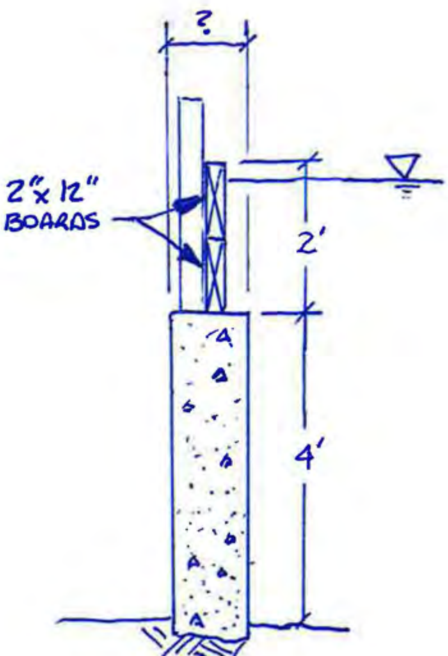
WHEREAS, the Tule River Tribal Council will apply for grant funding through the U.S. Bureau of Reclamation Drought Resiliency Project for FY: 2015 in the amount of $300,000, including a 50% in-kind or match; and the Tribe has the financial resources at hand to provide the amount of funding and/or in-kind contributions in the funding plan; and

THEREFORE BE IT RESOLVED, that the Tule River Tribal Council authorizes the Tribal Chairman, or Officers of the Tribal Council, as his designee to negotiate and execute all necessary grant documents pertinent to the administration of said contract application and amendments necessary to carrying out the implementation of this contract; and

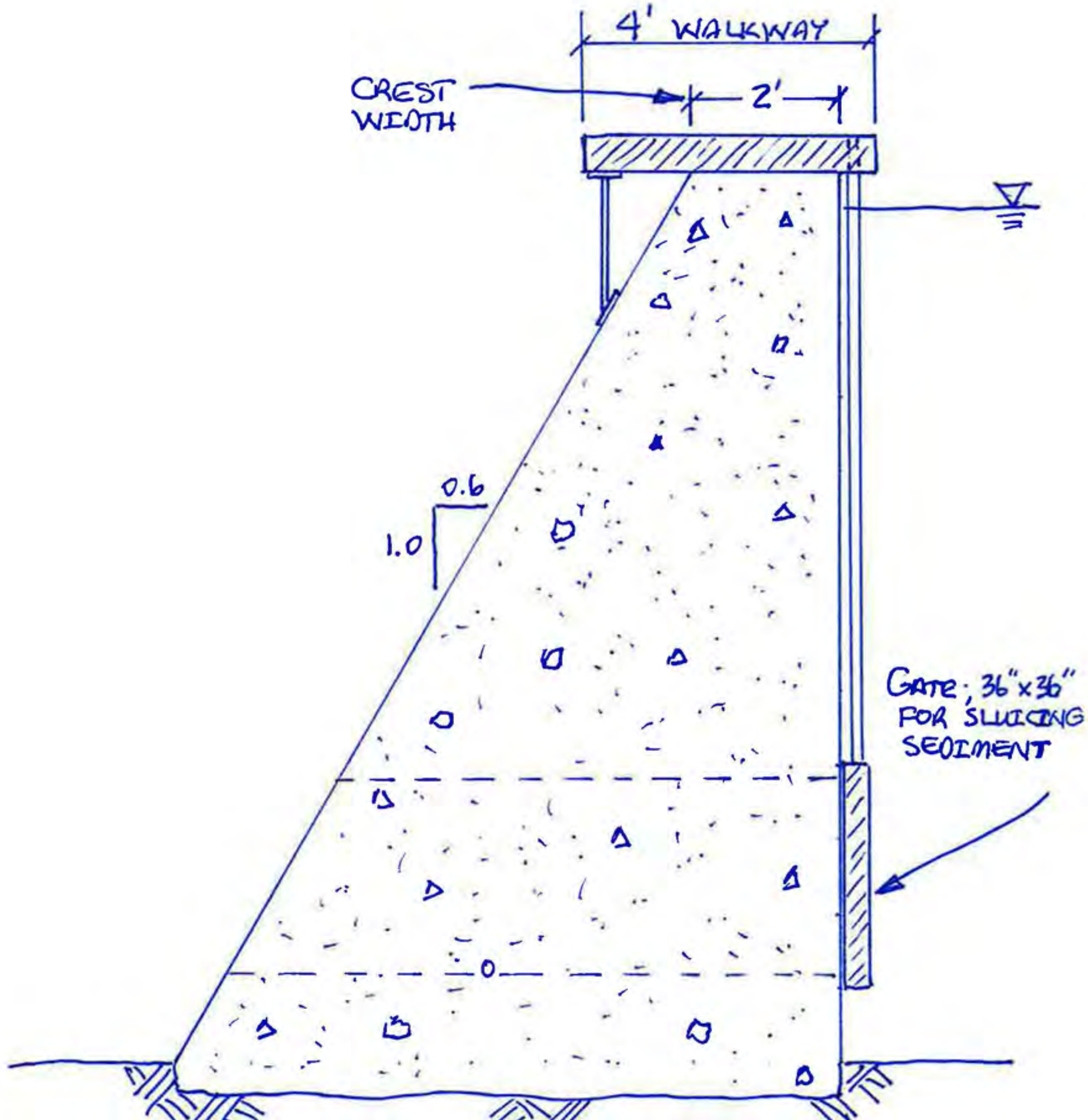
THEREFORE BE IT FURTHER RESOLVED that this Resolution has not been amended or rescinded in any way.



Area of Select Sites on the South Fork Tule River **Site**	
Gage 3580	13,080
Cedar Creek Site	17,274
Kessing Creek Site	25,267
Bear Creek Site	29,249
Gage 4100	61,505



EXISTING



PROPOSED

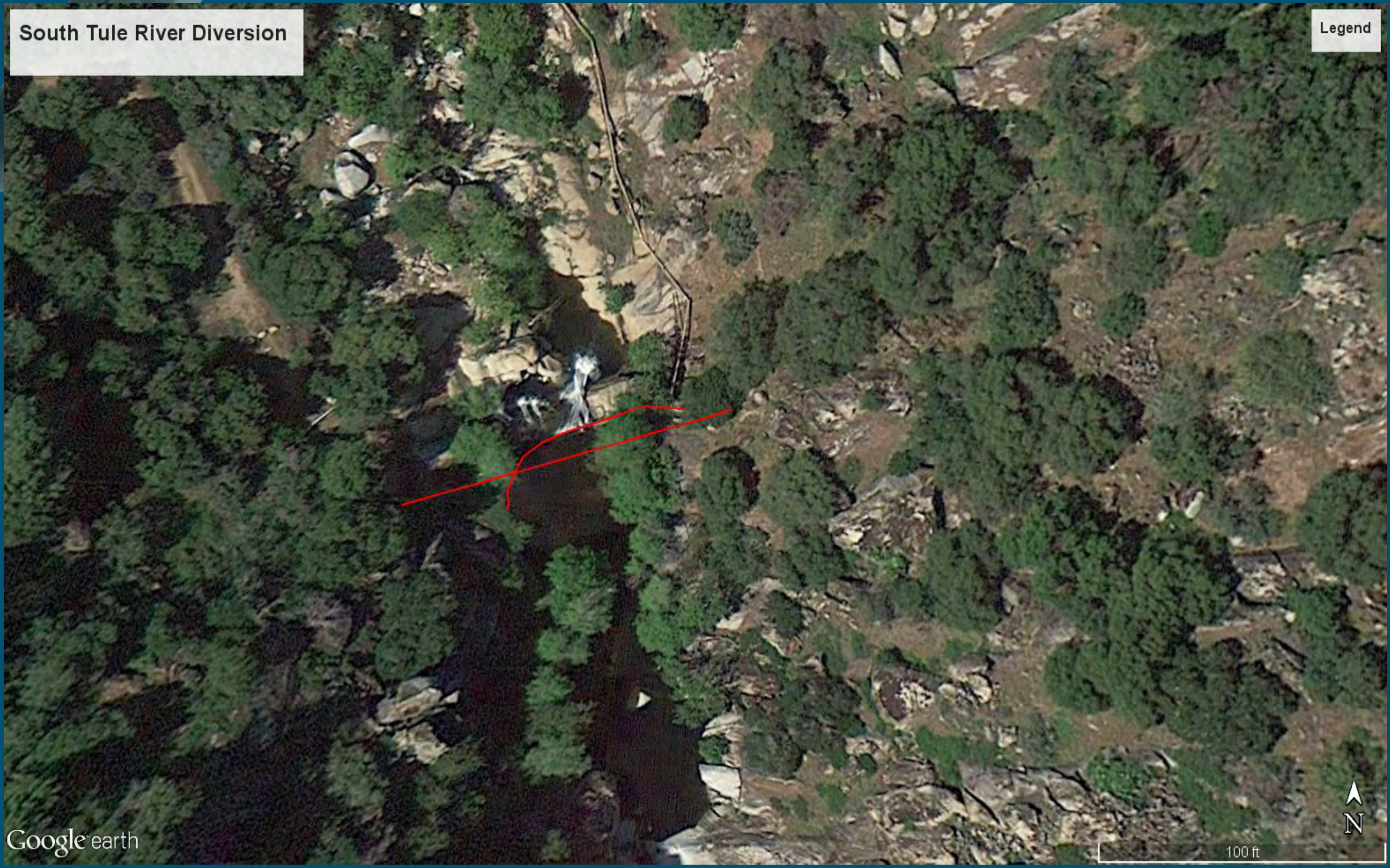
Tule River Indian Tribe

Painted Rock Dam Improvements

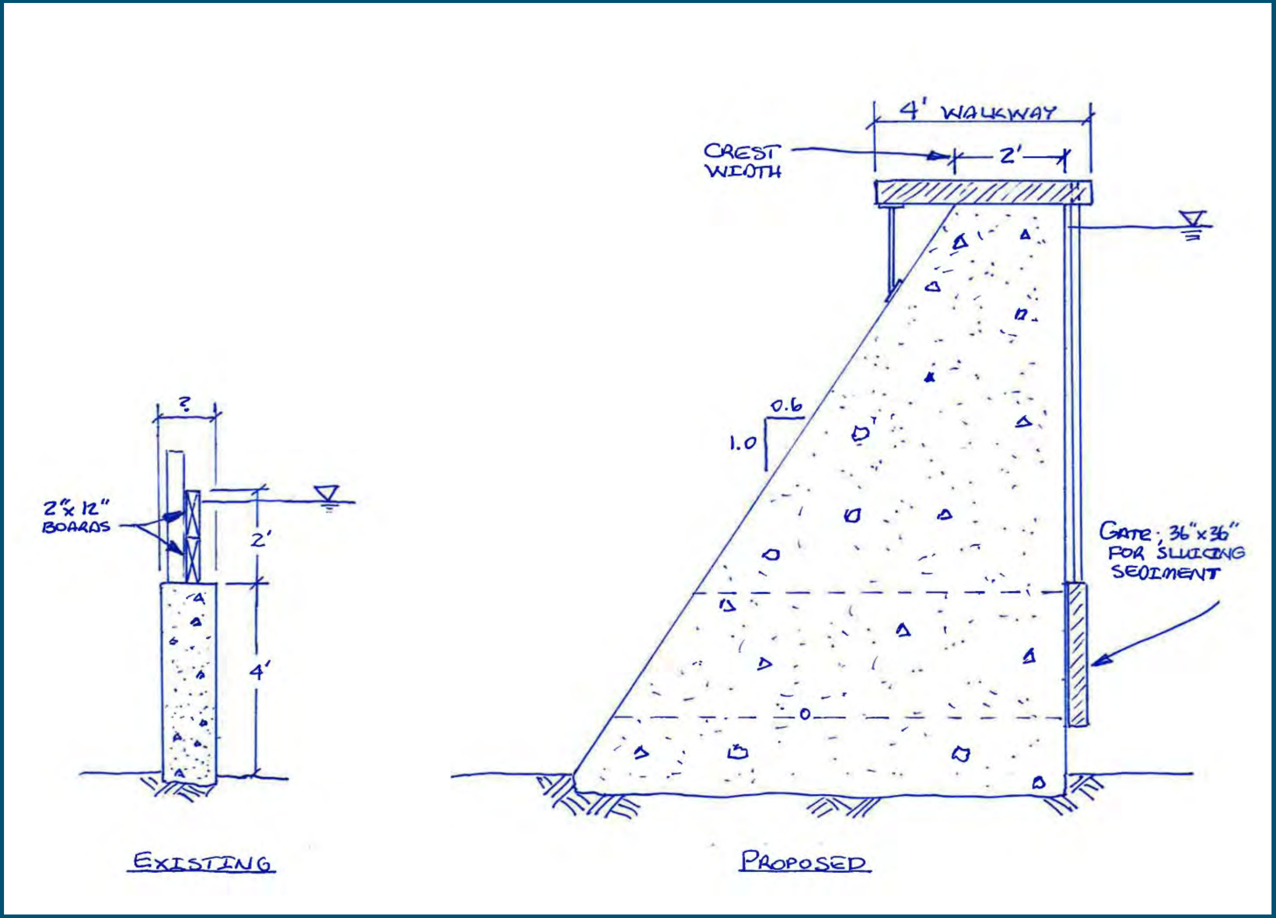
GEI Consultants

Existing Dam Elements

Potential Dam Alignment

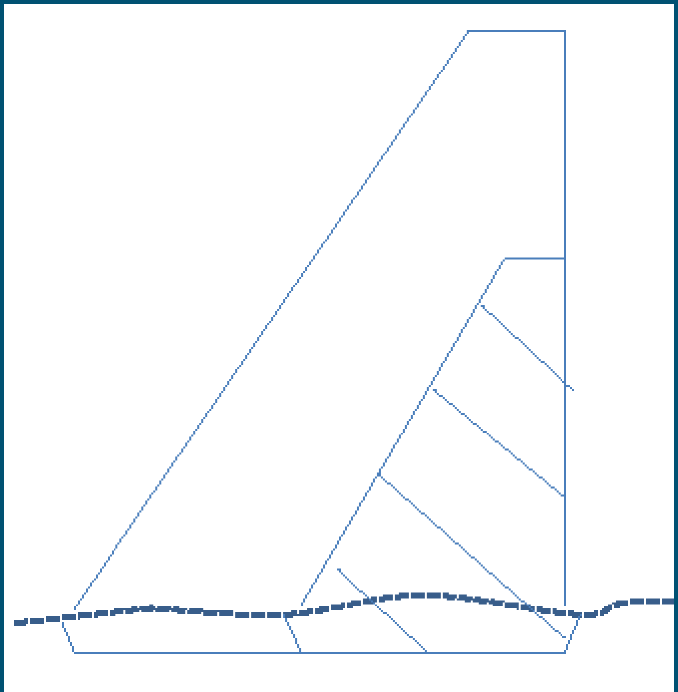


Dam Cross Sections



Future Dam Raise

Issues to Consider:



- Drilling/testing program
- Inundation area
- Dam alignment
- Abutment conditions

Painted Rock Dam Improvements
Reconnaissance/Feasibility Level Cost Estimate
Engineer's Opinion of Probable Construction Cost (OPCC)

Date: May 28, 2015

Item No.	Supplies or Services	Description	Quantity	Unit	Unit Price	Amount
1	Mobilization and Demobilization	Preparing access, moving in, and setting up equipment and facilities for the Work.	1	LS	$ 25,000.00	$ 25,000.00
2	Clearing and Grubbing	Removal of vegetation, rubbish, and other items as necessary to provide a suitable working surface.	1800	SF	$ 5.00	$ 9,000.00
3	Diversion and Care of Stream during Construction	Construction of a cofferdam and control/management of stored water.	1	LS	$ 15,000.00	$ 15,000.00
4	Foundation Preparation	Preparing foundation area along dam alignment.	1200	SF	$ 10.00	$ 12,000.00
5	Dam Installation	Furnish, form and place concrete in accordance with dam cross-section.	150	CY	$ 900.00	$ 135,000.00
6	Sluice Gate and Operator	Furnish and install cast-iron sluice gate and associated operator for sluicing sediment.	1	LS	$ 16,000.00	$ 16,000.00
7	Walkway Installation	Furnish and install metal walkway along dam crest to provide access to sluice gate operator.	200	SF	$ 20.00	$ 4,000.00
8	Waterline Intake Connection	Furnish and install facilities to transmit water from storage facility and connect to the existing transmisson pipeline.	1	LS	$ 10,000.00	$ 10,000.00
9	Removal and Disposal of Existing Structures	Excavation, removal, and hauling of materials and structures off-site for disposal.	1	LS	$ 20,000.00	$ 20,000.00
					Total Unadjusted OPCC:	$ 246,000.00
	Construction Contingency (50%)					$ 123,000.00
					Total Adjusted OPCC:	$ 369,000.00

Site Number: 11204100
Site Name: SF TULE R NR RESERVATION BNDRY NR

**used minimum gage height for data

Lowest Recorded Height (ft):							
	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14
Largest Neg. slope :	0.0218	0.0447	0.0107	0.0061	0.0061	0.0061	0.0061
Projected Value by end of month :	4.596	3.5143	2.9283	2.7453	2.5562	2.3732	2.1841
Projected Value (assuming largest slope)	4.596	3.5143	1.8743	1.2203	0.5445	-0.1095	-0.7853
Actual end:	4.9	3.26					

**assuming trend of extreme slopes based on historical data

Notes:

COMMENT: Fluxuating trend for the months after September until April due to varying precipitation patterns, but assuming zero precipitation in our projections so will adopt September Conditions

Analysis:Change in Gage Height

	April	May	June
Average Slopes:	0.0015	-0.01257	-0.0090833
STD:	0.017434	0.005514	0.0085181
2014 Slopes	-0.0049	-0.0111	-0.0121
	July	August	September
Average Slopes:	-0.01	-0.00318	
STD:	0.003616	0.006657	
2014 Slopes	-0.0447		

COMMENT: Currently trends for the 2014 are within a

April

2008	6.05	6.02
2009	6.17	6.15
2010	6.26	6.21
2011	7.4	7.38
2012	6.51	6.35
2013	5.8	5.78
2014	5.73	5.73

May

2008	5.98	5.94
2009	6.1	6.21
2010	6.67	6.63
2011	6.61	6.58
2012	6.37	6.32
2013	5.54	5.52
2014	5.61	5.56

June

2008	5.7	5.66
2009	5.73	5.73
2010	6.36	6.39
2011	6.37	6.35
2012	5.73	5.7

standard deviation of the average of slopes based on historical data. July is over STD of average.

2013	5.3	5.27
2014	5.2	5.21

July

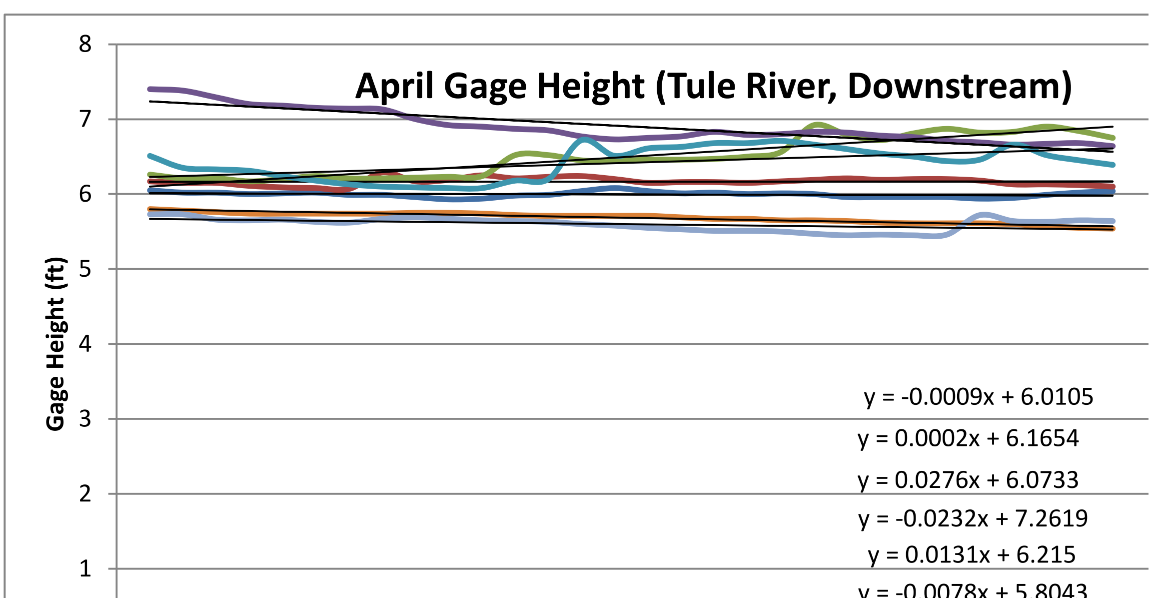
2008	5.44	5.37
2009	5.42	5.47
2010	5.93	5.91
2011	5.95	5.92
2012	5.63	5.65
2013	5.17	5.09
2014	4.75	4.57

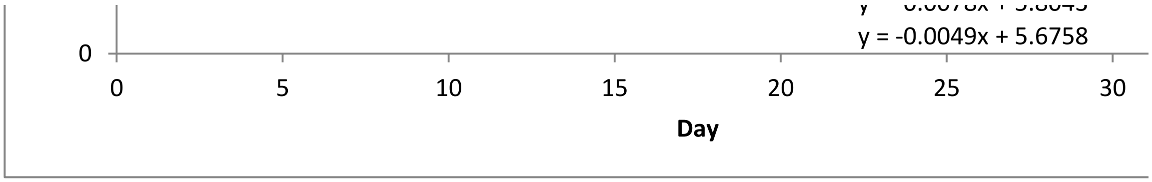
August

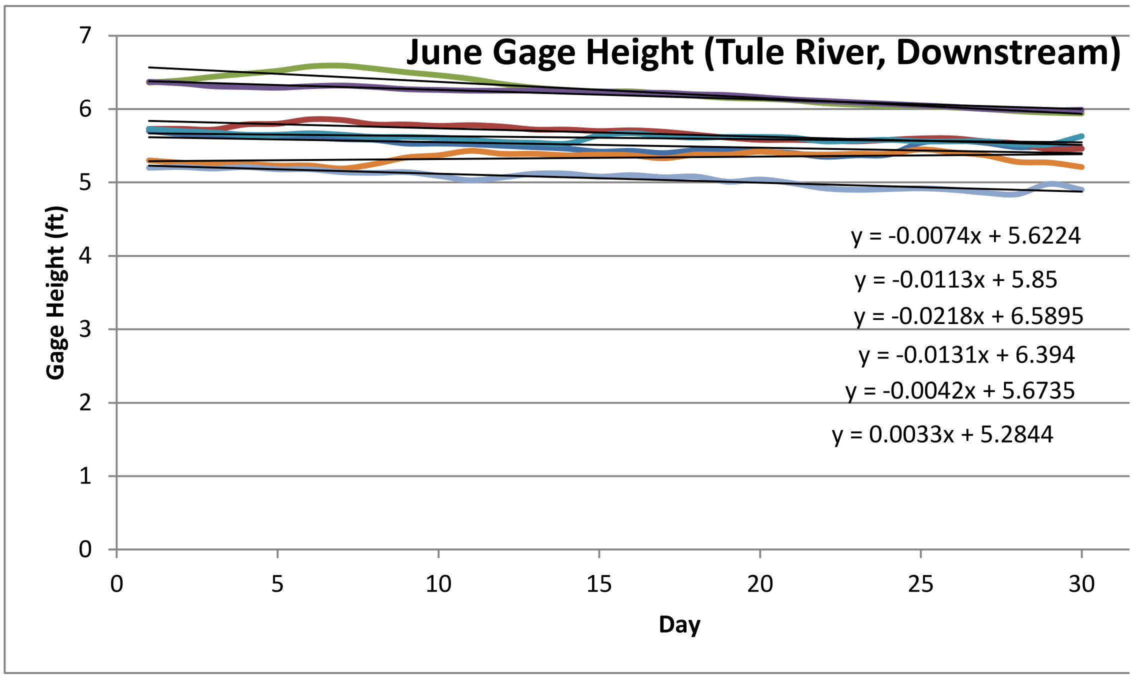
2008	5.19	5.19
2009	5.16	5.16
2010	5.45	5.44
2011	6	5.97
2012	5.37	5.32
2013	4.66	4.68
2014	3.26	3.26

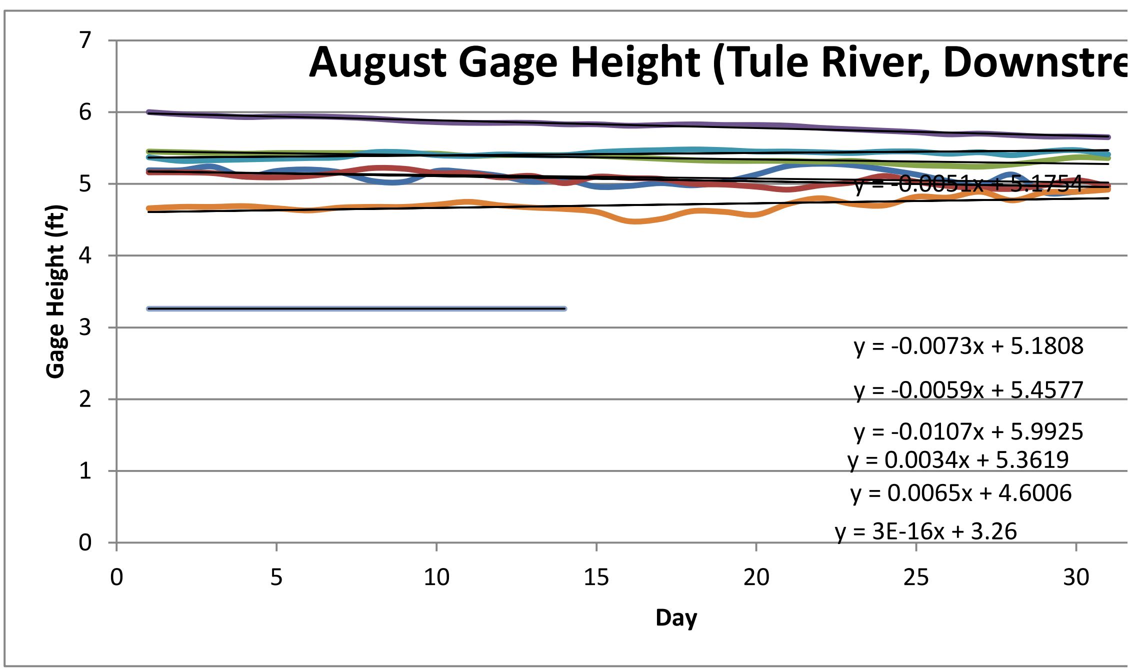
September

2008	5.06	5.09
2009	4.96	4.98
2010	5.33	5.28
2011	5.66	5.65
2012	5.45	5.47
2013	4.9	4.95




y = -0.0049x + 5.6758
0
0 5 10 15 20 25 30
Day


June Gage Height (Tule River, Downstream)
Gage Height (ft)
7 6 5 4 3 2 1 0
y = -0.0074x + 5.6224
y = -0.0113x + 5.85
y = -0.0218x + 6.5895
y = -0.0131x + 6.394
y = -0.0042x + 5.6735
y = 0.0033x + 5.2844
0 5 10 15 20 25 30
Day


August Gage Height (Tule River, Downstre
Gage Height (ft)
7 6 5 4 3 2 1 0
y = -0.0051x + 5.1754
y = -0.0073x + 5.1808
y = -0.0059x + 5.4577
y = -0.0107x + 5.9925
y = 0.0034x + 5.3619
y = 0.0065x + 4.6006
y = 3E-16x + 3.26
0 5 10 15 20 25 30
Day

Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15
0.0061	0.0061	0.0061	0.0232	0.0201	0.0218	0.0158	0.0107
1.995	1.8242	1.6412	0.9452	0.3221	-0.3537	-0.8435	-1.1752
-1.4611							

6.02	6	6.01	6.02	5.99	5.99	5.96	5.93	5.94
6.15	6.11	6.09	6.08	6.07	6.29	6.17	6.19	6.25
6.21	6.17	6.2	6.24	6.21	6.21	6.22	6.23	6.24
7.29	7.2	7.18	7.15	7.14	7.13	7	6.92	6.9
6.33	6.31	6.24	6.18	6.13	6.1	6.09	6.08	6.08
5.76	5.74	5.74	5.74	5.74	5.74	5.75	5.75	5.74
5.66	5.65	5.66	5.63	5.62	5.67	5.69	5.67	5.65

5.92	5.93	5.93	5.93	5.93	5.94	5.95	5.9	5.91
6.45	6.36	6.32	6.28	6.3	6.26	6.21	6.19	6.16
6.59	6.63	6.68	6.66	6.65	6.63	6.67	6.6	6.58
6.58	6.6	6.61	6.63	6.62	6.7	6.64	6.58	6.53
6.29	6.26	6.23	6.19	6.16	6.12	6.1	6.07	6.06
5.51	5.5	5.5	5.52	5.57	5.61	5.6	5.57	5.53
5.53	5.51	5.5	5.51	5.59	5.57	5.55	5.53	5.5

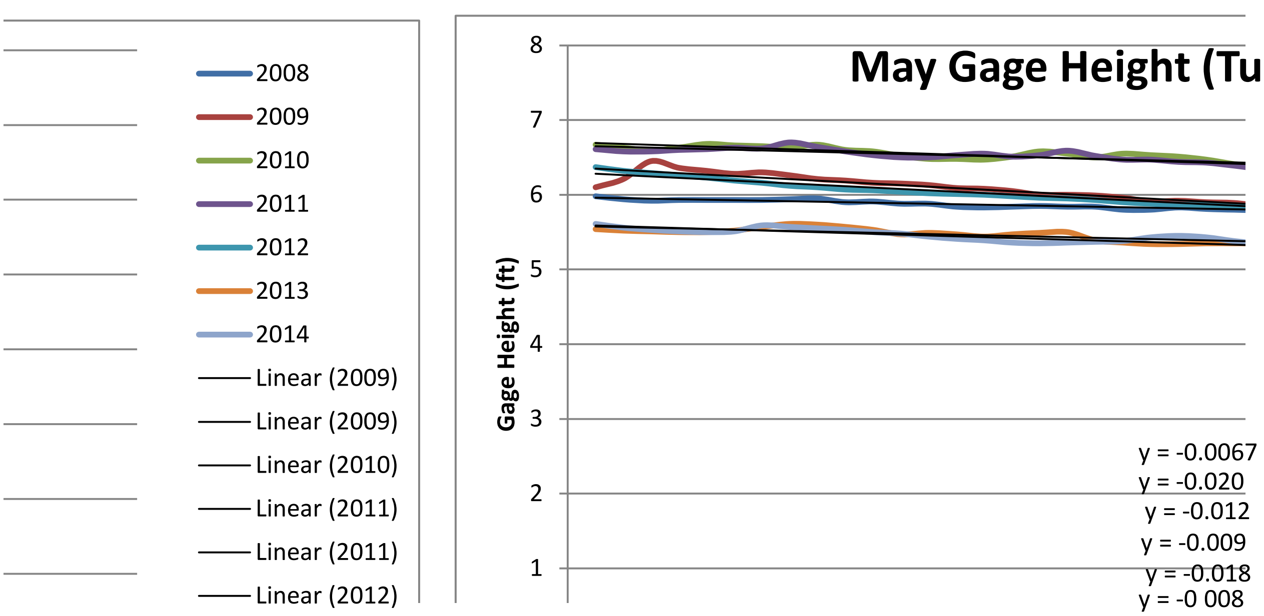
5.65	5.64	5.64	5.62	5.59	5.58	5.53	5.53	5.52
5.72	5.79	5.8	5.86	5.85	5.79	5.79	5.77	5.78
6.44	6.48	6.52	6.58	6.59	6.55	6.5	6.46	6.41
6.31	6.3	6.29	6.31	6.32	6.3	6.27	6.26	6.25
5.68	5.65	5.65	5.67	5.65	5.62	5.62	5.61	5.58

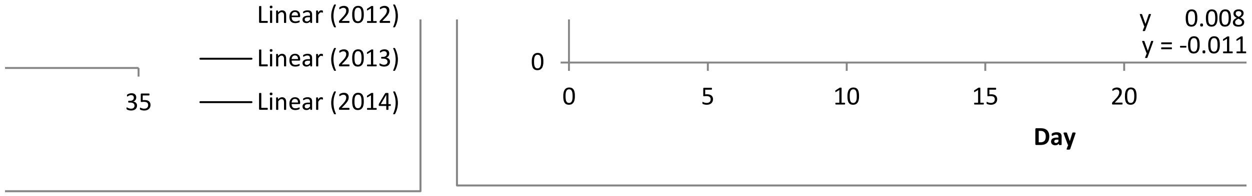
5.25	5.25	5.23	5.23	5.19	5.25	5.34	5.37	5.43
5.19	5.21	5.18	5.18	5.14	5.13	5.14	5.09	5.03

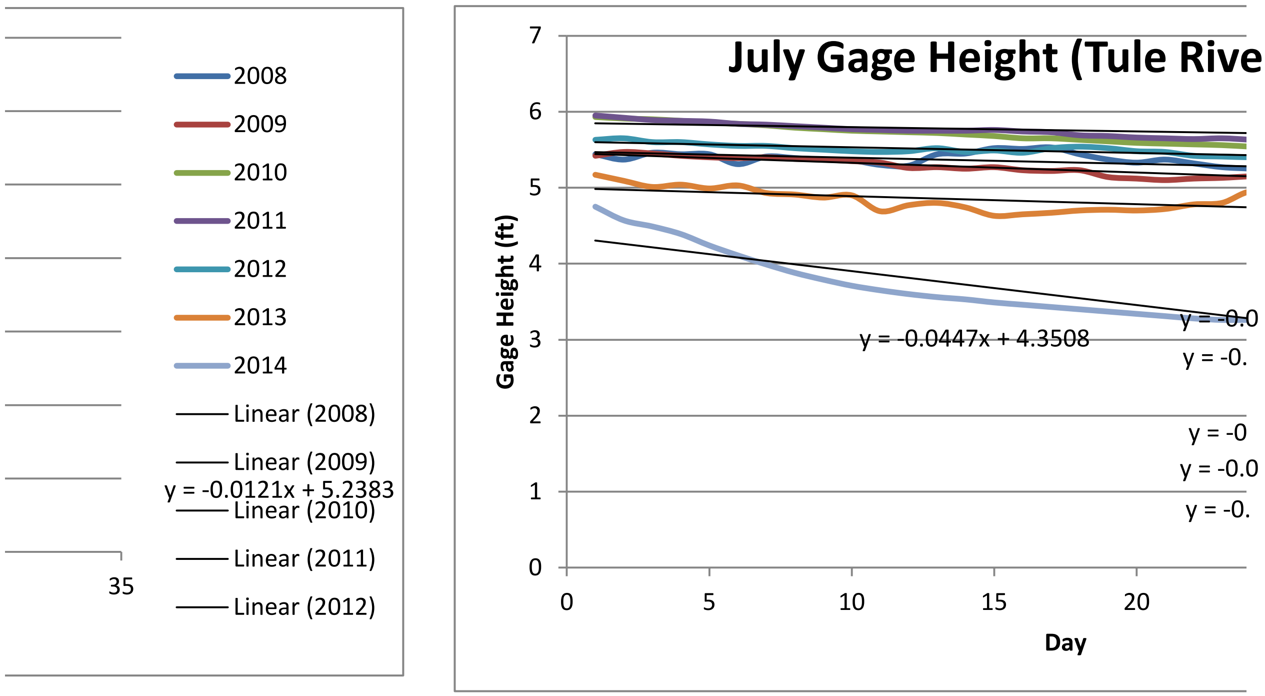
5.46	5.44	5.44	5.31	5.41	5.39	5.37	5.36	5.3
5.45	5.42	5.4	5.39	5.4	5.38	5.37	5.35	5.33
5.9	5.88	5.86	5.84	5.82	5.79	5.77	5.75	5.74
5.89	5.88	5.87	5.84	5.83	5.81	5.79	5.77	5.76
5.6	5.6	5.57	5.55	5.55	5.52	5.5	5.48	5.47
5.01	5.04	4.99	5.03	4.93	4.91	4.87	4.9	4.69
4.49	4.39	4.24	4.11	3.99	3.88	3.79	3.71	3.65

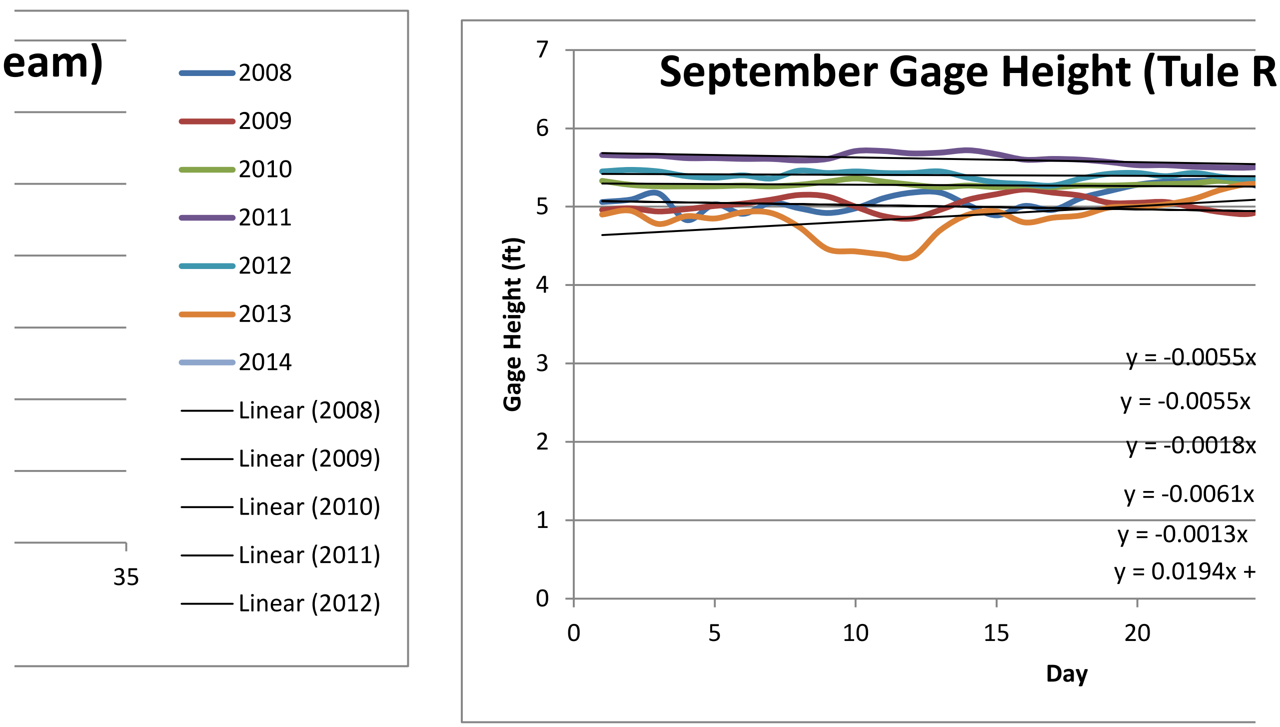
5.24	5.1	5.18	5.2	5.16	5.04	5.03	5.18	5.16
5.15	5.1	5.09	5.11	5.16	5.22	5.21	5.15	5.15
5.43	5.42	5.43	5.43	5.43	5.43	5.42	5.42	5.39
5.95	5.93	5.94	5.94	5.93	5.91	5.88	5.86	5.85
5.33	5.34	5.35	5.36	5.37	5.44	5.44	5.4	5.39
4.68	4.69	4.66	4.63	4.67	4.68	4.68	4.71	4.75
3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26

5.17	4.83	5.03	4.91	5.05	4.98	4.92	4.98	5.11
4.94	4.97	5.01	5.04	5.09	5.15	5.13	5	4.88
5.26	5.26	5.26	5.27	5.26	5.28	5.32	5.36	5.32
5.65	5.62	5.62	5.61	5.61	5.59	5.61	5.71	5.71
5.45	5.39	5.37	5.4	5.36	5.46	5.43	5.45	5.43
4.78	4.88	4.85	4.93	4.92	4.74	4.46	4.43	4.39




Linear (2012)
Linear (2013)
Linear (2014)
35
y 0.008
y = -0.011
0
0
5
10
15
20
Day


July Gage Height (Tule Rive
2008
2009
2010
2011
2012
2013
2014
Linear (2008)
Linear (2009)
Linear (2010)
Linear (2011)
Linear (2012)
y = -0.0121x + 5.2383
35
7
6
5
4
3
2
1
0
Gage Height (ft)
y = -0.0447x + 4.3508
y = -0.0
y = -0.
y = -0
y = -0.0
y = -0.
0
5
10
15
20
Day


eam)
2008
2009
2010
2011
2012
2013
2014
Linear (2008)
Linear (2009)
Linear (2010)
Linear (2011)
Linear (2012)
35
September Gage Height (Tule R
7
6
5
4
3
2
1
0
Gage Height (ft)
y = -0.0055x
y = -0.0055x
y = -0.0018x
y = -0.0061x
y = -0.0013x
y = 0.0194x +
0
5
10
15
20
Day

5.98	5.99	6.04	6.08	6.04	6.01	6.02	6	6.01
6.21	6.23	6.24	6.2	6.15	6.16	6.16	6.15	6.17
6.52	6.52	6.45	6.44	6.46	6.46	6.47	6.5	6.56
6.87	6.85	6.77	6.73	6.75	6.77	6.83	6.79	6.8
6.18	6.2	6.72	6.51	6.61	6.63	6.68	6.68	6.71
5.72	5.71	5.71	5.71	5.71	5.69	5.67	5.67	5.65
5.64	5.63	5.6	5.58	5.55	5.53	5.51	5.51	5.5

5.88	5.88	5.84	5.83	5.84	5.85	5.84	5.84	5.8
6.15	6.13	6.09	6.08	6.05	6	6	5.99	5.96
6.52	6.48	6.48	6.47	6.51	6.58	6.55	6.5	6.55
6.5	6.5	6.53	6.55	6.51	6.53	6.59	6.52	6.47
6.04	6.02	6.01	6	5.98	5.96	5.95	5.93	5.9
5.47	5.49	5.47	5.44	5.47	5.49	5.5	5.39	5.36
5.48	5.44	5.41	5.39	5.36	5.35	5.36	5.37	5.38

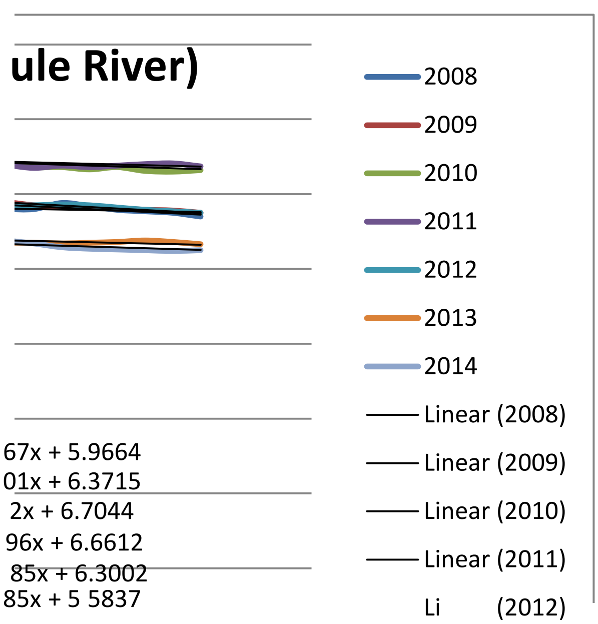
5.5	5.48	5.46	5.42	5.43	5.4	5.44	5.44	5.42
5.76	5.72	5.72	5.7	5.71	5.69	5.65	5.61	5.58
6.34	6.29	6.26	6.24	6.24	6.21	6.18	6.15	6.14
6.25	6.25	6.24	6.24	6.22	6.22	6.2	6.19	6.16
5.55	5.54	5.53	5.64	5.67	5.63	5.61	5.62	5.62

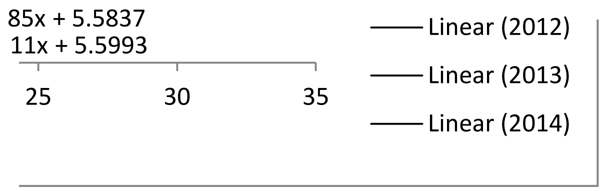
5.39	5.39	5.37	5.38	5.37	5.33	5.38	5.38	5.42
5.07	5.12	5.12	5.08	5.1	5.07	5.08	5.01	5.04

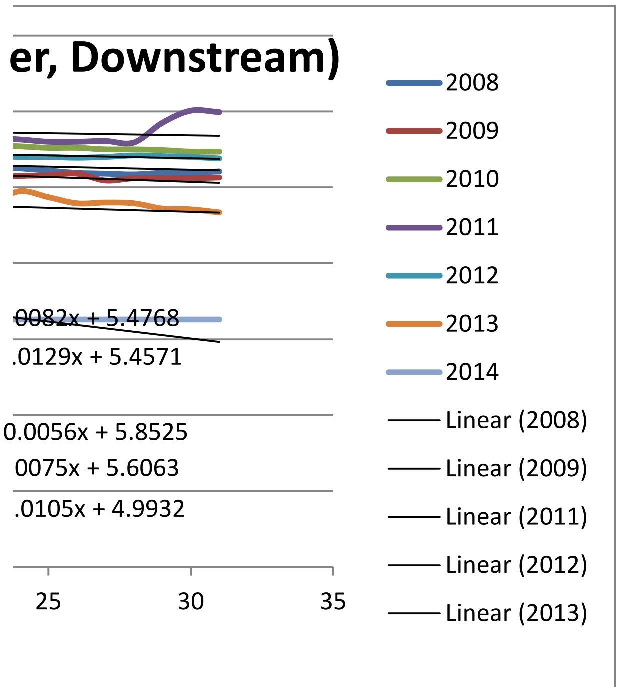
5.29	5.44	5.45	5.52	5.51	5.53	5.44	5.37	5.33
5.26	5.27	5.25	5.27	5.23	5.22	5.23	5.14	5.12
5.73	5.72	5.7	5.68	5.65	5.65	5.63	5.61	5.59
5.75	5.75	5.75	5.76	5.74	5.73	5.69	5.68	5.66
5.48	5.52	5.47	5.49	5.46	5.52	5.54	5.52	5.48
4.77	4.8	4.74	4.63	4.65	4.67	4.7	4.71	4.7
3.6	3.56	3.53	3.49	3.46	3.43	3.4	3.37	3.34

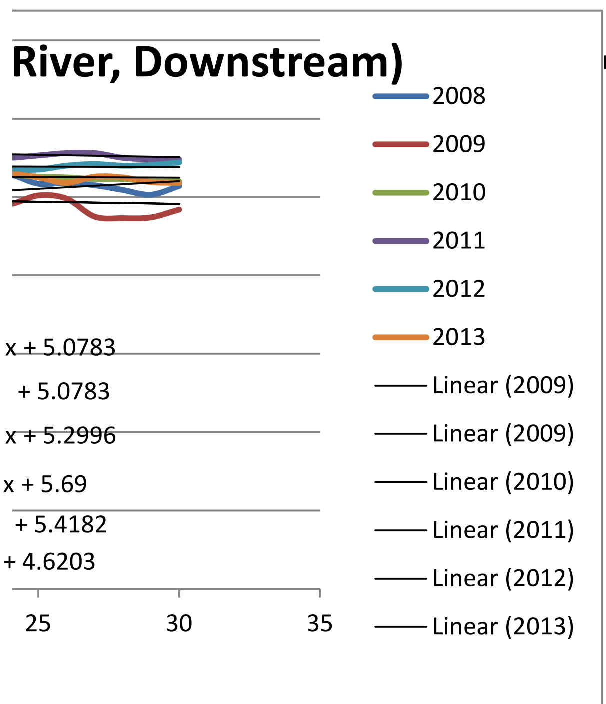
5.11	5.03	5.06	4.96	4.97	5.01	4.98	5.03	5.13
5.09	5.11	5.01	5.1	5.08	5.07	5	4.99	4.96
5.4	5.4	5.4	5.39	5.37	5.35	5.33	5.32	5.32
5.85	5.85	5.83	5.83	5.81	5.82	5.83	5.82	5.82
5.41	5.4	5.4	5.44	5.46	5.47	5.48	5.47	5.45
4.7	4.67	4.65	4.61	4.48	4.51	4.62	4.61	4.57
3.26	3.26	3.26						

5.18	5.18	5.02	4.89	5.01	4.96	5.11	5.2	5.28
4.85	4.96	5.09	5.16	5.22	5.18	5.14	5.05	5.05
5.28	5.25	5.27	5.25	5.27	5.25	5.27	5.27	5.28
5.68	5.69	5.72	5.67	5.6	5.61	5.6	5.57	5.53
5.43	5.45	5.37	5.31	5.29	5.27	5.36	5.42	5.43
4.36	4.7	4.9	4.94	4.8	4.86	4.89	4.99	5









ril Slopes	May Slopes	June Slope	July Slope	Aug Slope
-0.0009	-0.0067	-0.0074	-0.0082	-0.0073
0.0002	-0.0201	-0.0113	-0.0129	-0.0051
0.0276	-0.012	-0.0218	-0.0056	-0.0059
-0.0232	-0.0096	-0.0131	-0.0075	-0.0107
0.0131	-0.0185	-0.0042	-0.0105	0.0034
-0.0078	-0.0085	0.0033	-0.01528	0.0065
-0.0049	-0.0111			

6	5.96	5.96	5.96	5.96	5.94	5.95	5.99	6.02
6.19	6.21	6.19	6.2	6.2	6.18	6.13	6.13	6.12
6.92	6.79	6.72	6.81	6.87	6.82	6.83	6.9	6.84
6.83	6.82	6.78	6.76	6.71	6.69	6.66	6.67	6.68
6.66	6.6	6.54	6.5	6.44	6.46	6.66	6.52	6.45
5.65	5.64	5.62	5.61	5.61	5.61	5.6	5.57	5.55
5.47	5.45	5.46	5.45	5.46	5.72	5.64	5.63	5.65

5.8	5.83	5.81	5.8	5.8	5.88	5.84	5.79	5.77
5.91	5.92	5.9	5.89	5.85	5.83	5.83	5.81	5.79
6.53	6.51	6.47	6.41	6.36	6.36	6.33	6.36	6.31
6.47	6.44	6.43	6.39	6.35	6.38	6.36	6.38	6.4
5.88	5.87	5.86	5.85	5.85	5.86	5.85	5.82	5.79
5.34	5.34	5.35	5.35	5.35	5.34	5.35	5.36	5.38
5.43	5.45	5.43	5.38	5.34	5.29	5.27	5.26	5.25

5.4	5.35	5.37	5.38	5.54	5.57	5.54	5.48	5.49
5.58	5.57	5.56	5.58	5.6	5.6	5.56	5.53	5.45
6.12	6.08	6.06	6.04	6.04	6.02	6	5.97	5.95
6.13	6.11	6.09	6.07	6.05	6.03	6	5.99	5.98
5.61	5.56	5.57	5.58	5.56	5.56	5.56	5.52	5.52

5.39	5.38	5.39	5.39	5.45	5.41	5.37	5.28	5.27
4.99	4.92	4.9	4.91	4.92	4.9	4.86	4.84	4.98

5.37	5.32	5.27	5.25	5.22	5.19	5.18	5.17	5.19
5.1	5.12	5.13	5.15	5.16	5.18	5.09	5.12	5.12
5.58	5.57	5.56	5.54	5.52	5.52	5.5	5.5	5.49
5.65	5.64	5.65	5.63	5.6	5.6	5.61	5.59	5.85
5.47	5.42	5.41	5.4	5.4	5.39	5.4	5.42	5.41
4.72	4.78	4.8	4.95	4.87	4.79	4.8	4.79	4.72
3.31	3.28	3.26	3.26	3.26	3.26	3.26	3.26	3.26

5.25	5.28	5.26	5.2	5.13	5.04	4.98	5.13	4.88
4.92	4.98	5.02	5.11	5.03	4.97	4.94	4.93	4.98
5.32	5.31	5.32	5.29	5.26	5.25	5.24	5.27	5.32
5.81	5.78	5.76	5.74	5.72	5.69	5.7	5.68	5.66
5.45	5.44	5.43	5.45	5.45	5.42	5.44	5.4	5.45
4.72	4.8	4.72	4.7	4.82	4.81	4.89	4.77	4.88

5.32	5.33	5.33	5.29	5.17	5.18	5.15	5.09	5.03
5.06	4.99	4.93	4.91	5.02	4.98	4.75	4.73	4.74
5.29	5.3	5.33	5.29	5.26	5.25	5.23	5.23	5.2
5.53	5.51	5.5	5.5	5.53	5.56	5.56	5.5	5.48
5.39	5.43	5.38	5.35	5.35	5.4	5.42	5.4	5.41
5.03	5.1	5.22	5.29	5.25	5.18	5.26	5.25	5.19

6.04
6.1
6.75
6.64
6.39
5.54
5.64

5.75	5.7
5.78	5.75
6.3	6.32
6.41	6.37
5.77	5.75
5.36	5.33
5.24	5.25

5.46
5.46
5.94
5.99
5.63

5.21
4.9

5.19	5.21
5.12	5.13
5.47	5.47
6.01	5.99
5.4	5.38
4.71	4.67
3.26	3.26

4.89	4.93
5.05	4.97
5.37	5.36
5.66	5.65
5.47	5.41
4.89	4.92

5.14
4.84
5.2
5.48
5.44
5.18

YEAR	00060, Discharge, cubic feet per sec							
	Monthly mean in ft3/s (Calculation Period: 2000-1 Period-of-record for statistical calculation res							
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
2000								
2001	12	24	35.5	49.9	28.2	6.64	4.54	1.52
2002	48.8	26.4	59.2	51.1	28	11.8	5.89	2.45
2003	29.4	31.5	50.3	56	109.5	31.9	12.6	6.63
2004	19.8	41.1	52	27.8	15.1	7.07	3.06	1.71
2005	107.8	43.7	130.4	117.1	159.2	60.6	24.1	9.2
2006	50.6	28	95.4	272.5	115.5	39.8	16.4	6.12
2007	13.2	26	35.2	31.2	17.9	7.18	2.16	0.993
2008	28.9	77.4	57	41.3	31.8	11.6	5.01	2.22
2009	19.6	39.5	41.2	41.1	37.3	14.4	4.45	1.87
2010	25.9	94.1	110.5	105.2	100.1	69	21.4	7.37
2011	113.1	76.9	192.2	187	121.8	75.8	34.6	14.8
2012	21.6	22.9	40.1	109.6	51.1	14.9	5.27	3.57
2013	22	23.8	21.6	16.5	10	4.51	1.02	0.598

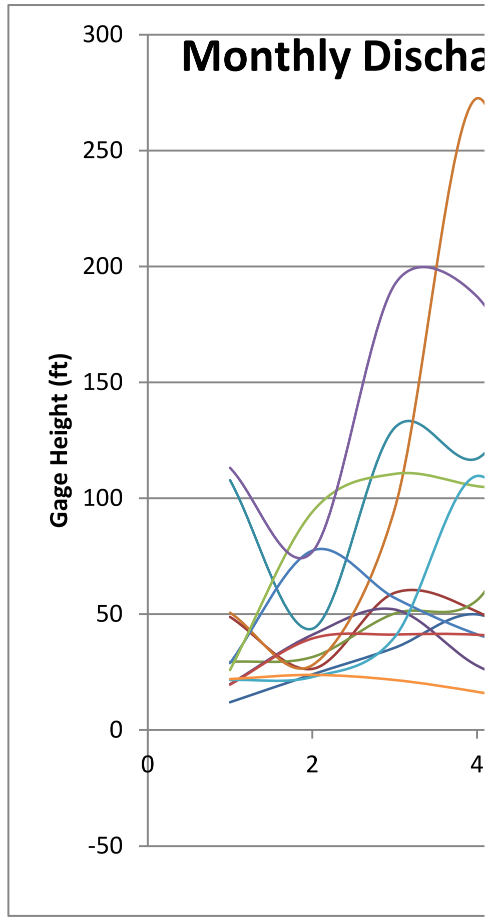
Outliers
Dry Months

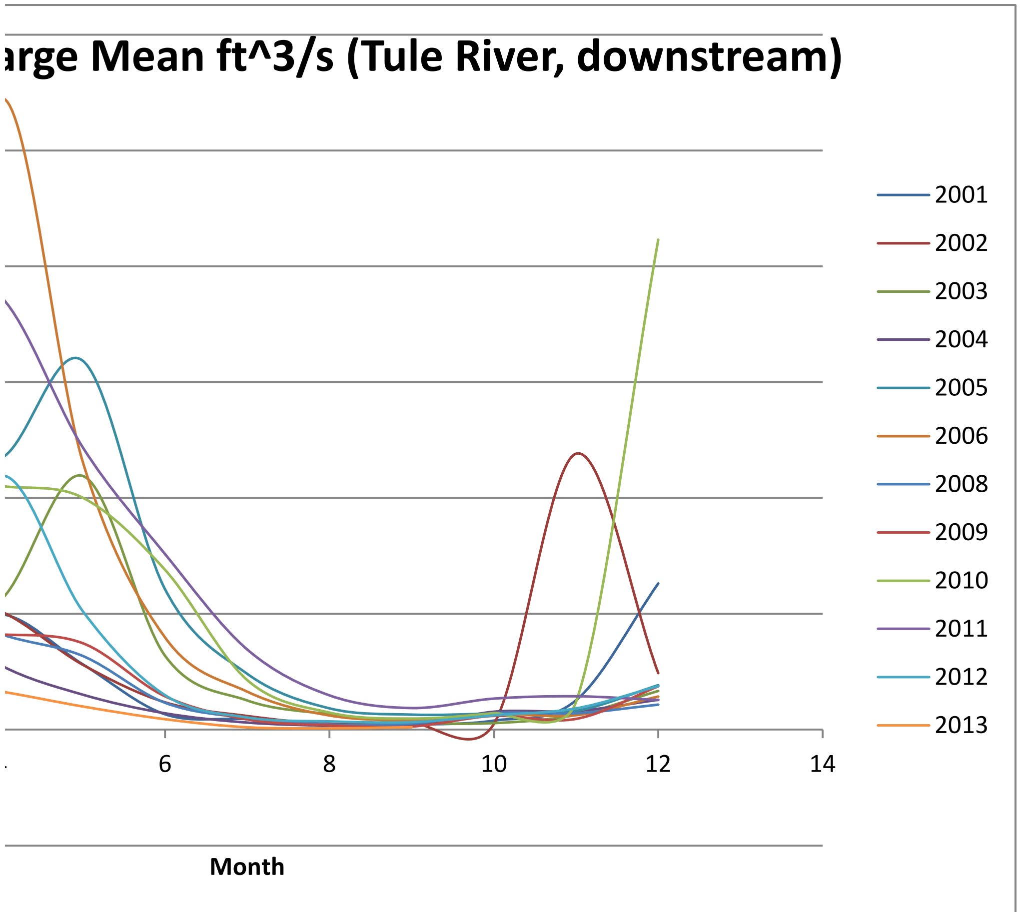
Tulare County, California
Hydrologic Unit Code 18030006
Latitude 36°01'27", Longitude 118°48'45"
NAD27

ːcond,
0-01 -> 2013-09-30)

ːtricted by user

Sep	Oct	Nov	Dec
	7.8	9.1	8.9
2.14	3.9	12.7	63.1
2.93	2.46	119.1	24.4
3.14	2.83	6.37	16.7
1.58	7.75	8.05	12.9
6.49	6.95	8.1	19.2
4.26	6.84	6.24	14.3
1.87	3.13	4.3	14.2
2.56	7.19	7.08	10.8
1.35	5.95	4.65	18.7
4.79	7.13	12	211.5
9.33	13.4	14.4	12.8
3.26	6.18	9.18	18.8
1.05			





arge Mean ft^3/s (Tule River, downstream)
2001
2002
2003
2004
2005
2006
2008
2009
2010
2011
2012
2013
6
8
10
12
14
Month

Site Number: 11203580
Site Name: SF TULE R NR CHOLOLLO CAMPGROUND NR PORTERVILLE CA

**used minimum gage height for data

Lowest Recorded Height (ft):	2.8	(Sept 1 2013)				
	Jun-14	**Jul-14**	**Aug-14**	**Sep-14**	**Oct-14**	**Nov-14**
Largest neg slope :	0.0179	0.006	0.0034	0.0024	0.0024	0.0024
Projected Value by end of month :	2.393	2.654	2.708	2.636	2.5616	2.4896
Project Value (assuming largest slope, 0.0179)	2.393	2.2851	2.708	2.1531	1.5982	1.0612
Actual	2.84	2.81				

**assuming trend of extreme slopes based on historical data

Notes:

QUESTION: Why was there a much larger change in height in 2010 & 2011 as compared to the rest?

COMMENT: Gage Heights in September varied from staying the same, slightly increasing, and slightly decreasing

COMMENT: Fluxuating trend for the months after September until April due to varying precipitation patterns, but assuming zero precipitation in our projections so will adopt September Conditions

Analysis:Change in Gage Height

	April	May	June
Average Slopes:	0.0039167	-0.00978333	-0.0074
STD:	0.0107353	0.006679047	0.00820536
2014 Slopes	-0.0024	-0.0072	-0.0033
	July	August	September
Average Slopes:	-0.0074333	-0.00286667	
STD:	0.0055773	0.002556299	
2014 Slopes	0.0006	-0.0034	

April

2009	3.74
2010	3.93
2011	4.31
2012	3.82
2013	3.4
2014	3.16

May

2008	3.79
2009	3.79
2010	4.2
2011	4.08
2012	3.94
2013	3.17
2014	3.17

June

2008	3.51
2009	3.51

COMMENT: Only used April and May has comparisons because other months are either not recorded for 2014 or the data fluxuates too much from precipitation

COMMENT: 2014 has not shown a significant decrease in the change in gage height from beginnging of month to end (stays within standard deviation based on historical data) and it does not always have the highest decrease as compared to historical data.

2010	4.13
2011	4
2012	3.36
2013	3.02
2014	2.92

July

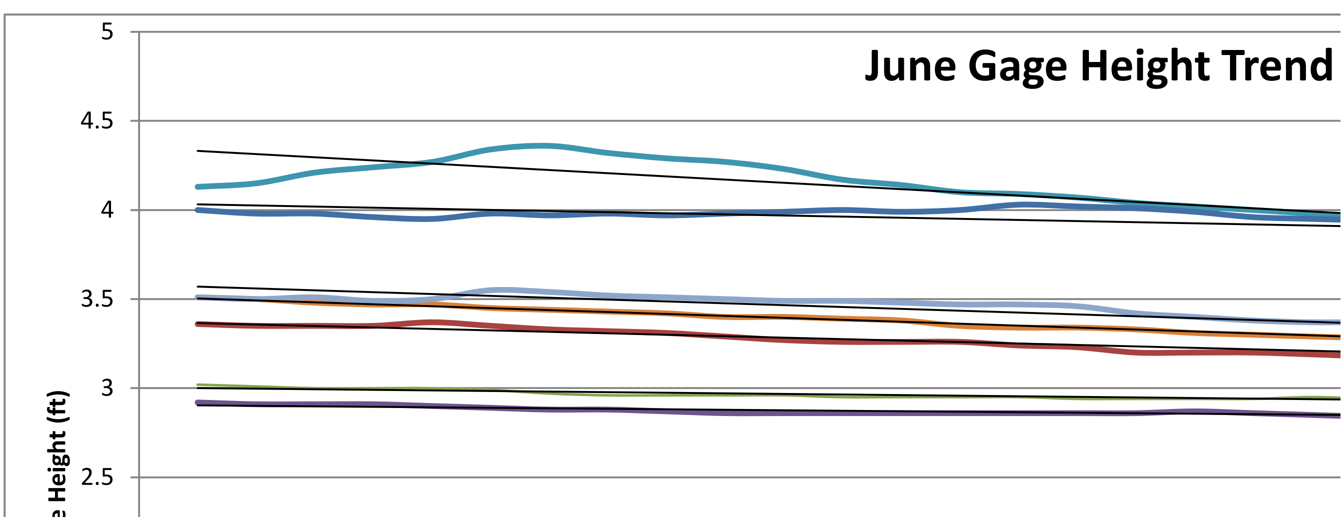
2008	3.19
2009	3.23
2010	3.79
2011	3.73
2012	3.16
2013	2.88
2014	2.82

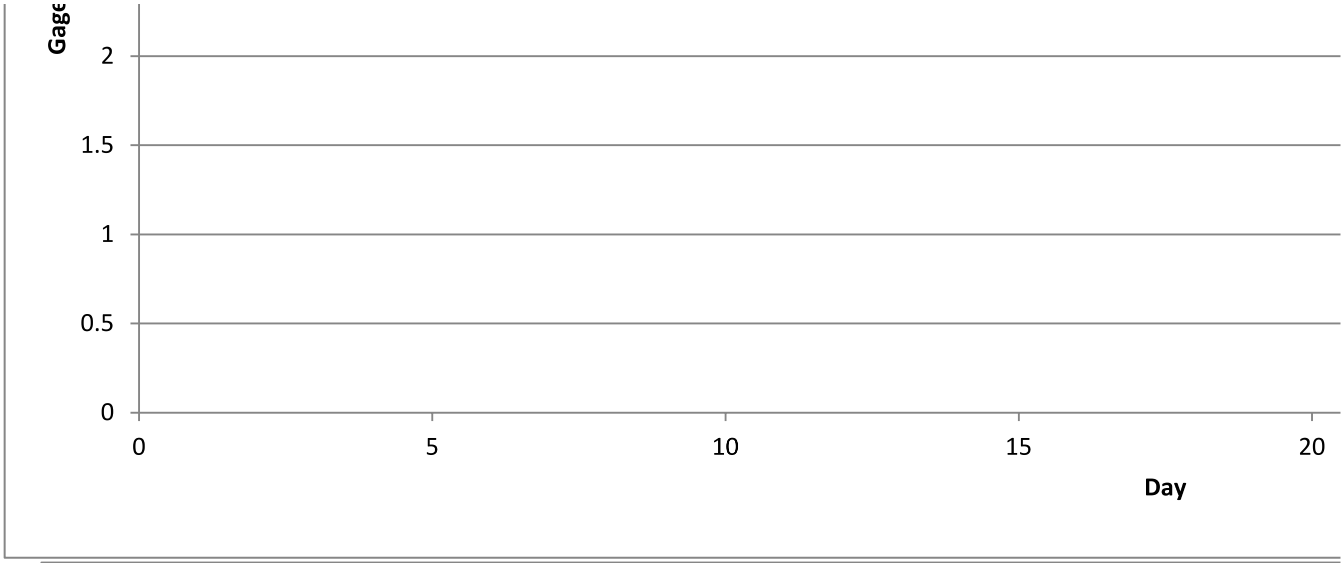
August

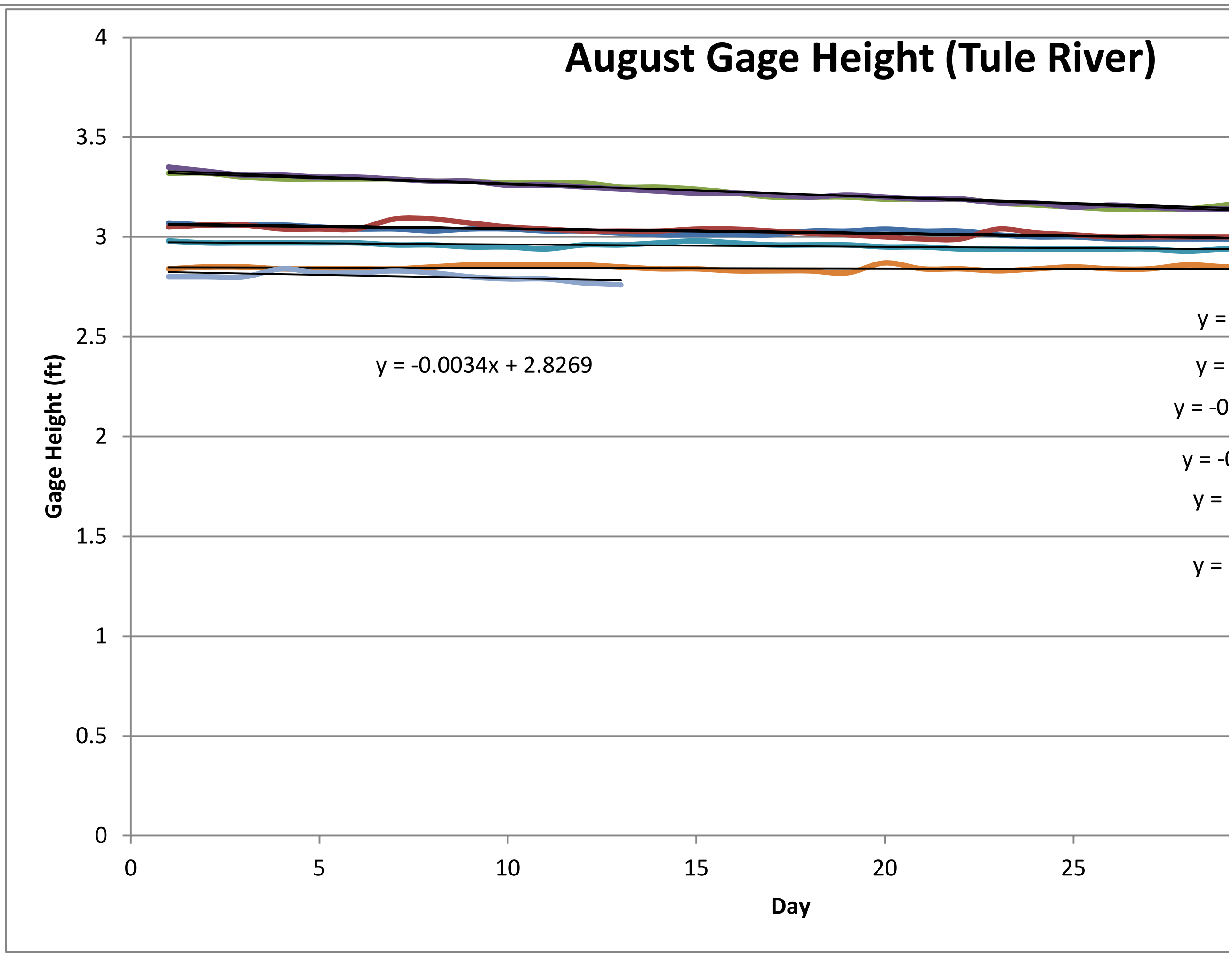
2008	3.07
2009	3.05
2010	3.32
2011	3.35
2012	2.98
2013	2.84
2014	2.8

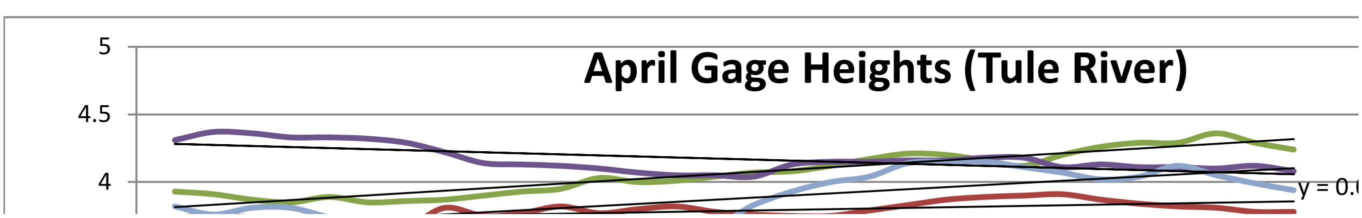
September

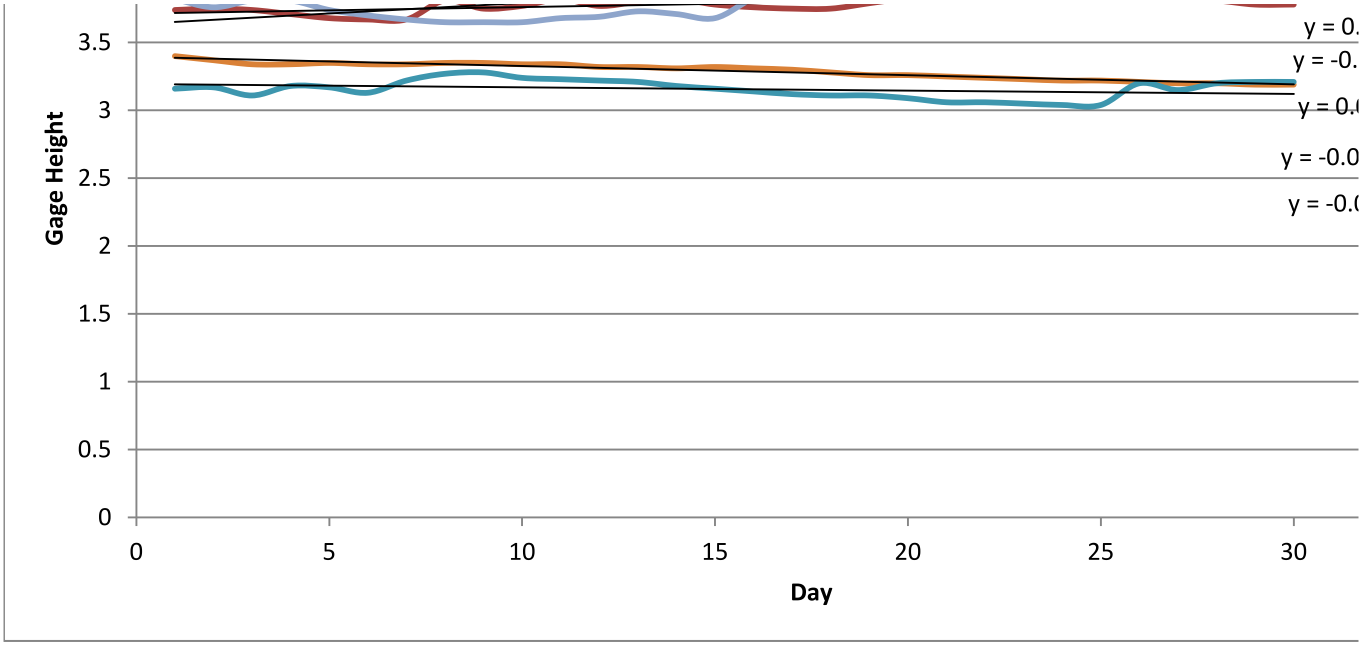
2008	2.99
2009	3.01
2010	3.14
2011	3.13
2012	2.96
2013	2.8




Gage
2
1.5
1
0.5
0
0
5
10
15
20
Day


August Gage Height (Tule River)
Gage Height (ft)
4
3.5
3
2.5
2
1.5
1
0.5
0
y = -0.0034x + 2.8269
0
5
10
15
20
25
Day


April Gage Heights (Tule River)
5
4.5
4



y = 0.
y = -0.
y = 0.0
y = -0.0
y = -0.0
3.5
3
2.5
2
1.5
1
0.5
0
Gage Height
0
5
10
15
20
25
30
Day

Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15
0.0024	0.0024	0.0024	0.0024	0.0077	0.0185	0.0179	0.0064	0.0069
2.4152	2.3408	2.2736	2.1992	1.9682	1.3947	0.8577	0.6593	0.4454
-0.072	-0.1464	-0.2208	-0.2928					

3.75	3.74	3.71	3.68	3.67	3.67	3.81	3.75	3.77
3.91	3.87	3.85	3.89	3.85	3.86	3.87	3.9	3.93
4.37	4.36	4.33	4.33	4.32	4.29	4.22	4.14	4.13
3.76	3.81	3.81	3.74	3.7	3.67	3.65	3.65	3.65
3.37	3.34	3.34	3.35	3.34	3.34	3.35	3.35	3.34
3.17	3.11	3.18	3.17	3.13	3.22	3.27	3.28	3.24

3.77	3.76	3.76	3.74	3.73	3.74	3.75	3.75	3.74
4.2	4.11	4.06	4.02	4	4	3.97	3.95	3.93
4.18	4.16	4.21	4.26	4.25	4.25	4.25	4.27	4.21
4.09	4.1	4.13	4.17	4.21	4.22	4.25	4.17	4.09
3.91	3.87	3.85	3.82	3.77	3.76	3.72	3.7	3.69
3.16	3.15	3.14	3.14	3.15	3.2	3.21	3.21	3.17
3.13	3.11	3.09	3.09	3.1	3.15	3.14	3.14	3.13

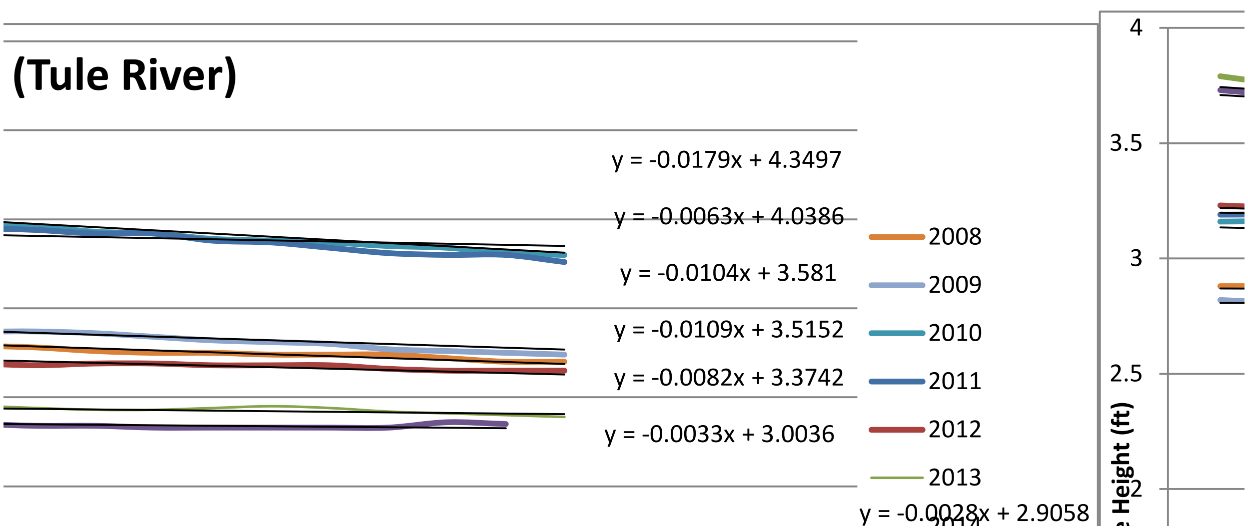
3.5	3.48	3.47	3.47	3.45	3.44	3.43	3.42	3.4
3.5	3.51	3.49	3.5	3.55	3.54	3.52	3.51	3.5

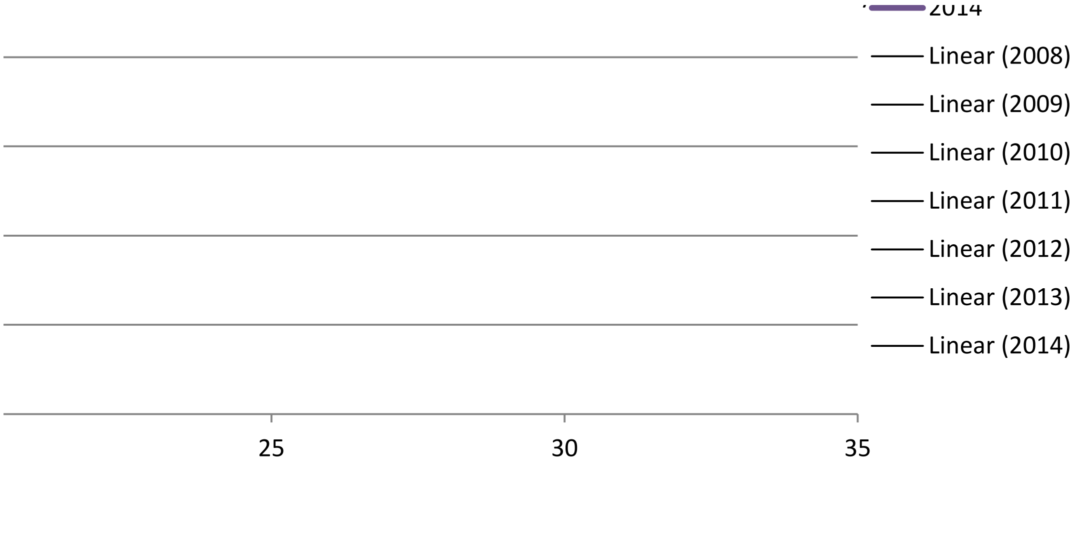
4.15	4.21	4.24	4.27	4.34	4.36	4.32	4.29	4.27
3.98	3.98	3.96	3.95	3.98	3.97	3.98	3.97	3.98
3.35	3.35	3.35	3.37	3.35	3.33	3.32	3.31	3.29
3.01	3	3	3	2.99	2.97	2.96	2.96	2.96
2.91	2.91	2.91	2.9	2.89	2.88	2.88	2.87	2.86

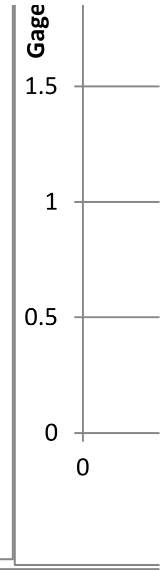
3.19	3.18	3.18	3.18	3.17	3.16	3.14	3.14	3.14
3.22	3.2	3.2	3.19	3.2	3.19	3.18	3.18	3.18
3.76	3.74	3.71	3.69	3.67	3.66	3.63	3.6	3.6
3.71	3.69	3.67	3.66	3.65	3.63	3.61	3.59	3.57
3.16	3.14	3.12	3.12	3.11	3.1	3.09	3.08	3.07
2.88	2.88	2.88	2.87	2.87	2.86	2.85	2.85	2.84
2.81	2.81	2.81	2.81	2.81	2.81	2.81	2.8	2.8

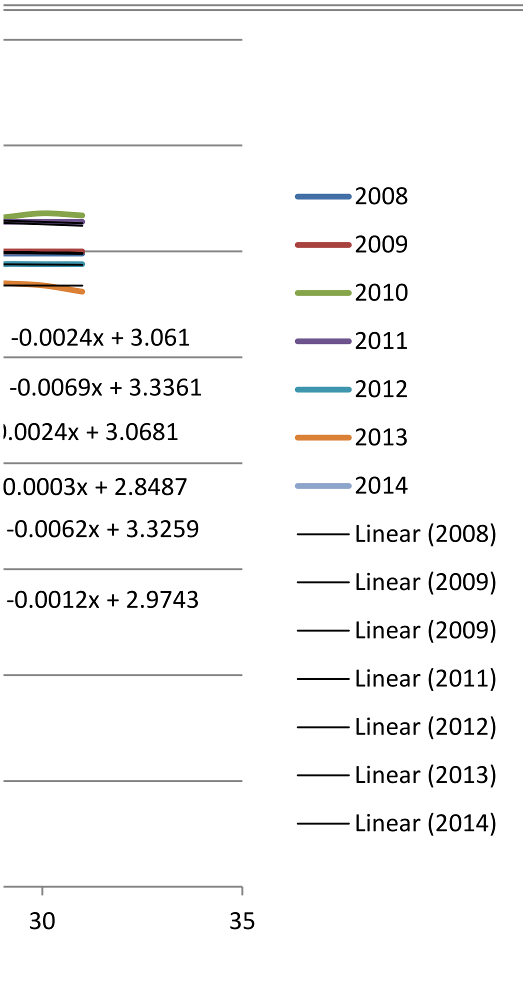
3.06	3.06	3.06	3.05	3.04	3.04	3.03	3.04	3.04
3.06	3.06	3.04	3.04	3.04	3.09	3.09	3.07	3.05
3.32	3.3	3.29	3.29	3.29	3.29	3.28	3.28	3.27
3.33	3.31	3.31	3.3	3.3	3.29	3.28	3.28	3.26
2.97	2.97	2.97	2.97	2.97	2.96	2.96	2.95	2.95
2.85	2.85	2.84	2.84	2.84	2.84	2.85	2.86	2.86
2.8	2.8	2.84	2.82	2.82	2.83	2.82	2.8	2.79

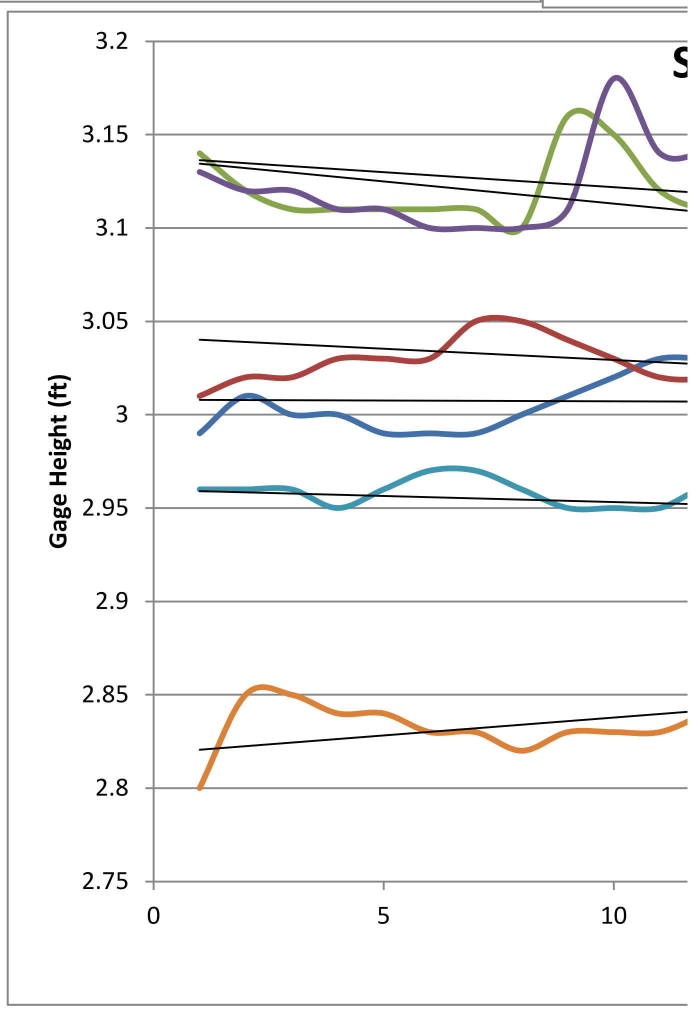
3.01	3	3	2.99	2.99	2.99	3	3.01	3.02
3.02	3.02	3.03	3.03	3.03	3.05	3.05	3.04	3.03
3.12	3.11	3.11	3.11	3.11	3.11	3.1	3.16	3.15
3.12	3.12	3.11	3.11	3.1	3.1	3.1	3.11	3.18
2.96	2.96	2.95	2.96	2.97	2.97	2.96	2.95	2.95
2.85	2.85	2.84	2.84	2.83	2.83	2.82	2.83	2.83

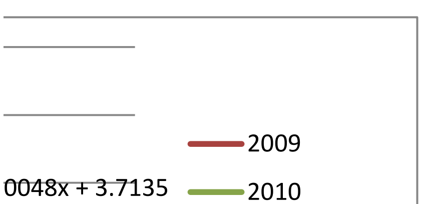


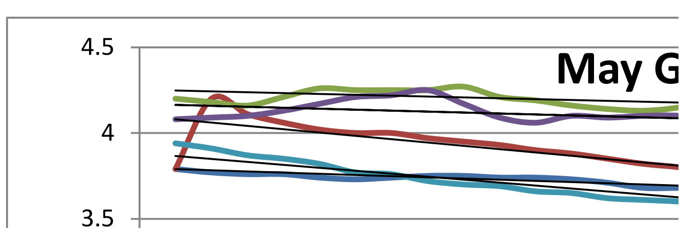

2014
Linear (2008)
Linear (2009)
Linear (2010)
Linear (2011)
Linear (2012)
Linear (2013)
Linear (2014)
25
30
35

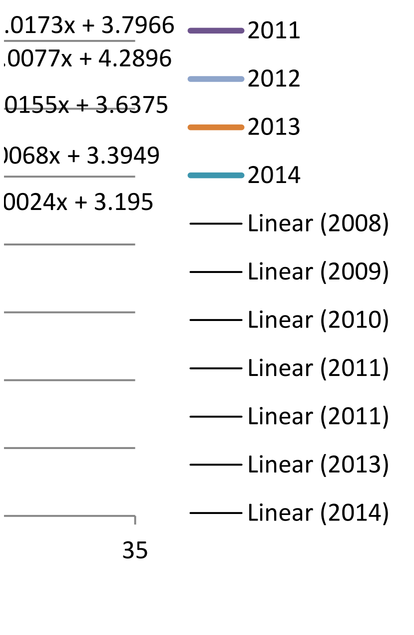

Gage
1.5
1
0.5
0
0

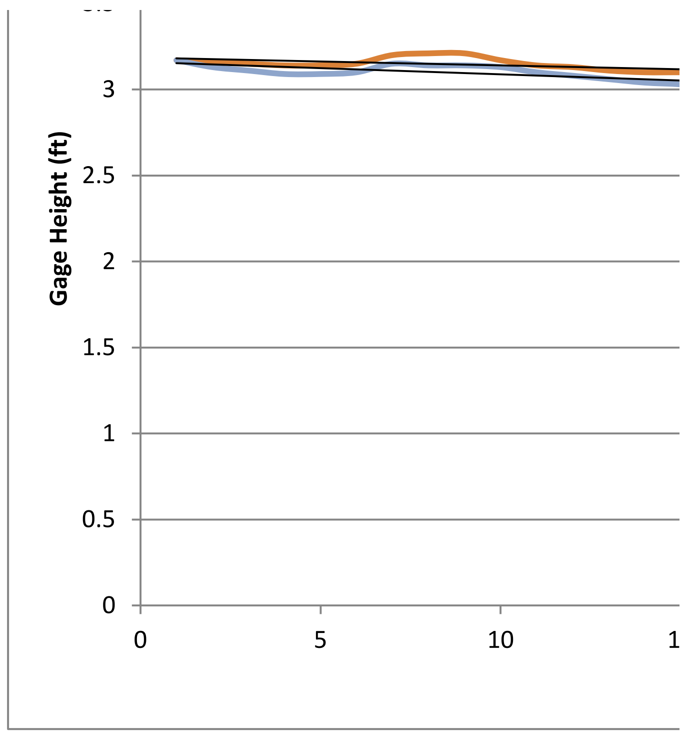

-0.0024x + 3.061
-0.0069x + 3.3361
.0024x + 3.0681
0.0003x + 2.8487
-0.0062x + 3.3259
-0.0012x + 2.9743
2008
2009
2010
2011
2012
2013
2014
Linear (2008)
Linear (2009)
Linear (2009)
Linear (2011)
Linear (2012)
Linear (2013)
Linear (2014)
30
35


Gage Height (ft)
3.2
3.15
3.1
3.05
3
2.95
2.9
2.85
2.8
2.75
0
5
10


0048x + 3.7135
2009
2010


May G
4.5
4
3.5


.0173x + 3.7966
.0077x + 4.2896
0155x + 3.6375
)068x + 3.3949
0024x + 3.195
35
2011
2012
2013
2014
Linear (2008)
Linear (2009)
Linear (2010)
Linear (2011)
Linear (2011)
Linear (2013)
Linear (2014)


Gage Height (ft)
3
2.5
2
1.5
1
0.5
0
0
5
10
1

Sep-15	Oct-15	Nov-15	Dec-15	Jan-16
0.0024	0.0024	0.0024	0.0024	0.0024
0.371	0.2966	0.2222	0.1478	0.0734

Monthly Gage Heights (Minimum)

3.82	3.77	3.8	3.82	3.78	3.76	3.75	3.75	3.79
3.95	4.03	4	4.01	4.04	4.07	4.08	4.12	4.17
4.12	4.1	4.07	4.05	4.05	4.04	4.13	4.15	4.15
3.68	3.69	3.73	3.71	3.68	3.83	3.93	4	4.04
3.34	3.32	3.32	3.31	3.32	3.31	3.3	3.28	3.26
3.23	3.22	3.21	3.18	3.16	3.14	3.12	3.11	3.11

3.74	3.73	3.71	3.68	3.68	3.68	3.69	3.69	3.69
3.9	3.88	3.85	3.82	3.8	3.77	3.75	3.74	3.72
4.19	4.16	4.14	4.13	4.15	4.2	4.24	4.22	4.2
4.06	4.1	4.09	4.1	4.1	4.07	4.1	4.08	4.04
3.66	3.65	3.62	3.61	3.6	3.58	3.56	3.54	3.53
3.14	3.13	3.11	3.1	3.1	3.1	3.12	3.11	3.09
3.1	3.08	3.06	3.04	3.03	3.01	3.01	3.01	3.01

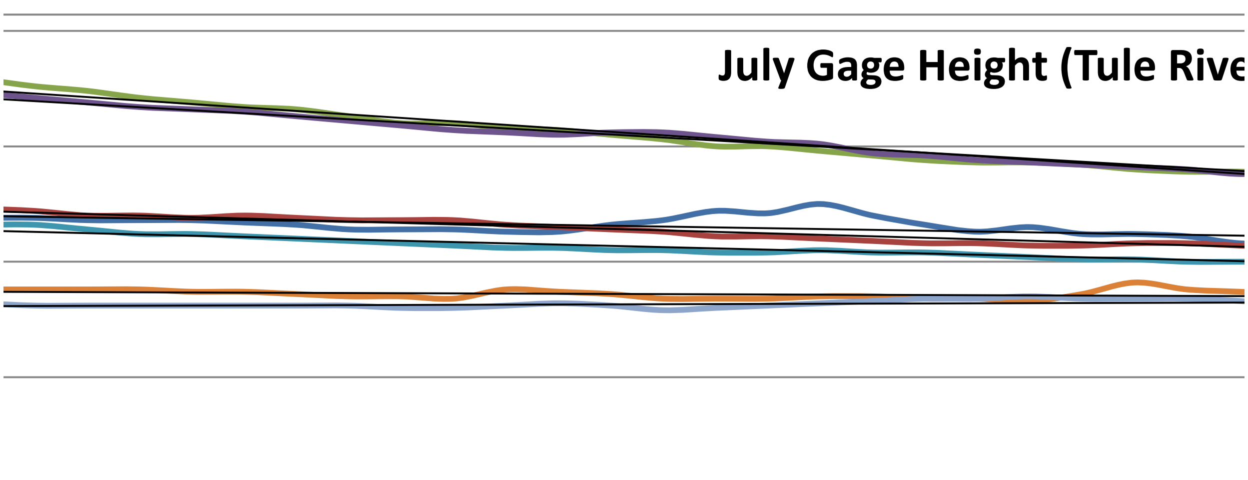
3.4	3.39	3.38	3.35	3.34	3.34	3.33	3.31	3.3
3.49	3.49	3.48	3.47	3.47	3.46	3.42	3.4	3.38

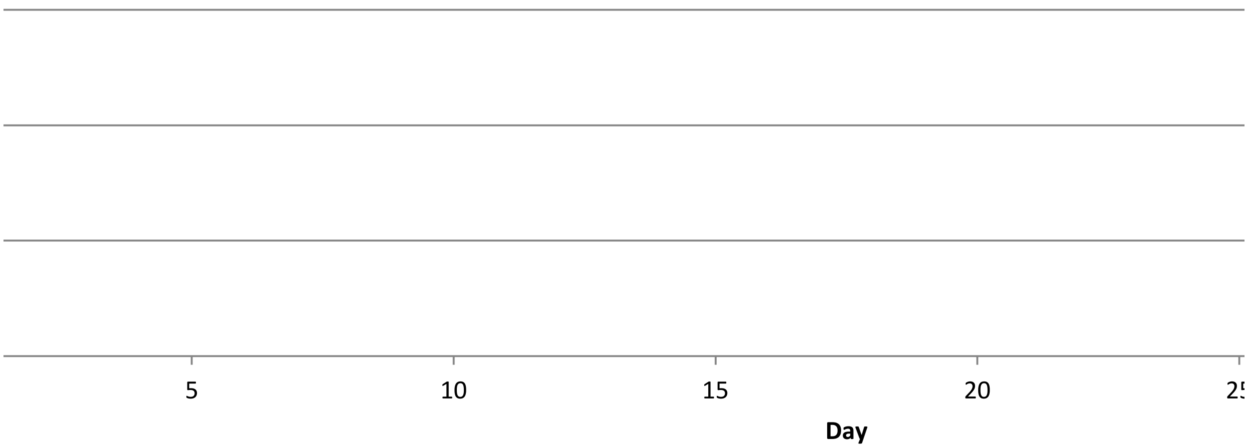
4.23	4.17	4.14	4.1	4.09	4.07	4.04	4.02	4
3.99	4	3.99	4	4.03	4.02	4.01	3.99	3.96
3.27	3.26	3.26	3.26	3.24	3.23	3.2	3.2	3.2
2.96	2.95	2.95	2.95	2.95	2.94	2.94	2.94	2.94
2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.87	2.86

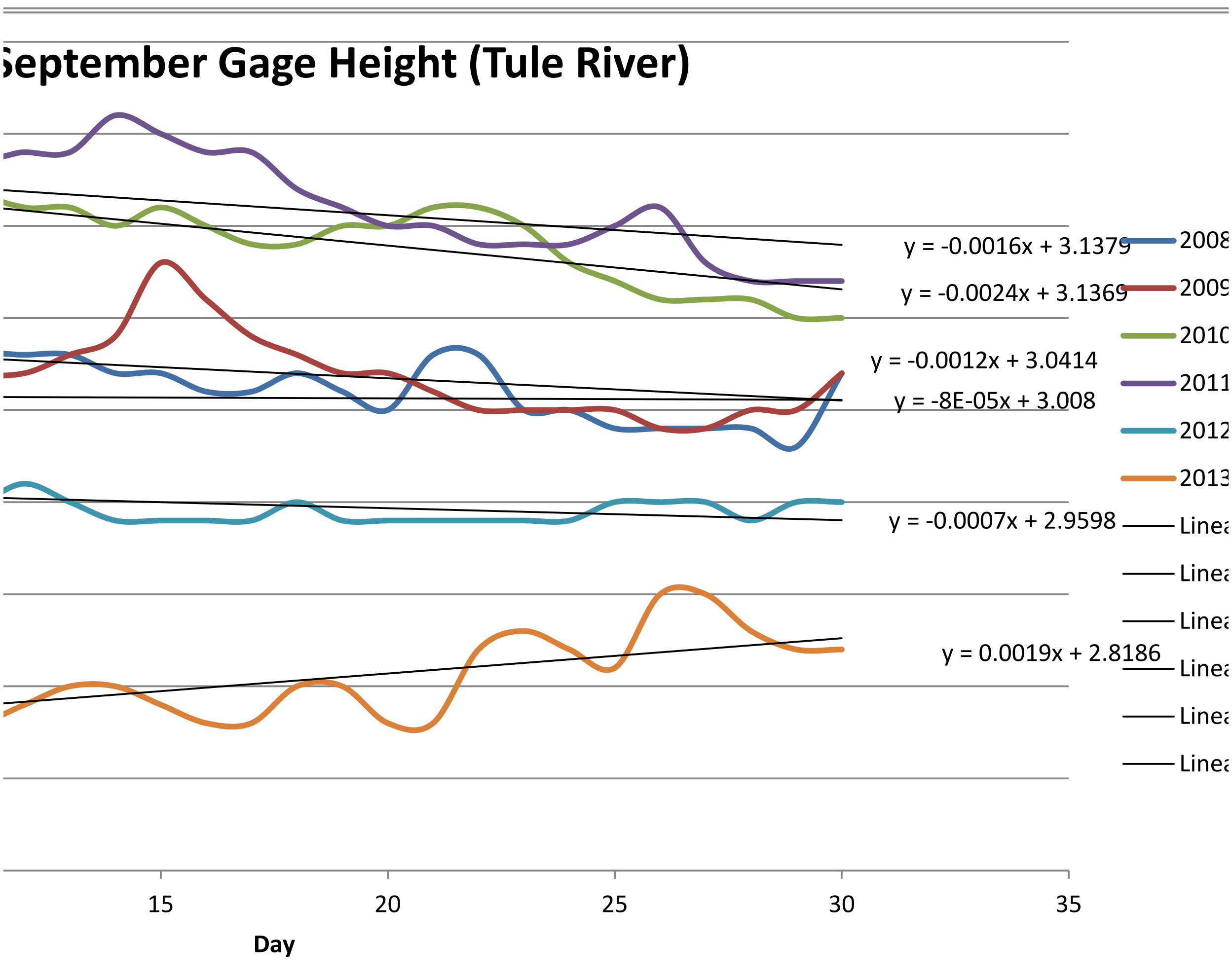
3.13	3.13	3.16	3.18	3.22	3.21	3.25	3.2	3.16
3.16	3.15	3.14	3.13	3.11	3.11	3.1	3.09	3.08
3.58	3.57	3.55	3.53	3.5	3.5	3.48	3.46	3.44
3.56	3.55	3.56	3.56	3.54	3.52	3.51	3.47	3.46
3.06	3.06	3.05	3.05	3.04	3.04	3.05	3.04	3.04
2.88	2.87	2.86	2.84	2.84	2.84	2.85	2.85	2.84
2.81	2.82	2.81	2.79	2.8	2.81	2.82	2.83	2.84

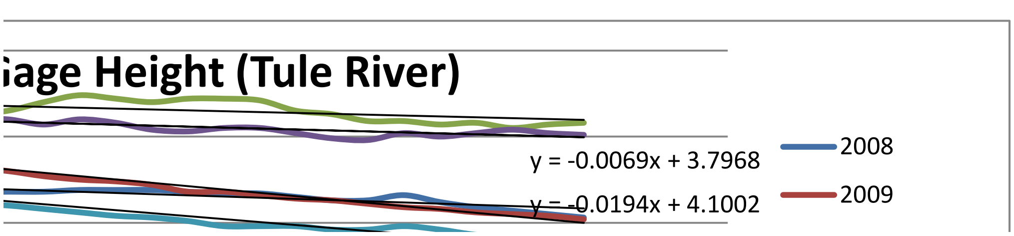
3.03	3.03	3.02	3.01	3.01	3.01	3.01	3.03	3.03
3.04	3.03	3.03	3.03	3.04	3.04	3.03	3.02	3.01
3.27	3.27	3.25	3.25	3.24	3.22	3.2	3.2	3.2
3.26	3.25	3.24	3.23	3.22	3.22	3.21	3.2	3.21
2.94	2.96	2.96	2.97	2.98	2.97	2.96	2.96	2.96
2.86	2.86	2.85	2.84	2.84	2.83	2.83	2.83	2.82
2.79	2.77	2.76						

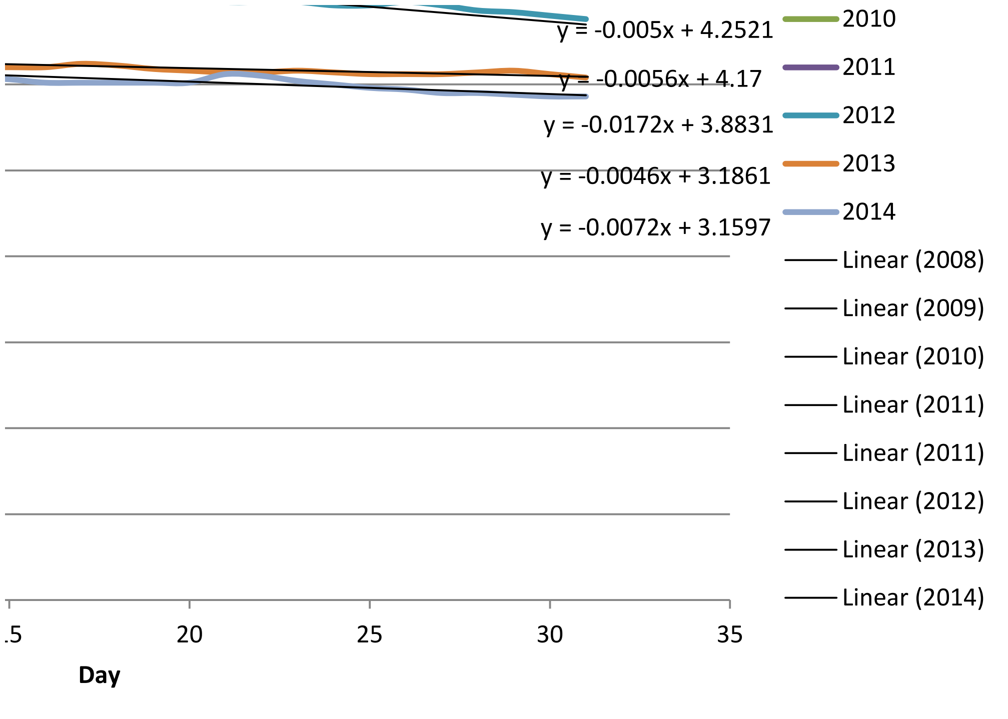
3.03	3.03	3.03	3.02	3.02	3.01	3.01	3.02	3.01
3.02	3.02	3.03	3.04	3.08	3.06	3.04	3.03	3.02
3.12	3.11	3.11	3.1	3.11	3.1	3.09	3.09	3.1
3.14	3.14	3.14	3.16	3.15	3.14	3.14	3.12	3.11
2.95	2.96	2.95	2.94	2.94	2.94	2.94	2.95	2.94
2.83	2.84	2.85	2.85	2.84	2.83	2.83	2.85	2.85




5
10
15
20
Day


eptember Gage Height (Tule River)
y = -0.0016x + 3.1379
y = -0.0024x + 3.1369
y = -0.0012x + 3.0414
y = -8E-05x + 3.008
y = -0.0007x + 2.9598
y = 0.0019x + 2.8186
15
20
25
30
35
Day


age Height (Tule River)
y = -0.0069x + 3.7968
2008
2009


y = -0.005x + 4.2521
y = -0.0056x + 4.17
y = -0.0172x + 3.8831
y = -0.0046x + 3.1861
y = -0.0072x + 3.1597
.5
20
25
30
35
Day
2010
2011
2012
2013
2014
Linear (2008)
Linear (2009)
Linear (2010)
Linear (2011)
Linear (2011)
Linear (2012)
Linear (2013)
Linear (2014)

3.83	3.87	3.89	3.9	3.91	3.87	3.84	3.82	3.81
4.21	4.2	4.16	4.12	4.2	4.26	4.29	4.29	4.36
4.16	4.16	4.18	4.18	4.11	4.13	4.11	4.11	4.1
4.14	4.15	4.15	4.11	4.07	4.02	4.04	4.12	4.05
3.26	3.25	3.24	3.23	3.22	3.22	3.21	3.2	3.2
3.09	3.06	3.06	3.05	3.04	3.04	3.2	3.15	3.2

3.68	3.67	3.67	3.65	3.63	3.63	3.66	3.62	3.59
3.68	3.68	3.66	3.64	3.63	3.61	3.59	3.58	3.56
4.22	4.22	4.21	4.15	4.13	4.09	4.09	4.07	4.08
4.03	4.05	4.05	4.02	3.99	3.98	4.02	4	4.02
3.51	3.48	3.48	3.48	3.46	3.46	3.48	3.46	3.43
3.08	3.07	3.07	3.08	3.07	3.06	3.06	3.06	3.07
3.01	3.06	3.05	3.02	3	2.98	2.97	2.95	2.95

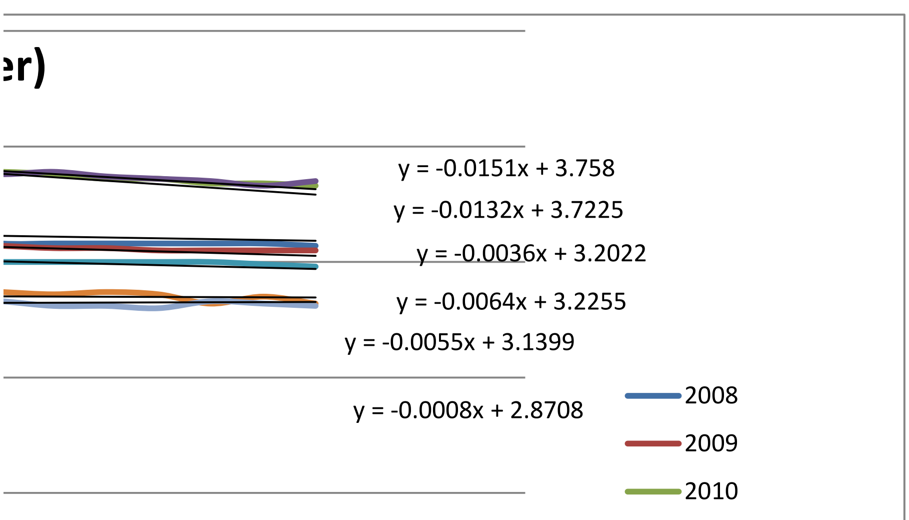
3.29	3.28	3.26	3.25	3.25	3.24	3.24	3.24	3.22
3.37	3.37	3.36	3.34	3.32	3.31	3.3	3.27	3.26

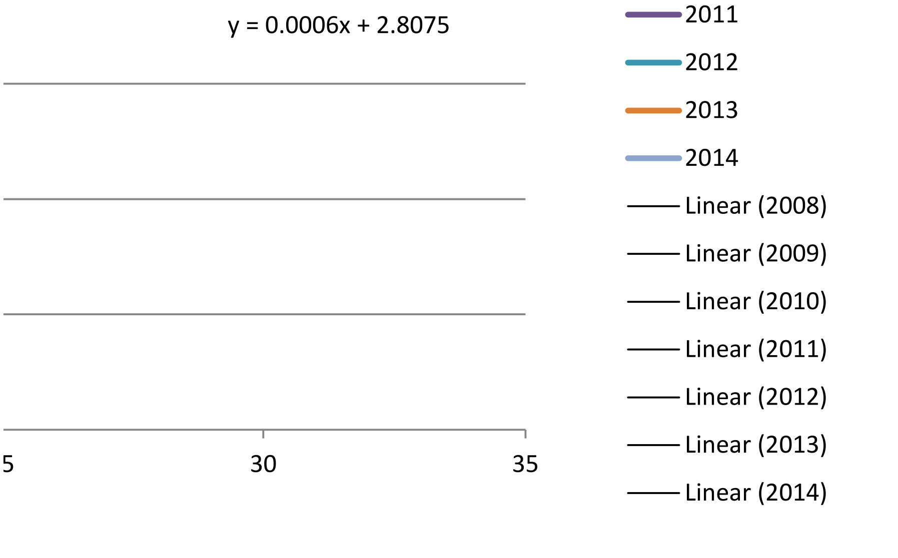
3.98	3.96	3.93	3.92	3.89	3.88	3.87	3.85	3.84
3.95	3.94	3.92	3.92	3.88	3.87	3.84	3.81	3.8
3.19	3.18	3.19	3.19	3.18	3.18	3.18	3.16	3.15
2.95	2.94	2.93	2.93	2.94	2.95	2.94	2.92	2.91
2.85	2.84	2.84	2.83	2.83	2.83	2.83	2.83	2.86

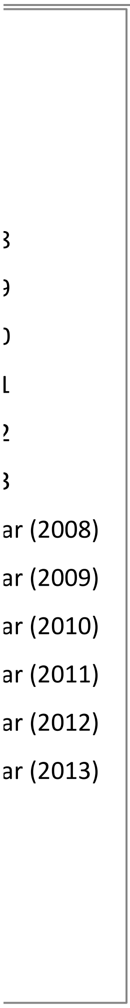
3.13	3.15	3.12	3.12	3.11	3.08	3.08	3.08	3.08
3.08	3.07	3.07	3.08	3.08	3.07	3.06	3.06	3.05
3.43	3.43	3.42	3.4	3.39	3.39	3.38	3.36	3.36
3.44	3.43	3.42	3.41	3.4	3.38	3.39	3.37	3.36
3.03	3.02	3.01	3.01	3	3	3	3	3
2.84	2.83	2.86	2.91	2.88	2.87	2.86	2.87	2.86
2.84	2.85	2.84	2.84	2.84	2.83	2.81	2.81	2.8

3.04	3.03	3.03	3.01	3	3	2.99	2.99	2.99
3	2.99	2.99	3.04	3.02	3.01	3	3	3
3.19	3.19	3.19	3.17	3.16	3.15	3.14	3.14	3.14
3.2	3.19	3.19	3.17	3.17	3.15	3.16	3.15	3.14
2.95	2.95	2.94	2.94	2.94	2.94	2.94	2.94	2.93
2.87	2.84	2.84	2.83	2.84	2.85	2.84	2.84	2.86

3	3.03	3.03	3	3	2.99	2.99	2.99	2.99
3.02	3.01	3	3	3	3	2.99	2.99	3
3.1	3.11	3.11	3.1	3.08	3.07	3.06	3.06	3.06
3.1	3.1	3.09	3.09	3.09	3.1	3.11	3.08	3.07
2.94	2.94	2.94	2.94	2.94	2.95	2.95	2.95	2.94
2.83	2.83	2.87	2.88	2.87	2.86	2.9	2.9	2.88







April Slope	May Slopes	June Slope	July Slopes	August
0.0004	-0.0069	-0.0179	-0.0151	-0.0059
0.0048	-0.0194	0.0063	-0.0132	-0.0062
0.0173	-0.005	-0.0104	-0.0036	-0.0024
-0.0077	-0.0056	-0.0109	-0.0064	-0.0012
0.0155	-0.0172	-0.0082	-0.0055	-0.0012
-0.0068	-0.0046	-0.0033	-0.0008	-0.0003

3.78	3.78
4.29	4.24
4.12	4.08
3.99	3.94
3.19	3.19
3.21	3.21

3.57	3.55	3.53
3.55	3.54	3.52
4.05	4.07	4.08
4.04	4.02	4.01
3.42	3.4	3.38
3.08	3.06	3.04
2.94	2.93	2.93

3.2	3.2
3.25	3.24

3.81	3.8
3.8	3.76
3.15	3.15
2.9	2.89
2.85	**2.84**

3.08	3.08	3.07
3.05	3.05	3.05
3.34	3.34	3.33
3.35	3.33	3.35
3	2.99	2.98
2.82	2.85	2.82
2.83	**2.82**	**2.81**

2.99	2.99	2.99
3	3	3
3.16	3.18	3.17
3.14	3.14	3.14
2.94	2.94	2.94
2.85	2.84	2.81

2.98	3.02
3	3.02
3.05	3.05
3.07	3.07
2.95	2.95
2.87	2.87

YEAR	00060, Discharge, cubic feet per sec							
	Monthly mean in ft3/s (Calculation Period: 2000-0							
	Period-of-record for statistical calculation res							
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
2000		21.5	31.2	31.8	24.5	12.4	5.94	3.65
2001	5.29	9.14	19.3	24.3	19.7	7.41	4.17	2.61
2002	20.9	12.6	21.4	26.3	18.4	11.6	5.22	2.68
2003	16	17.1	27.3	32.9	56.4	22.5	8.96	5.66
2004	10.2	12.8	27.5	15.9	9.4	4.82	2.46	1.72
2005	35.2	21.5	39.9	50.6	77.9	43.2	13.9	6.15
2006	23.8	14.9	34.1	82.8	67.3	23.7	10.4	5.68
2007						4.39	2.02	1.15
2008	11.9	24.9	31.5	26.6	22	10	5.43	2.52
2009	8.54	13.8	20.5	24.5	28.9	11.5	4.35	2.32
2010	10.5	28	32.1	42.7	51.6	47	14.2	6.37
2011	34.2	23	50.8	78.3	66.1	49.9	20.8	9.33
2012	11.2	10.5	17.6	45.6	24.5	9.15	4.72	2.73
2013	12.6	12	12.1	9.9	6.33	3.61	1.95	1.41
2014	2.2	4.5	4.3	7.4	5.3	3		

Provisional Data
Outliers
Dry Months

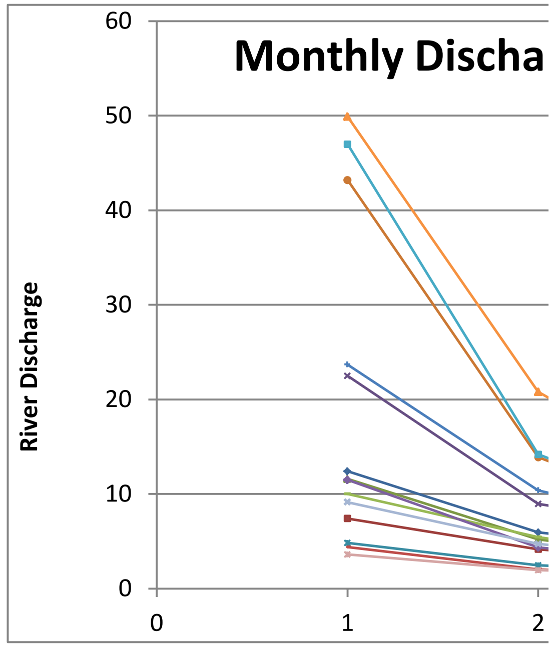
Tulare County, California
Hydrologic Unit Code 18030006
Latitude 36°02'54", Longitude 118°39'12"
NAD27

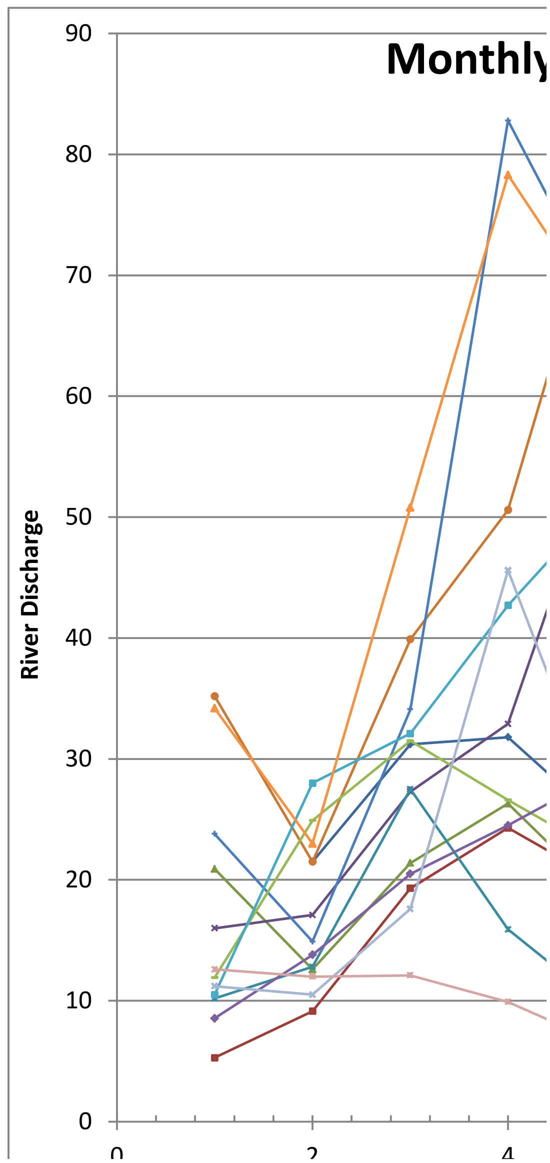
cond,

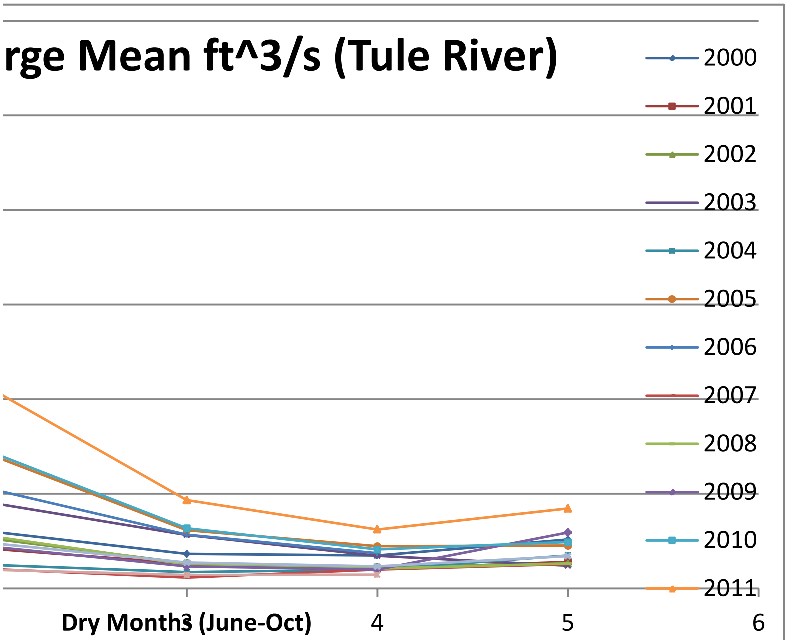
2-01 -> 2013-09-30)

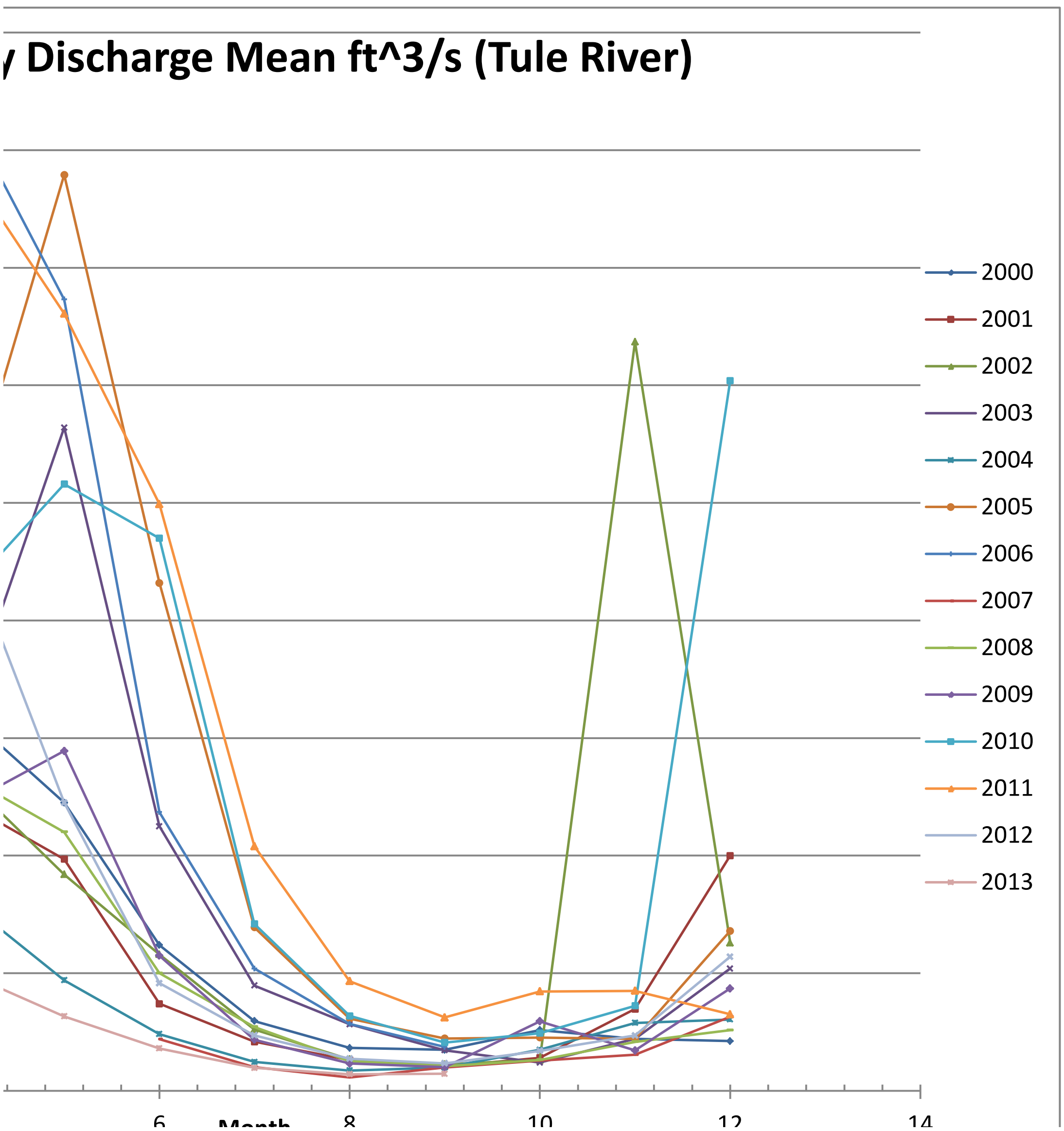
tricted by user

Sep	Oct	Nov	Dec
3.49	5.17	4.42	4.23
2.07	2.81	6.95	20
2.25	2.62	63.7	12.6
3.45	2.4	4.41	10.4
1.98	3.49	5.78	6.07
4.45	4.53	4.43	13.6
3.72			
1.99	2.58	3.07	6.31
2.08	2.63	4.16	5.15
2.01	5.91	3.44	8.7
4.11	4.9	7.23	60.4
6.24	8.45	8.5	6.51
2.33	3.4	4.7	11.4
1.45			






rge Mean ft^3/s (Tule River)
Dry Months (June-Oct)
3
4
5
6
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011


/ Discharge Mean ft^3/s (Tule River)
6
Month
8
10
12
14
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013


Month

Tule River Indian Tribe

Water Settlement Technical Report

Submitted on behalf of:

Tule River Indian Tribe
340 N Reservation Rd
Porterville, CA 93257

Submitted by:

NRCE
GEI Consultants
Native American Rights Fund
Kenney & Associates

June 2013

Table of Contents

List of Figures

List of Tables

List of Appendices

Executive Summary

The Tule River Indian Tribe (Tribe) relies on water resources in the South Tule River Basin to meet water demands on the 55,396-acre Tule River Indian Reservation (Reservation) in south-central California. Both surface and groundwater resources are currently used to meet water demands on the Reservation; however, the Tribe is only using a small portion of the available surface water supply to which the Tribe is entitled. Groundwater supplies that are available to the Tribe are limited and are not always of acceptable quality for domestic use.

The Tribe's water treatment plant currently has the capacity for providing 501,700 gallons per day (562 acre-feet per year) at maximum production. The Tribe typically tries to run the treatment plant at maximum capacity and uses groundwater sources to help make up shortfalls. In many years, the Tribe does not have adequate water supplies in the late summer and early fall to meet the current minimum 100,000 gallons per day of water demand.

Many of the residents on the Reservation continue to have a relatively low standard of living in substantial part due to the absence of an adequate and reliable potable water supply and delivery system. Inadequate water supplies have resulted in reduced opportunities for economic development to occur on the Reservation and may prevent off-Reservation Tribal members from relocating to the Reservation.

The estimated future water demand of the Reservation in the year 2112 is 7,103 acre-feet per year. Of this total, it is estimated 1,974 acre-feet per year would be allocated for domestic, commercial, municipal and industrial (DCMI) uses and 5,129 acre-feet per year would be allocated for irrigation. These water demand figures are based on reasonably conservative projections of future potential Reservation population growth and economic development. To meet a portion of this water demand, the Tribe is proposing to develop Phase 1 of a dam and reservoir project in conjunction with other water infrastructure projects. The Phase 1 dam would impound a 5,000 acre-foot reservoir, which would meet the year 2112 projected DCMI demand and a portion of the future irrigation water demand of irrigable lands on the Reservation.

Other options besides a dam project are not adequate to meet the Reservation's future needs. For example, if water storage tanks were to be used to store South Fork Tule River water instead of a dam, several thousand tanks would need to be constructed. Those groundwater wells on the Reservation that produce potable water generally have low yields (less than 20 gallons per minute) so groundwater can only be viewed as a short-term source. In addition, climate change studies generally predict increased variability in precipitation and runoff from year to year in the future, making the need for a sizeable storage project on the Reservation even more critical.

There are a number of sites along the South Fork of the Tule River on the Reservation that are judged to be viable for construction of a concrete gravity dam using roller-compacted concrete (RCC) construction methods. Further studies and subsurface explorations would need to be performed to confirm current findings and provide the basis for final project planning and design of the dam and its appurtenant facilities.

The preferred dam and reservoir location is the Lower Bear Creek site on the South Fork of the Tule River just downstream from the confluence with Bear Creek. The average demand that could be met from construction of this reservoir is 2,871 acre-feet per year, which would provide water for all of the DCMI demand (1,974 acre-feet per year) and irrigation of 220 acres. Three other sites for a dam were evaluated; however, the Lower Bear Creek site is preferred by the Tribe, based on the results of a Screening Workshop held on March 6-7, 2013.

In addition to the dam and reservoir, the Phase 1 project would include a raw water conveyance pipeline from the reservoir to a new or expanded water treatment plant, which is also part of the project. Distribution system improvements are also planned to be implemented as part of the project. Construction of the dam and raw water pipeline would require improvements to the main road existing through the Reservation, as well as new access roads.

The estimate of total project cost for the preferred alternative (dam and reservoir at the Lower Bear Creek site) is $159 million, in December 2012 dollars, as shown below:

Estimate of Total Project Cost – Storage Developed at Lower Bear Creek Site	
Itemized Construction Costs (ICC)	
Dam and Reservoir	$59,469,000
Road Improvements	$11,048,000
Raw Water Pipeline	$3,111,000
Water Treatment Plant Expansion	$1,890,000
Water Distribution System	$8,320,000
Itemized Construction Cost Subtotal (ICCS):	**$83,838,000**
Design Contingency	
Dam and Reservoir (20% to 22% ICC)	$11,894,000
Road Improvements (20% to 22% ICC)	$2,210,000
Raw Water Pipeline (25% ICC)	$778,000
Water Treatment Plant Expansion (30% ICC)	$567,000
Water Distribution System (30% ICC)	$2,496,000
Base Construction Subtotal (BCS)	**$101,783,000**
Mobilization, Bonds & Insurance (9% BCS)	$9,160,000
Construction Contingency (15% BCS)	$15,267,000
Direct Construction Subtotal (DCS)	**$126,210,000**

Estimate of Total Project Cost – Storage Developed at Lower Bear Creek Site	
Design Engineering (8% DCS)	$10,097,000
Construction Administration & Engineering (8% DCS)	$10,097,000
Legal, Permitting, Mitigation (10% DCS)	$12,621,000
Total Opinion of Probable Project Cost (OPPC)	**$159,025,000**

Note 1: ICC= Itemized Construction Cost for individual project features.
Note 2: ICCS = Itemized Construction Costs Subtotal, sum of all 5 project features.
Note 3: BCS = Base Construction Subtotal, sum of ICCS and design contingency.
Note 4: DCS = Direct Construction Subtotal, sum of BCS, mobilization, bond, insurance, construction contingency
Note 5: The cost estimates in this report are considered to be Class 4 estimates per the Association for the Advancement of Cost Engineering (AACE) International Cost Estimate Classification System.

1.0 Introduction

1.1 Purpose and Scope

The purpose of this study is to provide a compilation and analysis of the studies developed to provide a technical foundation for the construction of a dam, reservoir, and other water infrastructure on the Reservation associated with the Tule River Indian Water Rights Settlement.

1.2 Federal Authority to Participate and Conduct Study

The Secretary of the Interior is given the authority to pursue technical studies pursuant to U.S. Bureau of Reclamation (Reclamation) law (Section 1, Act of June 17, 1902, 32 Stat. 388; and Section 9, Reclamation Act of 1939; 53 Stat. 1193) for the purpose of evaluating the technical viability of water development in the Reclamation states. The Reservation is located in California, a Reclamation state. This report has been developed with the advice and assistance from Reclamation.

1.3 Background

1.3.1 Location and Setting

The Reservation is located in south-central California, approximately 75 miles south of Fresno in Tulare County, as shown on Figure 1-1.

The Reservation is situated on the western slope of the Sierra Nevada Mountains and lies almost entirely within the South Fork Tule River drainage basin. The South Fork Tule River flows into the Tule River at Success Reservoir, which is located about ten miles west of the Reservation. There are no significant water users upstream of the Reservation. The topography is generally steep, with elevations ranging from about 900 feet near the Reservation's western boundary to 7,500 feet near the Reservation's eastern boundary. Most of the inhabited land is situated along the lower reach of the South Fork Tule River on the western side of the Reservation. The current acreage of the reservation held in trust by the United States covers 55,396 acres. The Tribe also owns, in fee, additional acreage contiguous to the Reservation, and a small parcel outside the South Tule River basin held in trust by the United States.

The climate on the Reservation can vary considerably by season and is strongly correlated with elevation. The average daily high temperature within the Reservation is about 77°F throughout the lower elevations and 55°F at higher elevations. Concurrently, the average low temperature ranges from about 55°F throughout the lower parts of the Reservation to 27°F at higher elevations. The majority of the precipitation on the Reservation falls along the upper reaches of the South Fork Tule River watershed (average of 45 inches annually). Precipitation along the lower reaches averages about 20 inches annually. The Reservation's lower foothill areas are generally covered with grasses and chaparral. Oak, sycamore, alder, and other deciduous trees are common adjacent to the streambed. At higher elevations, there are stands of pine, fir, spruce, cedar, and giant sequoia.

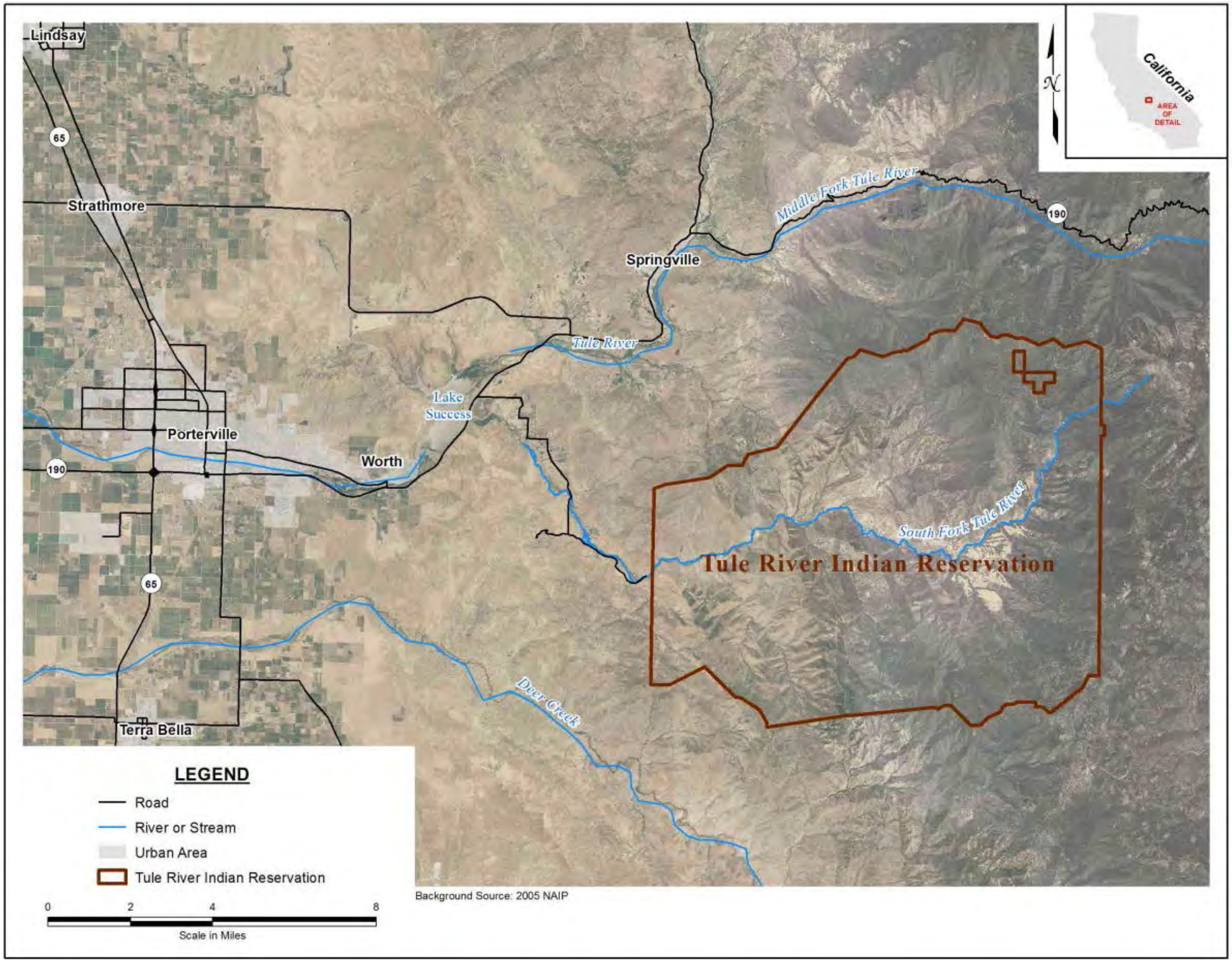
1.3.2 Socioeconomic Characteristics

The Tule River Indian Reservation is the homeland of the Tule River Tribe. They are descendants of the Yokuts Indians, a large group of linguistically-related people who occupied the San Joaquin Valley in California for thousands of years prior to contact with Euro-American settlers.

The current Tribe has a population of 1,720 people, of which 970 live on the Reservation. In general, a significant segment of the tribal population lives at or below the poverty line.

The injustices and inequities of the past are still present and continue to affect the Tule River Tribe. The Tribe has been plagued with unemployment and mortality rates substantially higher - and a standard of living substantially lower - than is experienced by non-Indian communities near the Reservation. For example, while on-Reservation socioeconomic conditions have improved over time, the estimated on-Reservation poverty rate has continued to exceed regional averages. In fact, as recently as 2005, the poverty rate for employed members of the Tule River Tribe was about 48 percent (BIA 2005). This compares to an approximately 12 percent poverty rate within Tulare County that same year (US Census 2005). As a result, the Reservation's residents suffer from a relatively low standard of living, which may be in part attributed to the absence of an adequate and reliable potable water supply and delivery system.

Figure 1-1: Reservation Location Map



2.0 Existing Water Supply and Infrastructure

2.1.1 General

The Tule River Reservation water system relies upon a series of wells, springs, and water drawn directly from the South Fork Tule River, which is treated to meet potable water standards. The Tribe's documented water usage is constrained by the availability of water supplies and the water distribution system and, therefore, is not representative of the actual demands for water.

The amount of water diverted annually from the South Fork Tule River is not known, as past diversions by the Tribe have been unmeasured. The quality of river water is affected by grazing upstream, as well as other land uses and activities in the watershed.

Natural springs are evident throughout the Reservation and these are being used for a combination of agricultural irrigation and drinking water augmentation. Several large springs show high levels of carbon dioxide and are therefore restricted to agricultural usage.

Wells are located throughout the Reservation, but are concentrated in the Reservation's Lower Valley where they augment the treated surface water serving the community. Less than a quarter of wells that have been drilled on the Reservation are operational due to either a lack of production or water quality concerns. Well yields tend to be modest, with most producing less than 30 gallons per minute (gpm).

2.1.2 Water Quality

Water quality within the South Fork Tule River watershed is generally good although the river water does at times exceed federal Safe Drinking Water Act (SDWA) standards for certain constituents and the groundwater at certain locations is unsuitable for potable use. The Tribe currently conducts daily turbidity measurements of water leaving the treatment plant as well as monthly coliform tests at various locations within the distribution system following federal SDWA guidelines. The Tribe complies with the U.S. Environmental Protection Agency (EPA) sampling requirements for annual and biannual water quality testing.

In addition, the Tribe conducts water quality sampling at 30 established locations within the South Fork Tule River watershed. The Tribe currently has a Quality Assurance Program Plan (QAPP), approved by EPA, to obtain and test these samples, as well as a Sampling and Analysis Program Plan (SAPP). The SAPP can be found in Appendix D. About one year ago, the Tribe was funded by EPA to expand the number of sampling locations, which now includes some locations near the proposed dam sites described in Section 5 of this report. The Tribe takes samples to test for various water quality parameters and also takes field readings for pH, turbidity, conductivity, temperature and bacteria. The Tribe expects to develop new QAPP and SAPP documents in the near future to cover the expanded sampling scope. The new QAPP is being developed following EPA guidelines, as documented in EPA QA/R-5, *EPA Requirements for Quality Assurance Project Plans* (http://www.epa.gov/quality/qs-docs/r5-final.pdf).

Water quality exceedances in the South Fork Tule River are generally from turbidity and bacteria. These exceedances are believed to result from nonpoint sources, primarily livestock grazing, with other likely contributors being construction earthwork activities, erosion and sedimentation from unpaved roads, septic tanks located near the river in areas of thin soils and/or shallow groundwater, and activities associated with road maintenance.

Although there are only limited sampling data from the South Fork Tule River near the proposed dam sites at this time, bacteria levels in the river are known to generally increase from upstream to downstream. Noticeable increases in bacteria concentrations occur at locations where there are greater numbers of houses and when river flows are low.

2.1.3 Groundwater Supply

Groundwater occurs in the shallow alluvial deposits along the main stem of the South Fork Tule River and in the cracks and fractures of the granite bedrock underlying the Reservation. Of the twenty-two (22) wells inventoried on the Reservation, only five are operational at this time. Wells were taken out of production due mainly to water quality problems and insufficient yields. Well yield is influenced by proximity to fractures and fissures in the local granite bedrock, but can be affected by the presence of underground limestone and marble. Yields of most wells drilled into the bedrock on the Reservation range from near zero to 50 gpm. The three wells that pump into the main public water system have capacities of 25 gpm, 10 gpm, and 30 gpm. Of the remaining two wells, one serves the Apple Valley and the other serves the Cow Mountain area. Those wells have capacities of 17 gpm and 13 gpm, respectively.

Although groundwater availability on the Reservation is not adequate for large-scale agriculture potential, groundwater yields may be adequate to meet a portion of future domestic water demand.

The quality of water in local wells is an issue. Approximately 30-percent of the 280 septic systems on the Reservation are approaching a state of failure with a few already discharging to the surface. Most developed wells either lack an annular seal or have one that is not sufficiently deep to protect the well. Wells are located in areas close to grazing lands, near buildings and areas of human activity, or close to septic systems. Most of the wells are old, have a variety of pumps and piping, and are maintained only when problems occur.

2.1.4 Water Treatment System

River water, delivered through a ten inch pipe at an upstream location, is not metered. An older turbine meter installed above the plant inlet has become non-functional. The plant is old, but has been upgraded with limited new equipment.

The Tribe's water treatment plant was upgraded in 2004-05 to increase its capacity from 150 gpm to approximately 300 to 350 gpm. The projected maximum day demand for the Reservation is approximately 1,050 gpm. The Tribe’s water treatment plant currently has the capacity for 501,700 gallons per day 562 acre-feet per year at maximum production. This limit along with the unreliable water supply constrains current water usage and future development on the Reservation. The Tribe typically tries to run the treatment plant at maximum capacity and uses wells to help make up any shortfalls.

2.1.5 Water Storage and Distribution System

The overall water system is not considered to be adequate to meet current Tribal needs. Water cannot be delivered to all homes on a year-round basis. Some homes do not have water supply in the early summer months because of inadequate supply and distribution system capacity issues. Water shortages are becoming increasingly common as more and more tribal members move back to the reservation into new homes. There is not enough water to meet the demand, especially in the summer. The Tribe's Public Works Department has issued water conservation notices for the last five years, requesting that tribal members use water sparingly, and report leaks, to prevent shortages to the domestic water supply. Despite these notices, tribal members still continue to run out of water every year. The outages vary from one day to one week. There is no “gray water” system presently on the Reservation, although discussions aimed at developing one have begun.

The water storage system consists of a series of tanks ranging in size from 3,000 gallons to 200,000 gallons. The tanks do not function as a coordinated storage system and, in some cases, were improperly designed. Plans are underway to add a new 400,000 gallon tank, to be interconnected with two existing smaller tanks. The new tank would serve a proposed Justice Center, which will soon be under construction. It should be noted that this new tank provides for only some short-term development on the Reservation and is not adequate to serve the Tribe’s long-term development plans. The water storage system is not regularly monitored for water in storage or for structural conditions.

The distribution system consists of ±50-year-old, 4-inch-diameter asbestos cement pipe and includes 6- and 8-inch-diameter pipes of varying ages. Some of the pipes have deteriorating seals, cracked or eroded sections and occasionally poorly constructed house connections. The system is relatively unmonitored although the system is monitored visually for signs of leakage.

House connections are generally 1-inch-diameter, although more than one home may be served by a single connection. One 2-inch-diameter connection system was found to be serving at least five houses.

Individual houses are not metered. They are also not inspected for leaking pipes and/or fixtures. A significant amount of water may be lost due to system leakage; however, the absence of metering makes the quantity of loss very difficult to estimate.

The storage capacity is not adequate to meet peak use domestic consumption and fire flow demands. Even with direct pumping, insufficient water is available for a major structure fire. Grass fires are routine during the summer, but often require the use of potable resources.

3.0 Future Population and Water Demand

3.1 Current Population

While recent Tribal population data from the Tribe, U.S. Bureau of Census and Bureau of Indian Affairs (BIA) are inconsistent, together they indicate that as of December 2012 approximately 1,200 people lived on the Reservation, including an estimated 235 non-tribal members. As of December 2012, the total enrolled membership of the Tribe was 1,720 people. Therefore, an estimated approximately 56-percent of the Tribe's members presently live on the Reservation.

3.2 Future Population

To a large extent, the existing and future water needs on the Reservation correlate directly to the Reservation's population. In conformance with the provisions and goals of the negotiated water rights settlements, and therefore for purposes of this study, the future water needs on the Reservation are based on a 100-year population projection beginning in the year 2013.

The potential Reservation population was estimated because the overall intent of the needs assessment analysis is to estimate the quantity of water the Tribe would require in the year 2112 to create a homeland for all its peoples. As such, population projections and water demand were calculated such that all Tribal members, and associated non-tribal members, could live on the Reservation if they chose to do so. Water demand quantities calculated are sufficient to meet the domestic, commercial, municipal, industrial and agricultural water needs of the Tribe as a whole. To perform the population projection analysis, demographic data for the Tribe was obtained from the Tribe, U.S. Census Bureau, BIA, Tulare County and Indian Health Services (IHS).

A cohort-survival model was used to estimate the potential population of the Reservation in the year 2112. Such a model is designed to project the evolution of a community's population based on its initial size and age structure in combination with information on the population's recent female member average birth rates for different child-bearing age ranges, and the population's recent mortality rates by age.

The model starts with a community's current female population broken down by age and applies birth rate estimates by age cohort to estimate the number of births that will occur in the first year of the projection. The estimated number of births is then divided between males and females based on the overall proportion of males to females within the community's current population. The female population is then shifted forward one year and the estimated number of female births added in the age zero slot. The female population in each year is also adjusted to account for expected mortality. The same calculation of births and shifting of the population is done 100 times to develop a projection of the community's female population 100 years out. Concurrently, the community's current male population is shifted forward each year over 100 years adding the estimated male births generated from the female population model and adjusting to account for estimated mortality.

Based on the data obtained from these sources, and as noted earlier, it was estimated that at the end of 2012 the Tribe's total membership was 1,720 people. This total was then broken down by sex and five year age cohort based on recent demographic data for the Tribe published by the U.S. Census Bureau. Tulare County county-wide average birth rates (from the U.S. Census Bureau) in combination with recent Tule River Tribe mortality data provided by the Tribe was then applied to this population breakdown to project the Tribe's membership population year-by-year through the year 2112 applying a cohort-survival projection framework. Birth rate assumptions were not derived from birth rate data provided by the Tribe because that data lacked the necessary level of detail for inclusion in the analysis. Tulare County county-wide birth rate trends reflect a generally higher standard of living than historically experienced by the average Tule River tribal member living on the Reservation. As the Tribe further develops its reservation's economy, particularly due to the continued success of its gaming operations and, importantly, acquires a reliable potable water supply, it would be expected that the Reservation's standard of living will quickly improve to a level comparable to surrounding non-Indian communities. Accordingly, the Tulare County birth rate data is presumed to be a reasonable reflection of the future birth rates that will be realized by the Tribe.

The cohort-survival model indicates that by the year 2112 the Tribe's total membership will reach about 6,035 people. This translates to an average annual cumulative rate of growth of 1.3-percent over the 100 year projection period. This rate of growth is consistent with the U.S. Census Bureau's recent long-term population growth projections for Native Americans for the United States as a whole.[1] In addition, there are currently an estimated 235 non-tribal members living on the Reservation. This means that there is approximately one non-member living on the Reservation for about every seven tribal members (living both on and off the Reservation). Assuming the ratio holds into the future, this translates to an estimated 825 non-members living on the Reservation in the year 2112 (a conservative number as it does not give weight to off-Reservation members who may have non-member family now or in the future). Thus, the total potential population of the Reservation in the year 2112 is projected, on the low end, to reach approximately 6,860 people. On the high end, factoring in off-Reservation tribal members with non-member family, the total population is projected to reach approximately 7,495 people.

Data from the U.S. Census Bureau's 2010 Census of Population indicates that the Indian population on the Tule River Reservation averaged about 3.5 persons per household and that

[1] In 2010 the U.S. Census Bureau projected that the Alaska and Native American population of the United States would increase from an estimated approximately 3.2 million to almost 5.5 million by the year 2050. This translates to an annual average cumulative rate of growth of 1.35% over the 40 year projection period.

there were 476 single and multi-family housing units on the Reservation (U.S. Census Bureau, 2010). Using this rate as representative of average future residential occupancy on the Reservation, it is estimated that in the year 2112 approximately 1,960 homes will be needed to accommodate all of the Reservation's minimum projected potential population of 6,860 people.

3.3 Reservation Water Needs

The following analysis is based upon a projected population of 6,860 people. Future Reservation water needs are separately evaluated by water use category: Domestic, Commercial, Municipal, Industrial, and Agricultural.

3.3.1 Domestic Water Use

The Tribe's on-Reservation future domestic water needs will depend directly on the Reservation's future population. According to tribal representatives, many tribal members desire to live on the Reservation are unable to do so because of a lack of on-Reservation housing. Historically, available housing on the Reservation has fallen well short of demand. Consequently, construction of new housing has long been a priority of the Tribe. Working with the Department of Housing and Urban Development (HUD) and other funding sources, the Tribe has developed several housing programs for its members and designated over 2,000 acres of Reservation land for future housing development. New housing continues to be built, but the rate of construction is inadequately low and primarily limited by insufficient available water supply.

3.3.1.1 Indoor Water Demand

Brown and Caldwell (1984) conducted a study for HUD and estimated indoor water use by homes with no water-conserving devices averages 78 gallons per capita per day (gpcd), while those with high-efficiency conservation devices average 60 gpcd (Wilson, et al., 2003). The California Department of Water Resources (CDWR) reports that overall interior water use in California remained near an average of 80 gpcd during the 1980's (CDWR, 1994a). The Reservoir does not require water conservation devices in residences and it is therefore assumed that 80 gpcd is a reasonable estimate of the future average indoor water use of Reservation residents.

Accordingly, and based on a projected total potential population of 6,860 people, the year 2112 average indoor residential water needs of the Reservation are estimated to be approximately 548,900 gallons per day (615 acre-feet per year).

3.3.1.2 Outdoor Water Demand

In addition to indoor water use, each Reservation household should have sufficient water available to it for outdoor purposes, including gardens and landscape irrigation.

A study of 20 residences in Las Cruces, New Mexico reported irrigated land ranged from 3,328 square feet to 5,219 square feet per household (Wilson et. al., 2003). The water claim negotiated for the Jicarilla Apache Reservation was based in part on an irrigated area of 3,200 square feet per household (Jicarilla Apache Indian Reservation, no date). Based on these figures it is assumed that households on the Tule River Indian Reservation will average 3,500 square feet (0.08 acres) of garden and/or irrigated area. This may prove conservative since the availability of land within areas of the Reservation designated for future residential development is significant.

According to the work of Natural Resources Consulting Engineers (NRCE), the cultivation of turf on the Reservation's lower areas has an average crop water requirement of 4.3 acre-feet per acre per year (NRCE, 2012). Based on this figure, the estimated annual year 2112 household outdoor (landscape/garden) water needs of the Reservation are estimated at approximately 674 acre-feet per year.

In addition to landscape/garden water use, many tribal households use residential water for small-scale stock watering. In the mid-1990's it was estimated that about 100 horses were provided water from the community water system on the Reservation. This is about one horse for every two reservation households at that time (Dabney, 1996). A more current estimate of the Reservation's horse population is not available. Horses require approximately 12 gallons of water per day (U.S. Department of Agriculture, 1983). Therefore, assuming that the historical ratio of about one horse to every two houses remains unchanged into the future, it is anticipated that in the year 2112 approximately 980 horses will live on the Reservation. Therefore, it is estimated water demand for horses is about 11,760 gallons per day (13.2 acre-feet per year).

3.3.1.3 Total Domestic Water Demands

In summary, the total projected year 2112 combined indoor and outdoor domestic water needs of the Tule River Reservation are approximately 1,302 acre-feet per year (about 0.66 acre-feet per year per household).

3.3.2 Commercial Water Use

Presently, commercial development on the Reservation is limited to the Tribe's casino and a few small sundry/grocery outlets. However, in the future, with continued population growth and increased visitation to the Reservation it is anticipated that on-Reservation commercial services, such as a gasoline station and larger grocery store, will be developed. In its 1997 economic development plan, the Tribe identified several commercial ventures it proposes to implement on the Reservation such as a laundromat and larger grocery store (Overall Economic Development Plan, 1997). In addition, the Tribe may pursue commercial development on tribal land south of the current Reservation.

According to the CDWR, commercial water uses represent about 20-percent of total municipal water use in the Tulare Lake region of California or about 30-percent of domestic use (CDWR, 1994b). It was assumed that the Reservation's future commercial water needs will be 30-percent of its domestic needs or about 391 acre-feet per year of water in the year 2112.

3.3.3 Municipal Water Use

The municipal water needs assessment is broken down into two categories: general municipal needs and fire protection needs.

3.3.3.1 General Municipal Demand

The Tule River Tribe owns and operates administrative and community buildings and infrastructure that use water. Furthermore, the Tribe needs water to provide vital services to its residents such as street and sewer cleaning, infrastructure construction, and maintenance. There is very little available data on current general municipal water use on the Reservation, and the information which is available is mostly anecdotal. The existing community water system provides water to approximately ten tribal buildings, including the Tribe's council offices and health clinic. In 1996, the Tribe estimated that the total average water use of Reservation structures connected to the community water system, including the Reservation's approximately 200 homes (at that time), ten public facilities and the Eagle Mountain Casino, ranged from about 125,000 to 455,000 gallons per day (Dabney, 1996), depending on the time of year. At the time, as is the case today, there were significant leaks, inefficiencies and metering inaccuracies in the water system such that the estimated actual water use excluding waste was extremely difficult to measure. Accordingly, data on actual general municipal water use on the Reservation does not provide an accurate basis for projecting future municipal water use with an efficient and metered water storage, treatment and delivery system. According to a 2010 report on water use in Canada, combined commercial and institutional water use is about 34-percent of domestic use (Environment Canada, 2010). Assuming, as discussed above, that the Reservation's future commercial water needs will equal 30-percent of its domestic needs, the Reservation's projected future general municipal water needs are assumed equal to 4-percent of its domestic needs based on the Canadian experience. The estimated year 2112 general municipal water on the Reservation is 52 acre-feet per year.

3.3.3.2 Fire Protection Demand

The Reservation lacks a community fire protection system using water tenders and fire personnel. Current urban fire protection services are provided to the Reservation by the Tulare County fire department using water trucks. In the past, this has proven inadequate. In 1996 the Reservation's tribal council and administrative building caught fire and the fire department response time was insufficient to prevent the building from burning.

The National Fire Protection Agency provides minimum standards for residential fire protection water supplies irrespective of structure dimension. In the case of single or multi-resident structures with exposure hazards like those found on the Reservation (i.e., brush and trees), the minimum fire protection water supply requirement is 3,000 gallons per residence. If there are 1,960 residences on the Reservation in the year 2112, the Reservation's minimum water supply needs for residential fire protection would be about 18 acre-feet per year.

Additional water supplies will also be necessary for the fire protection of non-residential structures such as the tribal council offices, housing office, casino, etc. This water is assumed included in the future general municipal water needs of the Reservation as estimated previously.

3.3.3.3 Total Municipal Water Demand

The projected total municipal water need of the Tule River Indian Reservation in the year 2112 is 70 acre-feet per year.

3.3.4 Industrial Water Use

The Tribe has on-Reservation mining development opportunities that will require the consumptive use of water once operational. The Tribe has designated approximately 405 acres of the Reservation land for mining and processing of the minerals limestone and dolomite and has an interest in developing a sand and gravel operation.

According to the Department of Energy (2003), water use in mining operations can be divided into three categories: mining, processing, and mineral conveyance. In most types of mining, relatively little water is used in actual ore extraction. Water is used in crushing, mainly for dust control. Screening, grinding, and milling can require significant amounts of water, depending on the scale of operation. Once ore is crushed, the mined product can be transported through a pipeline as aqueous slurry to a processing plant some distance away. Water use depends on the flow properties of the slurry and, in some cases, the purity or contaminants in the water used to prepare the slurry.

3.3.4.1 Mining: Limestone and Dolomite

Deposits of both limestone and dolomite (magnesium rich limestone) are located on the Reservation. Limestone is used by farmers as a soil amendment to reduce soil acidity and is used in glass manufacturing and as roofing gravel. The agricultural sector is a primary end-market for limestone. Dolomite has applications in agriculture and is commonly used as a cattle feed supplement because it is high in magnesium, an essential nutrient in growing and finishing cattle and for promoting cow gestation and lactation (National Research Council, 1996). Outside of agriculture, dolomite is used in fiberglass and steel production and as a softening agent in water treatment.

3.3.4.2 Mining: Sand and Gravel

The Tribe has also expressed interest in developing a sand and gravel operation on the Reservation and according to a 1978 report published by the BIA, the Tribe has developable areas of sand and gravel along the South Fork Tule River near the Reservation's western boundary. However, due to high transportation costs, most sand and gravel operations serve local and regional markets. Accordingly, sand and gravel mining on the Reservation would serve on-Reservation and nearby construction-related demand. Given the projected potential population growth of the Reservation and continued strong regional population growth, there may be a ready source of demand for future sand and gravel production on and near the Reservation.

3.3.4.3 Total Industrial Water Demand

There is no direct basis available to reasonably estimate the amount of water that may be required by the Tribe for its potential future mining activities on the Reservation due to a lack of information on the probable intensity of this mining and the amount of water required per unit of production or acre excavated. This noted, according to the USGS, water use for mining in California in 2005 was approximately 14.9-percent the amount of water used for domestic purposes (USGS, 2009). Applying this percentage to the projected year 2112 potential annual domestic water needs on the Reservation of 1,302acre-feet per year, the projected potential future industrial (mining)-related water needs of about 194 acre-feet per year.

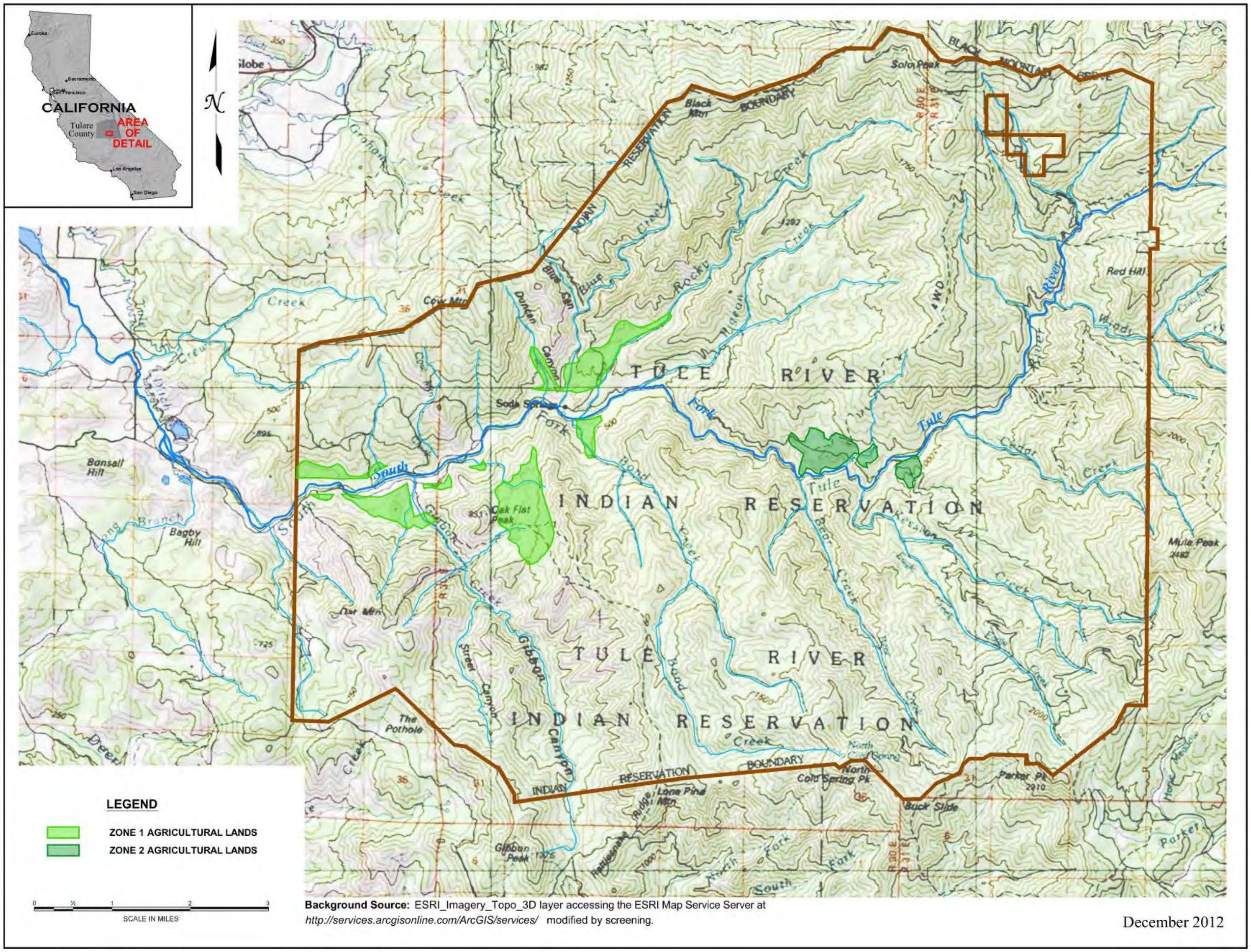
3.3.5 Agricultural Water Use

The Reservation has a significant resource base of arable land and timber resources which offer the Tribe significant economic opportunity. In the past, the development of the Tribe's natural resources, particularly its arable land base, has been largely constrained by a lack of a significant and reliable developed water supply.

3.3.5.1 Irrigation Water Demand

The Tribe has designated approximately 1,257 acres of the Reservation for irrigated agriculture. These lands are shown in Figure 3-1. Although there are additional lands on the Reservation that are also suitable for sustained irrigation, the Tribe has preliminarily designated those lands for other uses (such as housing, rangeland or open space). Should the Tribe decide in the future to convert more Reservation land to irrigated agriculture, its agricultural water needs would change accordingly.

Figure 3-1: Current Designated Agriculture Lands



The Tribe has identified a number of crops it may produce on its agricultural lands in the future including alfalfa hay, apples, olives, pistachios, grapes and Christmas trees. All these crops, except Christmas trees, are grown in large quantities in the region and have highly developed and accessible local marketing outlets.

For the purposes of this study, it is assumed that 50-percent of the Reservation lands proposed for agriculture will be planted in field crops and the other 50-percent in permanent crops. This cropping pattern is reasonably representative of the County-wide cropping pattern. The representative field crop selected for this evaluation is alfalfa. The representative permanent crops consist of an equal amount of pistachios, olives, and wine grapes.

The total annual diversion requirements for each of the representative crops were determined by NRCE as reported in a separate memorandum (NRCE, 2012). The weighted average diversion requirement for the cropping pattern described above is 48.9 inches (4.08 acre-feet per acre). Multiplying this diversion requirement by the 1,257 acres of designated irrigated agriculture on the Reservation yields a total annual diversion requirement at full production of about 5,129 acre-feet per year of water.

3.3.5.2 Livestock Water Demand

Livestock is a major sub-sector of the Tulare County agricultural economy and an important activity on the Reservation. According to the Tribe, there are about 1,000 head of cattle on the Reservation. These 1,000 cattle fully utilize the capacity of Reservation lands designed for grazing. It is anticipated that the quantity of range land on the Reservation will not change in the future, and therefore, the number of cattle on the Reservation in the year 2112 will remain at 1,000 head. Typically one animal-unit requires between 10 and 15 gallons of water per day depending on conditions (U.S. Department of Agriculture, 1983). Assuming an average water requirement for cattle at the upper end of this range, the total annual water needs of range cattle on the Reservation is estimated at approximately 17 acre-feet per year.

3.3.5.3 Total Agricultural Water Demand

The projected agricultural water needs of the Tule River Indian Reservation will be about 5,146 acre-feet per year.

3.3.6 Total Future Reservation Water Demand

The total estimated future consumptive water need of the Tule River Indian Reservation in the year 2112 is 7,103 acre-feet per year as shown in Table 3-1. This water quantity is based on reasonable projections of future potential Reservation population growth and economic development.

Table 3-1: Estimated Future Tribal Water Demand

Water Need	Projected Water Need (acre-feet per year)
Domestic	1,302
Commercial	391
Municipal	70
Industrial	194
Agricultural	5,146
Total	**7,103**

4.0 South Fork Tule River Historical and Extended Streamflow Records

4.1 General

The Reservation is drained almost entirely by the South Fork Tule River, which constitutes the surface water supply available to the Tribe. Because the Reservation incorporates the majority of the headwaters of the South Tule River, the Tribe has historically had access to the un-depleted flow of the river.

Four streamflow gages are located on the South Fork Tule River near the Reservation boundary. The Tribe, in conjunction with the USGS, arranged for the installation and operation of Gages 11203580 and 11204100. These gages went online on different dates, but the period when both gages are recording has been continuous since October 1, 2000. Streamflow data are available for the period of October 1, 2000 through September 30, 2011 (2001-2011 water years). Table 4-1 lists the existing and discontinued stream gages on the South Fork Tule River along with the average annual flow recorded at those gages.

Table 4-1: Stream Gages on the South Fork Tule River

Gage No.	Gage Name	Period of Record (Complete Water Years)	No. of Years of Complete Record	Average Flow (acre-feet per year)
11204500	South Fork Tule River near Lake Success	1931 – 1954 1957 – 2011	79	32,800
11204000	South Fork Tule River near Porterville	1911 – 1916 1919 – 1921 1928 – 1932	14	25,100
11204100	South Fork Tule River near Reservation Boundary near Porterville	2001 – 2011	11	26,400
11203580	South Fork Tule River near Chololło Campground near Porterville	2001 – 2011	11	12,400

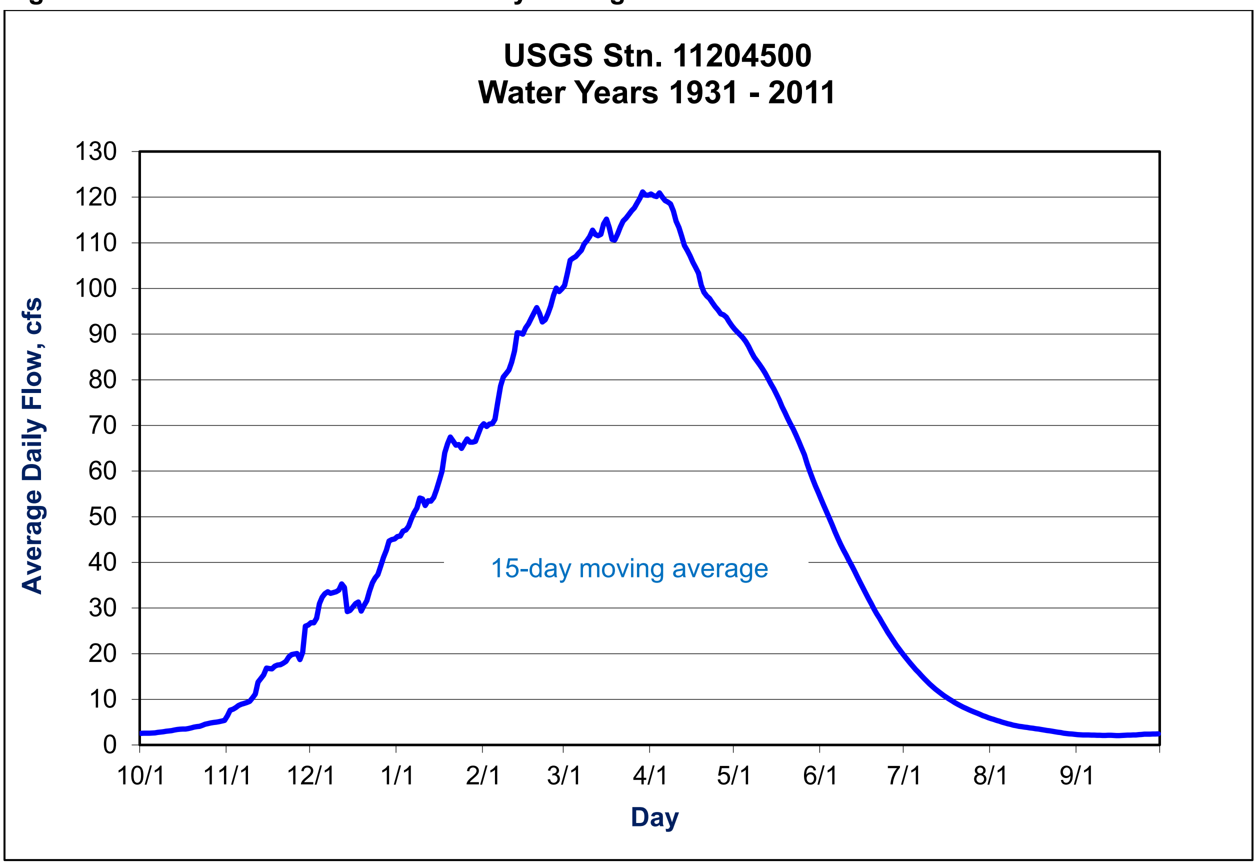
Gage 3580 is located on the South Fork Tule River above the Cedar Creek confluence near the Chololło Campground. Gage 4100 measures the streamflow of the South Fork Tule River near where it exits the Reservation. Gage 4100 is located near the discontinued Gage 4000, which was located on the Reservation upstream of the Gibbon Creek confluence. Records from Gage 4000 exist intermittently over water years 1911 to 1932.

The only long-term gage on the South Fork Tule River is Gage 4500, "South Fork Tule River near Lake Success", which is located 3.2 miles downstream of the Reservation boundary. The USGS operated the gage from water year 1930 to water year 1990. After that period, the U.S. Army Corps of Engineers (COE) took responsibility for the gage. The COE uses flow data from Gage 4500 to assist in operating Lake Success Dam. The streamflow records include 79 complete years of data, which include records overlapping the entire periods of record for Gages 4100 and 3580.

4.2 Streamflow Characteristics

Figure 4-1 shows a 15-day moving average of the average daily streamflow of the South Fork Tule River. The daily average streamflow follows a distinct seasonal pattern typical of rivers along the western Sierra Nevada Mountains. Beginning around November, streamflow increases with increasing precipitation. Peak flows generally occur around the end of March, representing the peak runoff from snowmelt. As temperatures increase and precipitation decreases during summer months, streamflow rates steadily drop until reaching minimum flows around September. The average September streamflow is approximately 2-percent of the average streamflow in March.

Figure 4-1: South Fork Tule River Daily Average Streamflow



4.3 Streamflow Extension

In order to thoroughly examine the hydrology of the South Fork Tule River basin, it is desirable to extend the record of the two on-Reservation gages over a longer period than the actual recorded data. Extending the flow records at the gages helps to ensure that they contain sufficient variation in flows to be representative of the long-term hydrology in the basin and is useful for planning purposes - such as the sizing of a future reservoir.

The period of record for the two on-Reservation gages covers complete water years 2001-2011 (eleven years). Through the flow extension analysis the period of record at both gages is increased to the period covering water years 1949 to 2011. Water years 1955 and 1956 are excluded due to missing data. The extended period of record is 61 years.

4.3.1 Streamflow Record Extension of Gage 4100

The record of Gage 4100 is extended using the data from Gage 4500. Figure 4-2 plots the measured streamflow at Gage 4500 against the corresponding measured flow at Gages 4000 and 4100 for the entire overlapping period of record (1931-32, 2001-11)[2]. Close examination of this figure reveals changes in the relationship between the two locations at different flow magnitudes. In order to best capture the correlation between flows at Gage 4500 and the western Reservation boundary, the flow records were split up into three ranges generally corresponding to low, medium, and high flow ranges as determined by the flow magnitude at Gage 4500 (Table 4-2). This was done to better represent the behavior of the river under the range of flow conditions typically experienced.

[2] Flow data from Gages 4100 and 4000 are used to represent a single location in this analysis, which is essentially the river near the western Reservation boundary.

Figure 4-2: Flow at Gage 4500 v. Gage 4000/4100 (≤ 300 cfs), WY 1931, 1932, 2001-2011

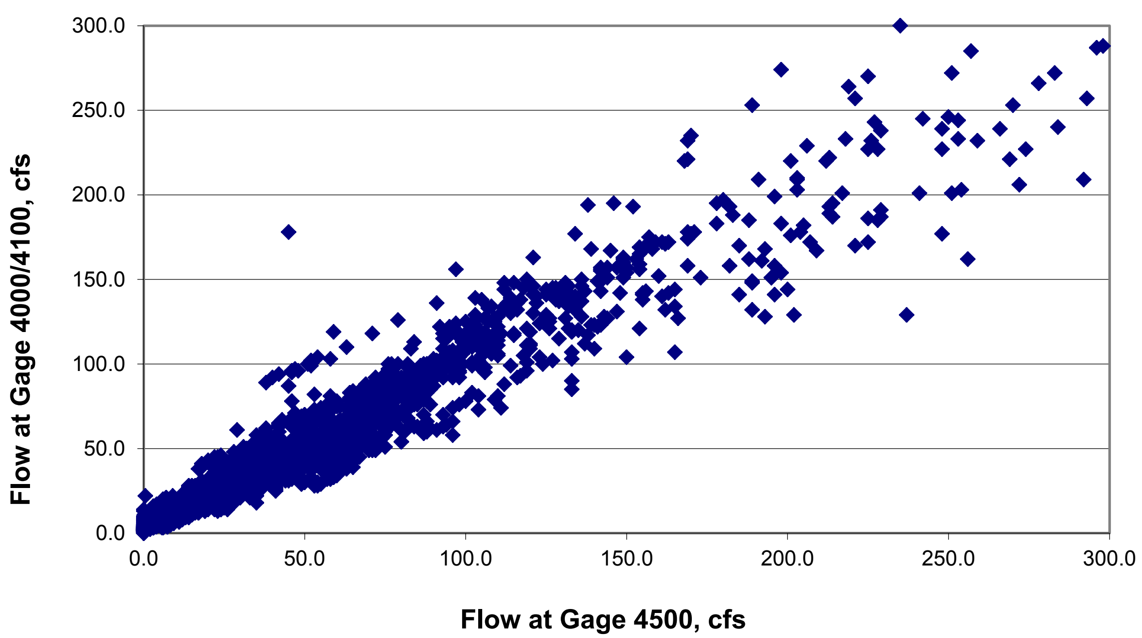


Table 4-2: Flow Ranges for Extension of Gage 4100

Flow Range	Flow Limits*
Low	$Q_{4500} \leq 5$ cfs
Medium	5 cfs < $Q_{4500} \leq 60$ cfs
High	$Q_{4500} > 60$ cfs

*Q_{4500} is the daily discharge at Gage 4500, in cfs.

4.3.1.1 Low-Flow Record Extension

Low flows, defined as flows at Gage 4500 less than or equal to approximately 5 cfs, are highly influenced by seepage and depletion by riparian vegetation. In addition, the South Tule Independent Ditch Company (STIDC) is capable of diverting most, if not all, of these low flows during certain times of the year. While there are numerous days of recorded zero flow at Gage 4500, there are very few days of zero flow at Gage 4000 and no recorded days of zero flow at Gage 4100. Therefore, poor correlation exists for the low-flow range (Figure 4-3) making regression techniques impractical. Instead, the average daily flow value at Gage 4100 was estimated for each month during those days when the flow at Gage 4500 was less than or equal to 5 cfs and assigned these average low-flows under the same flow conditions. These average low-flow values are listed in Table 4-3. For February and March, there were no recorded instances of flow less than or equal to 5 cfs at Gage 4500 during the overlapping period of record. For these two months, the average low-flow value was estimated as the average of the January and April values.

Figure 4-3: Flows at Gage 4500 v. Gage 4000/4100 (< 5 cfs), WY 1931, 1932, 2001-2011

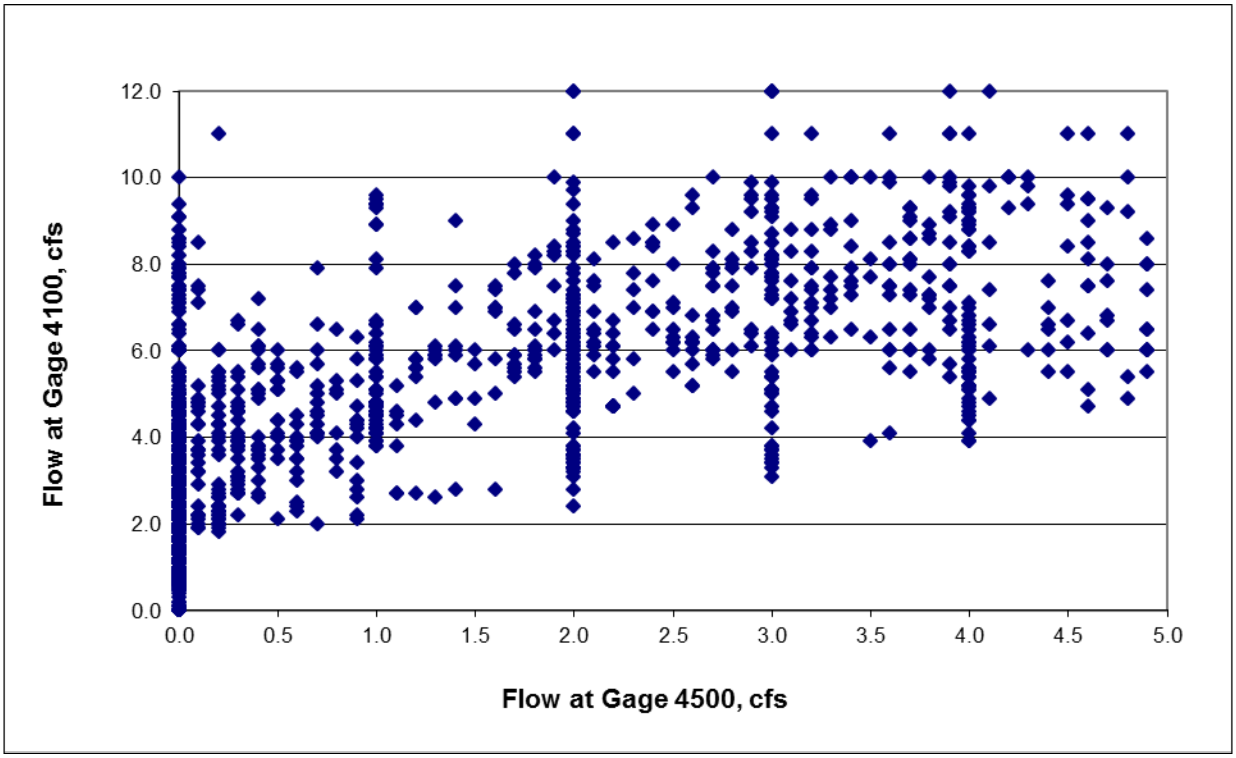


Table 4-3: Average Daily Low-Flows for Extension of Gage 4100, cfs

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
4.2	5.0	6.0	7.4	7.8*	7.8*	8.2	6.7	6.3	4.6	3.3	3.3

*February and March low flows estimated as average of January and April values.

4.3.1.2 Medium Flow Record Extension

For medium flows (5 cfs < Q_{4500} < 60 cfs), the natural logarithm transformed regression was used in the following form (Maidment, 1993):

$$\hat{Q}_{4100} = e^{\left(k + bX + 0.5s^2\right)}$$

where: $\hat{Q}_{4100}$ = *Estimated daily flow at Gage 4100, cfs*

X = *Natural log of daily flow at Gage 4500, ln(Q_{4500})*

k = *Regression constant = 0.444*

b = *Regression coefficient = 0.880*

s^2 = *Standard error of regression = 0.0580*

The R^2 factor is a regression parameter that indicates the goodness of fit of the regression equation measured against the actual data. An R^2 of 1 indicates that the flows at Gage 4100 are correlated perfectly with flows at Gage 4500, while an R^2 of 0 indicates no relationship between the flows at the two gages. The R^2 value for the medium flow regression analysis is 0.86.

4.3.1.3 High Flow Record Extension

For high flows (Q_{4500} > 60 cfs), Gage 4100 was extended using normal linear regression in the following form:

$$\hat{Q}_{4100} = k + bQ_{4500}$$

where: $\hat{Q}_{4100}$ = *Estimated daily flow at Gage 4100, cfs*
Q_{4500} = *Daily flow at Gage 4500, cfs*
k = *Regression constant = 5.22*
b = *Regression coefficient = 0.955*

The R^2 value for the high flow regression analysis is 0.88.

4.3.2 Streamflow Record Extension of Gage 3580

Examining the eleven complete years of overlapping data for Gages 4100 and 3580 reveals that although the flows at the two gages are closely related, there is a systematic difference that should be recognized. Figure 4-4a, 4-4b, 4-4c and 4-4d display the daily flow at Gages 3580 and 4100 for water years 2001 through 2011. The figures show that streamflows at the two gages generally follow the same pattern but differ in magnitude. Analysis of the data reveals a two-season relationship. The first season corresponds to the rising limb of the hydrograph, typically November up to the beginning of May, at which time the flow peaks. During this period, the flows at Gage 4100 are consistently larger than the flows at Gage 3580. The second season occurs during the falling-limb of the hydrograph, typically May through October. During this period, the relative magnitude of flows at Gage 4100 rapidly declines and closely approximates the flow at Gage 3580 by mid- to late-summer. Figures 4-5 and 4-6 plot the daily flows at Gage 4100 against the corresponding flows at Gage 3580 for the rising-limb and falling-limb seasons, respectively.

This two-season relationship occurs because during the winter and spring leading up to the year's peak flow (i.e., the rising-limb of the hydrograph), flow is predominantly snowmelt and there are contributions from most of the tributaries, including those between the two gages. Thus, flow increases as you move downstream. During the falling-limb season, most of the flow transitions from snowmelt to base flow and there is likely significant depletion by riparian vegetation relative to the flow. Contributions from the lower tributaries during this time (mainly the summer and early fall) are minimal.

Separate regression equations for the rising-limb and falling-limb seasons were used to account for the variations between the two-seasons. During the transition between the rising-limb to the falling-limb, the regression equations are applied on a weighted basis each year during a three-day transition period (April 30 to May 2). Table 4-4 shows the ratio of the regression equations used during the transition period. No transition period was found to be necessary between the two periods at the end of October.

Figure 4-4a: South Fork Tule River On-Reservation Daily Gage Flow (WY 2001-2003)

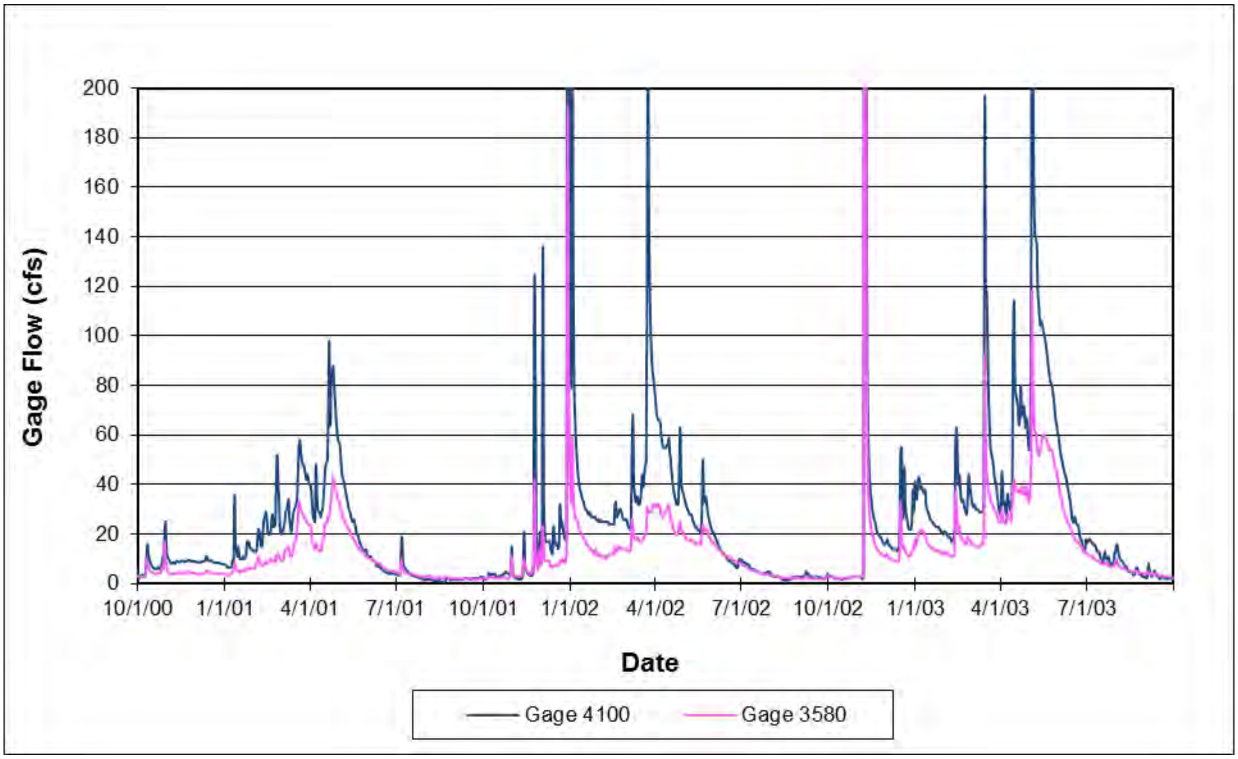


Figure 4-4b: South Fork Tule River On-Reservation Daily Gage Flow (WY 2004-2006)

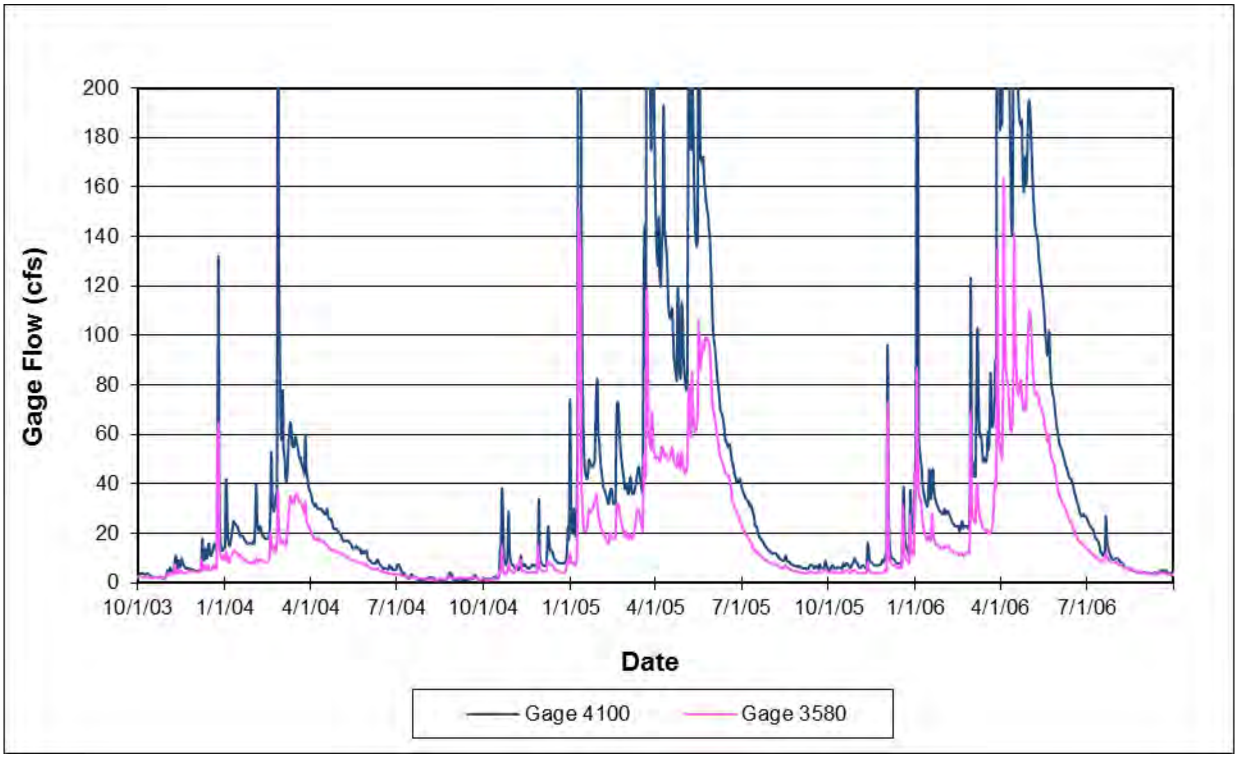


Figure 4-4c: South Fork Tule River On-Reservation Daily Gage Flow (WY 2007-2009)

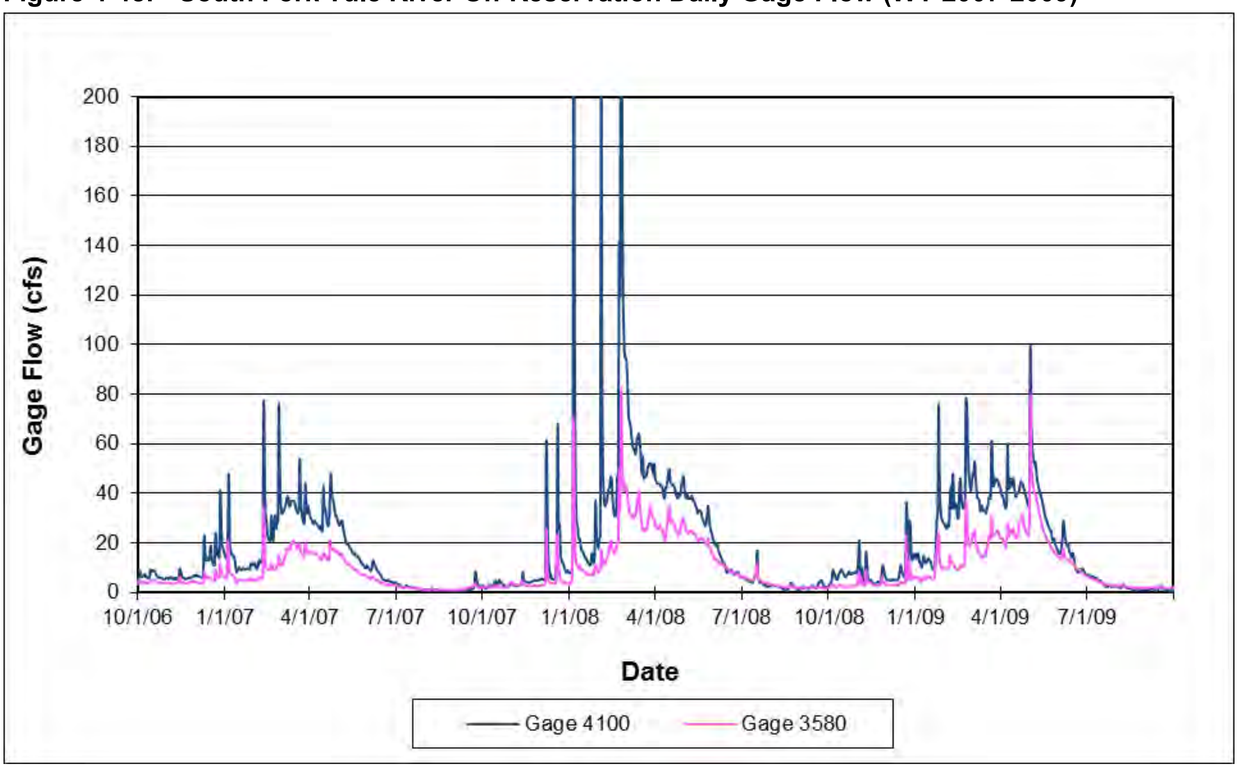


Figure 4-4d: South Fork Tule River On-Reservation Daily Gage Flow (WY 2010-2011)

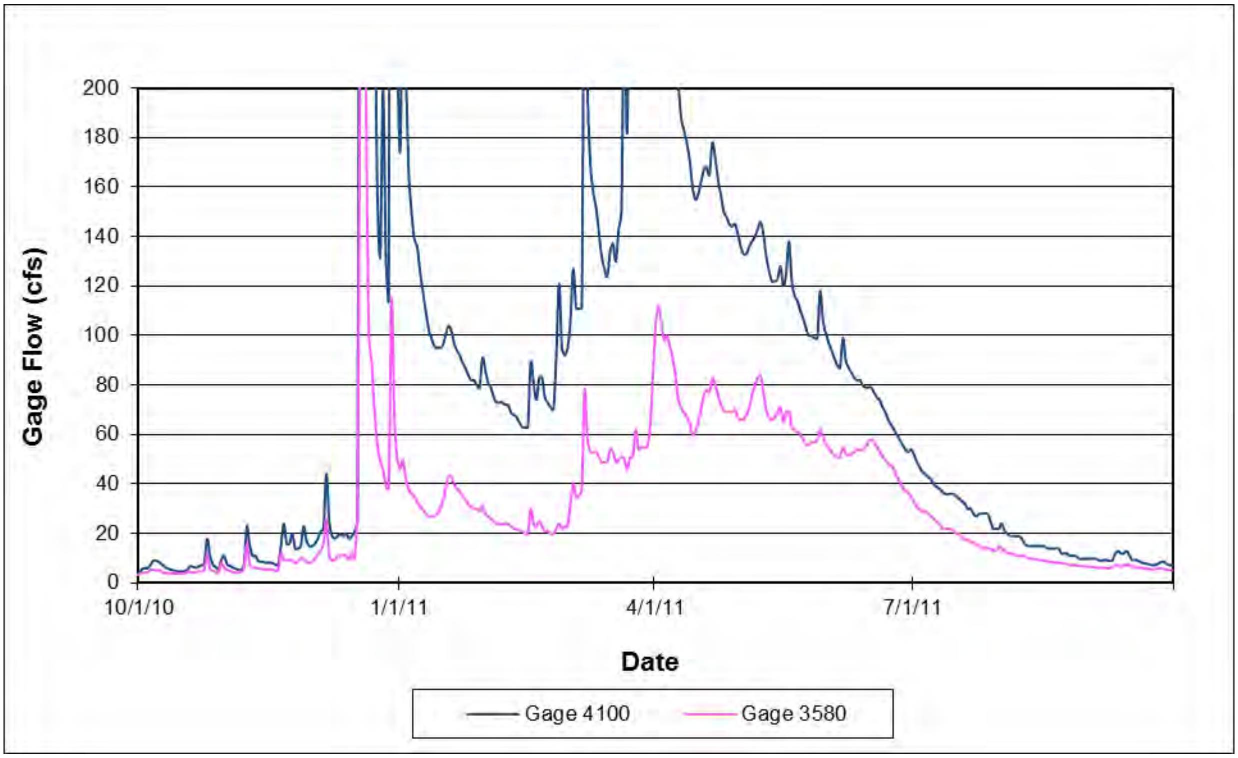


Figure 4-5: Flow at Gage 4100 v. Gage 3580, Rising-Limb Season, WY 2001-2011

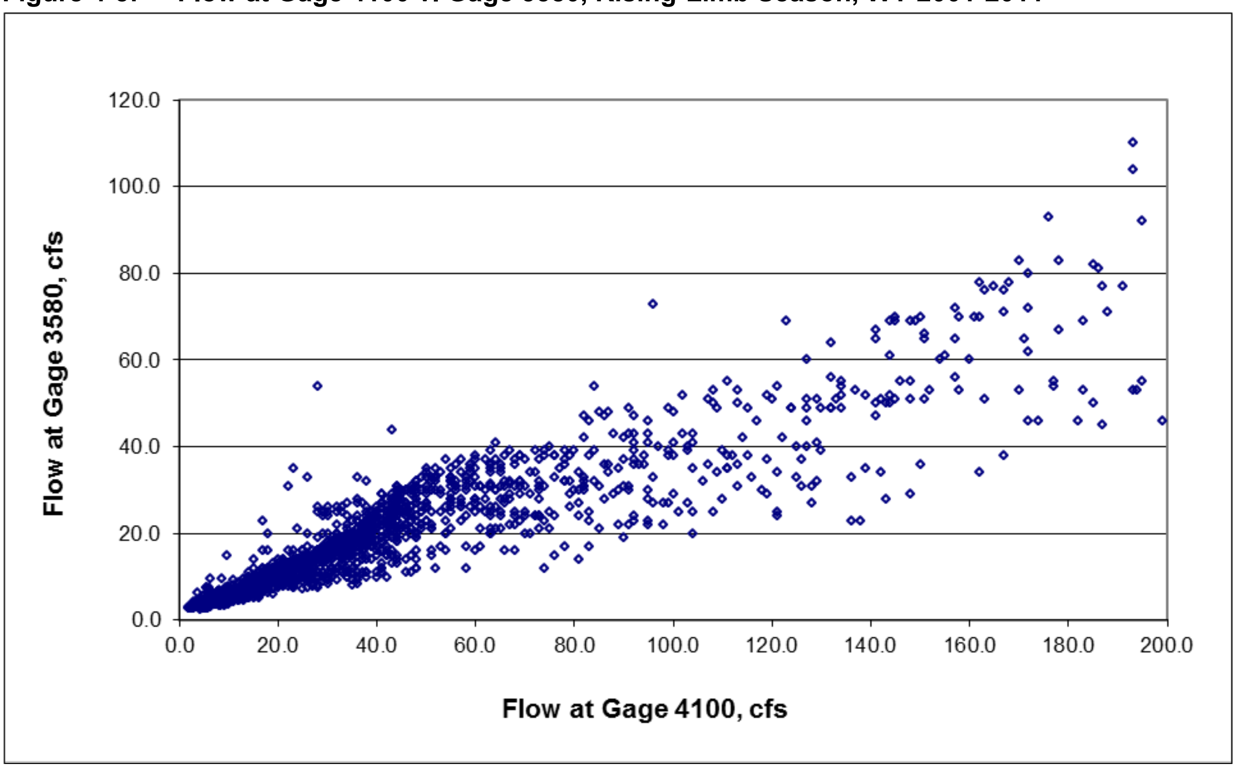


Figure 4-6: Flow at Gage 4100 v. Gage 3580, Falling-Limb Season, WY 2001-2011

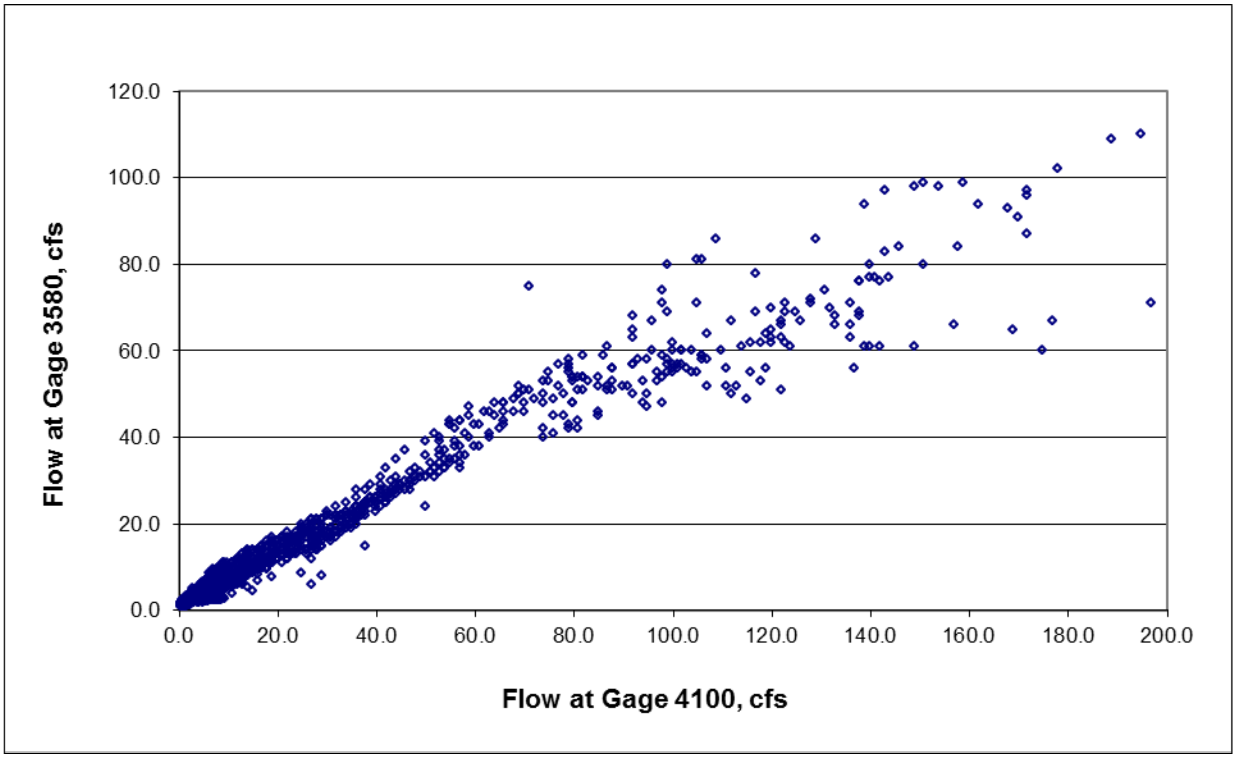


Table 4-4: Ratio of the Regression Equations applied during the Transition Period.

Transition Date	Ratio High Flow : Low Flow
April 30	2:1
May 1	1:1
May 2	1:2

4.3.2.1 Rising- and Falling-Limb Regression Equation Analysis

At Gage 3580, the flows are separated into rising-limb and falling-limb ranges. The rising-limb season is considered from November 1 to April 30 and the falling-limb season from May 1 to October 31.[3] For each of these two parts, a regression relationship was developed to best fit the observed data.

[3] Since the regression equations are applied on a ratio basis for the transition period from April 30 to May 2, these three days are included in both the rising-limb and falling-limb regression analyses.

4.3.2.2 Rising-Limb Season

For the rising-limb season, Gage 3580 was extended using natural logarithm transformed regression in the following form (Maidment, 1993):

$$\hat{Q}_{3580} = e^{\left(k + bX + 0.5s^2\right)}$$

where:

$\hat{Q}_{3580}$ = *Estimated daily flow at Gage 3580, cfs*
X = *Natural log of daily flow at Gage 4100, ln(Q_{4100})*
k = *Regression constant = -0.032*
b = *Regression coefficient = 0.796*
s = *Standard error of regression = 0.067*

The R^2 value for the Part A regression analysis is 0.92.

4.3.2.3 Falling-Limb Season

For the falling-limb season, a second order regression relationship was applied in the following form:

$$\hat{Q}_{3580} = k + b1Q_{4100} + b2(Q_{4100})^2$$

where:

k = *Regression constant = 0.614*
$b1$ = *First regression coefficient = 0.694*
$b2$ = *Second regression coefficient = -0.00116*

The R^2 value for the Part B regression analysis is 0.97.

4.3.3 Results

The flow characteristics for Gage 4100 and Gage 3580 resulting from the gage flow extension analysis are summarized in Table 4-5. Flows recorded at Gage 4100 are assumed to be approximately equal to the flows at the Reservation's western boundary.

Table 4-5: South Fork Tule River Extended Gage Flow Characteristics

Gage No.	Average Flow (acre-feet per year)	50% Exceedance Flow (acre-feet per year)	80% Exceedance Flow (acre-feet per year)
4100	33,900	23,100	12,000
3580	14,400	11,100	6,600

Note: Record extension period is WY 1949-2011, excluding 1955-56.

4.3.3.1 Gage 4100 Flow Extension

The predicted and measured flows for Gage 4100 are presented in Figure 4-7a, 4-7b, 4-7c and 4-7d. As shown in these figures, the flows predicted by the regression equations reasonably approximate the actual flows, although there are periods of both over- and under-estimation. It should be noted that for purposes of reservoir evaluation modeling, it is the low and medium flows that have the largest impact on reservoir sizing.

Figure 4-7a: Predicted versus Measured Flow at Gage 4100, WY 2001-2003

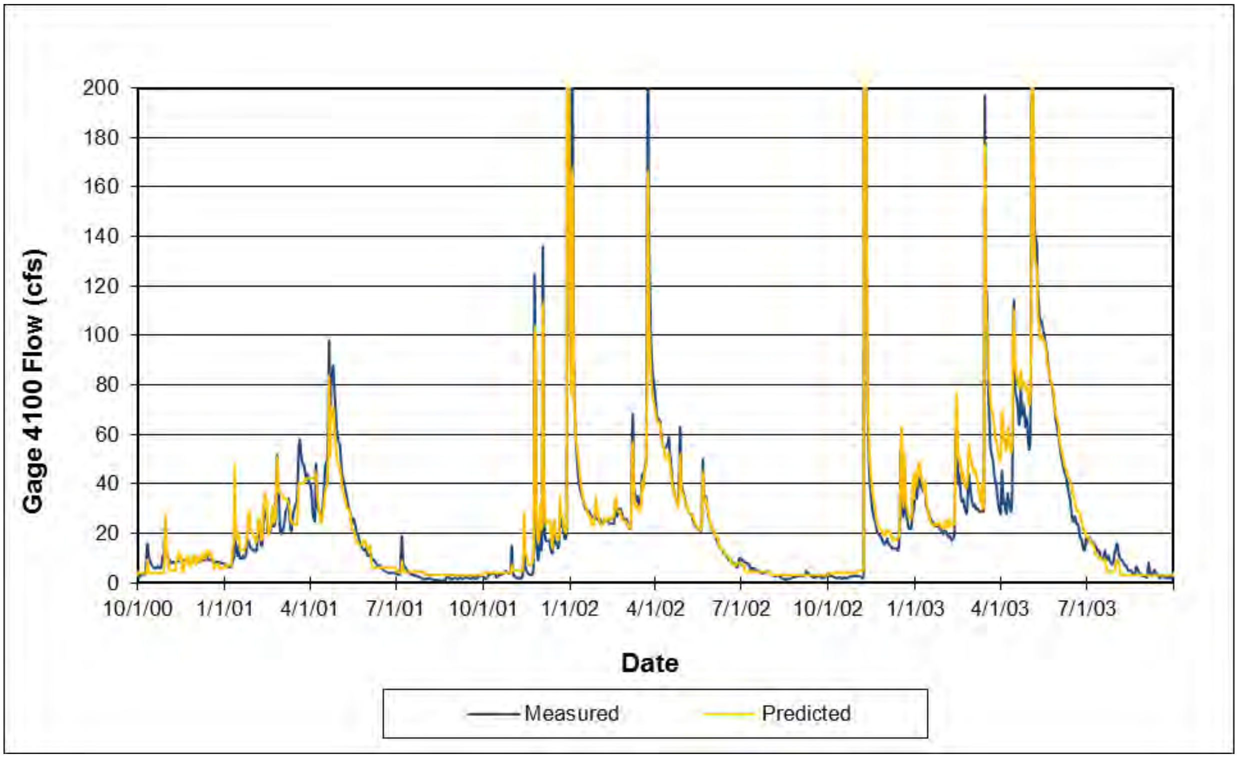


Figure 4-7b: Predicted versus Measured Flow at Gage 4100, WY 2004-2006

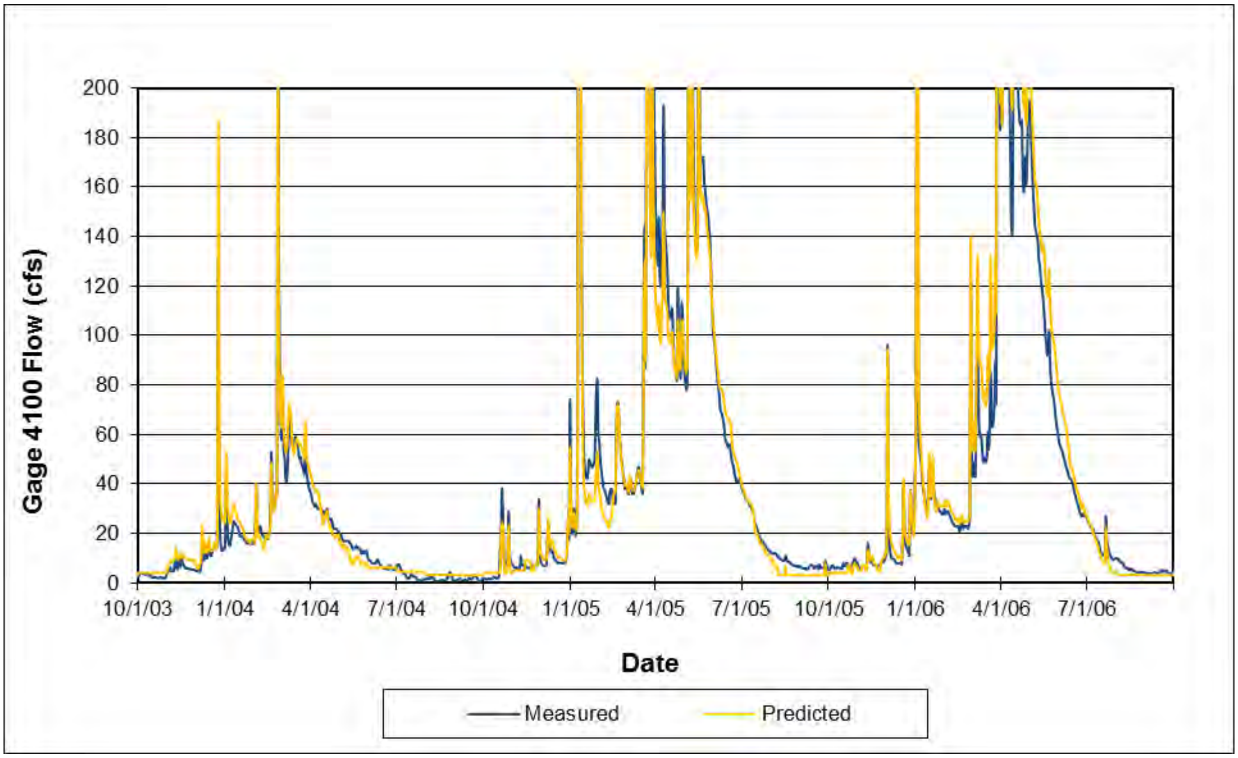


Figure 4-7c: Predicted versus Measured Flow at Gage 4100, WY 2007-2009

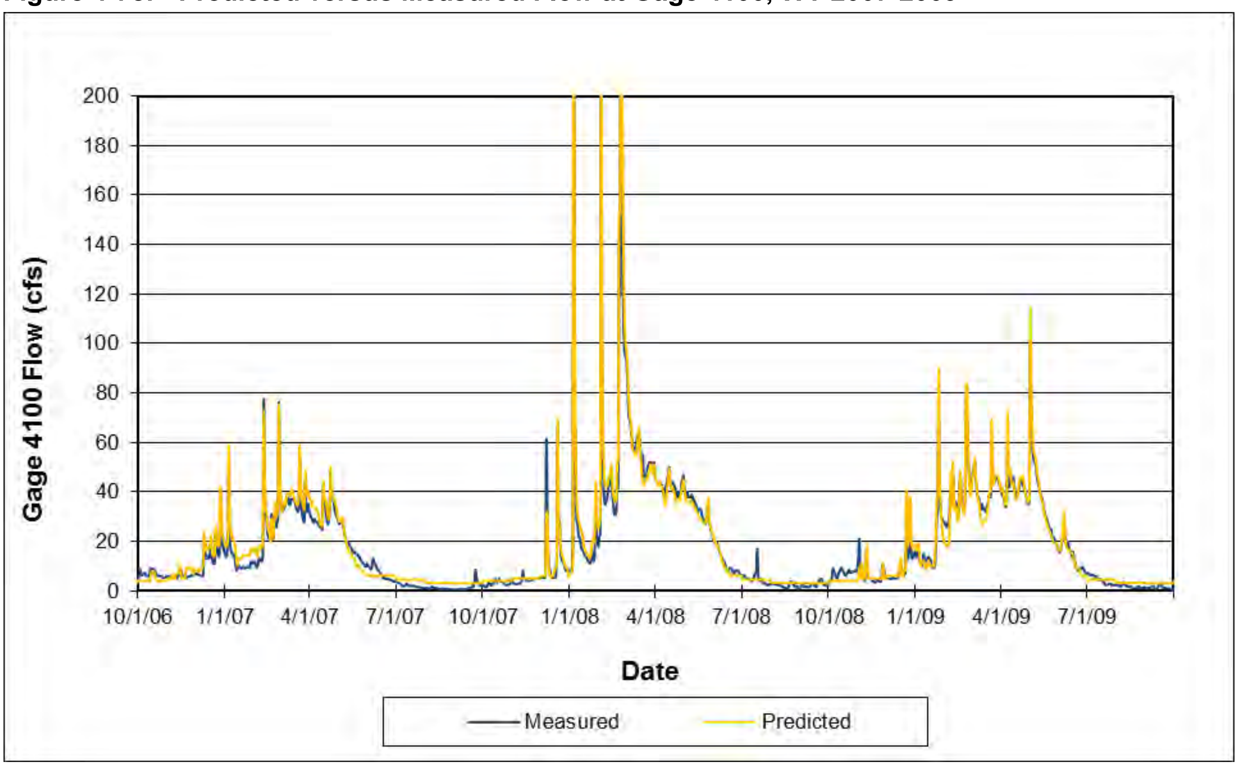
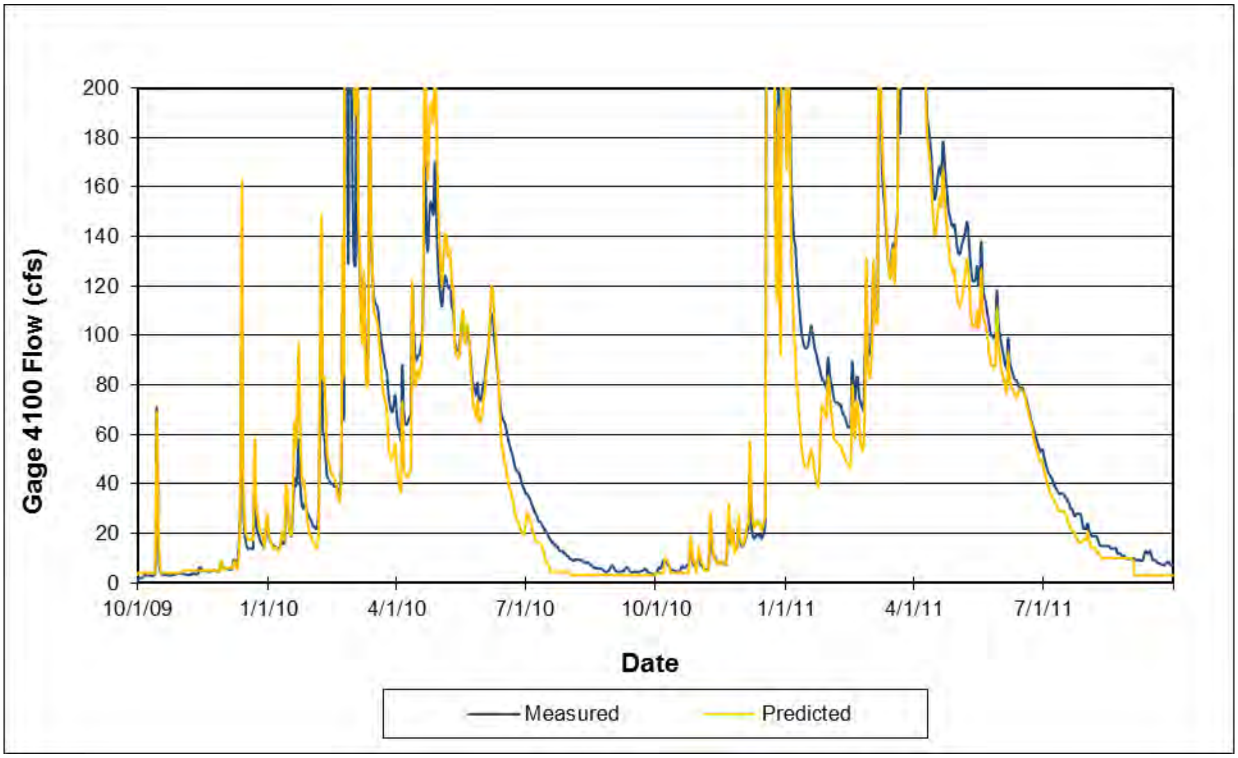


Figure 4-7d: Predicted versus Measured Flow at Gage 4100, WY 2010-2011



4.3.3.2 Gage 3580 Flow Extension

Figure 4-8a, 4-8b, 4-8c and 4-8d display the predicted flows at Gage 3580 for water years 2001-2011, as well as the measured flows during this same period for comparison. The predicted flows accurately approximate the measured flows for both the rising and falling limbs of the hydrograph, although there are periods of both over- and under-estimation.

Figure 4-8a: Predicted versus Measured Flow at Gage 3580, WY 2001-2003

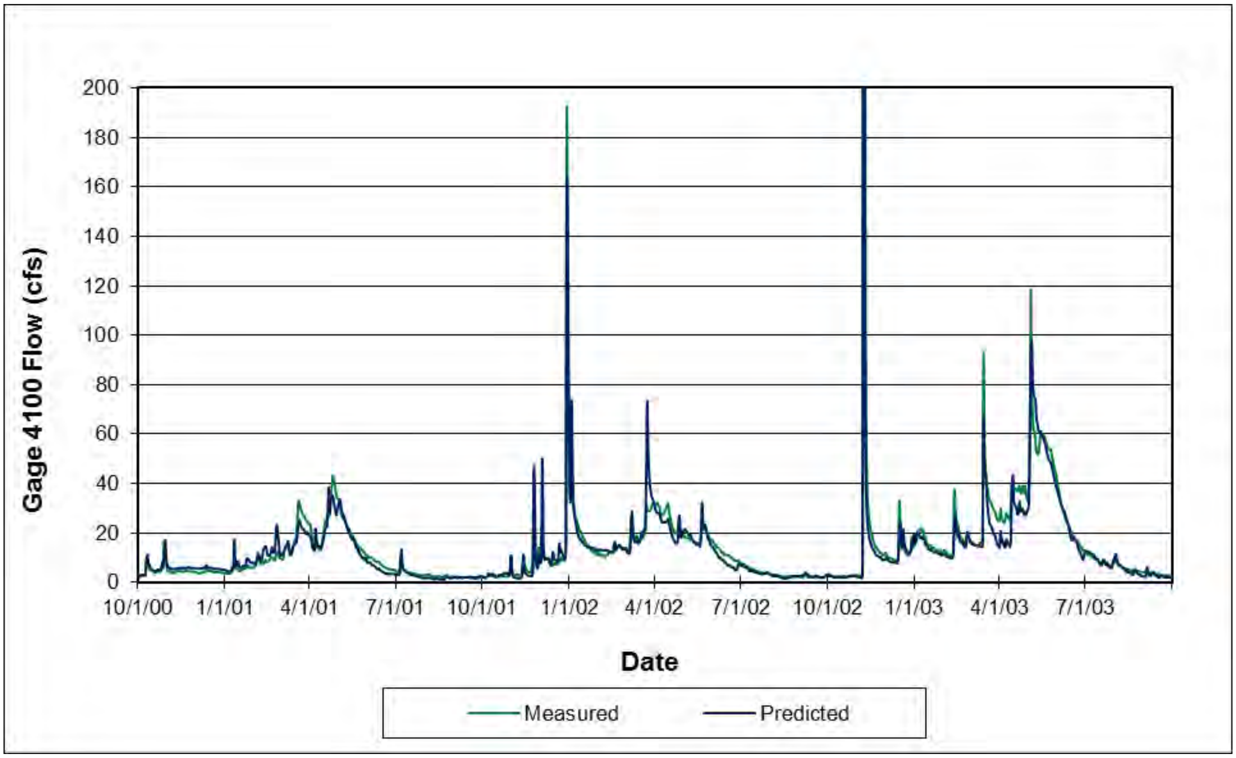


Figure 4-8b: Predicted versus Measured Flow at Gage 3580, WY 2004-2006

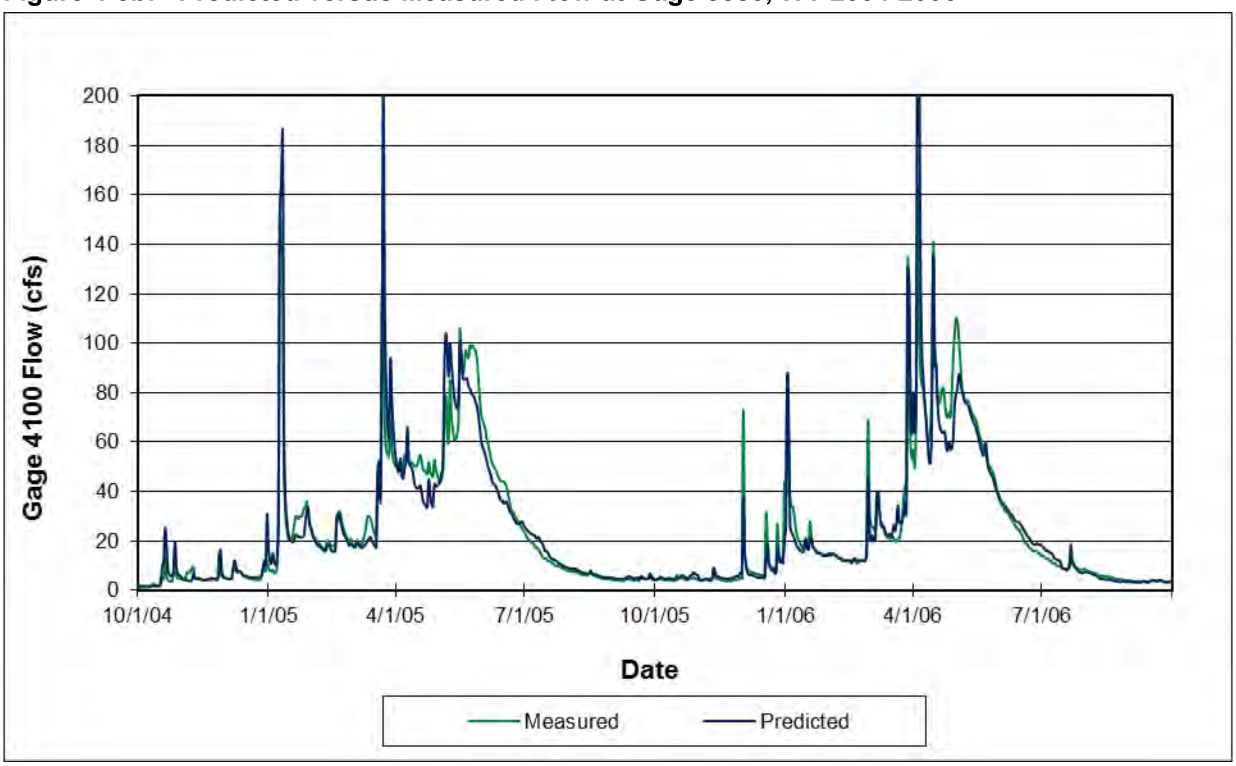


Figure 4-8c: Predicted versus Measured Flow at Gage 3580, WY 2007-2009

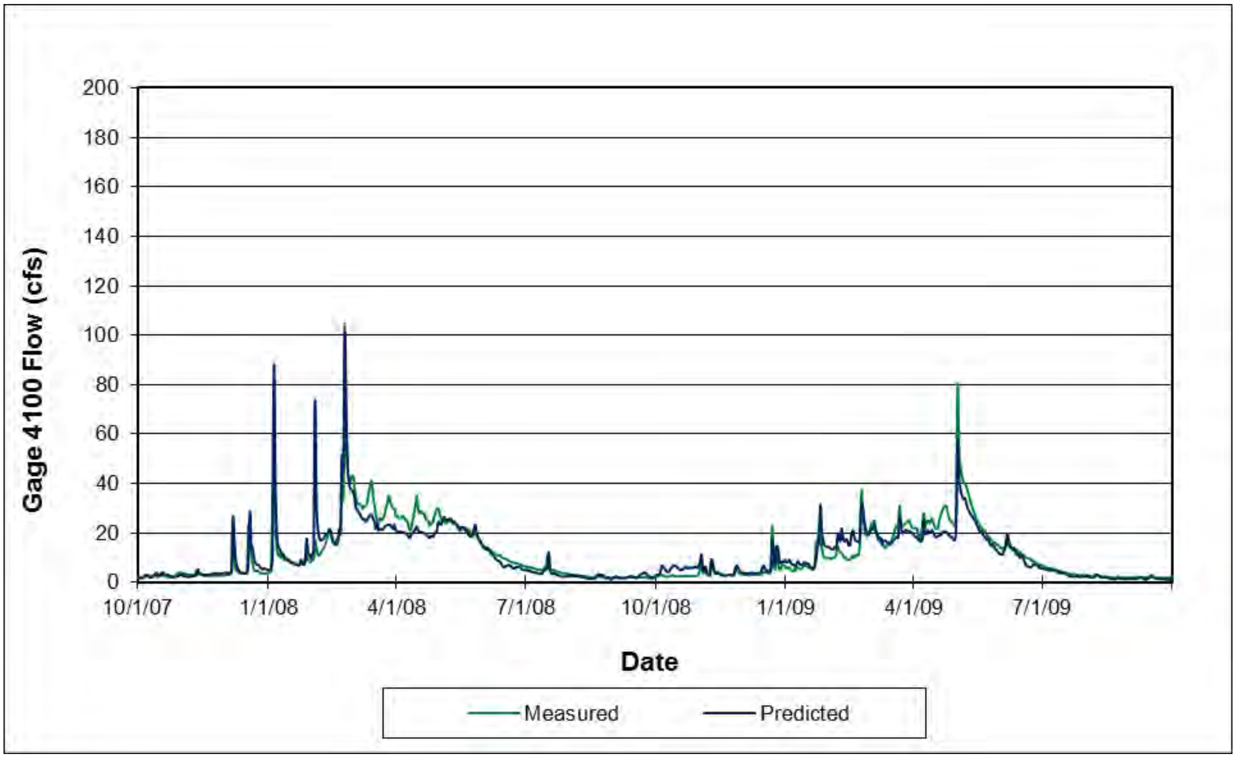
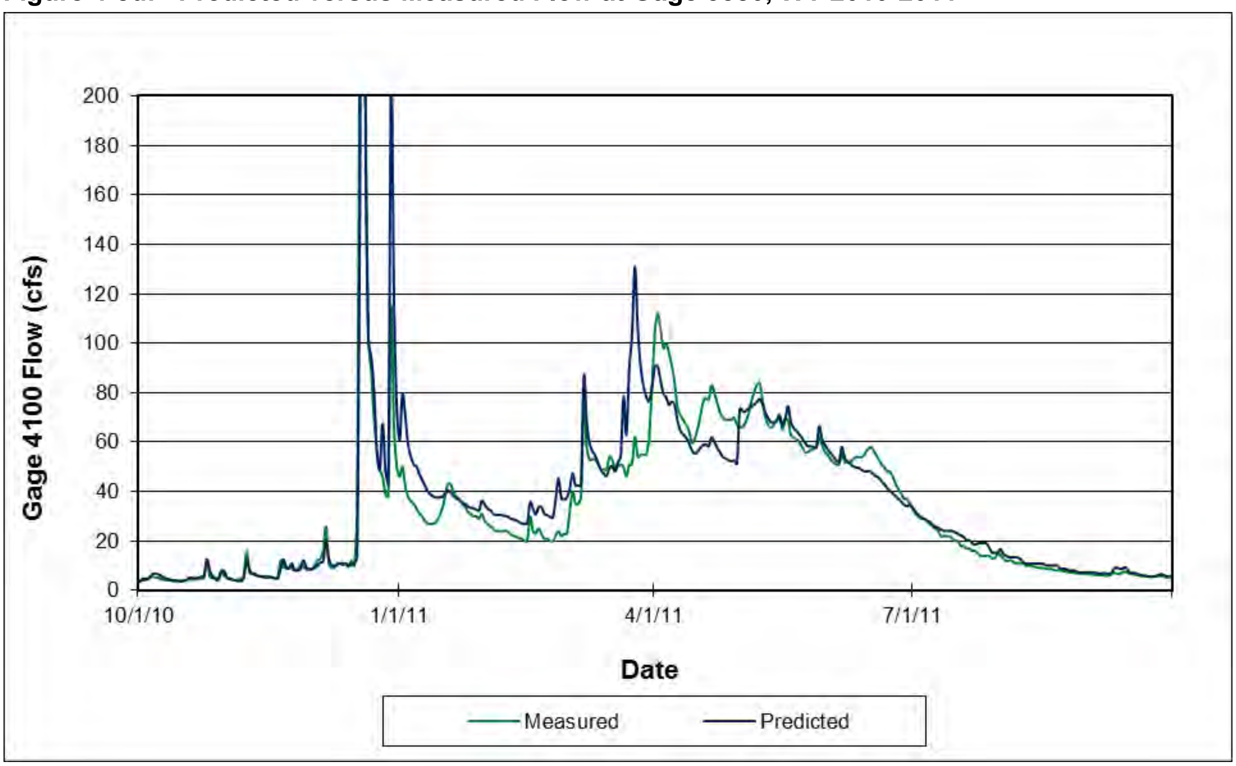


Figure 4-8d: Predicted versus Measured Flow at Gage 3580, WY 2010-2011



4.4 Climate Change Considerations

Reclamation has been studying the effects of climate change in relation to water supply and demand in the western United States for many years. Based on this ongoing work, Reclamation offered the following discussion of climate change considerations specific to the Central Valley, the Tulare Lake Basin, and the Tule River Indian Tribe.

4.4.1 Historical and Current Conditions

The South Fork Tule River drainage basin is located on the southeastern boundary of the Central Valley of California. The Central Valley is divided into three regions including the Sacramento, San Joaquin and Tulare Lake Basins. The South Fork Tule River flows into the Tule River which drains into the Tulare Lake Basin. The Sacramento River drains the northern portion and the San Joaquin drains the central and southern portions of the Central Valley. Both of these rivers flow into the Sacramento-San Joaquin Delta. Typically, the Tulare Lake Basin is internally drained. However, in some wetter than normal years, flow from the Tulare Lake region reaches the San Joaquin River.

The historic climate of the Central Valley is characterized by hot and dry summers and cool and damp winters. Basin average mean-annual temperature has increased by approximately 2 °F for the area during the course of 20^{th} century. The Sacramento Valley receives greater precipitation than the San Joaquin and Tulare Lake basins. In winter, temperatures below freezing may occur, but snow in the valley lowlands is rare. Stream flow in the Sacramento River and San Joaquin River basins has historically varied considerably from year to year. Runoff is generally greater during the winter to early summer months, with winter runoff generally originating from rainfall-runoff events and spring to early summer runoff generally supported by snowmelt from the Cascade Mountains and Sierra Nevada. During the course of 20^{th} century a decline in spring runoff and an increase in winter runoff were observed in the basin.

4.4.2 Studies of Future Climate and Hydrology

There exists a potential for climate change to adversely impact existing and planned water supplies via changes in precipitation, temperature, snow water equivalent (SWE), and stream flows (in both timing and magnitude). Future changes in Central Valley climate and hydrology have been the subject of numerous studies. A good summary of studies completed prior to 2006 was published by Vicuna and Dracup (2007). For the Central Valley watersheds, Moser et al. (2009) reports specifically on future climate possibilities over California and suggest that warmer temperatures are expected during the 21^{st} century, with an end-of-century increase of 3-10.5 °F.

The effects of projected changes in future climate were assessed by Maurer (2007) for four river basins in the western Sierra Nevada contributing to runoff in the Central Valley. These results indicate a tendency toward increased winter precipitation; this was quite variable among the models, while temperature increases and associated SWE projections were more consistent. The effect of increased temperature was shown by Kapnick and Hall (2009) to result in a shift in the date of peak of snowpack accumulation to 4-14 days earlier in the winter season by the end of the century. Null et al. (2010) reported on climate change impacts for 15 western-slope watersheds in the Sierra Nevada under warming scenarios of 2, 4, and 6 °C increase in mean-annual air temperature relative to historical conditions. Under these scenarios, total runoff decreased; earlier runoff was projected in all watersheds relative to increasing temperature scenarios; and the high elevation southern-central region was more susceptible to earlier runoff.

4.4.2.1 Reclamation Studies of Future Climate and Hydrology

The potential risk that climate change poses to water supply is the motivation behind Public Law 111-11, Subtitle F (SECURE Water Act), section 9503 which authorizes the U.S. Department of Interior's Bureau of Reclamation (Reclamation) to assess climate change risks for water and environmental resources in "major Reclamation river basins." This assessment is being carried out through Reclamation's WaterSMART Basin Study Program. Of the eight major river basins being studied by Reclamation through WaterSMART, the San Joaquin River Basin is the one in closest proximity (and thus of greatest relevance) to the South Fork Tule River drainage basin in which development of water supplies are being evaluated for the Tule River Indian Tribe.

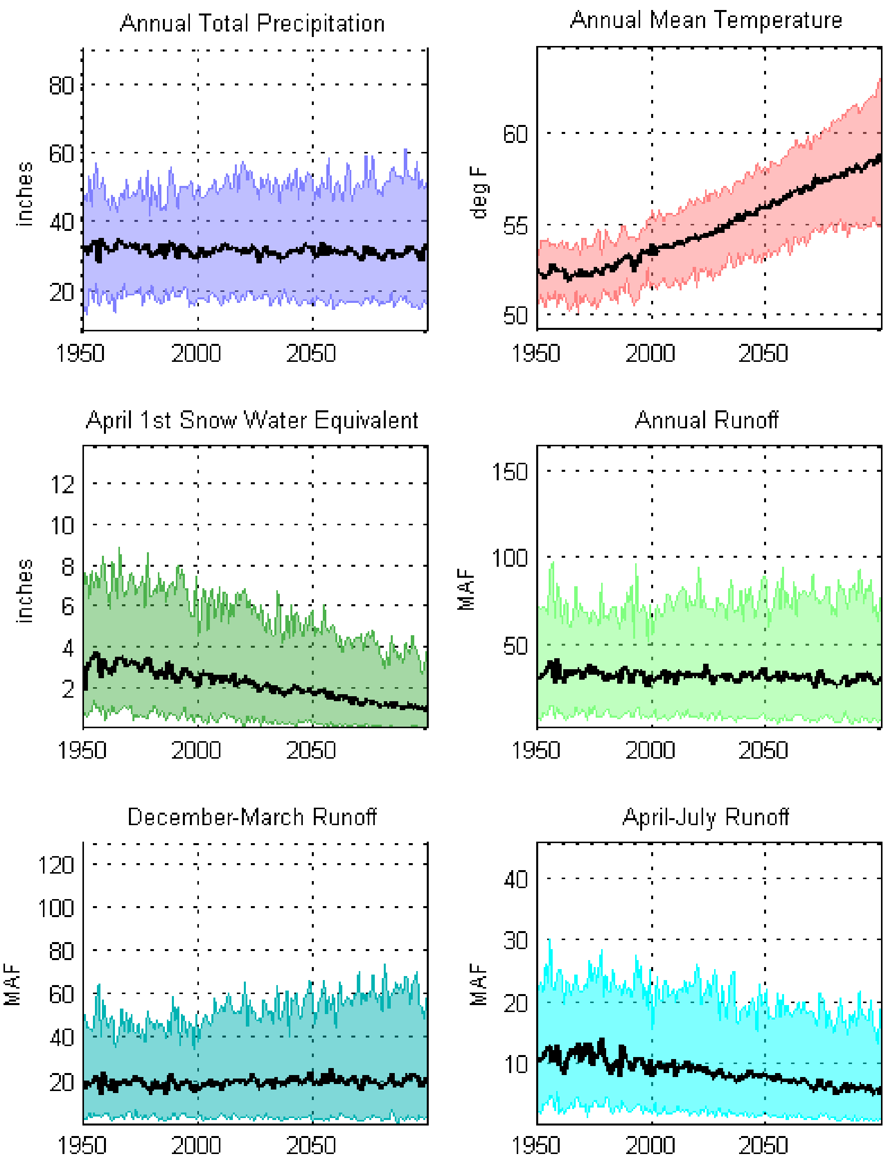
An initial report assessing climate change risks in the eight major basins has been released by Reclamation as Technical Memorandum (TM) No. 86-68210–2011-01**:** West-Wide Climate Risk Assessments: Bias-Corrected and Spatially Downscaled Surface Water Projections (2011a). This section on potential impacts of climate change describes the assessment of TM No. 86-68210–2011-01 with a focus on the San Joaquin Basin and the possible implications for the South Fork Tule River drainage basin. While this information is provided to assist in planning for and adapting to potential risks to the Tribe's water supply due to climate change, it is not intended to represent a quantitative analysis of such risks. While some quantitative estimates from TM No. 86-68210–2011-01 are presented for the San Joaquin Basin, they are intended to provide a qualitative assessment for the South Fork Tule River drainage basin specifically.

4.4.2.2 Hydroclimate Projections

TM No. 86-68210–2011-01 provides projections of the following hydroclimate variables: precipitation, temperature, snow water equivalent (SWE), and stream flow. These projections are based on climate projections from the World Climate Research Programme Coupled Model Intercomparison Project3 (WCRP CMIP3) that has been bias-corrected and spatially downscaled. These climate projections in turn were the basis for hydrologic projections based on watershed applications of the Variable Infiltration Capacity (VIC) macroscale hydrology model (Liang, et al., 1996). From these time-series climate and hydrologic projections (or hydroclimate projections), changes in hydroclimate variables were computed for three future decades: 2020s (water years 2020–2029), 2050s (water years 2050–2059) and 2070 (water years 2070–2079) from the reference 1990s' decade (water years 1990–1999). The reference 1990s refers to the ensemble of simulated historical hydroclimates, not the observed 1990s.

Figure 4-9 shows ensembles of hydroclimate projections for the combined Sacramento and San Joaquin Basins for six different hydroclimate variables: annual total precipitation (top left), annual mean temperature (top right), April 1st SWE (middle left), annual runoff (middle right), December–March runoff season (bottom left), and April–July runoff season (bottom right). The heavy black line is the annual time series of 50 percentile values (i.e., ensemble-median). The shaded area is the annual time series of 5th to 95th percentile.

Figure 4-9: Sacramento and San Joaquin Basins – Hydroclimate Projections.



The notable trends gleaned from Figure 4-9 are as follows. Annual mean temperature shows an increasing trend starting in the mid-1970s and continuing throughout the 21st century. The projected median temperature change in 2099 is about +5°F relative to 2000. For annual total precipitation, while Figure 4-9 shows a relatively steady (nominally decreasing) trend , it is important to note that other studies have shown that increases in precipitation are expected in the northern portion of the Central Valley while decreases are expected in the southern portion where the South Fork Tule River is located (Reclamation, 2011b). From the 1970s throughout the 21st century, April 1st SWE shows a decreasing trend. However, annual runoff shows only a nominally decreasing trend mirroring annual precipitation. Winter season runoff shows a nominally increasing trend, and the April–July runoff shows a decreasing trend reflecting the decrease in the spring snowpack and the greater proportion of total precipitation falling as rain rather than snow.

Figure 4-10 shows the spatial distribution of simulated decadal precipitation in the basin above the Sacramento and San Joaquin Rivers at the Delta: simulated 1990s' distribution of ensemble-median decadal mean condition (upper middle) and changes in decadal mean condition for three look ahead (2020s, 2050s, 2070s relative to 1990s) and at three change percentiles within the ensemble (25, 50, and 75). The ensemble-median change shows some increase in precipitation over the basin during the 2020s' decade from the 1990s' reference. By the 2050s, the northern part of the basin still continues to show precipitation increases from the 1990s' reference, but the southern parts of the basin show a decline in precipitation from the 1990s' reference decade. By the 2070s, precipitation across the entire basin shows a decline from the 1990s' reference.

Figure 4-10: Sacramento and San Joaquin Basins – Spatial Distribution of Simulated Decadal Precipitation.

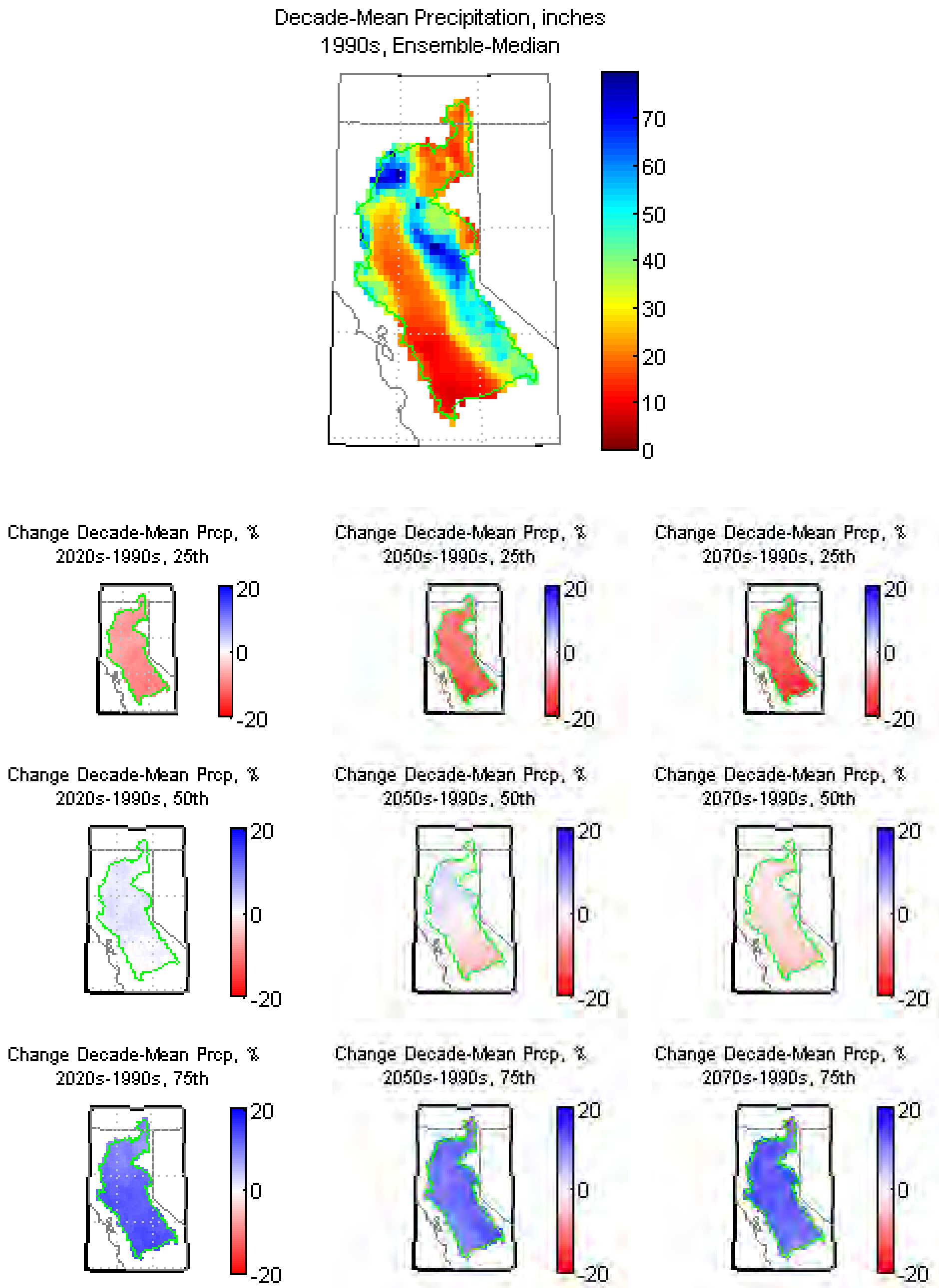


Figure 4-11 shows the spatial distribution of simulated decade mean temperature for the combined Sacramento and San Joaquin Basins: simulated 1990s' distribution of ensemble-median decadal mean condition (upper middle) and changes in decadal mean condition for three projected decades (2020s, 2050s, 2070s relative to 1990s) and at three change percentiles within the ensemble (25, 50, and 75). The median change for the 2020s', 2050s', and 2070s' decades relative to the 1990s shows an increasing temperature value throughout the basin.

Figure 4-11: Sacramento and San Joaquin Basins – Spatial Distribution of Simulated Decadal Temperature.

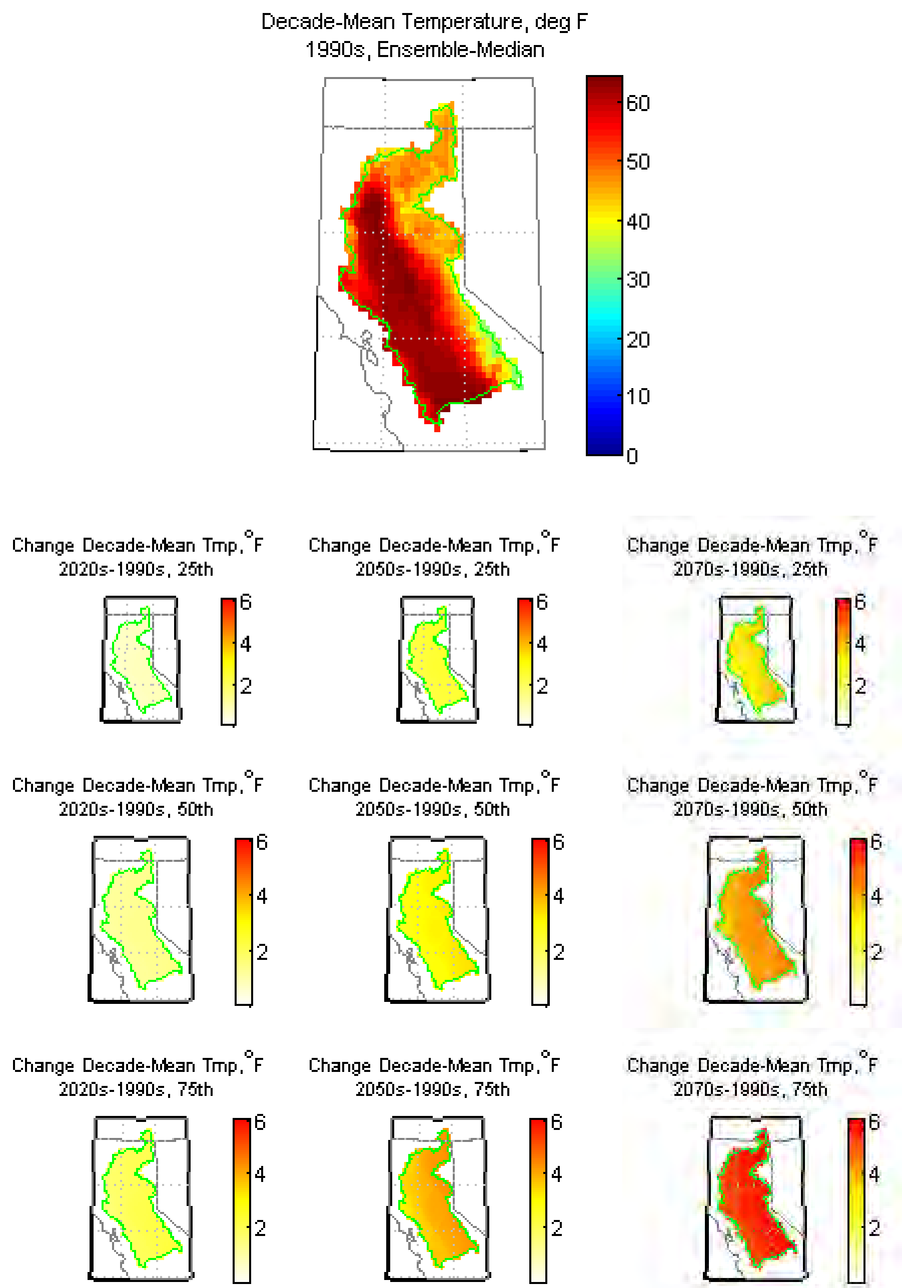
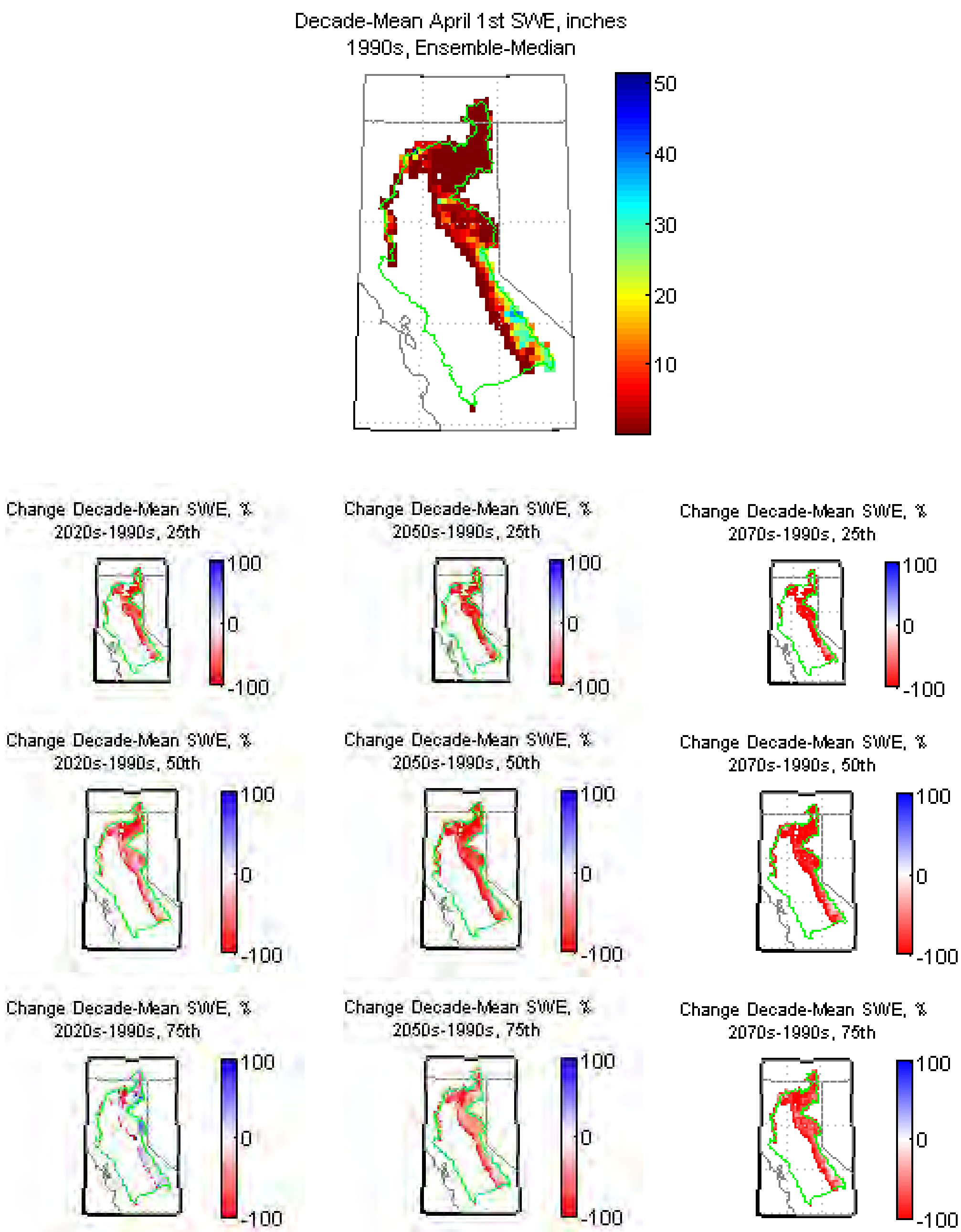


Figure 4-12 shows the spatial distribution of April 1st SWE in the combined Sacramento and San Joaquin Basins: simulated 1990s' distribution of ensemble-median decadal mean condition (upper middle) and ensemble-median change in decadal mean condition for three projected future decades (2020s, 2050s, 2070s relative to 1990s). The April 1st SWE shows persistent decline through the future decades from the 1990s' distribution.

Figure 4-12: Sacramento and San Joaquin Basins – Spatial Distribution of Simulated Decadal April 1st SWE.



4.4.2.3 Impacts on Surface Runoff and Stream Flow Timing

Figure 4-13 shows ensemble-median mean-monthly values (heavy lines) for the 1990s, 2020s, 2050s, and 2070s and the decadal-spread of mean-monthly runoff for the 1990s (black shaded area) and 2070s (magenta shaded area) where spread is bound by the ensemble's 5th to 95th percentile values for each month. For all the locations including Buena Vista Lake in the Tulare Lake Basin, there appears to be an earlier shift in the peak runoff timing; and for some locations, for example the Stanislaus River at New Melones Dam and the San Joaquin River near Vernalis, there is significant earlier shift to the peak runoff timing.

Figure 4-13: Sacramento, San Joaquin and Tulare Lake Basins – Simulated Mean-Monthly Runoff for Various Subbasins.

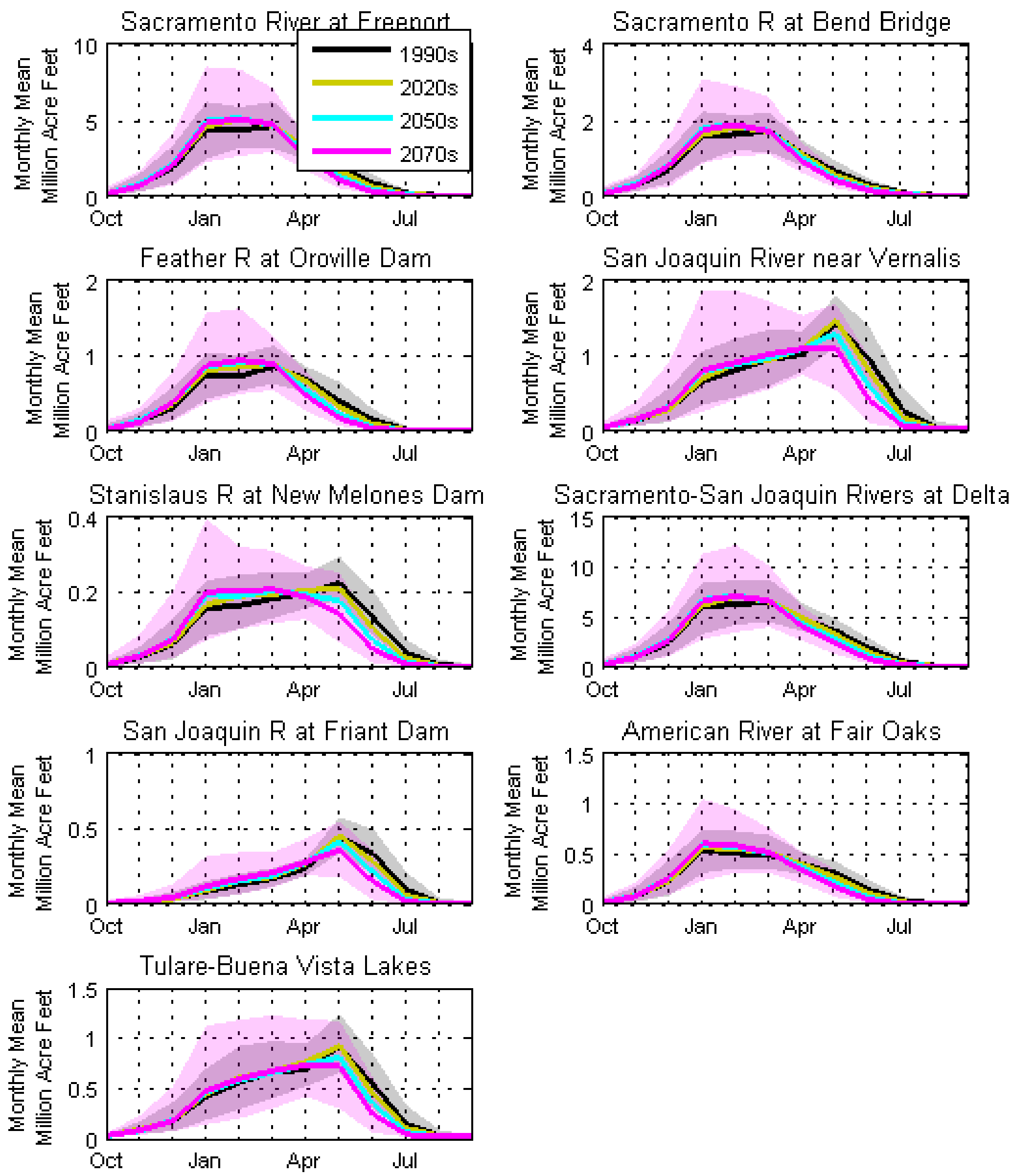
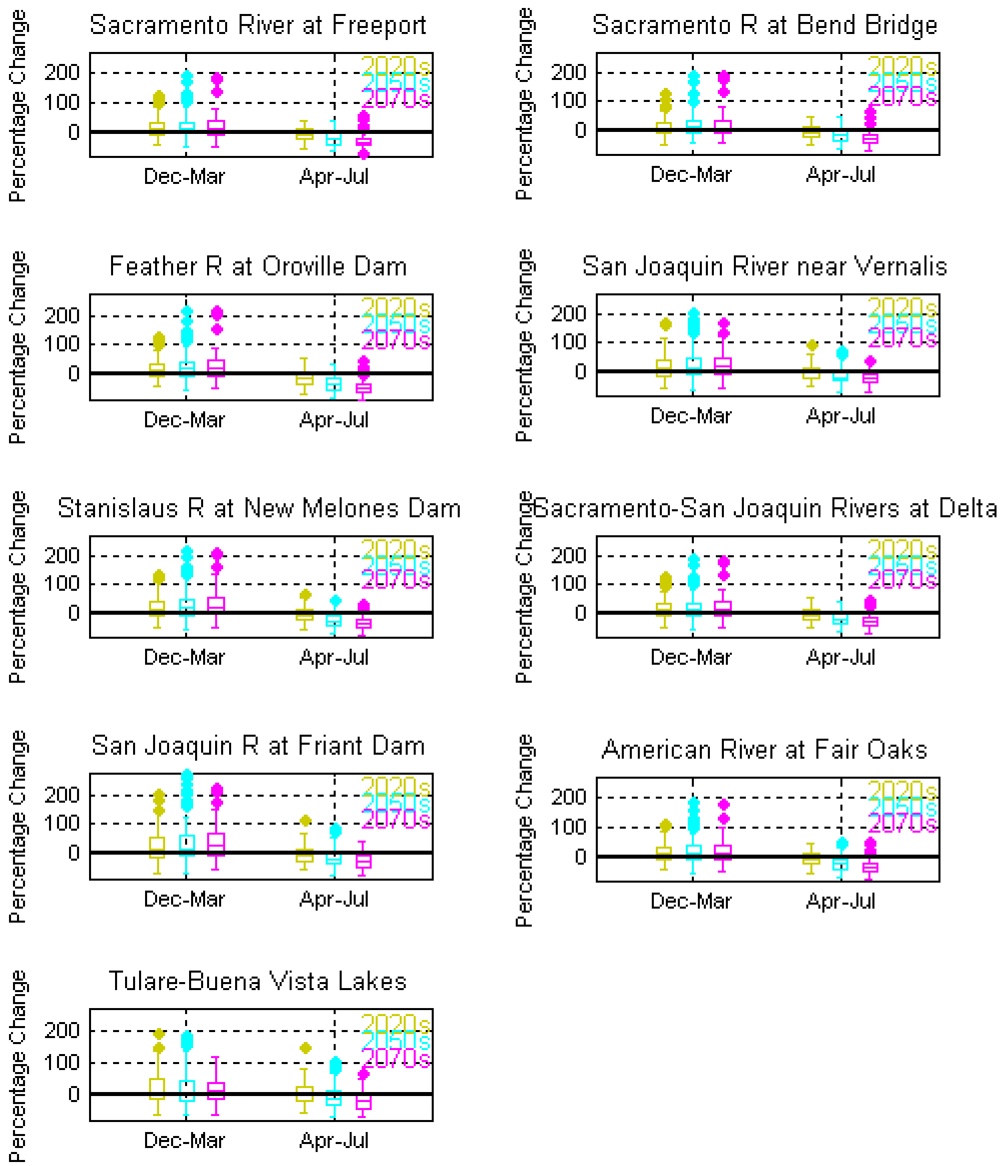


Figure 4-14 shows an ensemble-distribution (boxplot) of changes in mean-seasonal values (heavy lines) for the 2020s, 2050s, and 2070s relative to the 1990s, where the boxplots' box represents the ensemble's interquartile range and the box-midline represents ensemble-median. All locations show increases in median flow (horizontal line in the boxplot) for the December–March winter runoff season, and decrease in median flow for the April–July spring–summer runoff season.

Figure 4-14: Sacramento and San Joaquin Basins – Simulated Mean-Seasonal Runoff for Various Subbasins.



4.4.3 Climate Change Considerations Summary

While the estimates presented above for the Sacramento/San Joaquin Basins from TM No. 86-68210–2011-01 cannot be considered as quantitative projections of the hydroclimate variables for the South Fork Tule River drainage basin, they do provide qualitative expectations of the trends suggested by the current state of climate science and associated hydrologic analysis. To summarize, the following trends in hydroclimate variables can be reasonably expected:

1. April 1st SWE can be expected to decrease.
2. Winter runoff can be expected to increase.
3. April–July runoff can be expected to decrease.

The magnitude of these changes is subject to uncertainty which presents a challenge to the planning of water supply projects. Nonetheless, consideration of the expected trends may be worthwhile in the planning of the Tule River Indian Tribe's water supply project. Of particular concern is the fact that an increased rainfall to snow ratio means that a smaller fraction of the overall precipitation (occurring mostly in the winter) would be able to be stored and captured in reservoirs; this is because the natural storage of the snowpack is reduced (as evidenced by the decreased April 1st SWE values) and the higher volume of winter rainfall either infiltrates the soil or becomes runoff evading capture by the planned water system. And if the total volume of precipitation also decreases, then of course there is less overall water to store by any means.

Reclamation is continuing work on updating such hydroclimate projections (including incorporation of the latest World Climate Research Programme Coupled Model Intercomparison Project climate projections), and developing improved guidance and tools for the quantitative assessment of climate change risks to water resources and the development of adaptation strategies for water management projects.

4.4.3.1 Climate Change Impacts on Tule River Water Supply

As noted above, the general trends due to climate change in the region of the Tule River Indian Reservation predict less water stored in the snowpack during the winter due to warmer temperatures. This suggests that runoff during the year would occur in more concentrated periods of time (i.e., large flow events) in the future than experienced historically. Even if mean annual runoff remains the same, it appears that more variability in precipitation and runoff from year to year can be expected leading to greater uncertainty in the Tribe's water resources planning. Therefore, the need for storage on the Reservation becomes even more critical when climate change factors are considered.

5.0 Identification of Alternatives

5.1 Project Alternatives and Features

In accordance with the express provisions of the Tule River Water Rights Settlement Agreement, and the long-term needs for water supply on the Reservation, the only viable project alternative for water supply is a reservoir located on the Reservation. Based on the water demands identified in Section 3.0, it was determined that a Phase 1 dam and reservoir on the South Fork Tule River within the Reservation should be sized to provide 5,000 acre-feet of storage capacity. Depending on its location along the river, a reservoir of this size would provide somewhat varying amounts of firm yield to meet future water demands on the Reservation.

Other non-dam projects are deemed inadequate or impractical to meet the Phase 1 water demands. Assuming the South Fork Tule River is the primary source of the Tribe's future water supply, the amount of required storage is too large to be met through storage tank construction alone. For example, assuming a tank size of 400,000 gallons based on the new tank discussed in Section 2.1.5, over 4,000 tanks would need to be installed to provide 5,000 acre-feet of storage.

The Reservation's future needs cannot be met by groundwater. The design flow for the future water treatment plant is 1,050 gpm (see Section 2.1.4). The majority of wells that have been drilled on the Reservation are inoperable due to either low yields or poor water quality. Those wells that are in operation have production rates that range from 0 to 50 gpm, with most producing less than 30 gpm. Assuming an optimistic average well yield of 30 gpm, 35 wells would be required to provide this same design flow. There is no indication that anything approaching this number of wells could be successfully drilled and developed on the Reservation.

In addition to the dam and reservoir to provide the 5,000 acre-feet of storage, other key features of the project include a new raw water transmission pipeline from the dam to the treatment plant, an upgraded or expanded treatment plant, and extension of the existing water distribution system. Construction of the new dam, reservoir, and transmission pipeline would also require improvements to the existing access roads or new roads from the Reservation boundary to the project site areas.

Seven (7) potential dam and reservoir sites were originally identified, as follows (from downstream to upstream):

- Painted Rock
- Lower Bear Creek
- Upper Bear Creek
- Lower Cedar Creek

- Original Cedar Creek
- Upper Cedar Creek
- Cholollo

The locations of the Bear Creek and Cedar creek sites are shown on Figures 1 and 2 in Appendix B. The Tule Tribal Council elected to discard the Painted Rock and Chololllo sites due to negative impacts to social, cultural, and archaeological resource areas. The Original Cedar Creek site was replaced by the Lower Cedar Creek site due to a narrower valley section at the latter site and by extension, presumably a lower cost alternative. Additional information of the remaining four dam sites currently under consideration is contained in Section 5.4.

A new raw water supply pipeline is needed to transport water from the new reservoir to the water treatment plant and to supply irrigation water. This pipeline would generally be located along the existing main road from the town center to the Chololllo Campground. Additional information on this proposed pipeline is contained in Section 5.7.1.

The Tribe's existing water treatment plant would be expanded or a new facility would be constructed adjacent to the existing facilities to meet additional demands for potable water. Additional information on the new water treatment facilities is contained in Section 5.7.2.

The existing treated water distribution system would be improved to address identified deficiencies in the tribal water system, and the existing system would be expanded to serve the proposed future housing areas. Additional information on the water distribution system is contained in Section 5.7.3.

5.2 Dam and Reservoir Site Locations

The four potential dam sites have been named for their relation to the confluence with one of two South Fork Tule River tributaries: Bear Creek and Cedar Creek. Cedar Creek joins the South Fork Tule River approximately 2.3 river miles upstream of the Bear Creek confluence. The Lower Bear Creek and Upper Bear Creek dam sites are located 0.5 river miles downstream and 0.25 river miles upstream of the Bear Creek confluence, respectively. The Lower Cedar Creek and Upper Cedar Creek dam sites are 0.15 river miles downstream and 0.25 river miles upstream of the Cedar Creek confluence. The locations of the potential dam and reservoir sites are shown on Figures 1 and 2 in Appendix B.

5.3 Geology and Seismicity

The regional and site-specific geologic characteristics were reviewed by technical experts from the U.S. Department of Interior, Reclamation on a four-day site visit beginning on July 26, 2010. Results of that geologic site reconnaissance were presented in a report titled *Engineering Geologic Inspection of Potential Dam sites on the South Fork Tule River*

(Reclamation, 2010). The following geologic information was taken primarily from that report.

5.3.1 Regional Geology

The entire project area is located in the rugged western foothills of the southern Sierra Nevada Mountains. In this area, the dominant rock type is granitic in nature, extending from a few miles east of Porterville to the Owens Valley (over 50 miles to the east). Widely scattered within the granitic batholith are numerous discontinuous zones of metamorphic rock, each typically no more than a few to 10 miles in length.

Granite is the dominant rock type in the entire Cedar Creek Area, the upstream Bear Creek area and the Painted Rock dam site. Metamorphic rock is the dominant rock type in the downstream Bear Creek area. Both granite and metamorphic rock are hard, slightly fractured and fresh where exposed in the South Fork Tule River bottom and are weathered and more intensely fractured on the canyon slopes. Road cuts along the Main Road typically expose decomposed granite surrounding large granite core stones.

5.3.2 Faulting and Seismicity

The nearest major potentially active fault, the north-trending Kern Canyon Fault, is located just over 20 miles east of the project area. Major active faults such as the San Andreas, Garlock and White Wolf Faults are located 50 to over 80 miles from the project area.

The linear trend of Bear Creek and the foliated character of the metamorphic rock exposed in the creek bottom are strong indicators that the creek has developed along a northwest-trending shear zone. This shear zone is shown on the 1977 Geologic Map of California as being about 12 miles long and as one of several discontinuous and widely spaced northwest-trending shears. It is not considered to be an active fault.

There is currently no site-specific seismicity information for the proposed project. The project area is about 10 miles west of Lake Success Dam and about 30 miles north of Lake Isabella Dam, two dam facilities owned and operated by the COE, and have recently been heavily studied for potential seismic dam failure modes. It is likely that a high seismic design load will be required for design of a dam on the Reservation. For conceptual and final design, GEI recommends that a site-specific, probabilistic seismic hazard analysis be performed to evaluate the appropriate seismic design loads.

5.3.3 Dam Site Geology

Dam site geology for the four alternative dam sites currently under consideration is based on the previously referenced Reclamation geology report (2010). All four of the sites are located on the South Fork Tule River near the confluence of the Bear Creek Canyon and Cedar Creek Canyon. In general, only limited geologic information is provided in the

Reclamation report for all of the dam sites, and more-detailed field geologic reconnaissance is needed for each of the dam sites.

The geologic observations in the Bear Creek Canyon are described here, since Reclamation did not travel any distance up the Cedar Creek Canyon during their visit in July 2010. The Bear Creek Canyon was observed for a distance about one-half mile upstream of its confluence with the South Fork Tule River. Metamorphic rock is exposed in the northwest-trending linear creek bottom of Bear Creek, with a consistent foliation with N15°W strike and 60° northeast dip. Localized rock outcrops are separated by longer intervals of cobbles and boulders covering the creek bottom. Creek flows were absent in the cobble and boulder sections, because creek flows disappeared below the surface through these very pervious materials and formed small pools in areas of impervious rock outcrops.

The following are general descriptions of the surficial geology at each of the four potential dam sites.

5.3.3.1.1 *Upper Bear Creek Dam site*

The river bottom is typically characterized by cobbles and boulders and discontinuous outcrops of hard, fresh, water-scoured granite. Rock is poorly exposed on steep to moderate, well-vegetated canyon slopes. An area of continuous, hard, slightly-fractured fresh granite outcrops is located about 0.4 miles upstream of the Bear Creek Road. Outcrops extend 30 to over 50 feet vertically up from the river bottom on both canyon slopes.

5.3.3.1.2 *Lower Bear Creek Canyon Dam site*

Fresh, hard metamorphic rick forms continuous water-scoured outcrops along the river bottom for a distance of over one mile downstream of the Bear Creek road and numerous extensive outcrops on the very steep, high, lightly vegetated north canyon slopes. Rock outcrops are prominent near the river on the south canyon wall, but are obscured by dense vegetation o the upper slopes. The South Fork Tule River makes a sharp bend around the narrow ridge on the left side (looking downstream) of the canyon.

5.3.3.1.3 *Upper Cedar Creek Dam site*

The river bottom is characterized by cobbles, boulders and scattered hard, predominantly granitic outcrops with several areas of continuous outcrop located in the first 0.2 miles upstream of Cedar Creek Road. A few relatively extensive benches (river terraces) locally flank the riverbed. Rock is exposed as scattered outcrops in the well-vegetated canyon walls. A large area of continuous granite outcrops, located approximately 0.3 miles upstream of the Cedar Creek Road, is viewed as an excellent foundation for a concrete gravity dam.

5.3.3.1.4 *Lower Cedar Creek Dam site*

Most of the river bottom is characterized by long stretches of continuous, hard, water-scoured outcrops interspersed by shorter sections of cobbles, boulders, and scattered outcrops. Rock is poorly exposed on most well-vegetated canyon slopes. An approximately 1000-foot-long area of continuous granite outcrop is located about 0.4 miles southwest (downstream) of Cedar Creek Road. Outcrops on the south canyon slope extend from the river bottom to at least 60 vertical feet above the river. This outcrop is viewed as an excellent foundation for a concrete gravity dam.

5.4 Design Concepts of Dam and Reservoir Sites

This section presents the design of the proposed dams and appurtenant structures (spillway and outlet works) for Upper and Lower Bear Creek Dam and Upper and Lower Cedar Creek Dams, which are proposed to be constructed as roller-compacted concrete (RCC) dams[4]. The design concepts are appraisal level, with the primary purpose of establishing the major construction quantities and identifying major cost components for the construction cost estimate.

5.4.1 Selection of Dam Type

A dam type was first selected for these sites. Possible dam types include RCC gravity and rock-fill embankment. The RCC dam type was selected for all of these sites for the following reasons:

- Adequate earth-fill borrow materials do not appear to be available locally within the reservoir basin. Therefore, an earth-fill dam for these sites would not be economical.
- These sites appear to have an adequate rock foundation for a concrete gravity dam, such as an RCC dam, and therefore sites would be suitable for a rock-fill dam as well.
- Adequate borrow materials appear to be available for both rock-fill embankment and RCC dams. For a steep valley with a narrow valley bottom prevailing at all of these sites, it is GEI's experience that an RCC dam is generally more economical than a rock-fill embankment.
- The spillway for an RCC dam can be incorporated in the dam, with a significant cost saving on mass excavation in one of the abutments for a spillway channel that would be required for the rock-fill dam option.

5.4.2 General Design of RCC Dam and Appurtenant Structures

The storage capacity of 5,000 acre-feet was used as the basis to establish the heights of the RCC dams. This storage capacity includes an estimated sediment volume of about 150 acre-feet. For a normal storage of 5,000 acre-feet, the reservoir elevations were determined based on reservoir elevation-area-capacity curves (Figures 5-1, 5-2, 5-3, and 5-4).

[4] Roller compacted concrete, or RCC, is a construction technology used to construct a concrete gravity dam. RCC is a zero-slump concrete placed in lifts with conventional earthwork equipment.

The design dam crest elevations were determined by assuming a normal freeboard of 15 feet above the normal pool elevation. Required freeboard is determined based on routing of the inflow design flood (IDF). The IDF and flood routing studies would need to be performed during a subsequent feasibility study.

Figure 5-1: Upper Bear Creek Elevation-Area-Capacity Curve

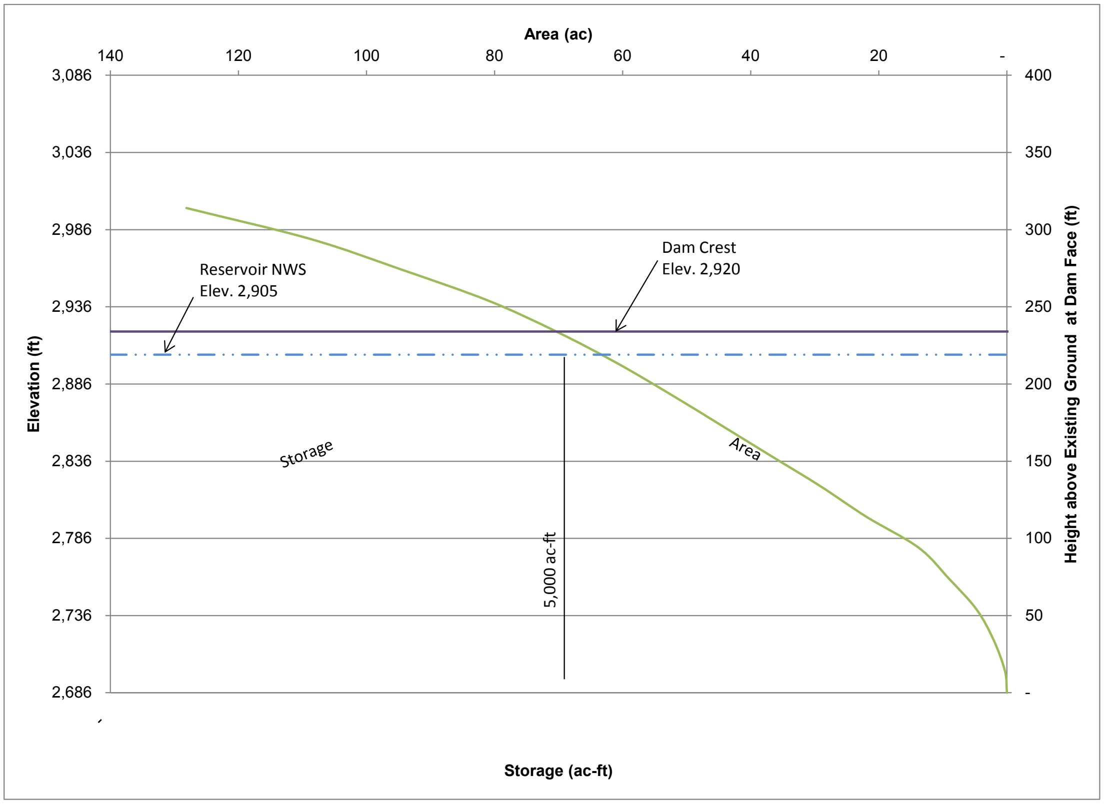


Figure 5-2: Lower Bear Creek Elevation-Area-Capacity Curve

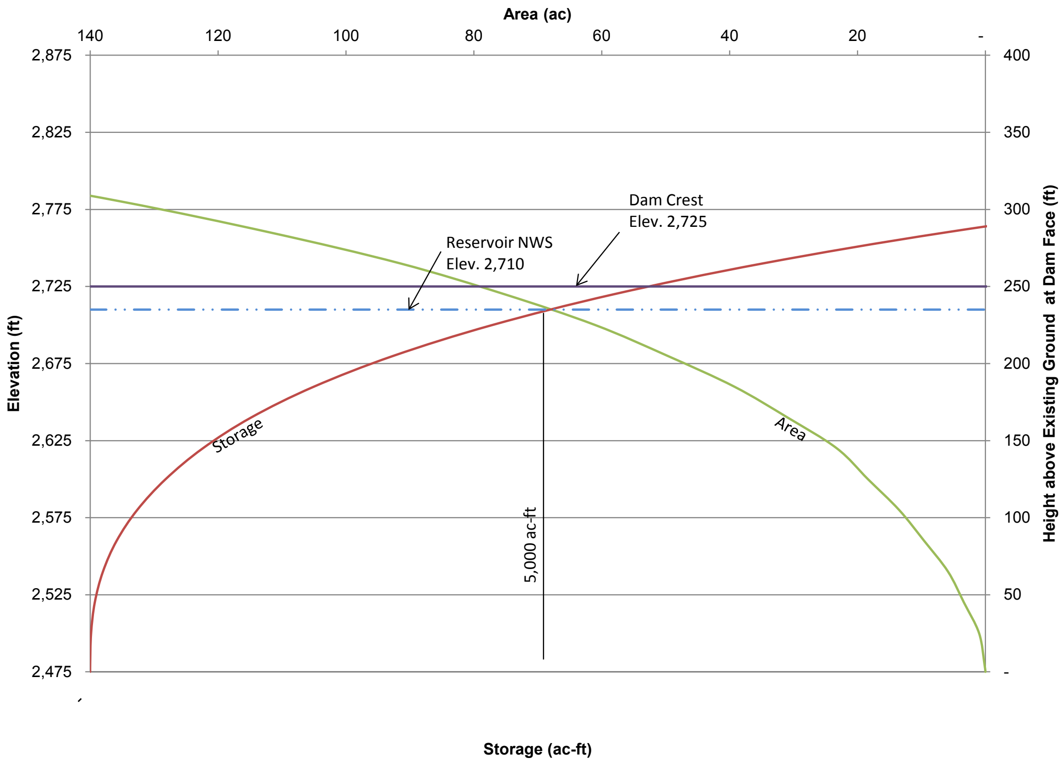


Figure 5-3: Upper Cedar Creek Elevation-Area-Capacity Curve

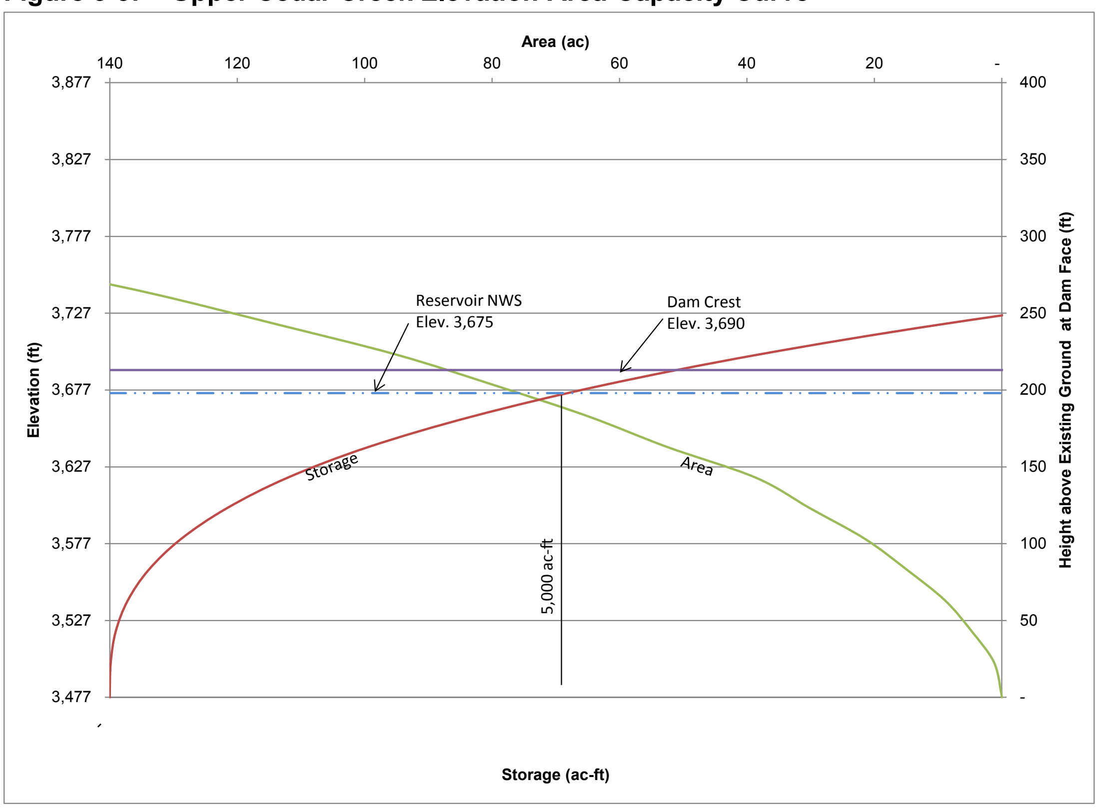
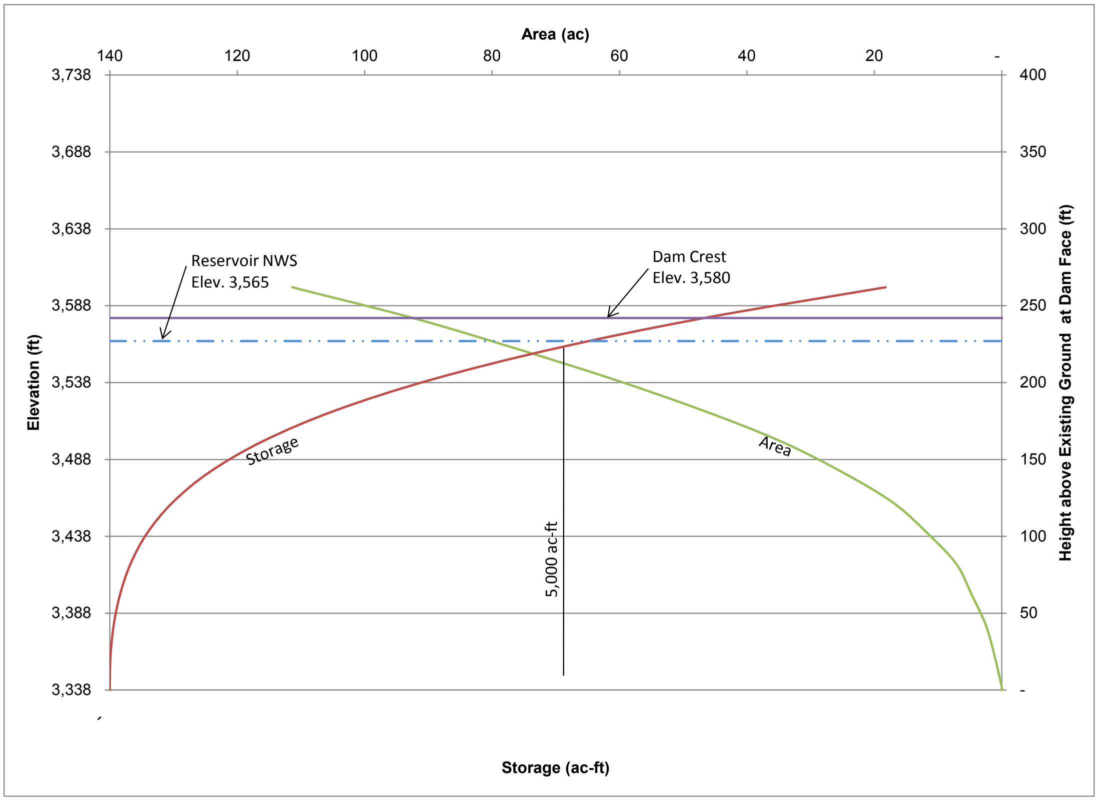


Figure 5-4: Lower Cedar Creek Elevation-Area-Capacity Curve



The figures presented in Appendix B include a Project Location Map, site location map, and a plan, profile and typical cross-section for each of the proposed dam and reservoir sites. The RCC dams would have structural heights[5] ranging from approximately 223 feet to 255 feet and hydraulic heights[6] ranging from approximately 198 feet to 235 feet. The depths of excavation vary for the dam sites and are consistent with Reclamation's recommendations as reported in *Engineering Geologic Inspection of Potential Dam Sites on South Fork Tule River* (Reclamation, 2010). The non-overflow section of the dam has a vertical upstream face, a 20-foot wide crest, and a 0.8H:1V downstream face. The cross sections of the dam are based on GEI's judgment and experience on similar structures. No stability analysis was performed to size the dam cross section. A reinforced concrete parapet wall would be constructed on the upstream and downstream end of the dam crest for public safety.

Topography used in this study was developed from a United States Geologic Survey (USGS) 7.5-minute, 1:24,000 scale, raster profile Digital Elevation Model (DEM) with 10-meter vertical resolution. This level of accuracy is considered acceptable for this planning-level study; however we recommend obtaining higher resolution topography for the final design phase. Coordinates used in this study are referenced to North American Datum (NAD) 27,

---

[5] The structural height is defined as the distance between the dam crest and the deepest part of the foundation excavation.
[6] The hydraulic height is defined as the distance between the dam crest and the lowest point on the existing ground surface along the dam axis.

Universal Transverse Mercator (UTM) Coordinate System, Zone 11, and U.S. Survey Feet. Elevations used in this study are referenced to National Geodetic Vertical Datum (NGVD) 1929, Feet.

Table 5-1 presents a summary of the primary conceptual dam size characteristics that were developed and used in this study.

Table 5-1: Summary of Proposed Dam Site Information

Dam Site Description	Gross Reservoir Storage (ac-ft)	Elevations		Freeboard (ft)	Dam Crest Width (ft)	Slope of Downstream Face (XH:1V)	Dam Height (ft)		Dam Axis Length (ft)	Gross Concrete Fill (2) (CY)
		Normal Water Surface	Nominal Dam Crest(1)				Hydraulic	Structural		
Upper Bear Creek	5,000	2,905	2,920	15	20	0.8	219	239	1,325	363,000
Lower Bear Creek	5,000	2,710	2,725	15	20	0.8	235	255	1,030	348,000
Upper Cedar Creek	5,000	3,675	3,690	15	20	0.8	198	223	1,380	416,000
Lower Cedar Creek	5,000	3,565	3,580	15	20	0.8	227	252	1,470	492,000

1. Based on recommendations presented in Tule River Tribe Proposed Water Storage Project DEC Review, Nov. 2009, by US Bureau of Reclamation.
2. Gross Dam Concrete Volume includes RCC and facing concrete. Not including concrete for the dam crest parapet walls, spillway training walls, or outlet works pipeline encasement and intake tower.

5.4.2.1 Foundation Treatment

Foundation treatment at the sites would consist of curtain grouting and consolidation grouting. The grout curtain would extend approximately one half of the structural dam height into the foundation. The grout curtain is provided to minimize foundation seepage through cracks and other flaws in the rock foundation. Immediately downstream of the grout curtain, foundation drains would be drilled from the gallery in the dam and extending roughly one-third of the structural dam height into the foundation.

5.4.2.2 Seepage Collection and Control

Drainage provisions would include a level and sloping drainage gallery, dam drains, and foundation drains. The foundation drains would serve to relieve uplift pressure on the dam base by providing a safe flow path beyond the grout curtain. In addition, interior dam drain holes would be drilled vertically through the dam, centered on the contraction joints and extending between the dam crest and the gallery to relieve any pressure buildup due to seepage through the vertical joints in the dam.

5.4.2.3 Grout-enriched RCC

Both the upstream dam face and downstream dam face would be formed and constructed with grout-enriched RCC (GERCC). The primary function of the upstream concrete facing is to serve as the primary seepage barrier, and also to protect the RCC from freeze-thaw damages. The primary function of the downstream facing in the non-overflow section is to provide freeze-thaw protection, while the GERCC within the spillway section is to provide freeze-thaw protection as well as resistance to hydraulic forces from the spillway discharge. In addition, the entire upstream face would be sealed with a geomembrane similar to what was used in the recently completed Olivenhain Dam in San Diego County to further protect the dam against seepage. The provision was included in GEI's conceptual design because of the anticipated high seismic design load and because the State of California may require similar seepage protection as for Olivenhain Dam.

5.4.2.4 Spillway

The spillway is an uncontrolled overflow structure constructed near the center of the RCC dam, with conventional mass concrete ogee crest and reinforced concrete training walls. The spillway width was assumed to be 200 feet at each dam location. This spillway crest width would be adequate to discharge a routed outflow of about 40,000 cfs, without overtopping of the dam crest.

An RCC dam is typically constructed in horizontal steps, and the exposed steps on the downstream face (spillway chute) would dissipate a significant amount of hydraulic energy, thus requiring a smaller stilling basin. For this study, GEI assumed a stilling basin length of 150 feet for all of the dams. The stilling basin foundation slab was assumed to consist of 2-foot-thick conventional concrete overlying 5-feet of RCC. A vehicular bridge with reinforced concrete piers was assumed to be provided over the spillway to allow access from one abutment to another.

5.4.2.5 Outlet Works

The outlet works would likely consist of a multi-level intake tower constructed with reinforced concrete and affixed to the upstream face of the RCC dam, and a 36-inch-diameter concrete encased welded steel outlet conduit. Each of the intake openings through the tower would be fitted with a trash rack and hydraulically operated gate, and the 36-inch outlet conduit would be guarded by a 36-inch hydraulic sluice gate. The outlet conduit would be founded on bedrock near the valley bottom on one of the two abutments adjacent to the spillway. A bifurcation of the outlet works conduit near the downstream dam toe, guarded by a 12-inch butterfly valve, would provide for diversion of water into a 12-inch-diameter ductile iron pipeline for raw water transmission to the planned water treatment plant near the existing Lumber Mill. The raw-water transmission pipeline is currently assumed to share the main gravel road alignment back to the Lumber Mill; however alternative alignments may result in cost savings. Further review of alignments will be performed during the feasibility phase of work. Additional discussion about the raw water transmission pipeline is provided in Section 5.7.1.

A second penetration into the 36-inch outlet conduit would also be provided to release minimum stream flows downstream of the dam. A sleeve valve, with upstream butterfly valve of the same diameter, would be provided to release the minimum flow. The 36-inch-diameter conduit would discharge into the spillway stilling basin via a pipe penetration through the sidewall of the basin. The conduit outlet would be equipped with a

36-inch butterfly valve (guard valve) and a 36-inch fixed-cone valve for releasing flows in excess of minimum stream flows.

5.5 Site Access Improvements

Access road improvements will be necessary for providing sufficient road widths and turning radius for construction and delivery vehicles. The Main Road to the Chollollo Campground is currently unpaved and narrow, with many switchbacks. The limits and scope of improvements are somewhat unknown at this point. Our current understanding is that pre-construction improvements to the gravel roads from the lumber mill (primary staging area) to the dam site, and post construction improvements to the paved road from the reservation boundary to the primary staging area would be necessary.

Pre-construction improvements to the gravel road between the primary staging area and the dam site would include road widening, adding turnouts for temporary vehicle stops, and improving the river crossings for heavy vehicles. Additionally, pre-construction improvements to the paved road from the Reservation boundary to the primary staging, including road widening to add 3-foot gravel shoulders and full-width shoulder pull offs for temporary vehicle stops, may also be necessary.

Post-construction improvements to the paved roads would likely be necessary to repair rutting and other damage resulting from heavy vehicle loads over the span of the construction period. Improvements would most likely range from local asphalt repairs to milling and overlaying or possibly full road section replacements if the damage is severe.

There is also the possibility that repairs may be necessary on Reservation Road beyond the Reservation boundary, extending as far as the intersection with Highway 190. Because this is a County road, however, the details of how those potential improvements are funded and executed are unknown. Early coordination with Tulare County is recommended so the Tribe can plan for and secure additional funding if necessary.

5.6 Site Access and Construction Considerations

This section addresses the following key design and construction issues that are important to the technical and economic feasibility of developing a new RCC dam and reservoir at any of the dam sites:

- Site access considerations;
- Construction staging areas;
- On-site quarry sources;
- Sources of cement and fly ash; and
- Off-site commercial material sources.

The information provided in this section is based on the report titled *Engineering Geologic Inspection of Potential Dam Sites on South Fork Tule River* (Reclamation, 2010).

5.6.1 Site Access Considerations

The assessment of access conditions to each of the potential dam sites is referenced from the Main Road, and would be applicable primarily for future field investigation work, such as drilling and test pit excavation. Further field work and topographic mapping will be required to undertake detailed studies of alignments for construction access.

5.6.1.1 Upper Bear Creek Dam site

The approximately 0.5-mile-long Bear Creek Road leaves the Main Road at about El. 2800 and ends near the South Fork Tule River at about El. 2550, about 0.2 miles northwest (downstream) of the confluence of the two streams. The road has a number of tight switchback turns, and is best driven in a high-clearance four-wheel-drive vehicle. Two of the switchbacks are flanked by flat shoulders that would provide excellent sites for exploratory drill holes, as would a flat area at the bottom of the road. Some tree trimming and road work would be required to make the road passable to a truck-mounted drill rig. Existing ranch roads are present on both the north and south sides of the South Fork Tule River Canyon. Some road improvement would be required to make the roads passable to a drill rig. The south side road crosses the river at a natural ford located about 0.3 miles upstream of Bear Creek Road.

5.6.1.2 Lower Bear Creek Dam site

Access from the upstream direction is via Bear Creek Road described in the Upper Bear Creek Dam Site. A second access route could be constructed down a moderately sloping, open ridgeline located about one-half mile downstream from Bear Creek Road. The south side of the South Fork Tule River is inaccessible to vehicles. Construction of an access road to the south side would be challenging.

5.6.1.3 Upper Cedar Creek Dam site

The approximately 0.1-mile-long Cedar Creek Road leaves the Main Road at about El. 3600 and ends near the South Fork Tule River at about El. 3450, about 0.2 miles northeast (upstream) of the confluence of the two streams. An evaporation gage next to the road is an easily recognizable landmark. The road has one tight switchback turn and is best driven in a high-clearance four-wheel-drive vehicle. Some road work would be required to make the road passable to a truck-mounted drill rig. The south side of the canyon can be accessed via a very rough, unimproved jeep trail that crosses the river at an unmaintained natural ford.

5.6.1.4 Lower Cedar Creek Dam site

The site is currently reached by walking downslope (south) to the South Fork Tule River from the Main Road at a point approximately 0.4 miles downstream of Cedar Creek Road. The south side of the canyon may be accessed by vehicle from the Main Road by taking Clubhouse Crossing (approximately 1.25 miles downstream of Cedar Creek Road and 0.8 miles downstream of the Upper Cedar Creek Dam site to a complex of ranch roads. An access road to the south canyon slope, which is the left abutment of the Upper Cedar Creek Dam site, could be constructed along the El. 3600 contour line from the ranch roads to the dam site.

5.6.2 Possible Construction Staging Areas

We anticipate that a main staging area and a secondary staging area would be required for the construction of the RCC dam. The main staging area would be the same for all four potential dam sites, and would likely be located at the existing Lumber Mill. The main staging area would be used for the following purpose:

- Office trailers for the contractor;
- Office trailers for the owner and engineer (Government use);
- Central receiving and storage for imported materials, equipment and supplies;
- Storage of contractor's construction equipment; and
- Vehicle parking.

The secondary staging area locations vary from dam site to dam site, and would be multiple-use area for the following uses:

- Concrete mixing plants for RCC and conventional concrete materials;
- Storage bins for cementitious materials (cement and fly ash);
- Power generators and maintenance trailers;
- Processing facilities for RCC aggregate, conventional concrete aggregate, and aggregate base course;
- Stockpiles of various processed aggregate materials;
- Storage of construction and haul equipment; and
- Contractor and construction management parking.

In general, it is preferable that all of these facilities be located close together; however, that is not always possible. It is desirable from a cost standpoint to have the aggregate processing facilities, aggregate stockpiles, and concrete mixing plants in close proximity to each other to minimize transportation and hauling costs. The following possible secondary staging areas were identified in the Reclamation geology report:

5.6.2.1 Upper and Lower Bear Creek Dam sites

Three areas were identified: (a) near the top of Bear Creek Road; (b) south of Wheatons; (c) south side of the canyon. The combined area of all three sites is estimated at over 8 acres.

5.6.2.2 Upper and Lower Cedar Creek Dam sites

Two areas were identified: (b) south side of the canyon at about El. 3500; (b) above the Main Road on the north side of the canyon. The combined area of the two staging areas is estimated at over 20 acres.

5.6.3 On-Site Rock Quarries

The economic and possibly environmental feasibility of an RCC dam at the four potential sites depend on the availability of rock quarries to manufacture aggregates for the RCC and conventional concrete. Based on preliminary site reconnaissance by Reclamation, it appears that on-site rock quarries are available for all of the potential dam sites to produce good quality coarse and fine aggregates. The granitic and metamorphic bedrock was described as hard and fresh with minor weathering, and these parent source rocks are known to produce aggregates that meet ASTM C33 requirements. Site-specific subsurface investigations and laboratory testing should be performed to obtain field and laboratory data for future conceptual and final designs.

The following possible quarry locations were identified in the Reclamation geology report for the four potential dam sites:

5.6.3.1 Upper and Lower Bear Creek Dam sites

Two areas: (a) along the South Fork Tule River and in the canyon walls just upstream of the Upper Bear Creek dam site; (b) above the Main Road about 0.3 miles downstream from its intersection with Bear Creek Road.

5.6.3.2 Upper and Lower Cedar Creek Dam sites

Above the Main Road about 0.4miles northwest of its intersection with the Cedar Creek Road, directly north of the north side staging area.

5.6.4 Sources of Cement and Fly Ash

Cement and fly ash (Class F) will be required for batching RCC and conventional concrete on site. These materials would most likely be transported from off-site sources in bulk and stored near the concrete plants on site. The nearest off-site sources of these materials have not been identified, and should be identified to establish the basis for construction cost estimates. Typically, fly ash is produced in coal-fired power plants, but it is important to identify those power plants that produce Class F fly ash.

5.6.5 Off-site Commercial Sand and Gravel Sources

Although it is not practical or economical to import sand and gravel materials (including RCC aggregate) for constructing the new dam for this project, four off-site areas with commercial operations or potential new quarries were identified in the Reclamation geology report:

5.6.5.1 East Porterville Area

The only active alluvial sand and gravel pit in the East Porterville area is the Mitch Brown Pit located about one mile downstream of Success Dam, within the Tule River flood plain.

Inactive alluvial sand and gravel pits are located between the Mitch Brown Pit and East Porterville. A potential alluvial sand and gravel source is located between Highway 190 and the Tule River near the southeastern corner of East Porterville, but the zoning and ownership of this land is unknown.

5.6.5.2 Reservation Road

Hard granite is being quarried and crushed into aggregates for road construction. This quarry is located on the side of a hill adjacent to Reservation Road, approximately 1.25 miles south of the Highway 190/Reservation Road intersection.

5.6.5.3 Lake Success-Northeast Areas

A large but depleted alluvial sand and gravel pit is located within the Tule River flood plain about three miles northeast of Success Dam. This pit may date back to the construction of Success Dam by the U.S. Army Corps of Engineers in 1961.

5.6.5.4 Deer Creek

The active Deer Creek Aggregate Pit is located on Avenue 120, about 7.75 miles southeast of Porterville and three miles east of Road 252. This pit is currently quarrying and crushing volcanic rock into aggregate, primarily for road construction. In general, the quality of volcanic rock is lower than that of granitic rock.

5.7 Water System

In addition to the dam and reservoir, a number of water system improvements would be needed to make use of the water impounded by the proposed dam and reservoir. Required improvements include:

- A new raw water line to convey stored water to the water treatment plant and proposed irrigation projects near Wheaton and on lower Pigeon Creek;
- Increased capacity at the water treatment plant; and
- Improvements to the existing distribution system to remedy existing deficiencies, including expansion of the water distribution system to supply water to identified Tribal housing areas.

In consideration of the local topography and the location of the proposed facilities, the Tribe may want to consider incorporating hydroelectric generation facilities into this project. More information regarding the proposed water system improvements and a brief discussion of hydroelectric generation potential is provided in Section 5.7.4.

5.7.1 Raw Water Pipeline

A raw water supply pipeline is needed to convey water from dam and reservoir to the water treatment plant and to irrigation water users. Design flow for the raw water pipeline is expected to be 1,850 gpm (4.1 cfs). This capacity is based on projected domestic, commercial, municipal and irrigation (DCMI) demands. Assuming a design velocity in the range of 5 to 6 feet per second (fps), the pipe diameter would be 12-inches. Ductile iron (DI) or polyvinylchloride (PVC) pipe would be the preferred pipe materials for the raw water pipeline. DI pipe has proven long-term performance history in many types of applications, but may require some form of corrosion protection. PVC pipe is significantly lighter in weight and resistant to corrosion. Recent price trends suggest that these two pipe materials may be cost-competitive. Class 350 DI pipe was assumed for the raw pipeline.

The elevation drop between the reservoirs and the water treatment plant (WTP) would vary from over 2100 feet (Upper Cedar Creek) to over 1100 feet (Lower Bear Creek). While some of the head between the reservoir and the WTP would be dissipated by pipe friction and other losses, pressure reducing valves would be required in order to maintain acceptable pressure within the pipe. Pipeline lengths and other key information for the dam and reservoir alternatives are summarized in Table 5-2 below.

Table 5-2: Approximate Raw Water Transmission Pipeline Layout Information

Dam and Reservoir Alternative	Length to WTP feet/miles	Elevation Drop (1) feet	No. of PRVs Required (2)
Upper Cedar Creek	46,800/8.9	2115	4
Lower Cedar Creek	43,500/8.2	2005	4
Upper Bear Creek	31,600/6.0	1360	2
Lower Bear Creek	27,100/5.1	1150	2

1. From maximum normal pool elevation to estimated WTP El.1560.
2. Assumes Class 350 DI Pipe and maximum pressure of 250 psi (100 psi safety margin).

Construction of the pipeline is expected to occur after the dam construction is complete because the road along which the pipeline would be located is required for construction access. The road is narrow and has several switchbacks; therefore, constructing the pipeline while the dam constriction is underway would be expected to hinder dam construction progress.

The pipeline would be located on the uphill side of the road. The pipeline would be placed in a trench, a significant portion of which may be excavated into rock. Depending on vertical alignment and rock conditions certain sections of the pipe might be placed above existing grade and covered with fill material. Thrust blocks and restraints would likely be required at critical changes in horizontal and vertical alignment. Combination air-vacuum valves and blow-off valves would be required.

5.7.2 Water Treatment

The Tribe's water treatment plant was upgraded in 2004-05 under IHS project CA 00-L30. The plant was expanded to increase its capacity from 150 gpm to approximately 300 to

350 gpm. The projected maximum day demand for the Reservation is approximately 1,050 gpm. Therefore, further expansion of the water treatment plant is required to treat an additional 700 gpm. Based on communication with Tribal personnel, a new treatment facility would be constructed in the vicinity of the existing facilities in order to accommodate the additional demand.

5.7.3 Water Distribution

A 2004 IHS study addressed deficiencies in the existing tribal water system (Indian Health Service, 2004). The existing water system comprises pipelines of mainly 4-inch and 6-inch diameters, two large storage tanks with a capacity of 200,000 gallons each, and 7 smaller storage tanks ranging in size from 3,000 to 40,000 gallons, with a combined capacity of 153,000 gallons.

The IHS report recommended the following improvements:

- The replacement all of the 4-inch water mains in the entire water distribution system with either 8-inch or 6-inch pipelines;
- Four smaller tanks to be replaced by a single 300,000 gallon tank;
- The installation of pressure reducing stations downstream of the proposed 300,000 gallon tank; and
- The replacement of a booster pump.

A funding request for the construction of these facilities is still pending based on information provided by the Tule River Tribe. No further improvements beyond the IHS recommendations are believed to be required to provide reliable service to the current service area.

Expansion of the water distribution system is required to serve the proposed future housing areas on the Reservation. New water transmission pipelines would connect to the existing distribution system and convey water to new storage tanks. New pipeline distribution systems would then deliver water from the storage tanks to the housing areas. All new pipelines would be C900 PVC pipe. Booster pumps would be needed at the connection points to the existing water system to pump water into storage tanks.

Pipeline lengths and elevations were obtained from USGS Quadrangle maps and geographic information system (GIS) analysis. A pipeline pressure limit of 150 pounds per square inch (psi) was used to size and locate the booster pump stations. The pipe friction losses were determined using the Hazen-Williams equation with a Hazen-Williams C-factor of 140. Design flow velocities in the transmission pipelines were limited to 5 fps.

The storage tanks would be constructed at locations with sufficient elevation to allow for gravity flow to the new housing areas. The tanks would be sized to provide operation storage, emergency storage, and fire suppression storage. Operation storage was estimated at 25-percent of the maximum day demand. Emergency storage was estimated at the average day demand. Storage for fire suppression was estimated at a flow rate of 750 gpm for 2-hour duration.

5.7.4 Hydroelectric Generation Potential

While this study does not currently include provisions for hydroelectric generation, the height of the dam and the elevation drop from the proposed reservoir sites to the water treatment plant presents at least two potential alternatives for hydroelectric generation facilities.

The Tribe could choose to evaluate either or both of the following options since the two systems could operate independently from each other. Installing both systems in parallel could provide the Tribe with nearly 1.0 megawatt (MW) of clean, renewable energy. However at a minimum, each option would require its own powerhouse, substation, and transmission facilities, and therefore the upfront and long-term costs would need to be carefully evaluated and weighed against the immediate and long-term benefits before any decisions are finalized.

5.7.4.1 Outlet Works Hydropower Option

The Tribe could take advantage of the required minimum stream discharge and the elevation drop from the reservoir normal water surface to the outlet works discharge location by adding hydroelectric facilities at the downstream end of the outlet works near the toe of the dam. Assuming a required minimum reservoir discharge of 20 cfs for stream and 85-percent efficiency provided by an appropriately sized Francis turbine, this hydropower alternative could feasibly generate between 260 and 340 kilowatts (kW)[7]. Adding hydropower generation capacity at this location could be accomplished with minimal modifications to the presently proposed facilities, including a second bifurcation from the primary outlet works conduit to reroute the discharge flows to a hydroelectric turbine in a new powerhouse adjacent to the proposed outlet works discharge location.

5.7.4.2 Raw Water Transmission Pipeline Hydropower Option

Another hydropower option for the Tribe's consideration includes taking advantage of the 1,100- to 2,100-foot elevation drop from the proposed dam sites to the water treatment plant by installing hydroelectric facilities immediately upstream of the water treatment plant. Hydroelectric facilities at this location could feasibly generate as much as 650 kilowatts (kW)[7] of renewable energy under the planned 4.1 cfs discharge capacity of the raw water delivery pipeline.

[7] Pipe entrance losses, friction losses due to bends in the pipeline, and other minor hydraulic losses have been neglected at this level of analysis. A detailed analysis of the hydroelectric generation potential would need to be performed during a more advanced stage of design to properly quantify and evaluate the costs and benefits of adding hydroelectric generation capacity.

Evaluation of this option prior to selection of a preferred dam site is recommended in consideration of:

- The difference in available elevation drop between the presently proposed dam sites and the water treatment plant for each of the proposed alternative dam sites; and
- The required modifications to the presently envisioned pipeline concept, including elimination of the pressure reducing valves to maximize pressure head at the hydroelectric generation unit(s) and thicker pipe walls to accommodate the high water pressures in the downstream pipeline reaches.

6.0 Hydrologic Evaluation of Storage Alternatives

6.1 General

This chapter discusses a hydrologic evaluation of the alternative dam sites. The purpose of the hydrologic evaluation is to assess the ability of each of the proposed dam sites to serve the projected water demands of the Tribe. The hydrologic evaluation consists of both a flow estimation analysis and reservoir modeling. The flow estimation analysis is performed to generate river flows estimates at the four alternative dam sites. The reservoir evaluation model is then used to evaluate the adequacy of the proposed reservoirs to meet the projected water demands.

The flow estimation analysis is performed by taking the extended gage flow data at the two on-Reservation gages (Section 3.0) and adjusting those flows to the different dam locations based on watershed area.

Once the flow estimation analysis was completed, a reservoir model was run for each of the proposed dam sites. The model provides a means to determine the yield from the alternative reservoir sites.

6.2 Hydrology for Alternatives Evaluation

The goal of flow estimation analysis is to create daily flow records at three ungaged sites located between USGS Gage 3580 and 4100 on the South Fork Tule River. These three sites correspond to the locations of the Lower Cedar Creek Site, Upper Bear Creek Site, and Lower Bear Creek Site. Gage 3580 records the flow at the Upper Cedar Creek Site. Inflow estimates are required at each of the potential reservoir sites to determine their respective reservoir yield. The ungaged sites are each located just downstream of the confluence with a major tributary of the South Fork Tule River. Table 6-1shows the locations of the three ungaged sites and major tributaries listed below.

- Cedar Creek (Lower Cedar Creek Site)
- Kessing Creek (Upper Bear Creek Site)
- Bear Creek (Lower Bear Creek Site)

6.2.1 Available Data

The available flow records from the two on-reservation USGS gages are described in Section 4.1. The extension of the gage flow records was described in Section 4.3. Gage 4100 is located at an elevation of 970 ft. Gage 3580 is at an elevation of 3700 ft.

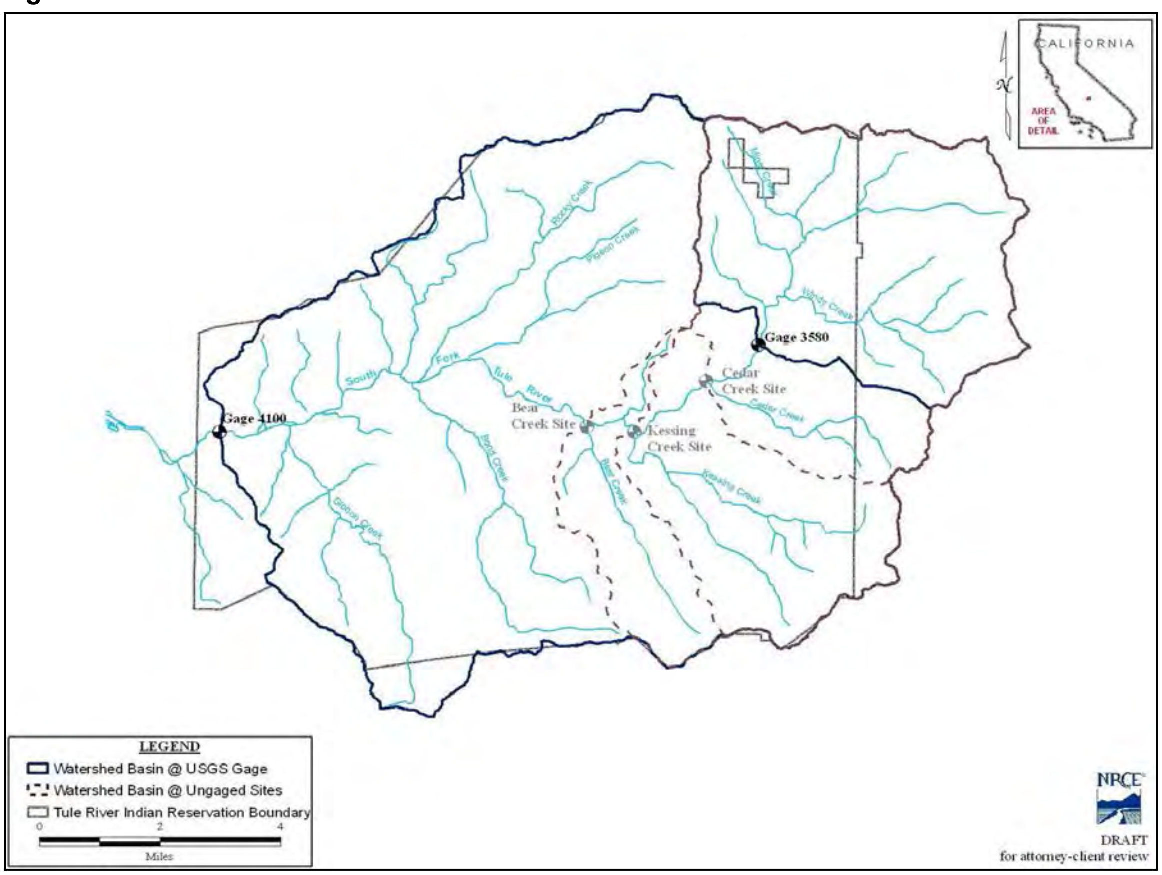
6.2.2 Basin Drainage Area

The watershed boundaries upstream from Gage 3580, Gage 4100 and the three ungaged sites were delineated to obtain basin drainage area. The boundaries of these watersheds were digitized using GIS software. The South Fork Tule River basin delineation obtained from United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) was further divided into the sub-basins of interest using contours on the 1:24,000 USGS topographic maps. An aerial image background was also used to periodically check for spatial accuracy and identify any physical anomalies that may impede water drainage. The basin areas for the five sites are shown in Table 6-1. The basin delineations are shown on Figure 6-1.

Table 6-1: Basin Area of Select Sites on the South Fork Tule River

Site	Basin Area (ac)
Gage 3580	13,080
Cedar Creek Site	17,274
Kessing Creek Site	25,267
Bear Creek Site	29,249
Gage 4100	61,505

Figure 6-1: Basin Delineations for Selected Sites on the South Fork Tule River



6.2.3 Flow Estimation Methodology

The flows at the ungaged dam sites are estimated using the drainage area ratio method. Since the three ungaged sites all lie between Gages 3580 and 4100, the flows at these sites can be estimated as a combination of the flows at the two gages. The combination is determined by assigning weighting factors to the flows at Gages 3580 and 4100 based on drainage area.

The daily gage flows at the three ungaged sites are determined using the equation below:

$$Q_{ungaged} = \frac{Q_{3580}(DA_{4100} - DA_{ungaged}) + Q_{4100}(DA_{ungaged} - DA_{3580})}{DA_{4100} - DA_{3580}}$$

where: $Q_{ungaged}$ = flow at ungaged site, cfs

Q_{3580} = flow at Gage 3580, cfs

Q_{4100} = flow at Gage 4100, cfs

$DA_{ungaged}$ = drainage area of basin at ungaged site, acres

DA_{3580} = drainage area of basin at Gage 3580, acres

DA_{4100} = drainage area of basin at Gage 4100, acres

6.2.4 Results

A summary of the results of the analysis at each of the four alternative dam sites for the time period 1949 to 2011 (excluding 1955 and 1956) is shown in Table 6-2.

The annual estimated gage flows at each dam site are provided in Table 6-2.

Table 6-2: Estimated Annual Flows at the Alternative Dam Sites

Location	Average (acre-feet per year)	50% Exceedance (acre-feet per year)	80% Exceedance (acre-feet per year)
Upper Cedar Creek (Gage 3580)	14,400	11,100	6,600
Lower Cedar Creek	16,100	12,100	7,000
Upper Bear Creek	19,300	13,900	7,900
Lower Bear Creek	20,900	14,900	8,300

6.3 Reservoir Operation Model Development

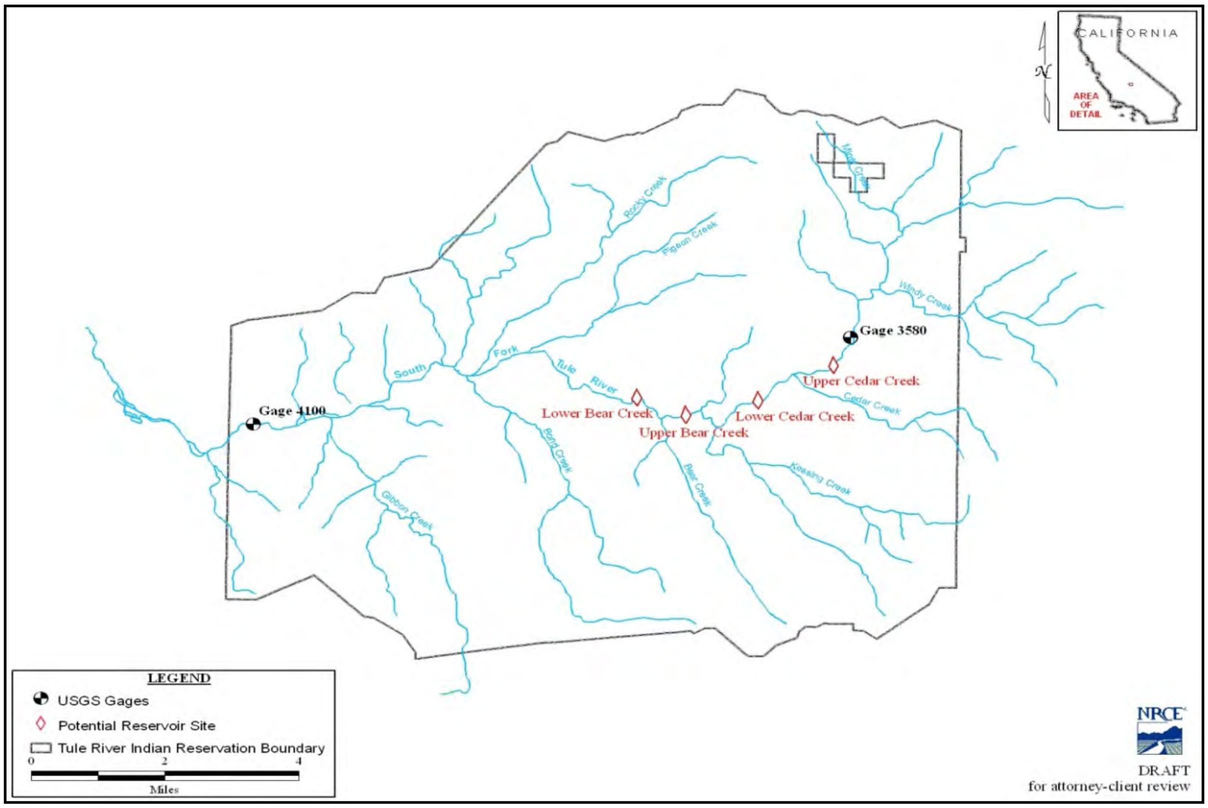
6.3.1 Model Purpose

The general purpose of the reservoir evaluation model (REM) is to determine the yield from a given size future reservoir at each potential site on the South Fork Tule River and to compare that yield to projected future tribal water demands. Four potential reservoir sites have been identified, as described in Section 5.0:

- Upper Cedar Creek
- Lower Cedar Creek
- Upper Bear Creek
- Lower Bear Creek

In order to determine the size of a future reservoir at these sites, it is important to estimate the reservoir inflows. The inflow for the Upper Cedar Creek site is the flow recorded by Gage 3580. For the remaining sites, daily inflows were estimated by using a combination of recorded flows at Gages 3580 and 4100. Figure 6-2 shows the location of Gage 3580, Gage 4100 and the four alternative reservoir sites.

Figure 6-2: USGS Gage Sites and Potential Reservoir Sites



6.3.2 *Future Water Needs for Modeling Purposes*

For the purposes of the REM, the target water demand to be served by the Phase I Project reservoir is the sum of the domestic, commercial, municipal, and industrial needs shown in

Table 3-1 plus some additional water for irrigation. The amount of irrigation is limited by the yield of the given reservoir.

For this study, it is assumed that the Phase 1 Project will serve an irrigation project consisting of a cropping pattern of 1/2 alfalfa, 1/6 pistachios, 1/6 olives, and 1/6 wine grapes as discussed in Section 3.3.5. The weighted average diversion requirement for this cropping pattern is 4.08 acre-feet/acre. The amount of irrigated acreage served by the Phase 1 Project varies depending on the dam site and is determined through the REM yield analysis. A summary of the Phase 1 Project water demands is shown in Table 6-3.

Table 6-3: Tule River Indian Reservation Phase 1 Project Water Demand

Description	Annual Water Use (acre-feet per year)
Domestic/Municipal	1,372
Commercial	391
Stock watering/Mining/Sand and Gravel	211
Irrigation	TBD
Total	**1,974 + Irrigation**

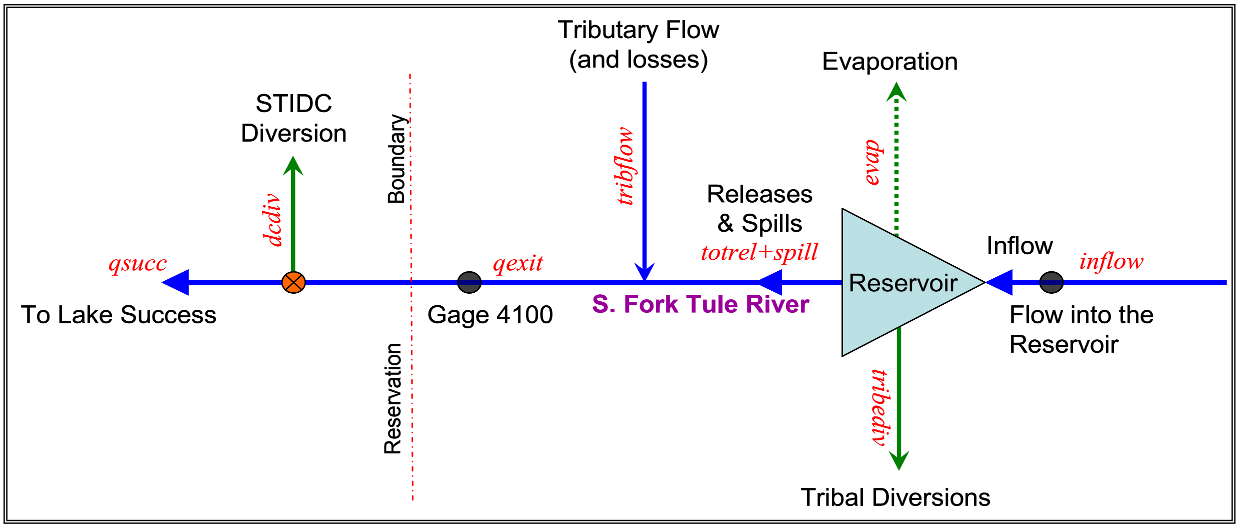
6.3.3 Model Formulation

The REM was developed by NRCE in-house and written in FORTRAN. The REM is run on a daily basis over the period 1949 to 2011 (water years) excluding 1955 and 1956 (61 years).

Figure 6-3 is a schematic representation of the REM. This figure shows the main variables that define the reservoir water balance. A short description of these variables is given below.

- Inflow - Flow entering the proposed reservoir. Determined through the flow estimation analysis for each of the dam sites.
- Evaporation (*evap*) – Reservoir evaporation
- Tribal Diversions (*tribediv*) – Total Tribal diversion. This is the sum of all applicable Tribal diversions and may include residential, domestic, and public uses (*rdpdiv*), agricultural use (*agdiv*), irrigated pasture (*pdiv*), commercial and industrial uses (*cidiv*), stockwatering use (*swdiv*), and sand and gravel use (*sgdiv*).
- Releases and Spills (*totrel* + *spill*) – Total reservoir release and spills.
- Tributary Flow (*tribflow*) – Tributary flow (gains and losses) downstream of the proposed reservoir and upstream of Gage 4100.
- STIDC Diversion (*dcdiv*) – Downstream STIDC diversion.
- Lake Success flow (*qsucc*) – South Fork Tule River flow downstream of the STIDC diversion that heads toward Lake Success.

Figure 6-3: Schematic of the Reservoir Evaluation Model



The reservoir water balance equation can be written as:

$$\text{In} - \text{Out} = \Delta S \text{ (storage)}$$

where: $In = inflow$

$Out = totrel + spill + tribediv + evap$

$\Delta S = previous\ day\ storage - current\ day\ storage$

6.3.4 Model Execution

The REM can be run to either solve for reservoir size or reservoir yield. The required input for each run includes reservoir inflow and downstream flow, shortage limits, reservoir operation rules, and reservoir stage/volume/surface area relationships. Each day, the model performs the water balance on the reservoir as described above. If solving for reservoir size, the user is required to provide the project water demands. If solving for reservoir yield, the user is required to provide the reservoir size.

6.3.4.1.1 *Shortage Limits*

The maximum allowable shortage limits specified when evaluating the reservoir sites are annual irrigation shortage, 10-year moving average irrigation shortage, and annual residential, domestic and public shortage. The model calculates annual shortage for each year of the model period. If any of these shortage limits are exceeded, the model automatically adjusts by either increasing the reservoir size or decreasing the project water demand.

For this analysis the maximum allowable DCMI shortage was set to 0-percent, meaning that the reservoir project must be sufficient to supply the entirety of that demand every year (i.e., firm yield). The irrigation shortage limits were set to 30-percent for a single year and 10-percent for the 10-year moving average.

6.3.4.1.2 Reservoir Operation Rules

The reservoir operation rules include minimum reservoir releases based on the flow entering the reservoir as well as limited reservoir fill schedule during dry years. These reservoir operation rules were determined as part of the Tribe's water rights negotiations.

These minimum releases, shown in Table 6-4, are used in the REM so that the downstream STIDC water demand is satisfied. The minimum releases are separated into two periods during the year, corresponding to the low flow season (June 1 – October 1) and all other times.

Table 6-4: Reservoir Operation Rules

Dates	Inflow into the Reservoir, cfs	Minimum Reservoir Release, cfs
June 1-October 1	≤ 3.5	3.5
	> 3.5 and ≤ 10	Inflow
	> 10	10
All other times	≤ 4	2.5
	> 4	4

In addition to the minimum releases to satisfy the STIDC water demands, the reservoir operation rules also call for mitigating impacts to the users of water out of Lake Success during dry years. This is accomplished by limiting the filling of the Tribe's reservoir to 9 acre-feet per day during March 1 – October 31 of dry years so as to allow some of the flow of the South Fork Tule River to continue on downstream. Dry years are determined as those water years in which the cumulative flow in the South Fork Tule River during the October through February period is less than the long-term 60-percent exceedance flow for that same period, as determined at Gage 3580.

6.3.4.1.4 Reservoir Stage/Volume/Surface Area Relationships

The reservoir stage/volume and volume/surface area relationship equations are obtained through regression analysis using data from Section 5.4.2. The regression equations can be expressed as follows:

$$Log(S) = sv_1 Log(V) + sv_c$$

$$Log(A) = av_1 Log(V) + av_c$$

where: S = *reservoir stage, ft*
V = *reservoir volume, ac-ft*
A = *reservoir surface area, ac*

The regression coefficients for use in these equations are shown in Table 6-5.

Table 6-5: Dam Stage/Volume/Surface Area Regression Coefficients

Site	Stage (H)/Volume (V) Regression Coefficients		Surface Area (A)/Volume (V) Regression Coefficients	
	sv_1	sv_c	av_1	av_c
Upper Cedar Creek Site	0.3637	0.9376	0.6766	-0.6271
Lower Cedar Creek Site	0.3664	1.0058	0.7172	-0.7876
Upper Bear Creek Site	0.4067	0.8031	0.6288	-0.5182
Lower Bear Creek Site	0.3776	0.9582	0.6904	-0.7251

6.3.5 Reservoir Evaporation

The REM estimates reservoir evaporation based on unit net evaporation estimates and the daily calculations of reservoir surface area. There are no direct evaporation estimates for the Tule River Indian Reservation. Therefore, a theoretical method to estimate evaporation was used. The Hargreaves equation was selected for this purpose because it only requires minimum and maximum daily temperatures to determine monthly gross evaporation rates (Jensen, et al., 1990). Temperature and precipitation data were obtained from the Glenville Climate Station.

The Hargreaves Equation is as follows:

$$E_t = 0.0023 \frac{R_A}{\lambda} (T + 17.8) TD^{\frac{1}{2}}$$

Where: E_t = *evaporation rate in mm/day*
R_A = *extraterrestrial radiation in MJ m-2d-1*
λ = *latent heat of vaporization in MJ kg-1*
T = *average daily temperature in °C*
TD = *the difference in maximum and minimum daily temperature in °C.*

The extraterrestrial radiation, R_A, is expressed as:

$$R_A = \left(\frac{24 * 60}{\pi}\right) G_{sc}\, d_r \left(\omega_s \sin\phi \sin\delta + \cos\phi \cos\delta \sin\omega_s\right)$$

Where: G_{sc} = *solar constant, equivalent to 0.0820 MJ m-2 min-1*
ϕ = *latitude in radians, negative for southern latitudes*
δ = *declination in radians*
d_r = *relative distance of the earth from the sun*
ω_s = *sunset hour angle in radians*

The declination, δ, in radians, is estimated as:

$$\delta = 0.4093 \sin\left(\frac{2\pi(284 + J)}{365}\right)$$

Where: J = *Julian day*

The term d_r is the relative distance of the earth from the sun, or

$$d_r = 1 + 0.033 \cos\left(\frac{2\pi J}{365}\right)$$

The sunset hour angle, ω_s, in radians is expressed as,

$$\omega_s = \arccos(-\tan\phi \tan\delta)$$

The average annual unit net evaporation on the Reservation estimated using the Hargreaves method is 36.3 inches. Average monthly values are shown in Table 6-6.

Table 6-6: Estimated Average Monthly Evaporation, Precipitation, and Net Evaporation, inches

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Evap	3.87	2.24	1.75	1.87	2.19	3.26	4.43	6.21	7.48	8.57	7.72	5.78
Precip	0.82	2.16	2.85	3.61	3.13	3.05	1.79	0.73	0.13	0.12	0.20	0.70
Net Evap	3.04	0.09	-1.11	-1.75	-0.94	0.21	2.65	5.48	7.34	8.43	7.52	5.06

6.4 Alternatives Analysis Modeling

In this study the REM was run to solve for reservoir yield given a 5,000 acre-feet reservoir. Five runs were performed, corresponding to the four alternative dam sites plus the No Action alternative (i.e., no future reservoir). The model results are shown in Table 6-7. All four of the reservoirs at the alternative dam sites are able to provide the full Phase 1 Project DCMI demand without any shortage. The reservoirs vary in the amount of irrigated acreage served, mainly due to differences in reservoir inflow.

Table 6-7: Reservoir Evaluation Model Results – Yield Analysis

Project Site	DCMI Demand Served (acre-feet per year)	Irrigated Acreage Served (acres)	Total Water Demand Served (acre-feet per year)	Average Reservoir Evaporation (acre-feet per year)
Upper Cedar Creek	1,974	80	2,300	194
Lower Cedar Creek	1,974	120	2,464	194
Upper Bear Creek	1,974	200	2,790	193
Lower Bear Creek	1,974	220	2,871	193
No Action Alternative	569	0	569	NA

6.4.1 Reservoir Filling

The REM is run under the assumption that the reservoir is half full (2,500 acre-feet) at the start of the simulation period. This is done in order to avoid the model results being unduly influenced by water supply shortages in the first year of the simulation. However, it is recognized that a period of time will be required following dam construction to fill the reservoir to that initial amount. It is anticipated that during this initial fill period there will be no diversions out of the reservoir for water supply purposes but the operational rules described in Section 6.3.4 will be in effect.

In order to estimate the length of time required to fill the reservoir to an initial volume of 2,500 acre-feet, the inflows and outflows to each of the four alternative dam sites were investigated. The difference between daily inflow and outflow gives an approximation of the amount of water that can be added to storage each day.[8] Table 6-8 shows the number of individual years within the 61-year model period where the available storage was able to reach 2,500 acre-feet.[9] In all cases, the reservoir was able to reach 2,500 acre-feet within any two consecutive years of the model period.

[8] The analysis neglects evaporation and seepage losses.
[9] While in all years of the model period for all dam sites the total annual inflow exceeds 2,500 AF, not all of this flow can be stored due to minimum release requirements and maximum daily storage limits during dry years.

Table 6-8: Reservoir Initial Fill Analysis

Project Site	No. of Years Able to Store 2,500 acre-feet	Percentage
Upper Cedar Creek	38	62%
Lower Cedar Creek Site	41	67%
Upper Bear Creek Site	48	79%
Lower Bear Creek Site	52	85%

As seen in Table 6-8, the chances of requiring two years for the initial halfway fill instead of one decrease as the dam sites move downstream. For example, in 38 years out of the total 61 year period the Upper Cedar Creek site would have filled to 2,500 acre feet. This is roughly equivalent to saying that there is a 62 percent chance that this dam site would need one year to fill halfway as opposed to two. The most downstream site, Lower Bear Creek, by comparison was able to fill halfway in 52 out of the 61 years, which is about an 85 percent chance.

7.0 Cost Evaluation of Alternatives

7.1 General

This section presents estimates of project costs for each of the four potential dam and reservoir sites, and includes the following components:

- Construction cost of the new dam and appurtenant structures;
- Construction cost of the new raw water transmission pipeline;
- Construction cost of the expansion of the existing water treatment plant;
- Construction cost of the expanded treated water distribution system;
- Construction cost of improvements to the existing access roads; and
- Program costs for the Tule River Tribe.

The basic design concepts described in Section 3.0 were used as the basis for the construction cost estimates. GEI prepared construction quantity estimates and developed the unit prices and lump sum prices for the major construction cost items. Design and construction contingencies were included in the construction cost to account for a variety of uncertainties and unknowns as described in more details below.

7.2 Overview of Cost Evaluation Process

The cost estimates were developed by GEI to enable relative comparisons among the proposed alternatives presented in this report and to provide a range of project implementation costs

Previous studies by Reclamation (1998) and NRCE (2007) provided cost estimates for alternative dam sites based on a dam cross section developed and provided by Reclamation in 1998. GEI reviewed this cross section and other cost components, and maintains the opinion that the costs from previous studies are not conservative for this level of study. Therefore, GEI has developed these cost opinions based on a modified cross section with a more conservative downstream slope.

The following cost estimates are based on GEI's experience on similar projects and evaluation of the major construction items appropriate to complete the work. Unit price breakdowns and quantity estimates were developed and are provided in Appendix C. Quantity estimates were based on the layouts provided in Appendix B. Lump sum prices are based on estimates of the work required and the corresponding cost.

Estimation of the prices was based on the following approach and assumptions:

- Estimated values corresponded to 2012 dollars, and would need to be escalated for future construction;

- Labor costs included provisions for base salary, benefits, workman's compensation and general liability insurance, payroll tax, field supervision, field office cost, temporary construction costs, small tools, other distributable costs and contractor overhead and profit;
- No hazardous materials were evident on the sites or included in the estimate for remediation;
- Material pricing was Free on Board (FOB) on site;
- For RCC dams, aggregates for concrete (except for cement and fly ash) were assumed to be from on-site sources; and
- Budgetary pricing was obtained from appropriate vendors and published reference for gates and valves, and other construction materials.

7.2.1 Allowances for Contingencies

For the Bear Creek alternatives (Upper and Lower Bear Creek Dam), the estimated construction costs include an allowance for design contingencies equal to 20-percent of the listed items. For the Cedar Creek alternatives (Upper and Lower Cedar Creek Dam), this allowance was increased to 22-percent of the listed items in consideration of the additional distance from the construction workers' living quarters and primary staging area to the dam site as compared to the Bear Creek sites. This extra distance may have cost implications including additional fuel costs for construction equipment and material deliveries, and increased labor costs due to lost time spent commuting to the dam site. While this additional cost is very difficult to estimate at this time, an additional cost allowance of two (2) percent was provided in the design contingencies.

Additional design contingencies beyond the 20-to 22-percent were applied to the raw water transmission pipeline (25-percent), water treatment plant expansion (30-percent), and water distribution system expansion (30-percent). The increased design contingency was applied to account for the preliminary level of the proposed design concepts for these facilities relative to the development of the design concepts for the dam and access road facilities.

In any case, the purpose of the design contingency is to account for the preliminary nature of the design, unknown site conditions, and approximate quantities. This design contingency will decrease as project development progresses towards final design and construction bidding.

The sum of the listed items plus the unlisted items allowance is defined for this study as the "Base Construction Subtotal" (BCS). An allowance for the construction contractor's costs for mobilization, bonds and insurance is included as a percentage of the BCS. For the Tule River Dam and Reservoir cost estimates, this allowance is assumed to be 9-percent of the BCS.

The cost estimates also include an allowance for construction contingencies. This allowance is for managing the financial risk of a project and is based on the risk management approach taken during bidding and construction. Construction contingencies are typically included to allow for project construction cost increases that could result from a variety of factors including:

- Unforeseen conditions at the site;
- Change orders during construction that are in addition to the original project scope; and
- Uncertainties and additional work associated with weather delays and construction on an active stream.

The total allowance for construction contingencies used in the cost estimates is 15-percent of the BCS.

The sum of the BCS, mobilization, bonds and insurance, and construction contingencies is defined as the "Direct Construction Subtotal" (DCS).

7.2.1.1.1 Owner's Program Costs

The Total Opinion of Probable Project Cost (OPPC), which is equal to the DCS plus allowances for selected program costs such as design engineering (8-percent); construction engineering and administration (8-percent); and legal, permitting and land acquisition (10-percent); is provided for each project alternative. These program costs do not include allowances for environmental mitigation and potential improvements to access roads beyond the Reservation boundary.

7.2.2 Limitations

The opinions of probable construction costs presented in this report are based on GEI's professional opinion of the cost to develop and construct the project as described in this report. The estimated costs are based on the sources of information described above, and our knowledge of current construction cost conditions in the locality of the project. Actual project construction and development costs are affected by a number of factors beyond our control such as supply and demand for the types of construction required at the time of bidding and in the project vicinity; changes in material supplier costs; changes in labor rates; the competitiveness of contractors and suppliers; changes in applicable regulatory requirements; changes in design standards; and environmental mitigation requirements and other conditions of project permitting. Therefore, conditions and factors that arise as project development proceeds through construction may result in construction costs that differ from the estimates documented in this report.

7.3 Dam Construction Costs for Alternative Sites

For this study, the estimated dam construction cost for each of the alternative dam sites can be broken down into four (4) major categories:

1. Site civil costs – These costs include site development and improvements for the borrow areas, river diversion and cofferdam, and reservoir clearing. Details of selected listed items under this category are discussed below:
   - The combined area of the primary and secondary staging areas is assumed to be 10 acres.
   - The total area of the rock quarry sources is assumed to be 8 acres. The rock quarry sources are expected to be located below the normal pool elevation of the reservoir in order to minimize reclamation costs.
   - No construction flood diversion analysis was performed on the cofferdam and stream diversion cost. Both the level of construction flood protection and the stream flow diversion would need to be evaluated and determined in future studies. For this study, we assume a temporary 50-foot-high rock fill upstream cofferdam, and a 36-inch temporary stream diversion pipe.
   - A significant portion of the reservoir area below normal pool elevation would need to be cleared based on the heavily vegetated conditions observed during previous site observations. For reservoir clearing, we assume the trees will be cleared and disposed of outside of the reservoir, but the stumps will be left in place.
2. Roller Compacted Concrete (RCC) Dam costs – These costs include foundation dewatering, excavation and treatment, foundation grouting, RCC dam and facing concrete, dam drainage provisions, geomembrane facing, and instrumentation. Details of selected listed items under this category are discussed below:
   - Drill and blast method will be required for foundation rock excavation. We assume that the excavated rock will not be suitable to be processed as concrete aggregate, and will be disposed in the reservoir.
   - The cost of borrowing and processing the RCC aggregate from the on-site quarry includes the equipment and labor to manufacture the hard granite or metamorphic rock into an aggregate that meets ASTM C33 durability requirements for concrete. The work includes excavating quarry rock, crushing and screening, and stockpiling processed aggregate. We assume that the aggregate will have a maximum particle size of 2 inches and fine contents (percent finer than No. 200 sieve) in the range of 5-to 10-percent. No more than three stockpiled sizes are anticipated.
   - This unit price of RCC consists of furnishing cement and fly ash, and batching, mixing, transporting, spreading, compacting, and curing RCC. The unit price also includes a bedding mix concrete applied on each RCC lift for the upstream 25 feet of the lift. The cement will be Type I/II low alkali, and the fly ash will

be Class F. The site is located in a high seismic area, and high strength is required for seismic stability. Based on GEI's design experience on RCC dams located in similar high seismic areas, we assume a mix with 150 pounds of cement and 150 pounds of fly ash per cubic yard of RCC. Cost allowance is provided in the unit price for cooling the RCC during mixing because of the anticipated hot placement environment at the site.

- An RCC test section will be required in the secondary staging area to evaluate the RCC trial mixes, contractor's equipment and procedure to construct various key design features, and to finalize the RCC design mix. This test section will be left in place upon completion.
- The unit price for the grout-enriched RCC facing consists of batching, mixing, transporting, spreading RCC in the facing areas; furnishing and placing cement grout; and compacting and curing the grout-enriched RCC. The average width of the upstream facing and downstream facing is assumed to be 24 inches. The cement grout will be a neat cement with a water: cement ratio of 1:1 by weight. The neat cement grout will first be poured over uncompacted RCC and allowed to soak into the RCC, and then immersion vibrators will be used to consolidate the grout. The surface of the consolidated RCC surface will then be compacted with a vibratory roller.
- The lump sum price for the gallery and adits consists of constructing level and sloping gallery, and two access adits. The gallery and adit section is assumed to have a width of 6 feet and a clear height of 10 feet. The level gallery is below the spillway section, with sloping gallery extending up each abutment on each side of the spillway. The roof and each side of the gallery will be formed RCC with no conventional concrete facing. The floor of the gallery will have a 12-inch-thick unreinforced concrete slab with a formed gutter for drainage collection. Appurtenances in the gallery and adit will consist of lighting, forced air ventilation, and handrails (one side only) along the sloping gallery.

3. <u>Outlet Works Structure costs</u> – The costs include the concrete gate tower, concrete-encased 36 inch steel outlet conduit, miscellaneous gates and valves, and control building, and power generator. Details of selected listed items under this category are discussed below:

- No structural analysis was performed to size the gate tower and base. Based on GEI's design experience on similar structures, we assume the tower to be 15 feet by 15 feet on plan, with an average thickness of 2 feet and a base of 25 feet by 25 feet.
- Three intake ports were assumed for multiple-level withdrawal: a low level, an intermediate level, and a high level. Each intake opening consists of a trash rack and a power-assisted sluice gate. A power-assisted sluice gate at the bottom of the tower serves as the guard gate for the outlet conduit.

4. Spillway costs – These costs include the ogee crest, concrete training walls, concrete stilling basin, and a vehicle access bridge across the spillway. Details of selected listed items under this category are discussed below:
   - The ogee crest, training walls, bridge piers, and stilling basin will be constructed of conventional concrete.
   - The spillway bridge cost was based on precast concrete deck and girder system, published Department of Transportation cost data.
   - The stilling basin slab was assumed to consist of 2-foot-thick conventional concrete overlying 5 feet of RCC.

Detailed cost spreadsheets prepared for each of the four (4) alternative dam sites are provided in Appendix C. Table 7-1 presents a summary of the estimated itemized construction costs (ICC) for the dam facilities, which exclude design contingencies, mobilization, bond and insurance, construction contingencies, and owner's program costs:

Table 7-1: Estimated Itemized Construction Costs for Dam Construction

	Upper Bear Creek	Lower Bear Creek	Upper Cedar Creek	Lower Cedar Creek
Site Civil	$2.3 million	$2.5 million	$2.8 million	$2.6 million
RCC Dam	$55.1 million	$51.8 million	$60.5 million	$69.9 million
Outlet Works	$2.1 million	$2.1 million	$1.7 million	$1.8 million
Spillway	$3.0 million	$3.1 million	$3.0 million	$3.0 million
Subtotal, Itemized Construction Costs (ICC):	**$62.1 million**	**$59.5 million**	**$67.9 million**	**$77.4 million**

7.4 Access Road Improvement Costs

No appraisal level designs and layouts were performed to estimate the construction costs for access road improvements. The access road improvements reflected in the cost tables include: pre-construction road widening to add 3-foot gravel shoulders to the paved roads and additional width to the gravel roads to provide 24-foot road widths, new permanent gravel roads from the main road to the dam sites, new temporary gravel roads for construction access around the dam site, and post-construction mill and overlay improvements to the paved roads to repair rutting and other damage that occurs due to the dam and pipeline construction activities.

There is also the possibility that repairs may be necessary on Reservation Road beyond the Reservation boundary, extending as far as the intersection with Highway 190. Since this is a County road, however, the details of how those potential improvements are funded are unknown. Costs for these improvements are not included in these cost opinions, however are believed to range between $5 and $20 million dollars, depending on the scope of work required. Early coordination with Tulare County is recommended so the Tribe can plan for and secure additional funding if necessary.

Table 7-2 presents a summary of the access road related ICCs, which exclude design contingencies, mobilization, bond and insurance, construction contingencies, and owner's program costs.

Table 7-2: Estimated Base Construction Costs for Road Improvements

Alternative Dam Site	Itemized Construction Cost (ICC)
Upper Bear Creek Dam site	$11.0 million
Lower Bear Creek Dam site	$11.0 million
Upper Cedar Creek Dam site	$14.1 million
Lower Cedar Creek Dam site	$14.1 million

7.5 Raw Water Transmission Pipeline Costs

The raw water transmission pipeline construction costs presented in Table 7-3 were derived from the proposed pipeline alignments described in Section 5.7.1. These costs exclude design contingencies, mobilization, bond and insurance, construction contingencies, and owner's program costs.

Table 7-3: Estimated Itemized Construction Costs for Raw Water Pipeline

Alternative Dam Site	Itemized Construction Cost (ICC)
Upper Bear Creek Dam site	$3.1 million
Lower Bear Creek Dam site	$3.1 million
Upper Cedar Creek Dam site	$4.9 million
Lower Cedar Creek Dam site	$4.9 million

7.6 Water Treatment Plant Expansion Costs

The water treatment plant expansion construction costs presented in Table 7-4 are based on costs developed by NRCE (NRCE, 2007). The original costs were generated from construction costs for the 2005 expansion of the Tribe's existing water treatment plant. Additional information regarding the proposed water treatment plant expansion is provided in Section 5.7.2. The ICCs presented in Table 7-4 have been escalated at a rate of 3-percent per year from 2007 to 2012, and exclude design contingencies, mobilization, bond and insurance, construction contingencies, and owner's program costs. The 3-percent escalation rate is probably conservatively high for the 2007-2012 period.

Table 7-4: Estimated Itemized Construction Costs for Water Treatment Plant Improvements

Alternative Dam Site	Itemized Construction Cost (ICC)
Upper Bear Creek Dam site	$1.9 million
Lower Bear Creek Dam site	$1.9 million
Upper Cedar Creek Dam site	$1.9 million
Lower Cedar Creek Dam site	$1.9 million

7.7 Water Distribution System Expansion Costs

The water distribution system expansion costs presented in Table 7-5 are based on costs developed by NRCE (NRCE, 2007). The original costs were based on recommendations developed to address deficiencies identified in a 2004 IHS study (Indian Health Service, 2004). Additional information regarding the proposed water distribution system expansion is provided in Section 5.7.3. The ICCs presented in Table 7-5 have been escalated at a rate of 3-percent per year from 2007 to 2012, and exclude design contingencies, mobilization, bond and insurance, construction contingencies, and owner's program costs.

Table 7-5: Estimated Itemized Construction Costs for Water Distribution Improvements

Alternative Dam Site	Itemized Construction Cost (ICC)
Upper Bear Creek Dam site	$8.3 million
Lower Bear Creek Dam site	$8.3 million
Upper Cedar Creek Dam site	$8.3 million
Lower Cedar Creek Dam site	$8.3 million

7.8 Summary of Project Costs

Table 7-6 presents a summary of the estimated project costs, including all ICCs and design and construction contingencies described in Section 7.2.1. The costs presented under "Project Totals" represent our opinion of the Tribe's entire program costs to develop the proposed water storage facilities, raw water transmission pipeline, water treatment plant expansion, and water distribution system expansion.

Table 7-6: Estimates of Total Project Costs

	Lower Bear Creek Dam	Upper Bear Creek Dam	Lower Cedar Creek Dam	Upper Cedar Creek Dam
Itemized Construction Costs (ICC)				
Dam and Reservoir	$59,469,000	$62,483,000	$77,391,000	$67,908,000
Road Improvements	$11,048,000	$11,048,000	$14,093,000	$14,093,000
Raw Water Pipeline	$3,111,000	$3,111,000	$4,908,000	$4,908,000
Water Treatment Plant Expansion	$1,890,000	$1,890,000	$1,890,000	$1,890,000
Water Distribution System	$8,320,000	$8,320,000	$8,320,000	$8,320,000
Itemized Construction Cost Subtotal (ICCS):	**$83,838,000**	**$86,852,000**	**$106,602,000**	**$97,119,000**
Design Contingency				
Dam and Reservoir (20% to 22%)	$11,893,800	$12,496,600	$17,026,020	$14,939,760
Road Improvements (20% to 22%)	$2,209,600	$2,209,600	$3,100,460	$3,100,460
Raw Water Pipeline (25%)	$777,750	$777,750	$1,227,000	$1,227,000
Water Treatment Plant Expansion (30%)	$567,000	$567,000	$567,000	$567,000
Water Distribution System (30%)	$2,496,000	$2,496,000	$2,496,000	$2,496,000
Base Construction Subtotal (BCS)	**$101,782,150**	**$105,398,950**	**$131,018,480**	**$119,449,220**
Mobilization, Bonds & Insurance (9% BCS)	$9,160,394	$9,485,906	$11,791,663	$10,750,430
Construction Contingency (15% BCS)	$15,267,323	$15,809,843	$19,652,772	$17,917,383
Direct Construction Subtotal (DCS)	**$126,209,866**	**$130,694,698**	**$162,462,915**	**$148,117,033**
Design Engineering (8% DCS)	$10,096,789	$10,455,576	$12,997,033	$11,849,363
Construction Administration & Engineering (8% DCS)	$10,096,789	$10,455,576	$12,997,033	$11,849,363
Legal, Permitting, Mitigation (10% DCS)	$12,620,987	$13,069,470	$16,246,292	$14,811,703
Total Opinion of Probable Project Cost (OPPC)	**$159,024,431**	**$164,675,319**	**$204,703,273**	**$186,627,461**

Note 1: ICC= Itemized Construction Cost for individual project features.
Note 2: ICCS = Itemized Construction Costs Subtotal, sum of all 5 project features.
Note 3: BCS = Base Construction Subtotal, sum of ICCS and design contingency.
Note 4: DCS = Direct Construction Subtotal, sum of BCS, mobilization, bond, insurance, construction contingency
Note 5: The cost estimates in this report are considered to be Class 4 estimates per the Association for the Advancement of Cost Engineering (AACE) International Cost Estimate Classification System.

8.0 Screening Analysis of Alternatives

8.1 Background

The alternatives screening process was first discussed with Tribal representatives in a meeting held in September 2010. A Technical Memorandum (*Tule River Indian Reservation -- Proposed Water Storage Project -- Dam Site Selection Criteria)* was prepared by Reclamation (Mid-Pacific Regional Office, Division of Design and Construction) to document the meeting. That memorandum summarizes the results of the September 2010 brain-storming session, which involved representatives from the Tribe, Reclamation, BIA, and the Tribal Water Team and its consultants. The screening factors discussed at the meeting and presented in that memorandum were grouped, as follows:

- Factor 1 – Social and Cultural
- Factor 2 – Environmental and Permitting
- Factor 3 – Dam Design and Construction Issues
  - Site Access
  - Staging and Stockpile Areas
  - Development of Concrete Aggregates

Numerous issues related to constructing a dam and reservoir were discussed at the meeting and the memorandum identified suggested weighting factor ranges for the criteria and in the case of Criterion 3, weighting ranges for three sub-criteria. Most of the dam design and construction issues identified at the meeting will ultimately be reflected in the cost estimates developed for each of the alternatives.

8.2 Screening Analysis

The framework developed for evaluation of water supply project alternatives on the Tule River Reservation includes definition of: the over-arching goals for the project; the objectives that must be achieved to attain these goals; and the criteria that must be met to achieve the objectives and goals. Performance measures were used to determine how well each of the criteria is met under a specific alternative. This process was designed to be "reproducible and defensible" in order to be compliant with requirements of Section 404(b) of the Clean Water act (CWA) and to assure that various Tribal interests are fairly considered. Ultimately, the alternatives screening and justification for selection of a preferred alternative will need to become part of the documentation for a Corps of Engineers 404 Permit and documentation of compliance with requirements of the National Environmental Policy Act (NEPA).

The alternatives evaluation framework developed for the project allows input from stakeholders to be accepted, quantified as appropriate, and used in the screening and comparison of project alternatives in very systematic way. The sensitivity of screening and ranking of alternatives to changes in the importance of various weighting factors can be systematically evaluated.

While the process is “numerical” in nature, it provides opportunities for discussion among decision-makers and for consensus- building among potentially diverse project stakeholders. The weighting factors are established in a group setting. This process allows for discussion of important factors and it often elicits valuable insights affecting ultimate design of the project features. The goals and criteria are established to be independent, and when possible, are based on quantifiable measures. Relative weights are assigned to each goal, objective and criterion.

The alternatives evaluation framework developed for the screening of alternatives for the Tule River Tribal Water Settlement Project is presented on Figure 8-1. The goals are fairly similar to the three main factors identified in Reclamation’s December 2010 memorandum on selection criteria. However, there are some differences. For example, the goals of minimizing environmental impacts relates directly to the CWA Section 404(b) requirement that, to be selected as a preferred water supply option, an alternative should be the “least environmentally damaging alternative”.

All project alternatives under consideration are required to supply, at a minimum, the Tribe’s future DCMI water needs based on the 100-year projections described in Section 3.3. The alternatives are further evaluated with respect to water supply based on their ability to serve irrigation water demand in addition to the DCMI demand.

As noted above, factors related to dam design and construction incorporate a large number of considerations that are reflected in the cost of the project alternatives. An alternative that is too expensive, in relation to other alternatives, is not expected pass the test of practicability under Section 404(b) of the CWA

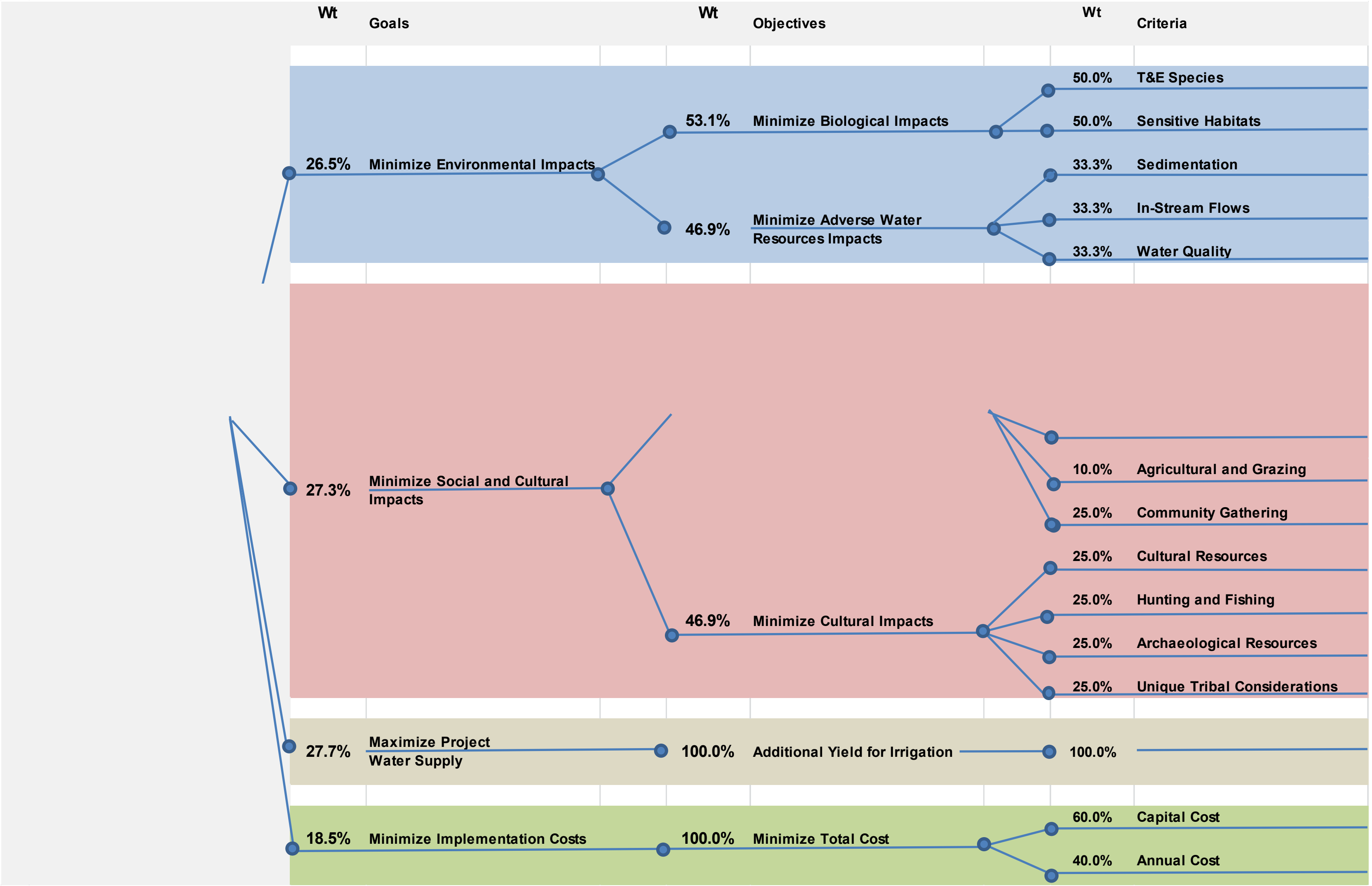
Many issues were discussed at the December 2010 meeting and these issues served as a general basis for establishing the goals, objectives, and criteria in the screening framework presented on Figure 8-1 and summarized in Table 8-1 below:

Table 8-1: Objectives and Criteria for Screening

Goals	Objectives	Criteria
Minimize Environmental Impacts	Minimize Biological Impacts	T&E Species
		Sensitive Habitats
	Minimize Water Resources Impacts	Sedimentation
		Instream Flows
		Water Quality
Minimize Social and Cultural Impacts	Minimize Social impacts	Traffic Effects
		Recreation Impacts
		Displacements
		Noise Impacts
		Agricultural and Grazing
		Community Gathering
	Minimize Cultural impacts	Cultural Resources
		Hunting and Fishing
		Archaeological Resources
		Unique Tribal Considerations
Maximize Water Supply	Additional Yield for Irrigation	Additional Yield for Irrigation
Minimize Costs	Minimize Costs	Capital Cost
		Annual Cost

The framework shown on Figure 8-1 was presented to the Tribal Water Team prior to the Screening Workshop, which was held at the Tribal Headquarters on March 6-7, 2013. During the Workshop, the Tribal Council, with assistance from representatives of key departments, participated in a process to establish the relative weights of the goals and objectives and to qualitatively score the alternatives in terms of their performance relative to the identified criteria.

Figure 8-1: Alternatives Screening Framework



8.2.1 Environmental Impact Considerations

The goal of minimizing environmental impacts was weighted by the Tribal Council at 26.5-percent, based on averaging of scores provided by members. This weighting is close to those given for social and cultural considerations and maximizing water supply for the Tribe. The objective of minimizing biological impacts (53.1-percent) was weighted nearly the same as the objective of minimizing water resources impacts (46.9-percent). The Tribal Council and representatives of the Tribal Natural Resources Department indicated that dam and reservoir projects developed at any of the sites would not have significant biological resource impacts nor would such impacts vary significantly from site to site. In terms of water resources impacts (sedimentation, in-stream flow changes, and water quality), the consensus during the Screening Workshop was that the sites lower in the watershed would have the potential for more negative impacts than sites higher in the watershed. Water resources impacts relate to sedimentation, channel maintenance, in-stream flows, and water quality. The scores (from 1 to 5) for each criterion reflect these considerations, with 5 representing the least impact and 1 the most impact. Weighting of the individual criteria were assumed to be equal, based on discussions at the Workshop.

8.2.2 Social and Cultural Impact Considerations

The goal of minimizing social and cultural impacts was weighted by the Tribal Council at 27.3-percent, based on averaging of scores provided by members. This weighting is close to those given for environmental considerations and maximizing water supply. The objective of minimizing social impacts (53.1-percent) was weighted nearly the same as the objective of minimizing water resources impacts (46.9-percent).

The Tribal Council and representatives of the Tribal various Tribal departments indicated that dam and reservoir projects developed at any of the sites would not have significant social impacts other than traffic and noise impacts. These impacts would be more significant for sites higher in the watershed due to increased travel distances for construction equipment and personnel and closer proximity to sites that are more heavily used for recreation and social gathering. Also, the upper sites near Cedar Creek would produce greater adverse impacts to recreational uses of the Reservation lands because access to the South Fork Tule River is easier and these locations are used more often by Tribal members for community gathering and stock grazing. The scores (from 1 to 5) for each criterion reflect these considerations, with 5 representing the least impact and 1 the most impact. Weighting of the individual criteria were developed based on discussions at the Workshop. Individual scores for each criterion were obtained from the participating Tribal Council members and averaged.

The Tribal Council and representatives of the various Tribal departments indicated that dam and reservoir projects developed at any of the sites would not have significant cultural impacts, but that whatever impacts might occur would generally be somewhat more significant for sites higher in the watershed. Also, the upper sites near Cedar Creek would produce greater adverse impacts to hunting and fishing because access to the South Fork Tule

River is easier at these locations. The scores (from 1 to 5) for each criterion reflect these considerations, with 5 representing the least impact and 1 representing the most impact. Weighting of the individual criteria were developed by GEI, based on discussions at the Workshop. Individual scores for each criterion were obtained from the participating Tribal Council members and averaged.

8.2.3 Water Supply Considerations

The goal of maximizing water supply was weighted by the Tribal Council at 27.7-percent, based on averaging of scores provided by members. This weighting is close to those given for environmental considerations and social and cultural considerations. As configured and described in Section 5.0 and 6.0, each of the dams will create a reservoir with 5,000 acre-feet of capacity. The Bear Creek sites would capture more of the runoff from the South Fork Tule River watershed than the Cedar Creek sites and therefore received higher point scores, because reservoirs at these locations will provide more water for irrigation while meeting the DCMI demands.

8.2.4 Cost Considerations

The cost consideration was ranked by the Tribal Council as the least important goal at 18.5-percent. The scores developed by the Tribal Council reflect the relative cost ranking of the four dam and reservoir projects, with Lower Bear creek receiving a score of 5 for capital cost and Lower Cedar creek a score of 1. Annual O&M costs for the Cedar Creek sites will be relatively higher than the Bear Creek sites because they are more remote from the town. O&M costs were assessed on a qualitative basis for the screening.

8.3 Screening Analysis Conclusions

The relative weighting established in the Screening Workshop and the point scores given in each category for each alternative are provided in Table 8-2 and graphically on Figure 8-2. Development of a dam and reservoir at the Lower Bear creek site was identified as the preferred project to meet future water needs of the Tribe. The primary reasons for this preference are summarized below:

- Lower Bear Creek captures runoff from the greatest watershed area and provides the greatest supply of water for the 5,000 acre-feet of storage planned for Phase I.
- While Lower Bear Creek may have the greatest potential for adverse impacts to sedimentation and water quality (reduced flushing flows from currently unregulated tributaries), these impacts are judged to be relatively minor and may be mitigated, at least in part, by reservoir operations. The Tribal Council does not consider there to be significant differences among the alternative dam and reservoir sites from the standpoint of other potential environmental impacts.
- At this time, Tribal Council does not believe that development at any of the sites would significantly impact social or cultural resources. However, the Cedar Creek

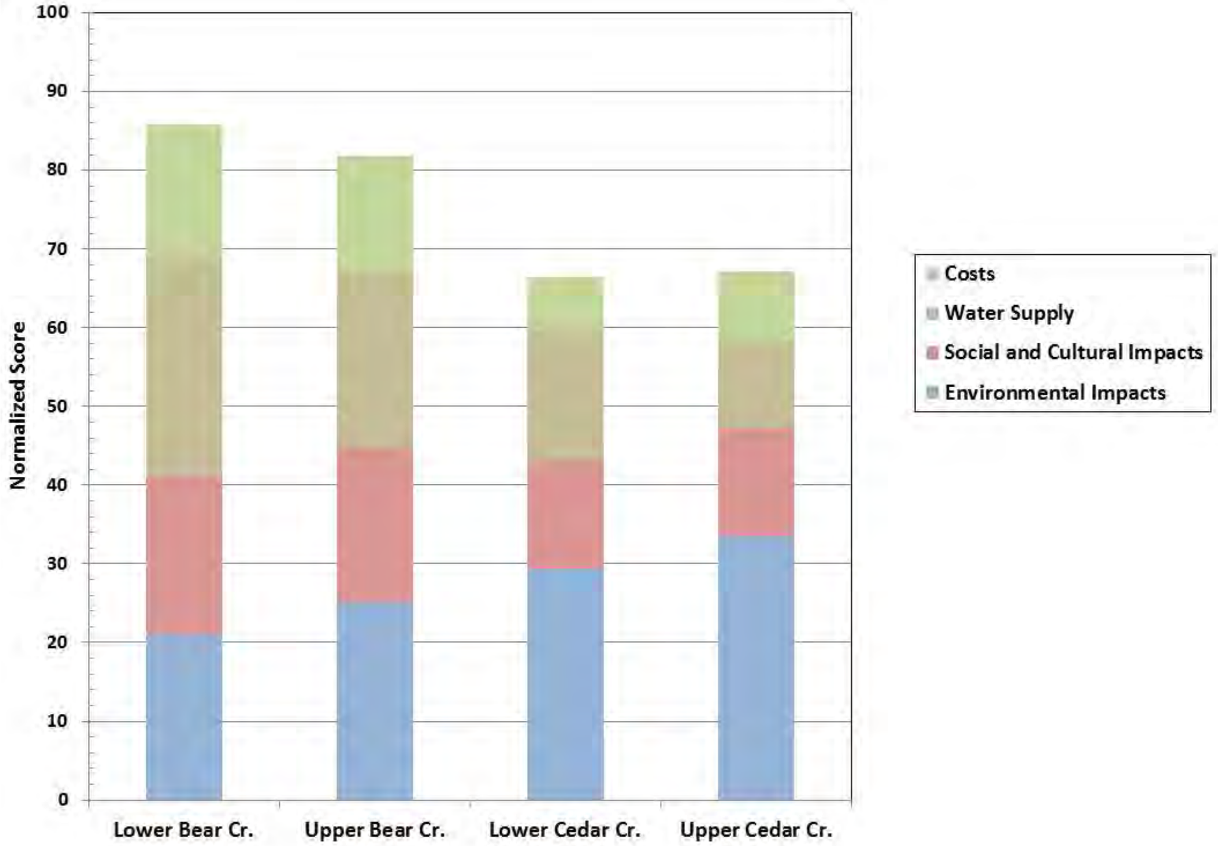
sites are currently more used by Tribal members for a variety of recreational and community-oriented activities.

- In comparison to the Bear Creek sites, the Cedar Creek sites will involve greater commuting distance for construction traffic and greater potential for conflicts between construction traffic and non-construction traffic on the main road from town to the upper portions of the watershed. Construction duration and noise and air quality impacts will be greater for the Cedar creek sites.
- Development at the Lower Bear Creek site will have the lowest construction cost, based on the estimates presented in Chapter 4. The lower cost is attributable not only to the dam, but also to the reduced length of the water supply pipeline from the dam to the water treatment plant. The reduced pipeline length will mean reduced pipeline maintenance costs and likely reduced risks of a potential service disruption.

Table 8-2: Screening Workshop Results

Base Case Evaluation of Alternatives for Tule River Water Project *Weights Established at 3/6-7/13 Workshop*	Goal Weight	Objective Weigl	Criteria Weight	Alternative 1 Lower Bear Creek	Alternative 2 Upper Bear Creek	Alternative 3 Lower Cedar Creek	Alternative 4 Upper Cedar Creek
Minimize Environmental Impacts	26.5%						
Minimize Biological impacts		53.1%					
T&E Species			50.0%	5	5	5	5
Sensitive Habitats			50.0%	5	5	5	5
Minimize Water Resources Impacts		46.9%					
Sedimentation			33.3%	1	2	3	4
Instream Flows			33.3%	1	2	3	4
Water Quality			33.3%	1	2	3	4
Minimize Social and Cultural Impacts	27.3%						
Minimize Social impacts		53.1%					
Traffic Effects			15.0%	3	3	1	1
Recreation Impacts			10.0%	4	4	2	2
Displacements			30.0%	4	4	3	3
Noise Impacts			10.0%	4	4	3	3
Agricultural and Grazing			10.0%	3	3	2	3
Community Gathering			25.0%	4	4	3	2
Minimize Cultural impacts		46.9%					
Cultural Resources			25.0%	4	4	3	3
Hunting and Fishing			25.0%	3	3	2	2
Archaeological Resources			25.0%	4	4	3	3
Unique Tribal Considerations			25.0%	4	4	3	3
Maximize Water Supply	27.7%						
Additional Yield for Irrigation		100.0%					
Additional Yield for Irrigation			100.0%	5	4	3	2
Minimize Costs	18.5%						
Minimize Costs		100.0%					
Capital Cost			60.0%	5	4	1	2
Annual Cost			40.0%	4	4	3	3
Weighted Scores	100.0%			4.29	4.09	3.32	3.36
Normalized Scores				85.8	81.8	66.4	67.2

Figure 8-2: Results of Alternatives Screening



9.0 Conclusions and Recommendations

9.1 Conclusions

The Tule River Tribe relies on water resources in the South Fork Tule River Basin to meet the water demands on its 55,396-acre Reservation in south-central California. Both surface and groundwater resources are currently used to meet water demands on the Reservation; however, the Tribe is only using a small portion of the available surface water supply to which the Tribe is entitled. Groundwater supplies that are available to the Tribe are limited and are not always of acceptable quality for domestic use.

The total estimated future consumptive water demand of the Tule River Indian Reservation in the year 2112 is 7,103 acre-feet per year, assuming full development of its irrigated agriculture potential. Of this total, 1,974 acre-feet is for domestic, commercial, municipal and industrial use and 5,129 acre-feet is for irrigation. These water demand figures are based upon reasonable projections of future potential Reservation population growth and economic development. To meet a portion of this water demand the Tribe is proposing to develop Phase 1 of a dam and reservoir project. The Phase 1dam will impound a 5,000 acre-foot reservoir, which will meet the entire year 2112 projected DCMI demand and a portion of the future irrigation water demand of irrigable lands on the Reservation while also providing minimum flow releases for downstream water users.

The water supply evaluation of the alternative dam sites in this report is based on the assumption that the future hydroclimate and hydrology of the South Fork Tule River basin will be similar to past conditions. However, studies of climate change generally predict less water stored in the snowpack during the winter and more concentrated periods of runoff with increased variability in precipitation and runoff from year to year. This uncertainty makes the need for storage on the Reservation even more critical.

There are a number of sites along the South Fork Tule River on the Reservation that are judged to be viable for construction of a concrete gravity dam using roller-compacted concrete (RCC) construction methods. Further studies and subsurface explorations will need to be performed to confirm current findings and provide the basis for final project planning and design of the dam and its appurtenant facilities.

The preferred dam and reservoir location is the Lower Bear Creek site on the South Fork Tule River just downstream from the confluence with Bear Creek. The average demand that could be met from this reservoir is 2,871 acre-feet per year, comprising 1,974 acre-feet of DCMI demand and irrigation of 220 acres. Three other sites for a dam were evaluated; however, the Lower Bear Creek site is preferred by the Tribe, based on the results of a Screening Workshop held on March 6-7, 2013.

In addition to the dam and reservoir, the Water Settlement Project would include a raw water conveyance pipeline from the reservoir to a new or expanded water treatment plant, which is also part of the project. Distribution system improvements are also planned to be implemented as part of the project. Construction of the dam and raw water pipeline would require improvements to the main road existing through the Reservation, as well as new access roads.

The opinion of total project cost for the preferred alternative (dam and reservoir at the Lower Bear Creek site) is $159 million, in December 2012 dollars.

9.2 Recommendations

The next steps in engineering and technical analyses for the project should include the following:

- Geologic reconnaissance and mapping of the Lower Bear Creek dam site and reservoir basin, as well as other potential sites that have been identified.
- Preliminary subsurface explorations at the Lower Bear Creek site to characterize foundation conditions and borrow materials in order to confirm that there are no conditions at this site that would preclude construction of the proposed dam and reservoir.
- Hydrologic studies to establish the inflow design flood and flood frequency relationships for dam design and construction planning.
- Evaluation of hydroelectric generation potentials at the dam, on the conveyance pipeline between the dam and the water treatment plant, and at the water treatment plant.
- Collection of surface water quality and sediment data to permit evaluation of impacts of project implementation and operations on water quality downstream of the dam and reservoir.
- Collection of environmental baseline information that will be needed to evaluate the impacts during construction and operation of the project.
- Collection of baseline socio-economic and social and cultural resources information that will be needed to evaluate the impacts resulting from construction and operation of the project.

The above engineering technical studies will provide information needed to advance the project into the detailed feasibility stage and prepare for the NEPA compliance processes and related permitting activities.

10.0 References

California Department of Water Resources, 1994a. California Water Plan Update. *Bulletin 160-93.*

California Department of Water Resources, 1994b. Urban Water Use in California. *Bulletin 166-4.*

Dabney, J., 1996, 1997, 1998. *Tule River Tribe Water Resources Director* [Interview] 1996, 1997, 1998.

Environment Canada, 2010. *2010 Municipal Water Use Report - Municipal Water Use, 2006 Statistics.* [Online]
Available at: http://www.ec.gc.ca/Publications/596A7EDF-471D-444C-BCEC-2CB9E730FFF9/2010MunicipalWaterUseReportMunicipalWaterUse2006Statistics.pdf

Garfield, R., 2009. *Testimony of Ryan Garfield Supporting S. 789 The Tule River Tribe Water Development Act,* s.l.: s.n.

GEI Consultants, Inc, 2011. *Tule River Dam and Reservoir Appraisal-Level Cost Opinion Technical Memorandum,* s.l.: s.n.

Indian Health Service, 2004. *Tule River Water Improvements,* s.l.: s.n.

Jensen, M. E., Burman, R. D. & Allen, R. G., 1990. Evapotranspiration and Irrigation Water Requirements. *ASCE Manuals and Reports on Engineering Practice*, Volume No. 70.

Jicarilla Apache Indian Reservation, n.d. *Quantification of Water Requirements for Uses of Irrigated Agriculture, Stockponds, Commercial, Public Water Supply, Domestic, Recreation and Reservoir Evaporation,* San Juan and Navajo River Basins in Rio Arriba and Sandoval County, New Mexico: s.n.

Kapnick, S. & Hall, A., 2009. *Observed Changes in the Sierra Nevada Snowpack: Potential Causes and Concerns,* s.l.: California Energy Commission.

Liang, X., Wood, E. & Lettenmaier, D., 1996. Surface Soil Moisture parameterization of the VIC-2L model: Evaluation and Modifications. *Glob Planet Chang,* Issue 13, pp. 195-206.

Maidment, D. R. e. i. c., 1993. *Handbook of Hydrology.* s.l.:s.n.

Maurer, E., 2007. Uncertainty in hydrologic impacts of climate change in the Sierra Nevada, California under two emission scenarios. *Climatic Change,* 82(3-4), pp. 309-325.

Moser, S. et al., 2009. *The Future is Now: An Update on Climate CHange Science Impacts and Response Options for California,* s.l.: California Energy Commission, PIER Energy Related Environmental Research Program.

National Fire Protection Agency, 1993. *NFPA 1231: Standards on Water Supplies for Suburban and Rural Fire Fighting,* s.l.: s.n.

Natural Resources Consulting Engineers, Inc., 1999. *Potential for Groundwater Development on the Tule River Indian Reservation Reconnaissance Level Investigation,* s.l.: s.n.

Natural Resources Consulting Engineers, Inc., 2007. *Updated Phase I Water Project Cost Estimate,* s.l.: s.n.

Natural Resources Consulting Engineers, Inc., 2008. *Updated South Fork Tule River Flow Extension Analysis,* s.l.: s.n.

Natural Resources Consulting Engineers, Inc., 2010. *Reservoir Operations Modeling,* s.l.: s.n.

Natural Resources Consulting Engineers, Inc., 2012. *Irrigation Water Requirements Investigation,* s.l.: s.n.

Null, S., Viers, J. & Mount, J., 2010. Hydrologic Response and Watershed Sensitivity to Climate Warming in California's Sierra Nevada. *PLoS One,* 5(4).

Reclamation, 1998. *Preliminary Assessment of Three Dam Sites,* s.l.: s.n.

Reclamation, 2009. *Tule River Tribe Proposed Storage Project DEC Review,* s.l.: s.n.

Reclamation, 2010. *Engineering Geologic Inspection of Potential Dam Sites on South Fork Tule River,* s.l.: s.n.

Reclamation, 2010. *Engineering Geologic Inspection of Potential Dam Sites on South Fork Tule River,* s.l.: s.n.

Reclamation, 2010. *Technical Service Center Travel Report,* s.l.: s.n.

Reclamation, 2010. *Tule River Indian Reservation Proposed Water Storage Project Dam Site Selection Criteria,* s.l.: s.n.

Reclamation, 2011a. *Reclamation Technical Memorandum (TM) No. 86-68210-2011-01, West-Wide Climate Risk Assessments: Bias-Corrected and Spatially Downscaled Surface Water Projections,* s.l.: s.n.

Reclamation, 2011b. *SECURE Water Act Section 9503(c) - Reclamation Climate Change and Water, Report to Congress,* s.l.: s.n.

Tule River Indian Tribe, 1997. *Overall Economic Development Program, 1997 Annual Report,* s.l.: s.n.

United States Census Bureau, 2010. *American Fact Finder, Detailed American Indian Tribe Data, Tule River Tribe,* s.l.: s.n.

United States Census Bureau, 2010. *American Fact Finder, Tulare County, California,* s.l.: s.n.

United States Department of Agriculture, Economic Research Service, 1983. Handbook of Water Harvesting. In: *Ag. Handbook #600.* s.l.:s.n., p. 7.

Vicuna, S. & Dracup, J., 2007. The Evolution of Climate Change Impact Studies on Hydrology and Water Resources in California. *Climatic Change,* 82(3-4), pp. 327-350.

Wilson, B., Lucero, A. & Romero, P., 2003. Water Use by Categories in New Mexico Counties and River Basins, and Irrigated Acreage in 2000. *NMOSE Technical Report 51.*

Appendix A Water Supply and Needs Supporting Technical Information

Appendix B Figures

Appendix C Cost Analysis Supporting Technical Information

Appendix D Sampling Analysis Program Plan

GEI Consultants

June 24, 2015

Geotechnical
Environmental
Water Resources
Ecological

U.S. Department of the Interior
Policy and Administration
Bureau of Reclamation

Subject: Tule River Tribe, Letter of Support

Dear Sir or Madam:

The purpose of this letter is to state our full support for the Tule River Tribe's application to the *WaterSmart: Drought Resiliency Project Grants for FY: 2015.* We have been working in partnership with the Tule River Tribe for a number of years and fully realize the seriousness and full implications of drought conditions, coupled with rapid climate change – especially in the Central San Joaquin Valley. The Tule River Indian Reservation is one of the oldest federally-recognized tribes in California and takes the utmost responsibility as "stewards of their homelands".

We will continue to work with them in matters of drought, training in emergency response situations such as wildfires, which are always a threat as temperatures increase and the flow of river waters decrease.

We truly appreciate your consideration of the Tule River Tribe's application and ask that you please give it serious consideration for full support.

Respectfully,

Jerry Peña, Jr., P.E.
Senior Consultant

Richard A. Westmore, P.E.
Senior Vice President

Table 2 - Sample Funding Sources

Funding Sources	% of Total Study Cost	Total Cost by Source

Recipient Funding		$
Reclamation Funding		$
Other Federal Funding		$
		$
Totals	0%	$

Title Page

PAINTED ROCK IMPROVEMENTS PROJECT

TABLE OF CONTENTS

Technical Proposal

1. Executive Summary

Date:	June 25, 2015
Applicant:	Tule River Tribe of the Tule River Reservation
Address:	340 North Reservation Road; Porterville, CA 93257 County of Tulare, California
Estimated Completion Date:	September 17, 2017
Location of Facility:	Tule River Indian Reservation

Through the support of the WaterSmart Resiliency Grant Program FY: 2015, the Tule River Tribe, in partnership with the Tule River Water Rights Team, Natural Resources Consulting Engineers, Inc., GEI Consulting Engineers and Scientists, and associated downstream water users of the South Fork of the Tule River will implement the construction of a 12 foot high crib dam in the Painted Rocks area of the Tule River Reservation which will increase the storage capacity of the old crib dam from 1.3 ac-ft to 3 ac-ft. Additionally, anticipated project benefits will allow increased knowledge and awareness of the rich historical and cultural presence of the area among tribal water management staff. Finally, the uniqueness of the project will enhance capabilities and skills learning among tribal water management staff in terms of resiliency to manage water resources effectively in times of drought and water abundance. Other benefits of the project include enhancement of various trout species – Rainbow, Brown Trout, as well as a variety of large and small game that inhabit the area.

2. Background Data

The Reservation is located in south-central California, approximately 75 miles south of Fresno in Tulare County. Porterville, the nearest city, is reached by a two-lane meandering road twenty miles due west. The Reservation is situated on the western slope of the Sierra Nevada Mountains and lies almost entirely within the South Fork Tule River drainage basin. The South Fork Tule River flows into the Tule River at Success Reservoir, which is located about ten miles west of the Reservation. There are no significant water users upstream of the Reservation.

The topography is generally steep, with elevations ranging from about 900 feet near the Reservation's western boundary to 7,500 feet near the Reservation's eastern boundary. Most of the inhabited land is situated along the lower reach of the South Fork Tule River on the western side of the Reservation. The current acreage of the reservation held in trust by the United States covers 55,396 acres. The Tribe also owns, in fee, additional acreage contiguous to the Reservation, and several small parcels outside the South Tule River basin. One 39 acre parcel adjacent to Highway 190 and approximately 8 miles northwest of the reservation is held in trust by the United States.

The climate on the Reservation can vary considerably by season and is strongly correlated with elevation. The average daily high temperature within the Reservation is about 77°F throughout the lower elevations and 55°F at higher elevations. Concurrently, the average low temperature ranges from about 55°F throughout the lower parts of the Reservation to 27°F at higher elevations. The majority of the precipitation on the Reservation falls along the upper reaches of the South Fork Tule River watershed (average of 45 inches annually). Precipitation along the lower reaches averages about 20 inches annually. The Reservation's lower foothill areas are generally covered with grasses and chaparral. Oak, sycamore, alder, and other deciduous trees are common adjacent to the streambed. At higher elevations, there are stands of pine, fir, spruce, cedar, and giant sequoia.

The primary source of water for the Tule River Indian Reservation is the South Fork of the Tule River, beginning below Slate Mountain in the Sierra National Forest east of the Reservation, flows to the west and north for approximately 38 miles. Gibbon Creek flows north from Gibbon Peak, south of the TRIR boundary, through Gibbon Canyon, onto the Reservation for approximately ten miles, and drains into the South Fork of the Tule River. Gibbon Creek flows are seasonal.

The Tribe's water treatment plant currently has the capacity for providing 501,700 gallons per day (562 acre-feet per year) at maximum production. The Tribe typically tries to run the treatment plant at maximum capacity and uses groundwater sources to help make up shortfalls. In many years, the Tribe does not have adequate water supplies in the late summer and early fall to meet the current minimum 100,000 gallons per day of water demand.

Reservation Water Needs

The following describes the varying nature of water needs on the Tule River Reservation:

- Indoor Water Demand – Presently serving approximately 200 homes at 50-78 gallons per day (gpd)
- Outdoor Water Demand – irrigate land for gardens and landscape average .08 acres per household; overall total of 4.3 acre feet per year.
- Livestock – approximately 1 horse per every 2 households, or 100 horses; use of approximately 12 gallons per day/each horse.
- Commercial Water Use – Eagle Mountain Casino, located on the reservation
- Municipal Water Use – General: street and sewer cleaning; infrastructure construction, and maintenance. Water for ten tribal buildings, including EMC ranges from 125,000 to 455,000 gallons per day (depending on time of year).
- Commercial Water use – Fire Protection: A minimum of 3,000 gallons of water is needed to protect each residence; additional water supplies will be necessary for the protection of non-residential structures; also, small brush fires that occur in the vicinity of the community.
- Industrial Water Use – The tribe may develop a sand and gravel operation minor mining project in the future; however, available data is not known to estimate the amount of water that may be required for potential mining activities. Estimates show that according to USGS, water use for mining in California in 2005 was approximately 14.9% of the water used for domestic purposes.
- Agricultural Water Use – Presently, the tribe's ability to develop its rich land and timber resources are constrained by a lack of significant and reliable sources of water – due to drought conditions.
- Irrigation Water Demand – the tribe has approximately 1257 acres of land for irrigated agriculture. These lands are additional lands that are designated for future housing. Should the tribe decide to convert use to irrigated agriculture, its agricultural needs would change accordingly.
- Livestock Water Demand – There are approximately 1,000 head of cattle on the reservation. These cattle fully utilize the capacity of the reservation lands designed for grazing. Typically one animal unit requires between 10-15 gallons of water per day. The total annual water needs for range cattle on the Reservation is estimated at approximately 17 acre feet per year.
- The estimated *future* water demand of the Reservation in the year *2112* is 7,103 acre-feet per year. Of this total, it is estimated 1,974 acre-feet per year would be allocated for domestic, commercial, municipal and industrial (DCMI) uses and 5,129 acre-feet per year would be allocated for irrigation. These water demand figures are based on reasonably conservative projections of future potential Reservation population growth and economic development.
- Other surface water beneficial uses of the Tule River that the tribe is considering include hydropower generation, warm and cold freshwater habitat, rare, threatened, or endangered species, spawning, reproduction, and/or early development of fish, groundwater recharge, and freshwater replenishment *(from CVRWQCB Water Quality Control Plan for the Tulare Lake Basin, Second Edition, Revised January 2004 [with approved amendments]).*

Housing Needs

The Tribe's on-Reservation future domestic water needs will depend directly on the Reservation's future population. According to tribal representatives, many tribal members desire to live on the Reservation are unable to do so because of a lack of on-Reservation housing.

Historically, available housing on the Reservation has fallen well short of demand. Consequently, construction of new housing has long been a priority of the Tribe. Working with the Department of Housing and Urban Development (HUD) and other funding sources, the Tribe has developed several housing programs for its members and designated over 2,000 acres of Reservation land for future housing development. New housing continues to be built, but the rate of construction is inadequately low and primarily *limited by insufficient available water supply*.

To meet a portion of this water demand, the Tribe is proposing to increase water capacity and improve water management at the Painted Rock Dam, in conjunction with other water infrastructure projects. The Painted Rock Improvement Project would impound *3.3 ac-ft* of surface water which would meet the year 2016 projected DCMI demand and a portion of the future irrigation water demand of irrigable lands on the Reservation.

Current and Potential Water Supply Shortfalls
The historic climate of the Central Valley is characterized by hot and dry summers and cool and damp winters. Mean annual temperature has increased by approximately 2 °F for the area during the course of 20th century. In winter, temperatures below freezing may occur, but snow in the valley lowlands is rare. During the course of the 20^{th} century, a decline in spring runoff in the Southern Sierra Nevada Mountains, as well as other regions in California has declined dramatically.

For the past 13 years the median daily discharge of the South Fork of the Tule River has decreased from *>40 cubic per second to >30 cubic feet per second in April 2014 to ≤ 4 cubic per second in April 2015.*

Additionally, the region of southeast Tulare County, California is within an 'Exceptional Drought' area. There exists a potential for climate change to adversely impact existing and planned water supplies via changes in precipitation, temperature, snow water equivalent, and stream flows. For the Central San Joaquin Valley watersheds, studies suggest that warmer temperatures are expected to increase by *3-10.5* degrees *F* by the end of the century *(Moser et al., 2009).*

Null et al. (2010) reported on climate change impacts for 15 western slope watersheds in the Sierra Nevada under warming scenarios of *2, 4, and 6 °C* increase in mean annual air temperature relative to historical conditions. Under these scenarios, total runoff decreased; earlier runoff was projected in all watersheds relative to increasing temperature scenarios; and the high elevation in southern central region was more susceptible to earlier runoff.

Of the eight major river basins being studied by BOR's WaterSmart Basin Study Program, the San Joaquin River Basin is the one in closest proximity (and thus of greatest relevance) to the South Fork Tule River Drainage basin in which development of water supplies are being evaluated by planners for the Tule River Tribe.

An initial report assessing climate change risks in the eight major basins has been released by Reclamation (TM No. 86-68210-01: West-Side Climate Risk Assessments: Bias-Corrected and Spatially Downscaled Surface Water Projections, 2011a). This section describes potential impacts of climate change with a focus on the San Joaquin Basin and possible implications for the South Fork of the Tule River drainage basin. While the information provided is not intended to represent a quantitative analysis of specific risks to the Tule River Tribe, the information provided is intended to provide a qualitative assessment for the South Fork of the Tule River and is useful to assist in planning for and adapting to potential risks to the tribe's present and future water supply.

Existing Water Supply and Infrastructure

The Tule River Reservation water system relies upon a series of wells, springs, and water drawn directly from the South Fork Tule River, which is treated to meet potable water standards. The Tribe's documented water usage is constrained by the availability of water supplies and the water distribution system and, therefore, is not representative of the actual demands for water.
The amount of water diverted annually from the South Fork Tule River is not known, as past diversions by the Tribe have been unmeasured. The quality of river water is affected by grazing upstream, as well as other land uses and activities in the watershed.

Natural springs are evident throughout the Reservation and these are being used for a combination of agricultural irrigation and drinking water augmentation. Several large springs show high levels of carbon dioxide and are therefore restricted to agricultural usage.
Wells are located throughout the Reservation, but are concentrated in the Reservation's Lower Valley where they augment the treated surface water serving the community. Less than a quarter of wells that have been drilled on the Reservation are operational due to either a lack of production or water quality concerns. The average annual water supply from the existing spring system is assumed to be *145 ac-ft/yr (129,000 gpd).*

Water Quality

Water quality within the South Fork Tule River watershed is generally good although the river water does at times exceed federal Safe Drinking Water Act (SDWA) standards for certain constituents and the groundwater at certain locations is unsuitable for potable use. The Tribe currently conducts daily turbidity measurements of water leaving the treatment plant as well as monthly coliform tests at various locations within the distribution system following federal SDWA guidelines. The Tribe complies with the U.S. Environmental Protection Agency (EPA) sampling requirements for annual and biannual water quality testing.

In addition, the Tribe conducts water quality sampling at 30 established locations within the South Fork Tule River watershed. The Tribe currently has a Quality Assurance Program Plan (QAPP), approved by EPA, to obtain and test these samples, as well as a Sampling and Analysis Program Plan (SAPP). The SAPP can be found in Appendix D. About one year ago, the Tribe was funded by EPA to expand the number of sampling locations, which now includes some locations near the proposed dam sites described in Section 5 of this report. The Tribe takes samples to test for various water quality parameters and also takes field readings for pH, turbidity, conductivity, temperature and bacteria. The Tribe expects to develop new QAPP and

SAPP documents in the near future to cover the expanded sampling scope. The new QAPP is being developed following EPA guidelines, as documented in EPA QA/R-5, EPA Requirements for Quality Assurance Project Plans (http://www.epa.gov/quality/qs-docs/r5-final.pdf).

Water quality exceedances in the South Fork Tule River are generally from turbidity and bacteria. These exceedances are believed to result from nonpoint sources, primarily livestock grazing, with other likely contributors being construction earthwork activities, erosion and sedimentation from unpaved roads, septic tanks located near the river in areas of thin soils and/or shallow groundwater, and activities associated with road maintenance. Although there are only limited sampling data from the South Fork Tule River near the proposed dam sites at this time, bacteria levels in the river are known to generally increase from upstream to downstream. Noticeable increases in bacteria concentrations occur at locations where there are greater numbers of houses and when river flows are low.

Groundwater Supply

Groundwater occurs in the shallow alluvial deposits along the main stem of the South Fork Tule River and in the cracks and fractures of the granite bedrock underlying the Reservation. Of the twenty-two (22) wells inventoried on the Reservation, only five are operational at this time. Wells were taken out of production due mainly to water quality problems and insufficient yields. Well yield is influenced by proximity to fractures and fissures in the local granite bedrock, but can be affected by the presence of underground limestone and marble. Yields of most wells drilled into the bedrock on the Reservation range from near *zero to 50 gpm.* The three wells that pump into the main public water system have capacities of *25 gpm, 10 gpm, and 30 gpm.* Of the remaining two wells, one serves the Apple Valley and the other serves the Cow Mountain area. Those wells have capacities of *17 gpm and 13 gpm*, respectively. Well yields tend to be modest, with most producing less than *30 gallons per minute (gpm)* and groundwater is limited by quantity and quality.

Although groundwater availability on the Reservation is not adequate for large-scale agriculture potential, groundwater yields may be adequate to meet a portion of future domestic water demand.

The quality of water in local wells is an issue. Approximately 30-percent of the 280 septic systems on the Reservation are approaching a state of failure with a few already discharging to the surface. Most developed wells either lack an annular seal or have one that is not sufficiently deep to protect the well. Wells are located in areas close to grazing lands, near buildings and areas of human activity, or close to septic systems. Most of the wells are old, have a variety of pumps and piping, and are maintained only when problems occur.

Water Treatment System

River water, delivered through a ten inch pipe at an upstream location, is not metered. An older turbine meter installed above the plant inlet has become non-functional. The plant is old, but has been upgraded with limited new equipment.

The Tribe's water treatment plant was upgraded in 2004-05 to increase its capacity from *150 gpm* to approximately *300 to 350 gpm.* The projected maximum day demand for the Reservation is approximately *1,050 gpm*. The Tribe's water treatment plant currently has the capacity for *501,700 gallons per day 562 acre-feet per year* at maximum production. This limit along with the unreliable water supply constrains current water usage and future development on the Reservation. The Tribe typically tries to run the treatment plant at maximum capacity and uses wells to help make up any shortfalls.

Water Storage and Distribution System
The overall water system is not considered to be adequate to meet current Tribal needs. Water cannot be delivered to all homes on a year-round basis. Some homes do not have water supply in the early summer months because of inadequate supply and distribution system capacity issues. Water shortages are becoming increasingly common as more and more tribal members move back to the reservation into new homes. There is not enough water to meet the demand, especially in the summer. The Tribe's Public Works Department has issued water conservation notices for the last five years, requesting that tribal members use water sparingly, and report leaks, to prevent shortages to the domestic water supply. Despite these notices, tribal members still continue to run out of water every year. The outages vary from one day to one week. There is no "gray water" system presently on the Reservation, although discussions aimed at developing one have begun.

The water storage system consists of a series of tanks ranging in size from *3,000 gallons to 200,000 gallons. The* tanks do not function as a coordinated storage system and, in some cases, were improperly designed. Plans are underway to add a new 400,000 gallon tank, to be interconnected with two existing smaller tanks. The new tank would serve the newly constructed Tribal Justice Center. It should be noted that this new tank provides for only some short-term development on the Reservation and is not adequate to serve the Tribe's long-term development plans. The water storage system is not regularly monitored for water in storage or for structural conditions.

The distribution system consists of ±50-year-old, 4-inch-diameter asbestos cement pipe and includes 6- and 8-inch-diameter pipes of varying ages. Some of the pipes have deteriorating seals, cracked or eroded sections and occasionally poorly constructed house connections. The system is relatively unmonitored although the system is monitored visually for signs of leakage.

House connections are generally 1-inch-diameter, although more than one home may be served by a single connection. One 2-inch-diameter connection system was found to be serving at least five houses.

Individual houses are not metered. They are also not inspected for leaking pipes and/or fixtures. A significant amount of water may be lost due to system leakage; however, the absence of metering makes the quantity of loss very difficult to estimate.

The storage capacity is not adequate to meet peak use domestic consumption and fire flow demands. Even with direct pumping, insufficient water is available for a major structure fire. Grass fires are routine during the summer, but often require the use of potable resources.

The Tribe's water treatment plant currently has the capacity for providing 501,700 gallons per day (562 acre-feet per year) at maximum production. The Tribe typically operates the treatment plant at maximum capacity and uses groundwater sources to help make up shortfalls. In many years, the Tribe does not have adequate water supplies in the late summer and early fall to meet the current minimum 100,000 gallons per day of water demand.

A minor source of water for the main water system is the *Carothers Spring*, which located at the highest point of the system at an approximate elevation of 3,000 ft. It has been reported that the spring produces an average of *50 gpm to 60 gpm*, but can exceed 100 gpm during wet winter months. From the spring, water flows to a 10,000 gallon storage tank before being sent to the water treatment plant. During the summer months, spring production is very low and a secondary source of water is necessary. This additional water is received from a river source.

There is an intake located at a Painted Rock Dam on the south fork of the Tule River (Photo below).

Although they are considered unreliable for regular use, there are 5 community wells that are sometimes used to supplement the main water system. The productions of these wells are summarized in the table.

Well # Yield

Well 1 22 gpm
Well 2 30 gpm
Well 5 31 gpm
Well 8 Not Being Used
(due to sand clogging)
Well 9 10 gpm
TOTAL 93 gpm

Technical Project Description

There are a number of sites along the South Fork of the Tule River on the Reservation that were assessed to be viable for construction of a concrete gravity dam using roller-compacted concrete (RCC) construction methods. Further studies and subsurface explorations would need to be performed to confirm current findings and provide the basis for final project planning and design of the dam and its appurtenant facilities.

In addition to the dam and reservoir, the Phase 1 project would include a raw water conveyance pipeline from the reservoir to a new or expanded water treatment plant, which is also part of the project. Distribution system improvements are also planned to be implemented as part of the project. Construction of the dam and raw water pipeline would require improvements to the main road existing through the Reservation, as well as new access roads. This project proved unfeasible by BOR due to high construction costs.

The Bureau of Reclamation has indicated that storage of water is a critical requirement of any water supply project due to the limitations of the available of water resources on the Reservation. Therefore, non-storage alternatives such as groundwater development have been eliminated from further consideration. Currently, the storage options being considered are:

- Reduced (less than 5,000 ac-ft) storage at the Lower Bear Creek site - this project would not reduce construction costs due to the topography and the requirement of a relatively high dam, roads improvements, and concrete construction. Project would not likely gain BOR's support. GEI Consultant firm for the tribe noted that even at a reduced storage size (from 5,000 ac-ft to 2,000 ac-ft) the project cost for just the dam and raw water pipeline would still be approximately $110M.

- Off-Reservation storage at McCarthy Ranch - This alternative calls for an on-stream dam to be constructed downstream of the Reservation at McCarthy Ranch, which the tribe currently owns in fee. BOR is currently investigating two potential damsites and will consider different sized reservoirs up to 5,000 ac-ft. It appears that the required dam will be small enough to allow earthfill construction, which is considerably less expensive than concrete.

- Small Crib Dams on the Reservation – This alternative involves the construction of crib dams combined with excavation into the rock stream channel to develop additional storage capacity. The Value Planning report describes a crib dam as "a steel structure consisting of vertical steel beams to which steel plate or sheet pile is attached, forming a crib. Steel cross members would provide lateral support, and the crib would be filled with rockfill." This alternative provides only very limited storage so would not be a solution by itself but would have to be combined with a larger storage project to satisfy the Tribe's demands.

BOR views crib dams as having the potential to serve the Tribe's existing needs on the Reservation and maybe some additional irrigation demand. They are currently considering 1-2 dams with capacities less than 20 ac-ft. The location of the crib dam(s) is still to be determined but BOR mentioned the Painted Rock site (i.e., where the Tribe's current river diversion is located) as a possibility.

- Lake Success - Under this alternative, the Tribe would be required to somehow acquire storage rights in Lake Success. To facilitate this process, Lake Success would be expanded through a spillway raise or a spillway raise in combination with a dam raise. Water would be pumped back up to the Reservation through a pipeline that likely would follow existing roads. BOR currently does not favor this alternative for several reasons. The Tribe would not have control over the storage facility. Any modifications to Lake Success would take many years (Mr. Gore estimated 20) because it would have to go through the approval process of the Army Corps of Engineers, who are currently engaged in safety of dams studies. BOR also notes that Lake Success in its current dimensions only fills to the spillway one in every ten years and that building more storage does not guarantee that additional storage will fill. BOR also does not have a clear idea of how the Tribe would acquire the storage right, which from the Tribe's perspective would have to be a senior right to provide sufficient reliability. There is also a large pumping requirement associated with this alternative.

  An idea put forward by the Tribal Water Team and supported by BOR staff is a two-project solution where the main Reservation would be served by a crib dam project and future development would be served by a McCarthy Ranch dam project. This assumes that the Tribe's future development would occur downstream of the Reservation in Success Valley. This concept is explored in more detail later in the discussion on the McCarthy Ranch storage alternative.

These studies are necessary because the Department of Interior (i.e., Federal Negotiation Team, Water Rights Office, and Working Group) has stated that it cannot support the Tribe's water project as currently configured due to the cost, which by the Tribe's estimate (work performed by GEI) is $160 million. As a reminder, that project consists of an on-Reservation concrete dam and 5,000 ac-ft reservoir at the Lower Bear Creek site, 12-inch raw water pipeline from the dam to the water treatment plant, water treatment plant expansion, and water distribution system expansion. The goal of the studies is to identify less expensive alternatives to the current water supply project and perform appraisal level cost estimates on those alternatives. How much less expensive the projects need to be is uncertain as DOI has not indicated what project cost they would be willing to support. The technical studies will rely on preliminary information generated from the Value Planning study that was previously presented to the Council.

The Painted Rock damsite, located at the same point on the South Fork Tule River as the existing diversion dam will be substantially less expensive than at any of the four sites previously investigated (Upper Cedar Creek, Lower Cedar Creek, Upper Bear Creek, Lower Bear Creek) due to its favorable accessibility and proximity.

It is estimated that in order to avoid inundating the nearest falls, the dam would have to be less than 20 feet high, corresponding to a storage volume of only 14 acre-feet. A reservoir of about 1,100 acre-feet would inundate the first two falls, while a reservoir of about 5,000 acre-feet would inundate the first two and part of the third falls. Please note that these values are only approximate based on a rough desktop analysis.

Painted Rock Dam Improvements Project

During its past work with the Tule River Tribe relative to water resources and needs, BOR views crib dams as having the potential to serve the Tribe's existing needs on the Reservation and maybe some additional irrigation demand. This is the Tribes first application to the WaterSmart program and includes the construction of a Crib Dam at the Painted Rock area. Once completed, the holding capacity will be considerably less than 20 ac-ft..

The Painted Rock Dam Improvement Project currently serves as a key component of the Tribe's water supply system and impounds approximately 1.3 acre-feet (AF). The storage that this facility provides has proven to be critical in meeting the Tribe's water demands in the midst of California's current drought. The dam at this site experiences a tremendous amount of sedimentation, which creates maintenance issues and has resulted in the reduction of the facility's storage capacity. Currently, the Tribe is making plans to dredge the sediment and restore capacity, it was determined that improvements at this site were necessary to improve operations and provide some drought resiliency within the water system. Preliminary evaluations determined that improvements to the existing dam structure would not be the most cost effective, long-term solution to address these issues. To improve the Tribe's ability to deliver water under drought conditions and improve the storage operations, the Painted Rock Dam improvements will include:

- Construction of a new 12-foot tall concrete dam, aligned just upstream of the existing dam location
- Installation of a new cast-iron sluice gate to allow sluicing of sediment during high flow events
- Installation of a new metal walkway, along the dam crest, to provide access to the sluice gate operator
- Improvements to the outlet works, connecting the new dam facility to the existing transmission pipeline

The construction of these new facilities would increase storage at this site by approximately 3 AF, nearly tripling the storage at Painted Rock, and providing a minimum of approximately 56% increase in tribe's water supply.

The Painted Rock Improvements Project will be initiated upon notice of funding by BOR WaterSmart Drought Resiliency Grant Program and will follow the prescribed timeline:

Estimated Length of the Dam is approximately 150 feet.

Anticipated Construction Equipment:

- Diesel Low-Boy to transport equipment to the site
- Medium-Sized Dozer (equivalent to a Caterpillar D6), for clearing and grubbing
- Medium-Sized Sheepsfoot Compactor (equivalent to a Caterpillar 563), for installation of cofferdam
- Medium-Sized Excavator (equivalent to a Caterpillar 375), for foundation preparation
- 4,000 gallon Water Truck for dust control
- 20 CY Dump Truck (2 of these), to haul off material and debris
- Concrete Truck and Pumper, to construct the dam
- Support Vehicles (2 trucks)

Anticipated Construction Sequence: 6 to 8 months of construction
October to November 2015 - Advertise and hire Engineering Consultant
November 2015 - Mobilize work crew, equipment availability
November 2015 – Orientation of project to tribal staff and mobile equipment operators
November 2015 Develop work schedule, safety meetings.

Activities:

October to November 2015

- Contractor would mobilize equipment onto site.

December 2015

- Initial work would begin with the use of the dozer and excavator to clear and grub the site along the dam alignment, and construction of the cofferdam to keep the construction site dry. This would include the installation of a temporary bypass to allow flow, impounded by the cofferdam, around the construction site.
- Debris would be hauled off-site.

January to February 2016

- After clearing and grubbing, the excavator would be utilized to prepare the foundation. This would include keying a trench (to sound rock) along the dam alignment to minimize seepage.
- Excavated material would be hauled to a staging area for storage.
- Once the foundation is prepared, the Contractor would start tying reinforcement steel and setting formwork for the dam installation. This work would also include the placement /installation of the sluice gate.

February to March 2016

- Contractor will install the outlet pipeline and make preparations for connection to the existing water transmission line.

- After the reinforcing steel and formwork are completed, the concrete will be placed (probably in two separate lifts), utilizing the concrete pumper.
- The concrete dam will cure in-place until the concrete has reached its designed strength, and then the formwork will be removed and the facility will be ready for operation.

March to May 2016

- Contractor will install the steel walkway along the crest of the dam and install the sluice gate operator.
- The cofferdam will be removed so that water will begin to fill behind the new dam and the connection to the water transmission main will be completed.
- Once the new facilities are in operation, the existing dam will be removed and the debris will be hauled off for disposal.

Anticipated Material Quantities:

- 150 CY of concrete
- 7 pounds (2 square inches) of reinforcement steel per lineal foot of dam cross section
- 200 square feet of steel walkway

Evaluation Criteria – Project Benefits

The Painted Rock Improvements Project is the result of intensive discussion and planning and considering other options in order to effectively deliver needed water in the shortest time while maximizing cost-savings. The construction of a12-foot crib dam combined with excavation into the rock stream will develop water storage over 3 times the existing capacity. This project will occur in the Painted Rock area of the Reservation. This project is the first of (2) stages which are independent of one another. The second project involves a much larger reservoir, will provide greater storage, and will increase water security for the tribe. It is estimated that the Painted Rock Improvements Project will serve as a key component of the tribe's water system and will impound approximately 3 ac-ft, nearly tripling the current storage. The expected lifetime use of the constructed dam can be estimated at (50) years.

The Painted Rock Improvements Project, upon completion, will impound approximately 3 ac-ft, nearly tripling the current storage. Estimates were calculated by Jerry Pena, CEI Consultants, Denver, Colo. It is estimated that project will increase the total supply by *57.7%.* This project is the initial steps that the tribe is taking to store water that was granted during negotiated water rights settlement.

The construction of the new crib dam facility will introduce tribal staff and tribal water managers to new ideas, skills, and technologies in water management, specific to dams. Additionally, the project will introduce tribal water operations staff to new maintenance issues, especially relative to sedimentation. Maintenance staff will develop specialized skills in water management which are necessary to improve operations to deliver water under drought conditions while improving storage.

The Tribe has not been able to fully utilize water generated from the flow of the South Fork of the Tule River. This is due to the lack of an effective storage facility. Upon, completion, the tribe will have taken its first steps to address this issue. The Painted Rock Improvements Project will increase storage capacity at Painted Rock from *1.3 ac-ft to 3.0 ac-ft, or 57.7%,* thus increasing water management by 100% since this is a first-ever type of project introduced to the Reservation since the early 1930's under FDR Reconstruction projects. It is estimated that at least *80%* of the tribe's surface water management will be managed in terms of increased resiliency in times of drought and high water runoff.

Drought Planning and Preparedness

As a pretext to drafting a Drought Plan that is specific to the needs and cultural values of the Tule River Tribe, community emergency response staff utilizes the State of California Drought Response Plan for implementation and as a guide. The plan stipulates that: 'Tribal Government Droughts in California may impact California Native American Tribes and tribal areas. State and federal agencies have primary responsibility for communicating with California Native American Tribes in affected areas, gathering information and, when possible, coordinating on drought relief assistance. For the purposes of this DCP, the term "California Native American Tribe" signifies all Indigenous Communities of California, including those that are federally non-recognized and federally recognized, and those with allotment lands, regardless of whether they own those lands. Responsible State and federal agencies may collaborate with Tribal governments to identify impacts of drought on Tribal lands, coordinate monitoring and forecasting, and identify ways in which State government might assist Tribal governments in responding to drought. This assistance would complement, not replace, existing Tribal relations with federal government programs, including those provided through the U.S. Bureau of Indian Affairs.'

For the past two years, the Tule River Tribe has been experiencing an exceptional drought, and appears that conditions will become increasingly worse. We've been experiencing drought conditions since 2012. For the first time in recorded history of the Tribe, the South Fork of the Tule River ceased its' flow. Many tribal members – young and old who proudly pronounce their name and heritage as the 'Tule River People' now sadly refer to themselves as 'Tule (No) River'. Thus the effect of having 'no water' was for many people – psychologically and spiritually saddening.

Ongoing or potential drought impacts

The State of California, and much of the desert southwest, is in the midst of a drought of historic proportions. California Governor Jerry Brown issued a statewide Drought Declaration on January 17, 2014, and on January28, 2014, Governor Brown also issued a revised Water Action Plan, with increased focus on the emergency drought conditions. Federal Secretaries Jewell, Pritzker, and Vilsack also issued a statement of support to the Brown declaration.

In 2013 beginning in June, flows in the South Fork Tule River became so low that the Tribe was unable to divert river water to its treatment plant. As a result of the drought the Tribe was forced to truck water onto the Reservation. Many tribal members ran out of water during the day due to the lack of supply and had to bathe at outdoor water tanks. During the hottest portions of the summer the Tribe brought elders to the Community Center to prevent them from overheating because there was no water to run their swamp coolers. Additionally, the water levels were so low in the last three years that if there had been a significant fire on the reservation, the fire sprinkler systems in Tribal buildings, and Reservation fire hydrants only had enough water to run for a few minutes before depleting supply and losing pressure.

Extreme low levels of rainfall and little, or now snow pack have contributed to exceptional drought conditions on the Reservation. The Tribe is concerned that wells on the Reservation are in peril of running dry. These drought conditions have reached historic levels and now pose an imminent threat to public health, property and the economy of the Tule River Indian Reservation; and the dry conditions on the reservation have increased the threat to ranchers across the reservation by limiting hay and water supplies.

The city of Porterville is the nearest town to the Tule River Indian Reservation and is reached by a two-land rural road twenty miles due west. Porterville has been nationally acclaimed for suffering heavily due to drought. Residents of East Porterville and experts say not having running water and breathing increasingly dusty air because of the drought is worsening health issues. And Residents of East Porterville and experts say not having running water and breathing increasingly dusty air because of the drought is worsening health issues.

The town of 7,500 people has no central water system and families rely on shallow private wells, which have been drying out as the drought worsens. Doctors in the area say they have seen a spike in respiratory illnesses, including chronic bronchitis, allergies and asthma.

A 75-mile drive southeast of Fresno, East Porterville gained notoriety after becoming one of the first Valley communities to suffer from the drought. It remains the hardest hit, now with around 700 homes, or about 3,000 people, reporting well failures.

Data shows the number of patients visiting the emergency room at nearby Sierra View Medical Center in Porterville complaining of breathing issues has increased by more than *25 percent since 2010.*

Sierra National Forest

(A tall pine tree erupts into flames as hot crews from the Central San Joaquin Valley keep the fire from crossing a meadow into a portion of the Sierra National Forest. The new fire season is proving to be severe).

The four-year drought has taken a toll on many things and the forest is no exception. Drought-stressed trees are being attacked by bark beetles in record numbers. Estimates are the 400,000 dead trees a year ago has grown to 5 million trees in the Central Sierra and 12 million trees statewide. Those numbers could double this summer, experts say.

With approximately *5 million* dead and dying trees in the Sequoia and Sierra National Forests and more dying every day, local officials are seeking a way to reduce the growing fire hazard.

Kevin Elliott, supervisor for Sequoia National Forest, said the most recent aerial survey of the local forest found *2.97* million dead trees covering a total of *173,000* acres of the 1.2 million acre forest.

Several species of wildlife have relocated from the high mountain areas into the Tule River community due to the lack of water supplies which directly affects their food supply. This puts community members at risk and could also lead to potential over kill of our wildlife if they are seen as a major threat to the safety of our community.

Ranchers in the community will be faced with a loss of income and other subsequent economic loss directly attributed to the lack of grazing availability and the depletion of water for their cattle. Last year dead cattle could be seen throughout their normal grazing areas because of the lack of food and water.

If the community is to rely solely on underground water for its basic needs then this leads to over pumping of ground water which causes land to sink – causing destruction to homes and other structures, and associated geological damage. At some point in the very near future, it is predicted that water will have to be limited to household and medical use, fire suppression, which will affect our economic stability. A major concern focuses on Eagle Mountain Casino, which is located within the boundaries of the Reservation would be forced to shut down due to unavailability of water for health and safety operations. Ceasing casino operations and tribal programs and departments would adversely affect approximately 200 tribal members employed by the tribe and approximately 8% of tribal members employed at the casino. Quality of life in the tribal community will be adversely affected, as will the tribe's natural environment. Recovery time to mitigate these combined impacts will take much time; however, can be even more impacted due to high fire danger during the hot summer months, perhaps even more so, should there be a high flood season during the spring and winter.

On January 30, 2015, the Tule River Tribal Council declared that a state of emergency exists, and until further notice the Tribe and all lands and natural resources within the Tribe's Reservation boundaries are in a state of drought. The Council further directed the Tribal Departments and staff to take all necessary actions to protect the land, water and natural resources of the Tribe given this state of Drought.

Severity of Actual or Potential Drought Impacts

The main inhabited area of the Reservation has approximately 250 homes, 16 public buildings, and a small casino, which are all served by the Tule River Main Water System.
The water system has been experiencing water shortages during periods of high demand.

Although the surface water source from the Tule River provides an ample quantity of water, the increasing population has put a great burden on the water delivery system and existing water sources of surface water cannot produce enough water to meet this demand.

The Tule River Tribe draws *80%* of its water from surface waters; and in the past 13 years the South Fork of the Tule River median daily discharge has been *>40 cubic feet per second*. During April 2014, the discharge dropped to *30 cubic feet per second,* and during April 2015 the discharge was < *4 cubic per second.* Adding to this, normal average rainfall at Tule River Reservation is *10-11 inches per year*; during 2014 rainfall was *decreased to 3.97* inches; during April 2015, rainfall decreased to *2.92 inches.*

The majority of the 1,200 residents on the Reservation continue to have a relatively low standard of living in substantial part due to the absence of an adequate and reliable potable water supply and delivery system. Inadequate water supplies have resulted in reduced opportunities for economic development to occur on the Reservation and may prevent off-Reservation Tribal members from relocating to the Reservation.

Currently the Tule River Indian Reservation community is experiencing "exceptional drought" conditions. The drought has been worsening since 2011, when there was below average rainfall in this area. Our community has been put on extreme water restrictions since April 2014 when the snowpack from the Southern Sierra Nevada Mountain Range had depleted causing major concern in the tribal community. In August 2014, the South Fork of the Tule River stopped flowing entirely thru the reservation. The South Fork of the Tule River accounts for over 60% of the tribal community domestic water use. With less water available through the river our springs and wells were burdened with meeting the additional need. With less than four inches of rain this past wet season community wells and springs are insufficiently charged.

If aquifers are insufficiently recharged, combined with the depletion of surface water runoff, the community will be at high risk for health impairments, and perhaps more lethal: the high fire danger. This year the Tribal Natural Resource Program documented numerous groves of dead pine trees throughout the forest due to the drought conditions. In addition, tribal members and households have been put on fire restrictions which limit community access to the high country for camping and other recreational activities. Without a snowpack the Tule River is expected to dry up as it did last year but earlier, in the months of June or July. Our fish will again die due to lack of flow. Community recreation such as fishing, swimming and summer cultural practices that revolve around the water will again take a hit and will no doubt worsen as long as the drought persists.

Furthermore, the water levels were so low in the last three years that if there had been a significant fire on the reservation, the fire sprinkler systems in Tribal buildings, and Reservation fire hydrants only had enough water to run for minutes before depleting supply and losing pressure.

The potential risk that climate change poses to water supply is the motivation behind Public Law 111-11, Subtitle F (SECURE Water Act), section 9503 which authorizes the U.S. Department of

Interior's Bureau of Reclamation (Reclamation) to assess climate change risks for water and environmental resources in "major Reclamation river basins." This assessment is being carried out through Reclamation's WaterSMART Basin Study Program. Of the eight major river basins being studied by Reclamation through WaterSMART, the San Joaquin River Basin is the one in closest proximity (and thus of greatest relevance) to the South Fork Tule River drainage basin in which development of water supplies are being evaluated for the Tule River Indian Tribe.

The magnitude of these changes is subject to uncertainty which presents a challenge to the planning of water supply projects. Nonetheless, consideration of the expected trends may be worthwhile in the planning of the Tule River Indian Tribe's water supply project. Of particular concern is the fact that an increased rainfall to snow ratio means that a smaller fraction of the overall precipitation (occurring mostly in the winter) would be able to be stored and captured in reservoirs; this is because the natural storage of the snowpack is reduced (as evidenced by the decreased April 1st SWE values) and the higher volume of winter rainfall either infiltrates the soil or becomes runoff evading capture by the planned water system. And if the total volume of precipitation also decreases, then of course there is less overall water to store by any means.

Climate Change Impacts on Tule River Water Supply

As noted above, the general trends due to climate change in the region of the Tule River Indian Reservation predict less water stored in the snowpack during the winter due to warmer temperatures. This suggests that runoff during the year would occur in more concentrated periods of time (i.e., large flow events) in the future than experienced historically. Even if mean annual runoff remains the same, it appears that more variability in precipitation and runoff from year to year can be expected leading to greater uncertainty in the Tribe's water resources planning. Therefore, the need for storage on the Reservation becomes even more critical when climate change factors are considered.

There exists a potential for climate change to adversely impact existing and planned water supplies via changes in precipitation, temperature, snow water equivalent (SWE), and stream flows (in both timing and magnitude). Future changes in Central Valley climate and hydrology have been the subject of numerous studies. A good summary of studies completed prior to 2006 was published by Vicuna and Dracup (2007). For the Central Valley watersheds, Moser et al. (2009) reports specifically on future climate possibilities over California and suggest that warmer temperatures are expected during the 21st century, with an end-of-century increase of 3-10.5 °F.

Future Population

To a large extent, the existing and future water needs on the Reservation correlate directly to the Reservation's population. Reservation are based on a 100-year population projection beginning in the year 2013. The potential Reservation population was estimated because the overall intent of the needs assessment analysis is to estimate the quantity of water the Tribe would require in the year 2112 to create a homeland for all its peoples. As such, population projections and water demand were calculated such that all Tribal members, and associated non-tribal members, could live on the Reservation if they chose to do so. Water demand quantities calculated are sufficient to meet the domestic, commercial, municipal, industrial and agricultural water needs of the Tribe as a whole. To perform the population projection analysis, demographic data for the Tribe was obtained from the Tribe, U.S. Census Bureau, BIA, Tulare County and Indian Health Services (IHS).

A cohort-survival model was used to estimate the potential population of the Reservation in the year 2112. It was estimated that at the end of 2014 the Tribe's total membership was 1,740 people. The cohort-survival model indicates that by the year 2112 the Tribe's total membership will reach about *6,035* people. This translates to an average annual cumulative rate of growth of 1.3-percent over the 100 year projection period. This rate of growth is consistent with the U.S. Census Bureau's recent long-term population growth projections for Native Americans for the United States as a whole. In addition, there are currently an estimated *235* non-tribal members living on the Reservation. This means that there is approximately one non-member living on the Reservation for about every seven tribal members (living both on and off the Reservation). Assuming the ratio holds into the future, this translates to an estimated *825 non-members* living on the Reservation in the year 2112 (a conservative number as it does not give weight to off-Reservation members who may have non-member family now or in the future). Thus, the total potential population of the Reservation in the year 2112 is projected, on the low end, to reach approximately *6,860* people. On the high end, factoring in off-Reservation tribal members with non-member family, the total population is projected to reach approximately *7,495* people.

Data from the U.S. Census Bureau's 2010 Census of Population indicates that the Indian population on the Tule River Reservation averaged about 3.5 persons per household and that there were 476 single and multi-family housing units on the Reservation (U.S. Census Bureau, 2010). Using this rate as representative of average future residential occupancy on the Reservation, it is estimated that in the year 2112 approximately 1,960 homes will be needed to accommodate all of the Reservation's minimum projected potential population of 6,860 people. *(In 2010 the U.S. Census Bureau projected that the Alaska and Native American population of the United States would increase from an estimated approximately 3.2 million to almost 5.5 million by the year 2050. This translates to an annual average cumulative rate of growth of 1.35% over the 40 year projection period).*

The Tule River Tribal Council is attempting to devise strategies for dealing with the drought not only in 2015, after a very challenging 2013 and 2014, but to address water security in a long-term, comprehensive manner. The Tribe requires the assistance of its Federal and state partners, and Congressional delegation, in this effort and the Tribal Council will immediately commence discussions with relevant Federal and state partners, and Congressional delegation, to develop short and long-term plans of action to address this crisis situation.

Nexus to Reclamation

Federal Authority to Participate and Conduct Study

The Secretary of the Interior is given the authority to pursue technical studies pursuant to U.S. Bureau of Reclamation (Reclamation) law *(Section 1, Act of June 17, 1902, 32 Stat. 388; and Section 9, Reclamation Act of 1939; 53 Stat. 1193)* for the purpose of evaluating the technical viability of water development in the Reclamation states. The Reservation is located in California, a Reclamation state. This report has been developed with the advice and assistance from Reclamation.

The purpose of the study was to provide a compilation and analysis of the studies developed to provide a technical foundation for the construction of a dam, reservoir, and other water infrastructure on the Reservation associated with the Tule River Indian Water Rights Settlement, *(WATER SETTLEMENT TECHNICAL REPORT JUNE 2013).*

Since 1971, the Tribe has diligently worked to establish its reserved water rights. The Tribe has always believed that its right to water can best be resolved by a single, comprehensive settlement agreement entered into with the down-river water users on the South Fork Tule River. For nine years these parties have negotiated the terms of an agreement. In November of 2007, a final settlement agreement was reached, entitled the *"Tule River Tribe Reserved Water Rights Settlement Agreement"* (Agreement). The Agreement is between the Tribe and the other major downstream water users: the Tule River Association (TRA), and the South Tule Independent Ditch Company (STIDC).

The Agreement seeks to settle the substantial claims the Tribe has against the United States. Finally, the Agreement seeks to provide the Tribe what it was originally promised: Sufficient and reliable water and land for a permanent and sustainable homeland for the Tribe and its members.

Performance Measures

The storage at the Painted Rock dam site is a critical component of the Tribe's surface water supply. The current storage at this site is estimated to be approximately 1 acre foot (AF) or approximately 300,000 to 400,000 gals. It is difficult to provide a definite quantity due to the lack of detailed topography (contours at 2-ft intervals, minimum) information at this location. The existing and proposed dams are less than 20 feet (5-foot and 12-foot, respectively) and we would need that level of accuracy to develop better storage capacity curves for the site. Project planners estimate that the proposed dam could provide between *2.5 AF and 3 AF* of storage (approximately *815,000 gallons and 975,000 gallons,* respectively). The benefit of this proposed improvement would be to double or possibly triple the Tribe's current surface water storage, which would help alleviate some of the tribal demands due to the drought.

Water resources management staff will calculate and compare the flow of water from the Painted Rock site before and after project implementation. It is vital to maintain accurate records of water flow for improved management of water resources during drought.

CERTIFICATION

UPON MOTION OF COUNCIL MEMBER **Yolanda Gibson**, SECONDED BY COUNCIL MEMBER **Kevin Bonds,** THE FOREGOING WAS ADOPTED BY THE TULE RIVER TRIBAL COUNCIL AT A DULY CALLED MEETING HELD ON **Thursday, June 18, 2015** AT WHICH A QUORUM WAS PRESENT BY THE FOLLOWING VOTES:

AYES: **7**

NOES: **0**

ABSTAIN: **1**

NEIL PEYRON, CHAIRMAN
TULE RIVER TRIBAL COUNCIL

YOLANDA GIBSON, SECRETARY
TULE RIVER TRIBAL COUNCIL

ATTEST TO:

RECORDING SECRETARY

Environmental Compliance

- *What are the types and quantities of environmental benefits provided, such as the types of species and their numbers benefited, acreage of habitat improved, restored or protected, or the amount of flow provided? How was this estimate calculated?*

  The site of the project is situated adjacent to pristine pools of deep clear water and is a perfect habitat for trout species: Rainbow and German Brown, as well as turtles, nesting birds among the high rock walls. The project will positively affect the trout species by providing colder, and deeper water for ensured survival through long drought seasons.

- *What is the status of the species of interest (i.e. endangered, threatened, etc.? How has the drought impact the species?*

  Fish species are non-endangered. The drought has impacted fish species in areas below Painted Rock -- as the river ceased to flow.

If the project will benefit federally listed threatened or endangered species please consider the following elements:

- *Is the species subject to a recovery plan or conservation plan under the ESA?* No.
- *What is the relationship of the species to water supply?* N/A
- *What is the extent of the proposed project that would reduce the likelihood of listing, or would otherwise improve the status of the species?* N/A
- *Is the species adversely affected by a Reclamation project?* N/A

Upon the completion of the Painted Rock Improvements Project a detailed assessment of the native trout habitat in the project area will be conducted to determine which course of action to be taken and will consider the following:

1. Passive Restoration

Modify the activities that are causing the degradation or that are preventing the ecosystem from recovering. Many riparian areas are capable of rapid recovery with a modification of land use.

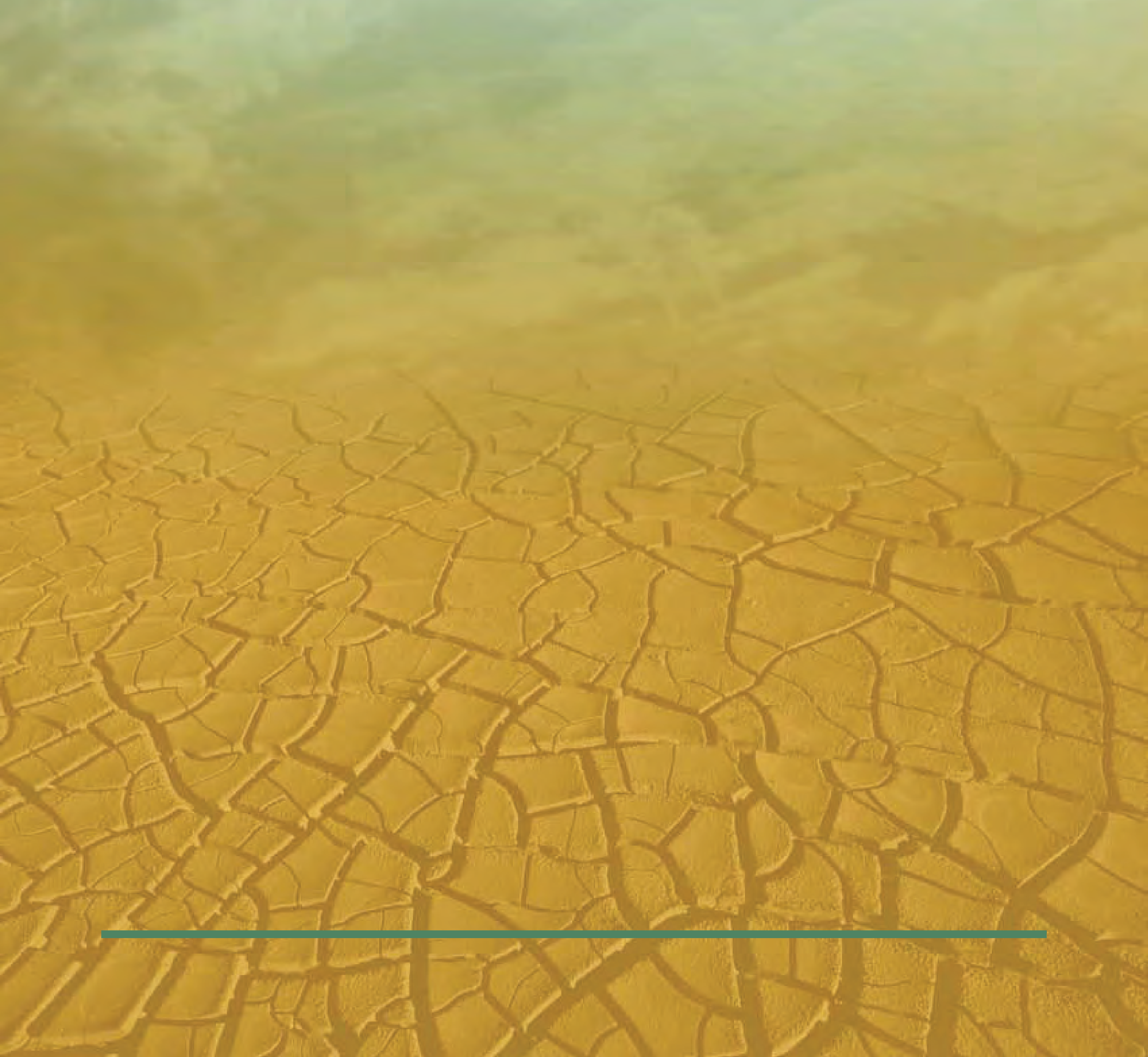
2. Active Restoration

In some situations, the injury to an ecosystem has been so great that simply modifying or stopping the injurious activity is not enough. Without some kind of active restoration the ecosystem will remain degraded indefinitely. Examples of active restoration include the reintroduction of native vegetation, the placement of woody debris, or the reconstruction of altered channels and landforms. It should be noted however, that because restoration activities occur along a continuum, the distinction between passive and active restoration activities is sometimes difficult to discern.

NOVEMBER 2010

2010 California Drought Contingency Plan

State of California | Natural Resources Agency | California Department of Water Resources



STATE OF CALIFORNIA – CALIFORNIA NATURAL RESOURCES AGENCY **ARNOLD SCHWARZENEGGER**, *Governor*

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

NOV 17 2010

To: California Water Plan Steering Committee and Interested Stakeholders

The California Drought Contingency Plan (DCP) represents the first State drought plan and was developed following the Governor's executive orders and drought proclamations in 2008 and 2009. It is a planning and implementation document which may be used to assist agencies in preparing for, responding to, and recovering from drought. The goals of the DCP are to minimize drought impacts through improved agency coordination, enhanced procedures for monitoring drought conditions and early warning capability, improved assessment drought impacts, and more effective response to drought emergencies.

The DCP has been prepared in conjunction with the California Water Plan (CWP) and will be updated every five years. As part of the development of this first plan, a number of important ideas were raised about how to further improve drought response and coordination with local agencies. The planning process for CWP Update 2013 will include the development and discussion of these important ideas.

As part of ongoing drought planning, DWR will continue to implement programs such as Integrated Regional Water Management, Water Use Efficiency and education and outreach as part of statewide drought preparedness. These programs in association with actions to address California's comprehensive water issues will ensure that the State's water needs can be met now and into the future.

Sincerely,

Mark W. Cowin
Director

CALIFORNIA DROUGHT CONTINGENCY PLAN

State of California
Arnold Schwarzenegger, Governor

California Natural Resources Agency
Lester A. Snow, Secretary for Natural Resources

Department of Water Resources
Mark W. Cowin, Director

Susan Sims
Chief Deputy Director

Kasey Schimke
Asst. Director Legislative Affairs

Matt Notley
Asst. Director Public Affairs

Cathy Crothers
Acting Chief Counsel

Dale Hoffman-Floerke
Deputy Director
Integrated Water Management

Gerald E. Johns
Deputy Director
Delta/Statewide Water Management

Jim Libonati
Deputy Director
Business Operations

John Pacheco
Deputy Director
California Energy Resources Scheduling

Ralph Torres
Deputy Director
State Water Project

Prepared under the supervision of

Wendy Martin
Statewide Drought Coordinator

and

Kamyar Guivetchi
Manager, Division of Statewide Integrated Water Management

Prepared by

Thang (Vic) Nguyen, Supervising Engineer, Water Resources
and
Lewis Moeller, Supervising Engineer, Water Resources

Assisted by

Megan Fidell, Water Resources Engineer
Doug Osugi, Supervising Engineer, Water Resources
Thomas Filler, Program Manager II
Mike Durant, Research Writer
Jim Rich, Economist

Acknowledgements:

This California Drought Contingency Plan could not have been accomplished without the input and assistance from the following State Agencies:

California Emergency Management Agency
Mark Johnson, Sheri Blankenheim, Tim Wilson, LeAnn Gilmore,

Becky Wagoner, Ken Worman, Rob Mead, Karma Hackney,

Katrina Limon, Erika Baker, Tom Maruyama,

Tamara Scott-Smith

State Water Resources Control Board
Darrin Polhamus, Liz Haven

California Department of Public Health
Gary Yamamoto, Mark Bartson

California Department of Conservation
Bruce Gwynne

California Department of Food and Agriculture
David A. Pegos

California Air Resources Board
David Edwards Rob Duvall

Governor's Office of Planning and Research
Seth Litchney

California Fire
Chris Keithley

California Department of Housing and Community Development
Cathy Creswell Panorea Avdis

California Public Utilities Commission
Rami Kahlon Cynthia Truelove Al Schiff

Delta Stewardship Council
Kent Coolidge

EXECUTIVE SUMMARY

California's water resources have been stressed by periodic drought cycles and unprecedented restrictions in water diversions from the Sacramento-San Joaquin Delta in recent years. Climate change is expected to increase extreme weather. It is not known if the current drought will abate soon or if it will persist for many years. However, it is certain that this is not the last drought that California will face.

In response to the recent drought, Governor Arnold Schwarzenegger issued Drought Proclamations and Executive Orders in 2008 and 2009 directing State agencies to take immediate actions to manage the crisis. The Department of Water Resources (DWR) was required to provide a report on the state's drought conditions and water availability. DWR subsequently committed to developing a Drought Contingency Plan (DCP) to address the possibility of continuing dry conditions in 2010 and beyond. This DCP contains strategies and actions State agencies may take to prepare for, respond to, and recover from droughts. Some components of this plan may be applied to water shortage events that occur in the absence of a drought.

The purpose of the DCP is to minimize drought impacts by improving agency coordination; enhancing monitoring and early warning capabilities; water shortage impact assessments; and preparedness, response, and recovery programs. The plan identifies an integrated, regional approach to addressing drought, drought action levels, and appropriate agency responses as drought conditions change.

An effective DCP will need transparent coordination and clearly defined roles and responsibilities of federal, State, and local agencies, and the timely dissemination of information to decision-makers. A drought communication and coordination structure is provided as Figure 1 and represents a general framework for agency planning and coordination. An Interagency Drought Task Force (Task Force) will be convened to provide coordination among agencies.

The Task Force will be chaired by the DWR Drought Coordinator with assistance from the California Emergency Management Agency (Cal EMA) Drought Coordinator. The roles of DWR and Cal EMA are defined and key duties of the Drought Coordinators are listed in Section V. DWR will coordinate overall drought activities while Cal EMA will focus on emergency response and recovery efforts. Drought coordination will occur through the DWR Regional Offices and Cal EMA Regions, and emergency response will be implemented in accordance with the Standardized Emergency Management System. State agencies participating in the Task Force is expected to function within existing agency authorities, responsibilities, and funding.

The Task Force provides policy direction to the Drought Monitoring Committee and the Impact Assessment Work Groups. The Committee and Work Groups provide situation reports and impact assessment reports to the Task Force, respectively. The Task Force ensures accurate and timely distribution of water supply data and drought forecasts to water managers and the public. Committee members consist of representatives from agencies responsible for monitoring weather and water supply data. Work Group members include representatives who assess drought impacts on the various regions

and sectors. The situation and assessment reports will be distributed to appropriate agencies and will be posted on the DWR Drought website (www.water.ca.gov/drought).

The potential roles and responsibilities of agencies and organizations which may be involved in drought management are defined in Attachment 1. By properly defining agency roles, drought response can be more effective and successful. Action tables are included in Tables 1 through 3 of the Attachment section and list activities agencies may take before, during, and after a drought with respect to planning and coordination, monitoring, local assistance, and conservation.

Tables 1 through 3 also suggest lead and supporting agencies to carry out the potential actions, and note related documents or references. Table 2 includes five levels of drought response, with each level signifying worsening drought conditions. For example, Level 1 represents an Abnormally Dry period (Raising Awareness of Drought), Level 3 a Severe Drought (Mandatory conservation in some communities and emergency actions), and Level 5 an Exceptional Drought (Water supplies cut off and maximum response). A Governor's emergency drought proclamation may be initiated at a Level 3 response. Drought indicators generally based on hydrologic parameters are recommended, but are not quantified to provide flexibility in drought response. Drought response actions may be unique to a particular region and not necessarily uniform statewide. Actual response may be based on evaluation of situation and/or assessment reports and observation of field impacts.

Implementation of activities or programs in Tables 1 through 3 is intended to minimize drought impacts and enhance recovery. Actions may be added or modified to these tables based on field experience and input from stakeholders. Flexibility and adaptability must be incorporated into these actions because of changing conditions and circumstances, and the inherent uncertainty in the nature of drought.

The DCP is intended to become part of the California Water Plan Update process which occurs every five years. This may require that the plan be periodically updated to best serve the needs of California. As the plan gets refined, it will include updated information, technology, and strategies.

Implementation of strategies contained in this DCP supports the comprehensive approach needed to provide clean, reliable, and sustainable water supplies to people, farms, and business in California. California's water problems do not end when the drought ends. Immediate action is needed on a comprehensive solution that includes aggressive conservation, new groundwater and surface water storage facilities, conveyance facilities and environmental restoration. California's future economic growth, quality of life and prosperity depend on it.

Contents

Figure

I. INTRODUCTION

The 2008 and 2009 Drought Proclamations and Executive Orders directed the Department of Water Resources (DWR) and other State agencies to take specific actions to respond to droughts. The February 2009 emergency proclamation required the preparation of a March 2009 status report to the Governor's office, which updated the state's drought conditions and water availability and identified activities DWR would initiate or support to help meet our most essential water needs in 2009 and plan for the possibility of a dry 2010.

The list of drought activities in the March 2009 status report included the preparation of a Drought Contingency Plan (DCP) to address the possibility of continued dry conditions through 2010 and beyond. The DCP was developed in consultation with the California Water Plan (CWP) Steering Committee (representing 21 State government agencies with jurisdictions over different aspects of water resources) and receiving input from its Advisory Committee.

The purpose of the DCP is to minimize drought impacts by improving agency coordination; enhancing monitoring and early warning capabilities; water shortage impact assessments; and preparedness, response, and recovery programs. The DCP includes a coordinated State government strategy to prepare for, respond to, and recover from droughts and water shortages, and identifies an integrated regional approach to assessing droughts, drought action levels, and appropriate agency responses as drought severity changes. This plan may be reviewed and updated with each CWP Update or as necessary to provide current information, technology, and strategies.

To accomplish the above purpose, the Drought Contingency Plan:

1. Recommends a general framework for agency planning and coordination to facilitate drought response and management.
2. Identifies activities and strategies that may be implemented to minimize drought impacts on vulnerable regions and sectors. These activities include actions that may be implemented before, during, and after a drought with respect to planning and coordination, monitoring, local assistance, and conservation programs.
3. Identifies the State, federal, tribal, and local agencies that have the lead or supporting roles in managing the drought response activities.
4. Promotes effective use of public, private, and tribal resources to manage response and mitigation efforts.

> **Definition:**
> Drought mitigation is actions or programs agencies may implement to minimize drought impacts and enhance recovery.

Although the current drought will eventually end, the restrictions on pumping from the Sacramento-San Joaquin Delta will continue to impact California's water supply. California may continue to experience significant negative economic impacts, requiring emergency responses due to widespread and deep water shortages, even in a year of average or above-average precipitation and snowpack. Some components of the DCP (such as the communication and coordination structure in Figure 1) could also be applied to water shortage events which may occur in the absence of a drought.

An effective drought response requires clear communication among State, federal, local, and tribal agencies and stakeholders and the timely dissemination of information to the public. An emergency drought response will be implemented in accordance with the Standardized Emergency Management System (SEMS) mandated for multi-agency and multi-jurisdictional responses to emergencies in California. DWR will chair the Interagency Drought Task Force (Task Force) and serve as the primary coordinator of the State's drought effort. The California Emergency Management Agency (Cal EMA) will support DWR in this function, focusing on emergency response and recovery. The Task Force will coordinate with federal, local, and tribal agencies and other stakeholders on drought management and response efforts. A general communication and coordination structure (Figure 1) is proposed for agency planning and drought response. The structure, or components of it, may be used at any phase of drought management.

Being proactive to drought management requires continuous monitoring of factors indicating the onset and severity of drought, as well as impacts to stakeholders. The DWR Drought (www.water.ca.gov/drought) and California Data Exchange Center (www.cdec.water.ca.gov) websites contain comprehensive water supply data such as precipitation, snowpack, and reservoir conditions. Drought and water shortage data will be used to assess drought and impacts, and help develop appropriate drought responses. The DWR Drought website also provides information on available emergency, technical and financial assistance programs; tips on water conservation; guidance on water transfers; and links to other State, federal, and local agency websites.

Defining when a drought occurs is commonly a function of dry conditions' impacts on water users and their responses, which may vary depending on the severity of the drought. A drought does not have a clearly defined beginning and end and it does not impact all water users equally. As a result of the variability and severity of droughts, the varying impacts experienced by different regions and sectors, and the unpredictability in the duration of droughts, this DCP must be flexible to adjust to local circumstances. Examples of State agency response actions for each drought stage are provided in Tables 1 through 3 of the Attachment; however, actual field conditions may dictate greater or lesser response actions based on evaluation of drought severity and impacts. Conditions must be evaluated as they occur and appropriate responses selected to address those specific conditions. The specific actions may need to be adapted, as conditions warrant, to the unique circumstances that may occur.

II. UNDERSTANDING DROUGHT AND WATER SHORTAGE

The onset of drought is a gradual phenomenon, whereas water shortage may be sudden, as would occur if an earthquake causes massive and cascading Delta levee failures, resulting in a shutdown of the Delta's export water pumps. Most natural disasters, such as floods or forest fires, occur relatively rapidly and afford little time for preparation for disaster response. With the exception of impacts to dryland farming and grazing, drought impacts may occur slowly over seasonal periods, and the effects may linger for years after the end of the event.

In California, drought is commonly associated with impacts and below normal precipitation. Drought impacts increase with the length of a drought, as water supplies in reservoirs are depleted and groundwater levels decline due to increased pumping. The extent of drought impacts is dependent on many factors including climate, water use patterns, available water supplies and geography.

More discussion related to understanding drought and drought response in California can be found in the article "Droughts Concepts and Impacts in California" (See Attachment 3). This article also describes drought impacts on different sectors in greater detail, including predicted outcomes from climate change.

III. HISTORICAL DROUGHT AND CLIMATE CHANGE

Droughts exceeding three years in California's measured hydrologic record have been relatively rare in Northern California, which is where the majority source of the State's water supply originates. Historical multi-year droughts include: 1912-13, 1918-20, 1923-24, 1929-34, 1947-50, 1959-61, 1976-77, 1987-92, and most recently the current drought which began in 2007. The 1929-34 Drought established the criteria commonly used in designing storage capacity and yield of large Northern California reservoirs.

In addition to historical measured data, scientists are now reconstructing historical weather conditions through analysis of tree rings (dendrochronology). Information on the thickness of annual growth rings can be used to infer historical weather and streamflow conditions. Some of the longest and best reconstructions have been developed for the Colorado River spanning more than 1,000 years. These reconstructions clearly show extended drought periods that are far more severe than anything experienced in the historical record. The recent drought and new information about drought patterns in the past 1,000 years have raised awareness of the need to address the possibility of long-term, sustained drought.

Warming temperatures due to global climate change, combined with changes in precipitation and runoff patterns, are projected to increase the frequency and intensity of droughts in California. Regions that rely heavily upon surface water (rivers, streams, and lakes) could be particularly affected as runoff becomes more variable, and more demand is placed on groundwater. Climate change and a projected increase in California's population will also affect water demand. Warmer temperatures will likely increase evapotranspiration rates and extend growing seasons, thereby increasing the amount of water that is needed for the irrigation of many crops, urban landscaping and environmental water needs.

IV. CALIFORNIA EMERGENCY SERVICES ACT AND GOVERNOR'S EMERGENCY PROCLAMATION

The California Emergency Services Act, Government Code Sections 8550 et seq, establishes how conditions of emergency are declared and describes the authorities of public agencies to prepare for and respond to emergencies. Pursuant to this Act, an emergency may be proclaimed by the Governor or by a city or county.

The governing body of a city or county proclaims a local emergency when the conditions of disaster or extreme peril exist. The proclamation enables the city or county to use emergency funds, resources, and powers, and to promulgate emergency orders and regulations. A local proclamation is a prerequisite to requesting a gubernatorial proclamation of emergency. The Secretary of Cal EMA may issue a letter of concurrence to a city or county declaration of local emergency. Cal EMA concurrence makes financial assistance available for repair or restoration of damaged public property pursuant to the California Disaster Assistance Act.

The Governor assesses the emergency situation and may proclaim a state of emergency when local resources are insufficient to control the disaster or emergency, typically in response to a local emergency proclamation. The Governor's proclamation activates the State Emergency Plan and invokes the California Disaster and Civil Defense Master Mutual Aid Agreement facilitating the provision of mutual aid from other cities and counties and state ageny assistance, permits suspension of state statutes or regulations, allows for state reimbursement of city and county response costs associated with the emergency, and allows property tax relief for damaged private property.

V. COMMUNICATION AND COORDINATION STRUCTURE FOR DROUGHT RESPONSE OR DROUGHT MANAGEMENT

Drought management is a responsibility shared by many agencies and organizations at the federal, State, Region, and local levels. This DCP outlines the roles and responsibilities of agencies and organizations that may be involved in drought management (See Attachment 1).

State agencies will be more effective in managing and responding to drought if there is an established structure for communication and coordination. SEMS is the established structure for emergency management, preparedness, response, recovery and mitigation, communication and coordination. A drought emergency would follow the same SEMS structure as used for all other statewide emergencies and disasters. Figure 1 depicts a general structure that can be used for emergency drought response. Some components of this structure, such as the Drought Monitoring Committee and/or Impact Assessment Work Groups, may be used at any phase (Before, During, or After a drought) of drought management.

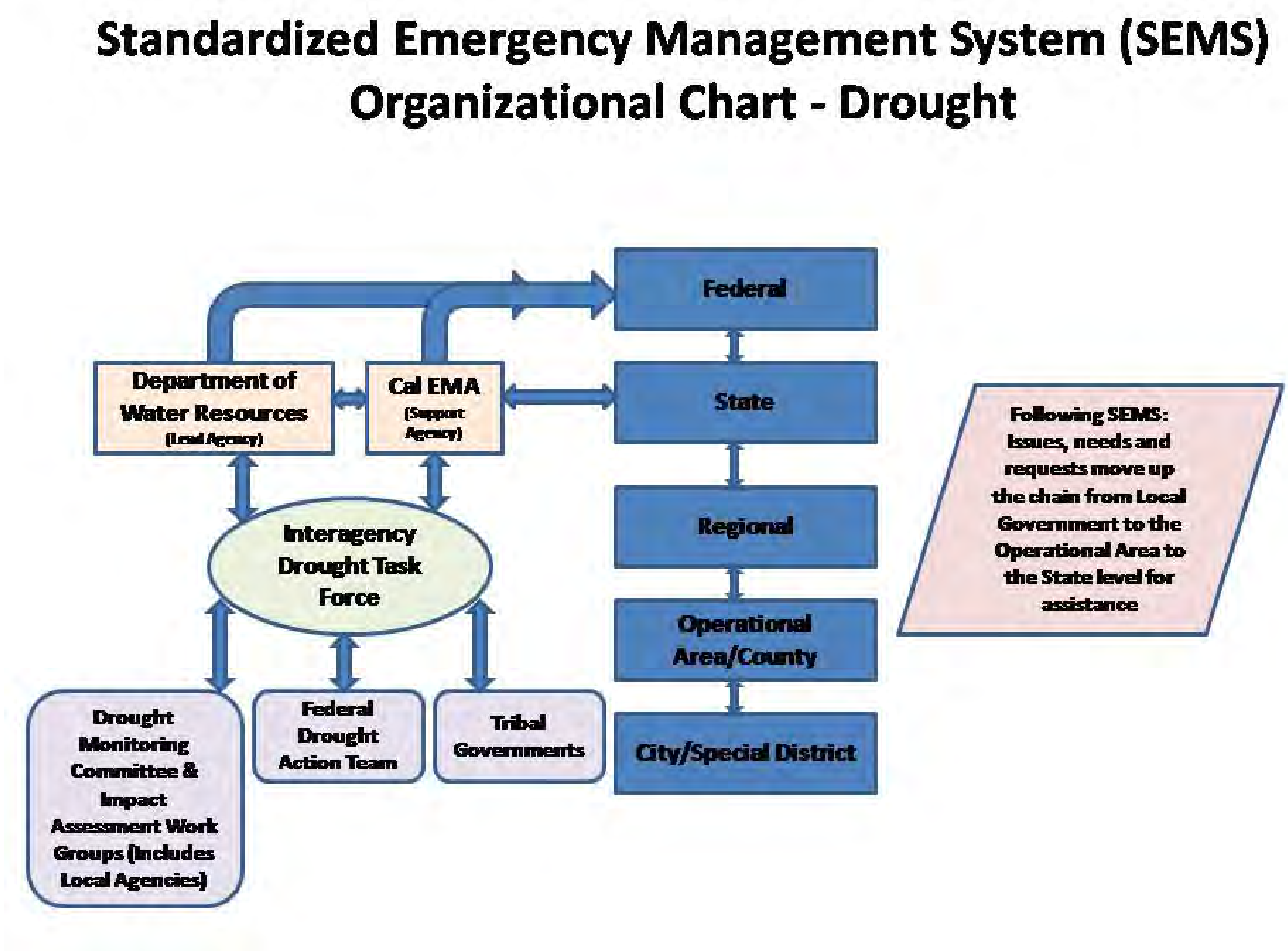


FIGURE 1: General Drought Communication and Coordination Structure

In addition, DWR's Public Affairs Office is expanding its comprehensive drought communication strategy to provide better access to water supply and drought information to a variety of audiences. The drought website, drought list serve, eNews and focused outreach to water policy managers, legislators and the media are all tools that can be used to meet drought communication needs.

Implementation of SEMS on emergency drought response and the general tasks of individuals, agencies, and working groups are described below.

Standardized Emergency Management System (SEMS)

As stated in Reference 5, SEMS is the cornerstone of California's emergency response system and the fundamental structure for the response phase of emergency management. SEMS is required by the California Emergency Services Act for managing multi-agency and multi-jurisdictional responses to emergencies in California. The system unifies all elements of California's emergency management community into a single integrated system and standardizes key elements. State agencies are required to use SEMS and local government entities must use SEMS in order to be eligible for any reimbursement of response-related costs under the state's disaster assistance programs.

The emergency drought response component of this plan will be implemented in accordance with SEMS.

Role of DWR and Cal EMA in Drought Response

The 2009 emergency drought proclamation (see Attachment 6) required that all agencies of the State government use and employ State personnel, equipment and facilities for the performance of any and all activities consistent with the direction of the Cal EMA and the State Emergency Plan (SEP). The SEP describes State government's response to disasters, including response by all levels of government and the private sector. In accordance with the California Emergency Services Act, the SEP describes the methods for carrying out emergency operations, the process for rendering mutual aid, the emergency services of government agencies, how resources are mobilized, how the public will be informed and the process to ensure continuity of government during an emergency or disaster.

The 2009 proclamation also directed DWR to take specific actions to respond to drought. These actions included promoting water conservation, implementing the water transfers program, and providing a status report on the state's updated water conditions. During the 2009 drought response, DWR, Cal EMA and other agencies formed a committee to monitor drought impacts and help provide drought relief. In responding to future droughts or water shortage emergencies, an Interagency Drought Task Force (Task Force) will be formed with DWR acting as Chair and Cal EMA providing support. The Task Force will coordinate overall drought activities among agencies and stakeholders. Cal EMA will focus on emergency response and recovery. Both agencies will collaborate to coordinate the remaining activities of the Task Force.

Drought Coordination through DWR Regional Offices and Cal EMA Regions

Through the DWR Regional Offices and Cal EMA Regions, the State will coordinate with local agencies, regions, and operational areas to identify local drought-related impacts, assess resulting damages and costs, and determine appropriate response actions. Coordination may also occur within the State's ten hydrologic regions as identified in the CWP. State agencies may be tasked to provide technical and local assistance support on water conservation; drought preparedness; emergency response, recovery, and mitigation; and other activities. The regional coordination will serve as the link between local communities and the State and federal agencies. For Cal EMA, drought coordination and response will transfer to program areas for recovery.

DWR maintains strategically located regional offices which assist public and other entities as well as the general public with various water issues throughout the state. The

DWR Regional offices are the Northern Region in Red Bluff, North Central Region in Sacramento, South Central Region in Fresno, and Southern Region in Glendale.

Cal EMA has three administrative regions which provide coordination and assistance to the local level in all phases of emergency management. These regions are the Inland Region, headquartered in Sacramento, the Coastal Region in Oakland, and the Southern Region in Los Alamitos. Cal EMA regions have the responsibility to carry out the coordination of information and resources within the region and between the SEMS state and regional levels to ensure effective and efficient emergency responses, recovery, and communications.

DWR Statewide Drought Coordinator

The DWR Statewide Drought Coordinator (DWR Drought Coordinator) will chair the Interagency Drought Task Force. The Drought Coordinator would be assigned by DWR to coordinate drought activities among federal, State, local and tribal governments, stakeholders, and the public. The key duties may include:

- Coordinate statewide drought response activities
- Prepare for future or continuing droughts through strategic drought planning with agencies and organizations
- Implement and manage drought-preparedness programs and policies
- Help oversee the update of the DCP as part of the California Water Plan update process
- Ensure accurate and timely distribution of water supply data and drought forecasts to water managers and the public
- Activate the Drought Operations Center to serve as a central point of contact for information and emergency assistance requests
- Assess vulnerability of key sectors, regions, and groups in the state and determine possible drought response
- Provide technical assistance
- Coordinate funding to support drought relief, groundwater projects, desalinization, conservation, recycling, and other water management projects to assist regions in dealing with drought
- Enhance public awareness and drought education by providing workshops and incorporating conservation campaigns into statewide events
- Provide administrative support to the Drought Task Force, workgroups, and committees
- Advise on water issues and concerns
- Update the DWR Drought website

The DWR Drought Coordinator may also reach out to other regions in the United States and other countries experiencing severe drought such as Australia, which has experienced sustained drought for the past 10 years, to collaborate and share information. By studying how other regions and countries have responded to long-term severe drought, DWR can help shape water management and drought policies to be better prepared for droughts.

Cal EMA Drought Coordinator

Cal EMA will assist DWR in coordinating the activities of the Task Force. The Cal EMA Drought Coordinator will collaborate with DWR's Statewide Drought Coordinator on agency response and other activities. The key duties may include:

- Coordinate emergency management needs related to the drought
- Collaborate with State, regional, local, and tribal agencies on providing workshops on drought preparedness, social services and other assistance
- Coordinate resource requests for providing bottled or trucked water and mobile desalinization

Interagency Drought Task Force (Task Force)

The Task Force is convened through a joint decision by DWR and Cal EMA in coordination with the Governor's Office generally at the onset of a drought or following an emergency drought declaration by the Governor. The Task Force is chaired by the DWR Statewide Drought Coordinator with assistance by the Cal EMA Drought Coordinator. Members will be comprised of executive and policy-level managers who provide direction for drought management programs and oversee the coordination of activities. The Task Force should also include a member from the Governor's office and a public information officer to address media needs.

The Task Force will coordinate with working groups, federal agencies, tribal organizations, and stakeholders on drought management. The Task Force is expected to function within existing agency authorities, responsibilities, and funding, and where applicable facilitate access to services and assistance to reduce drought impacts. The Task Force will provide policy recommendations for plan implementation, emergency response, plan review and modification. The Task Force will provide an integral mechanism to coordinate and integrate drought planning and management for all areas in California.

During non-drought, the Task Force may meet informally and use their broad expertise and authority to plan and prepare for future droughts. The Task Force identifies pre-drought strategies, and makes recommendations for response, recovery, and mitigation plans and determines the resources necessary to provide drought assistance.

Drought Monitoring Committee and Impact Assessment Work Groups of the Interagency Drought Task Force

The Drought Monitoring Committee (DMC) and Impact Assessment Work Groups' (IAWG) primary roles are to monitor water supply and drought, and to assess drought impacts on various regions and sectors. Work groups should meet regularly and more frequently during drought periods to monitor drought. Following each meeting, situation and impact assessment reports will be prepared and disseminated to the Task Force and agency leads, and will be posted on the DWR Drought website.

The DMC includes representatives from agencies responsible for monitoring weather and water supply conditions. The DMC assists in the development of a comprehensive monitoring network to monitor and assess drought conditions in the state where there may be data gaps. The principle objective is to develop a drought monitoring system that provides an early warning of drought by providing accurate, timely, and integrated information. Conditions to be monitored may include: precipitation, temperature, stream flows, reservoir levels, groundwater levels, snowpack, runoff, and soil moisture. Other information to be monitored may include: number of water agencies at voluntary and mandatory conservation, number of utilities with special problems, reservoir release requirements and Delta pumping restrictions, hydropower generation, areas with fire hazard potential, amount of fallowed land, and well drilling activity. Monitoring of these parameters will give an indication of water supply conditions and the extent of drought impacts.

A key task of this committee is to monitor information such as climate assessment, weather outlook, stream flow/runoff forecast, and reservoir and aquifer storage assessment. This information helps State and local water agencies manage the water supply needed for local communities, agriculture, environmental uses, and other needs of the state.

The IAWGs include members who represent groups who may be at risk from drought. The groups are created by the Task Force as needed and may include representatives from the following areas, organizations or disciplines:

a. Public Health
b. Biodiversity and Habitat
c. Agriculture
d. Recreation
e. Forestry and Fire
f. Infrastructure and Energy
g. Economics
h. Tribal governments

The IAWGs may assess impacts on vulnerable regions, sectors, and groups throughout the State. Members may include local agency representatives such as county emergency managers (identified in accordance with SEMS) and water agency officials, and other stakeholders who will work with the State to assess or respond to drought impacts. The IAWGs will assist the DMC and provide regional input on impending or current drought. These work groups will assess drought impacts and help develop appropriate response and mitigation strategies.

Federal Government

Generally drought emergency response activities follow a government hierarchy which starts with local and tribal governments, then Region, State and finally federal, with each level of response being exhausted or overwhelmed before proceeding to the next level. Local, tribal, State, and federal officials may work together in both planning for and responding to drought and water shortages.

Federal agencies provide a wide range of drought relief assistance primarily through the USDA. See Attachment 2 of the Appendix for key federal drought relief programs. Federal agencies have collaborated with State agencies on public forums to discuss strategies to address a range of water supply challenges facing California, including ongoing and future drought. In addition, DWR and U.S. Bureau of Reclamation (USBR) coordinate on water transfers activities and hold workshops to help urban water suppliers plan for drought conditions.

Tribal Government

Droughts in California may impact California Native American Tribes and tribal areas. State and federal agencies have primary responsibility for communicating with California Native American Tribes in affected areas, gathering information and, when possible, coordinating on drought relief assistance. For the purposes of this DCP, the term "California Native American Tribe" signifies all Indigenous Communities of California, including those that are federally non-recognized and federally recognized, and those with allotment lands, regardless of whether they own those lands. Responsible State and federal agencies may collaborate with Tribal governments to identify impacts of drought on Tribal lands, coordinate monitoring and forecasting, and identify ways in which State government might assist Tribal governments in responding to drought. This assistance would complement, not replace, existing Tribal relations with federal government programs, including those provided through the U.S. Bureau of Indian Affairs.

VI. PREPARING FOR A DROUGHT

California's water resources have been stressed by a number of factors including a growing population, groundwater overdraft, limitations on extraction of water from the Sacramento-San Joaquin Delta for the protection of fish, and increased competition for available water. Any additional stress from climate change will only intensify the competition for water resources. Warming temperatures, combined with changes in precipitation and runoff patterns, are expected to increase the frequency and intensity of droughts. For these reasons, drought preparedness should be considered in the overall management of the State's water resources.

California Water Plan Strategies for Preparing for a Drought

The California Water Plan (CWP) includes resource management strategies for water management in California. Of the 28 resource management strategies in the 2009 CWP Update, 18 address improving drought preparedness. The reader is directed to the CWP Update 2009, Volume 2 Resource Management Strategies (See www.waterplan.water.ca.gov/cwpu2009/index.cfm#volume2) for more detailed discussion of these strategies. The following includes a brief description of each strategy and how it may relate to water management or drought preparedness in California.

Agricultural Lands Stewardship

Agricultural lands stewardship broadly means the conservation of natural agricultural resources and protection of the environment on agricultural lands. Land managers practice stewardship by conserving and improving land for food, fiber and biofuels production, watershed functions, soil, air, energy, plant and animal and other conservation purposes. Agricultural lands stewardship also protects open space and the traditional characteristics of rural communities. Moreover, it helps landowners maintain their farms and ranches rather than being forced to sell their land because of pressure from urban development.

As defined in this strategy soil-building fallowing can be used as a drought management tool at the water district or farm level, especially where linked to drought payments that could be used on farm-related investments, purchases and debt repayments. Such expenditures would improve sustainability of the farm, and help support rural communities.

Agricultural Water Use Efficiency

The Agricultural Water Use Efficiency Strategy describes the use and application of scientific processes to control agricultural water deliveries and use, and achieve beneficial outcomes. The Strategy includes: 1) an estimation of net water savings resulting from implementation of efficiency measures as expressed by the ratio of water output to water input; 2) resulting benefits; and 3) strategies to achieve water use efficiency and its benefits. However, with increased agricultural water use efficiency, there is a corresponding potential for decrease in groundwater recharge that surface water irrigations provide in some areas.

The estimation of net water savings is the reduction in the amount of water used that becomes available for other purposes, while maintaining or improving crop yield. Net water savings recognizes: 1) uptake and transpiration of water for crop water use, 2) the role, benefits, and quantity of applied water that is recoverable and reusable in the agricultural setting, and 3) the quantity of irrecoverable applied water that flows to salt sinks, such as the ocean and inaccessible or degraded saline aquifers, or evaporates to the atmosphere, and is unavailable for reuse. The benefits, in addition to water savings, may include water quality improvements, environmental benefits, improved flow and timing, and often increased energy efficiency.

See the Agricultural Water Management Plans section on page 19 as an example of application of agricultural water use efficiency.

Conveyance – Delta

Conveyance infrastructure provides for the movement of water from one location to another. Conveyance infrastructure includes natural watercourses as well as constructed facilities such as canals and pipelines, including control structures such as weirs.

Conveyance through the Delta, located at the confluence of the Sacramento and San Joaquin rivers, naturally carries water westward from the upstream water drainage basins to the bays connected to the Pacific Ocean. The Delta, however, is also a highly manipulated network of natural streams and sloughs as well as constructed channels bordered by levees to prevent flooding of adjacent islands. The Delta is a critical element of both regional (e.g., Folsom South Canal) and interregional (Central Valley Project and State Water Project) water conveyance systems and is essential to sustaining the state's economy.

Redundancy (having more than one way to convey water) in the Delta conveyance system will provide increases in resiliency. This may, therefore, ensure some continuation of services during extreme events such as a long-term drought or following a catastrophic seismic event which damages the Delta levees and impacts the State Water Project operations, and allows for alternative operations to adjust to changing conditions. Additional discussion of this topic can be found in the CWP Update 2000, Volume 2, Chapter 4, Delta Conveyance Resource Management Strategy and in Volume 3, Sacramento-San Joaquin Delta Regional Report.

Conveyance - Regional/Local

An extensive system of regional and interregional conveyance facilities in the state moves water from a source location to an area where it is needed and/or conveys excess water safely to protect existing resources and infrastructure. Broad water management objectives and evaluations usually do not include specific regional or interregional conveyance options. Analyses must be made at project-specific levels to determine if improvements to conveyance facilities can provide system benefits or the ability to increase water supply and deliveries.

Increases in resiliency to extreme events by employing interconnected conveyance systems can provide some redundancy to ensure continuation of services during a long-term drought or short-term water shortage emergency.

Conjunctive Management and Groundwater Storage

Conjunctive groundwater management refers to the coordinated and planned use and management of both surface water and groundwater resources to maximize the availability and reliability of water supplies in a region to meet various management objectives. Surface water and groundwater resources typically differ significantly in their availability, quality, management needs, development and use costs. Managing both resources together, rather than in isolation, allows water managers to use the advantages of both resources for maximum benefit.

Drought relief for urban and agricultural water users and potential induced groundwater recharge could be gained through groundwater substitution transfer and agricultural water transfers.

Desalination – Brackish and Seawater

Desalination comprises various water treatment processes for the removal of salt from water for beneficial use. Desalination is used to treat seawater as well as brackish water (water with a salinity that exceeds normally acceptable standards for municipal, domestic, and irrigation uses, but less than that of seawater).

Desalination, when adopted as part of a diversified water supply portfolio, can offer several benefits including increase in water supply, reclamation and beneficial use of impaired waters, and increased water supply reliability during drought periods.

See website (www.water.ca.gov/desalination) for more information on desalinization in California.

Economic Incentives

Economic incentives include financial assistance, water pricing, and water market policies intended to influence water management. Economic incentives can influence the amount of use, time of use, wastewater volume, and source of supply. They can help local agencies and water districts respond to droughts and water shortages.

Incentives can be created or enhanced by facilitating water market transfers, by creating market opportunities where they didn't exist, by expanding opportunities where they currently exist, or by reducing market transaction costs.

Water market policies such as dry year water purchase programs and operation of a drought water bank to coordinate water transfers between willing sellers and buyers are part of this strategy as well as water cost incentives. Drought rate structures where unit water costs are increased during a drought gives customers a choice of paying the higher water rates or finding ways to use less water.

Ecosystem Restoration

Ecosystem restoration improves the condition of our modified natural landscapes and biological communities to provide for their sustainability and for their use by current and future generations. Successful restoration increases the diversity of native species and biological communities and the abundance and connectivity of habitats. This can include reproducing natural flows in streams and rivers, curtailing the discharge of waste and toxic contaminants into water bodies, controlling non-native invasive plant and animal species, removing barriers to fish migration in rivers and streams, and recovering wetlands so that they store floodwater, recharge aquifers, filter pollutants, and provide habitat.

As ecosystem restoration actions help recover the abundance of endangered species, there should be fewer Endangered Species Act conflicts, particularly in the Delta. These conflicts repeatedly disrupt water supplies often during droughts. Thus, one result of ecosystem restoration activities could be a more reliable water supply.

Flood Risk Management

Flood Risk Management is a strategy specifically intended to enhance flood protection. This strategy includes projects and programs that assist individuals and communities to manage floodflows and to prepare for, respond to, and recover from a flood. This strategy is a key element of integrated flood management, a process that promotes a comprehensive approach that considers land and water resources at a watershed scale within the context of integrated regional water management. The aim of this strategy is to maximize the benefits of floodplains, minimize the loss of life and damage to property from flooding, and recognize the benefits to ecosystems from periodic flood events.

This resource management strategy recognizes the potential benefits to water supply and drought preparedness. Detention of floodwaters with both structural and non structural methods could provide benefits to the extent that they result in additional water storage or groundwater infiltration and increased protection of water supply conveyance systems.

Land Use Planning & Management

Integrating land use and water management consists of planning for the housing and economic development needs of a growing population while providing for the efficient use of water, water quality, energy, and other resources. The way in which we use land—the pattern and type of land use and transportation and the level of development intensity—has a direct relationship to water supply and quality, flood management, and other water issues.

Land use resource management strategy brings together many concepts which if adopted together will make existing and future land development more efficient in use of water and hence makes communities more sustainable and resilient to the effects of drought.

Recharge Area Protection

Recharge areas are those areas that provide the primary means of replenishing groundwater. Good natural recharge areas are those where good quality surface water is able to percolate unimpeded to groundwater. If recharge areas cease functioning properly, there may not be sufficient groundwater for storage or use. Protection of recharge areas requires a number of actions based on two primary goals. These goals are (1) ensuring that areas suitable for recharge continue to be capable of adequate recharge rather than covered by urban infrastructure, such as buildings and roads; and, (2) preventing pollutants from entering groundwater in order to avoid expensive treatment that may be needed prior to potable, agricultural, or industrial beneficial uses.

The primary benefit of protecting recharge areas is that those recharge areas can be used by water managers to store water in aquifers as part of a program to provide a sustainable and reliable water supply of good quality, thereby reducing impacts due to drought.

Recycled Municipal Water

In 2009, DWR developed dual plumbing standards, in consultation with the California Department of Public Health and other agencies, to safely plumb certain buildings and commercial properties with both potable and recycled water systems. On November 18, 2009, the Building Standards Commission unanimously voted to approve the California Dual Plumbing Code and building codes were codified in January 2010. The code was published on July 4, 2010 which began the statutory 180-day period between publishing and the effective date of the code. The Dual Plumbing Code effective date is January 11, 2011.

In May 2009, the State Water Resources Control Board adopted the Recycled Water Policy (Recycled Policy) which is intended to support their Strategic Plan priority of promoting sustainable local water supplies. Increasing the acceptance and promoting the use of recycled water is a means towards achieving sustainable local water supplies and can result in reduction in greenhouse gases by reducing some of the need for imported water, a significant driver of climate change. The Recycled Policy is also intended to encourage beneficial use of, rather than solely disposal of, recycled water. To the extent water recycling provides additional water supply it provides additional resilience to drought.

In July 2009, the State Water Resources Control Board adopted General Waste Discharge Requirements for Landscape Irrigation Uses of Municipal Recycled Water (General Permit). The Landscape General Permit is consistent with the Recycled Water Policy, State and Federal water quality laws, including the statewide water quality standards established by the California Department of Public Health. The General Permit facilitates the streamlining of the permitting process to reduce the overall costs normally incurred by producer, distributors, and users of recycled water.

See website (www.water.ca.gov/recycling/) for more information on the water recycling and the California Water Plan Update 2009, Volume 2, Chapter 11 Recycled Water Management Resource Management Strategy.

Surface Storage – CALFED

The CALFED Record of Decision (2000) identified five potential surface storage reservoirs that are being investigated by the California Department of Water Resources, US Bureau of Reclamation, and local water interests.

- Shasta Lake Water Resources Investigation (SLWRI)
- North-of-the-Delta Offstream Storage (NODOS)
- In-Delta Storage Project (IDSP)
- Los Vaqueros Reservoir Expansion (LVE)
- Upper San Joaquin River Basin Storage Investigation (USJRBSI)

California's water resources future has become increasingly uncertain. Consequently, these proposed projects would need to perform well under a number of potential future conditions including climate change, alternative Delta conveyance and management, and disaster / emergency response.

Performance of the CALFED surface storage projects is measured using an operations simulation of the Central Valley Project and State Water Project systems. Results are often reported with both average annual values and dry period (1928-34, 1976-77, and 1987-92) average annual values, reflecting the importance of performance under drought.

Surface Storage Regional/Local

Surface storage uses reservoirs to collect water for later release and use. Surface storage has played an important role in California where the pattern, timing and location of water use does not always match the natural runoff pattern. Many California water agencies rely on surface storage as a part of their water systems. These reservoirs also play an important role in flood control and hydropower generation. Similarly, surface storage is often necessary for, or can increase the benefits from other water management strategies such as water transfers, conjunctive management and conveyance improvements. Some reservoirs contribute to water deliveries across several regions of the state while others only provide local water deliveries within the same watershed. There are two general categories of surface reservoirs: those formed by building a dam across an active river, and a second type called off-stream reservoir storage where the actual reservoir is in a separate geographic location away from the river supply, with water diverted or pumped into storage.

Additional surface storage capacity can also be developed by enlarging, reoperating or modifying existing reservoirs and their outlet structures. Smaller reservoirs typically store water annually in the winter season for use in summer months, while larger reservoirs also hold stored water over several years as a reserve for droughts or other emergencies.

System Reoperation

System reoperation means changing existing operation and management procedures for existing reservoirs and conveyance facilities to increase water related benefits from these facilities. System reoperation may improve the efficiency of existing water uses (e.g., irrigation) or it may increase the emphasis of one use over another. Although reoperation is generally regarded as an alternative to construction of major new water facilities, physical modifications to existing facilities may be needed in some cases to expand the reoperation capability. Legal changes also may be needed. Changes in water demands and the changing climate are the primary reasons to consider reoperation of existing facilities to increase project yield or address climate change impacts.

One operational concept is Forecast-Based Operations (FBO) used to operate a multi-purpose dam and its associated reservoir for flood control and water supply. FBO utilizes advanced forecasts of reservoirs inflows to reduce uncertainty and improve risk management in reservoir system operations. FBO allows dynamic flood storage rule curve used in reservoir operation for better flood protection and greater water supply potential. One example of FBO based reoperation is currently being developed at Folsom Dam and Reservoir. The potential benefits include increased water supply and improved operational flexibility and efficiency, drought preparedness and water quality.

Urban Water Use Efficiency

Water use efficiency is a strategy to reduce water demand and part of the roadmap to sustainable water uses and reliable water supplies. Urban water use efficiency involves technological (such as stormwater capture) or behavioral improvements in indoor and outdoor residential, commercial, industrial, and institutional water use that lowers demand and per capita water use which results in benefits to water supply and water quality. This strategy has multiple benefits to citizens, the economy, and the environment.

Drought responses under this resource management strategy include water agencies providing educational and motivational programs to inform their customers and provide incentives for water conservation practices during drought.

Specific examples of urban water use efficiency programs and activities are described under the "Additional Strategies and Activities for Preparing for a Drought" below.

Watershed Management

Watershed management is the process of creating and implementing plans, programs, projects and activities to restore, sustain and enhance watershed functions.

A primary objective of watershed management is to increase and sustain a watershed's ability to provide for the diverse needs of the communities that depend on it, from local to regional to state and federal stakeholders. Resource management using watersheds as an organizing unit has proven to be an effective scale for natural resource management.

A healthy watershed works like a sponge to store and release water to both streams and groundwater. In California, healthy watersheds increase the residence time of water, and tend to store and release water longer into the dry season leading to added resilience to drought.

Water Transfers

Water transfers are the sale of water from areas with excess water to areas in need of water. This voluntary change in the way water is usually distributed among water users is often in response to water scarcity. Many water transfers become a form of flexible system reoperation linked to many other water management strategies including surface water and groundwater storage, conjunctive water management, improved conveyance efficiency, water use efficiency, water quality improvements, and planned crop shifting or farmland fallowing. These linkages often result in increased beneficial use and reuse of water overall and are among the most valuable aspects of water transfers. Transfers also provide a flexible approach to distributing available water supplies for environmental purposes.

The 2009 DWR Drought Water Bank is an example of the use of transfers in responding to drought (see below section for further discussion on water transfers).

Please see the recently released 2009 California Water Plan update for additional information on the above strategies (www.waterplan.water.ca.gov/cwpu2009/index.cfm).

Highlighted Strategies and Activities for Preparing for a Drought

The State has taken or planned a number of actions and programs to prepare for the possibility of an extended drought and to minimize its impacts. These strategies and programs (described below) highlight some of the activities needed to respond to a potential long-term decrease in water supplies. Also, see Table 1 of the Appendix for potential actions agencies may take in preparing for a drought.

Drought Response Workshops and Planning

In 2009, DWR, Cal EMA, and Department of Public Health hosted a series of workshops throughout California to share updates on drought impacts and response activities, and to discuss local groundwater conditions and planning for Integrated Regional Water Management (IRWM) grants. Projects and programs that urban and agricultural agencies have been putting in place (often with state financial assistance) to improve local water supply reliability also help with drought preparedness. Implementation of IRWM over time could help improve planning for water supply reliability and drought preparedness at the regional scale, particularly in the context of local capital improvement planning for water infrastructure.

Preparing for droughts entails having in place an institutional framework that addresses not only actions that are directly related to provision of water supplies, but also provides for the information collection and expertise to support emergency services response. In some sectors (such as wildfire response) institutional capabilities are well developed in terms of mutual aid agreements and the state's incident command system. Development of institutional frameworks remains to be worked out in other sectors, including methodologies for quantifying and dealing with socioeconomic impacts.

Drought Monitoring And Forecasting

Monitoring and forecasting are essential to support effective drought responses. The ability to assess and predict drought require an extensive, long-term monitoring and data collection effort. Being proactive to drought management requires continuous monitoring of indicators to help predict the onset and extent of drought, as well as to help determine when to relax restrictions and return to normal operations. Real-time weather water supply data will be compared with historical records to evaluate drought.

DWR has already developed a drought website (www.water.ca.gov/drought) containing links to water supply data such as snowpack, precipitation, runoff, and reservoir storage to help evaluate current water supply. Also, the California Data Exchange Center (www://cdec.water.ca.gov/) installs, maintains, and operates an extensive hydrologic data collection network including automatic snow reporting gages for the Cooperative Snow Surveys Program and precipitation and river stage sensors for flood forecasting.

This information may be supplemented by a network of comprehensive data maintained by other State, federal, and local agencies or organizations to provide accurate and current information to guide management decisions. For example, the National Integrated Drought Information System (NIDIS) is a drought information system that brings together a variety of observations, analysis techniques, and forecasting methods in an integrated system to support drought assessment and decision-making (Reference 13). Opportunities for collaboration with NIDIS to supplement data or integrate activities should be explored in future DCP updates.

Also, DWR is finalizing upgrades to the California Irrigation Management Information System (CIMIS) including an increased number of weather stations and improved system maintenance that will provide important water saving irrigation information. This information, along with other drought data, is incorporated into drought impact reports and bulletins to provide current information on water supply conditions.

In addition, beginning in 2008, DWR began hosting Winter Outlook Workshops which brings together nationally known scientists to provide state water managers with the most accurate prediction possible for the water year that runs from October 1 through September 30. An accurate, long-range forecast for water year precipitation is a critical tool for water managers throughout the state.

Water Conservation

Water conservation refers to reducing water usage which helps lower water demand. A conservation measure is an action, behavioral change, technology, or improved design or process implemented to reduce water loss, waste, or use. Conservation should be a priority in all water management decisions because there is often not enough lead time during emergencies to undertake significant water saving improvements. The key to water conservation is public education.

In 2009, DWR partnered with the Association of California Water Agencies (ACWA) to launch a statewide water conservation campaign aimed to reduce water use and educate the public. The multi-year program aims to create a habit of saving water as a component of the comprehensive solutions to our water challenges. In May 2010, the campaign was re-launched under the title “Real People, Real Savings”, featuring real-life Californians and their water-saving stories to help encourage Californians to conserve water. DWR continues to incorporate the campaign into statewide events. Please visit the campaign website (www.saveourh2o.org) which contains conservation tips, videos, and tools on saving water.

In 2009, The Department of General Services mandated water conservation best management practices (BMP) for all state-owned facilities and requested owners of state-leased facilities to also implement BMP for water conservation. These conservation programs should be reviewed and updated periodically to incorporate improvements in technology and methodology.

20 by 2020 Water Conservation Plan

DWR has worked with other agencies and the legislature to develop a comprehensive plan to permanently reduce urban per capita water use 20% by 2020. The plan concludes that California can implement a range of activities designed to achieve 20% per capita reduction in urban water demand by 2020. These activities include improving an understanding of the variation in water use across California, promoting legislative initiatives that provide incentives to water agencies to promote water conservation, and creating evaluation and enforcement mechanisms to assure regional and statewide goals are met.

The Final 20x2020 water conservation plan was released in February 2010 (See www.swrcb.ca.gov/water_issues/hot_topics/20x2020/docs/20x2020plan.pdf).

DWR Water Transfers Program

Water transfers are a common tool for responding to drought impacts. The 2008 Executive Order directed DWR to implement a dry year purchasing program (which became the 2009 drought water bank) to assist water users if conditions were dry.

In 2009, DWR established a new Office of Water Transfers to coordinate all activities for the Department's transfer program and to develop the long-term water transfers program (This office subsequently has been restructured within DWR). DWR and USBR have also provided assistance with environmental compliance and endangered species coverage for water transfers. DWR and USBR have committed to the development of an ongoing, long-term water transfer program to provide ongoing flexibility in water management, and have begun the process for environmental compliance permitting for the program. Even though the need for water transfers may vary from year to year, external factors including climate change and challenges facing the Delta are increasing the frequency of need for water transfer to meet local water supplies demands.

In 2009, DWR implemented the Drought Water Bank (DWB) in response to a third year of drought. The DWB provided 74,100 acre feet (AF) of water for through Delta transfers for use in the San Joaquin Valley and Southern California. In addition to the water provided by the DWB, another 200,185 AF of water was transferred through the Delta through separate transfer agreements. Of this amount, 172,685 AF were provided through agreements resulting from the Yuba Accord.

More information regarding the DWR Water Transfers Program can be found at: www.water.ca.gov/drought/transfers/#

Model Landscape Ordinance

Many of the local agency water conservation campaigns are targeting reductions in outdoor water use. In September 2009, DWR adopted an updated model water efficient landscape ordinance. As required by AB 1881 of 2006, DWR distributed the ordinance to all local agencies. Not later than January 31, 2010, each agency was required to notify DWR that it has adopted the model ordinance or a local ordinance. Most local agencies have notified DWR whether they are enforcing the model ordinance or enforcing a local water efficient landscape ordinance. Numerous agencies are going a step further by making some provisions of their local ordinances more rigorous than the model ordinance. Many agencies view this as an opportunity to address limited water supply conditions, improve water quality and complement their existing water conservation programs.

In 2009, DWR partnered with the California Urban Water Conservation Council and various organizations throughout the state to conduct nine workshops on the model ordinance. The intention of the workshops was to assist local governments and urban water suppliers in adopting and implementing the model ordinance, or a local ordinance that is at least as effective as the model ordinance.

See website (www.water.ca.gov/wateruseefficiency/landscapeordinance)for more information on the water efficient landscape ordinance.

Urban Water Management Plans (UWMPs)

As a condition to receiving state drought financial assistance or water transfers provided in response to the drought emergency, urban water suppliers in California are generally required to implement a water shortage contingency analysis, as required by California Water Code section 10632. The analysis must address how they would respond to supply reductions of up to 50%, and must estimate supplies available to their systems in a single dry year and in multiple dry years. UWMPs must also address systems' responses to catastrophic interruptions of their supplies, such as those caused by earthquakes or power shortages.

The latest updates of UWMPs were due to DWR in 2005. DWR estimates that 453 suppliers were required to file plans in 2005; 410 plans have been received to date. The next set of updates is due in 2010. Beginning in 2007, DWR has held 18 UWMP workshops in response to the current drought, to encourage water systems to review and update their water contingency plans, and additionally has funded preparation of an updated urban drought guidebook in coordination with USBR and the California Urban Water Conservation Council.

See website (www.water.ca.gov/urbanwatermanagement) for more information on urban water management.

Agricultural Water Management Plans (AWMPs)

Under AB 3616, DWR, in cooperation with agricultural water suppliers, environmental interest groups, and other interested parties, developed a list of efficient water management practices for agricultural water suppliers in California, leading to development of a Memorandum of Understanding regarding development of AWMPs and Implementation of Efficient Water Management Practices, or EWMP (1996). Subsequently, DWR and agricultural and environmental signatories to the MOU formed the Agricultural Water Management (AWM) Council to oversee development of AWMPs and implementation of EWMP's. To date, there are 80 agricultural water suppliers constituting over 5.8 million acres of irrigated land. DWR provides technical and financial assistance to the AWM Council to help agricultural water suppliers develop water management plans. In addition, DWR provides technical review for each AWMP identifying its strengths and weaknesses. Based on DWR review along with AWM review, the AWM Council endorses the AWMP or takes no action. DWR is currently working with the AWM Council to expand drought contingency sections of the AWMPs.

See website (www.water.ca.gov/wateruseefficiency/agricultural/agmgmt.cfm) for more information on agricultural water management.

Mobile Desalinization

Mobile water desalination units are water treatment units (generally, Reverse Osmosis mobile desalination units) that can be truck-mounted or air-lifted, enabling the provision of short-term emergency water supply as well as supplemental supply for drought stricken or disaster areas. These units can be rapidly deployed to water stressed localities to generate potable water from contaminated local sources or from ocean water in coastal communities. They can also be quickly and easily decommissioned or moved to other locations should drought ease.

See website www.water.ca.gov/pubs/surfacewater/logistics_for_deploying_mobile_water_desalination_units/mobile_desalination.pdf for more information on mobile desalinization.

VII. RESPONDING TO A DROUGHT

Local government, water agency, and individual actions are usually the first line of drought response before impacts become severe and reach emergency level. Cities and water agencies may call for voluntary or mandatory water use restrictions. Counties may impose burning bans or take other emergency steps. State assistance may become necessary if drought persists and impacts exceed the local capacity to respond. If state resources are exhausted or inadequate to respond to a drought or water shortage, the Governor may next request a presidential declaration for federal assistance.

The following describes local, utility, and State agency drought response.

Local Agency Response

Local governments and water suppliers are responsible for managing their water system to ensure an adequate and safe water supply. Drought response at the local level is commonly voluntary or mandatory conservation imposed under local ordinances. The governing body of a city or county may proclaim a local emergency when the conditions of disaster or extreme peril exist. The proclamation enables the city or county to use emergency funds, resources, powers, and to promulgate emergency orders and regulations.

Many counties in California submitted drought-related emergency proclamations between 2007-2009. A common theme among the majority of the proclamations was related to agricultural water shortages. Additional impacts mentioned in the proclamations include the Fresno County unemployment food crisis, potential water shortages for the community of Redwood Valley in Mendocino County due to the low level of Lake Mendocino on the Russian River, and wildfire risks.

Water Agency Response

Implementing enhanced water conservation programs and calling for customers to achieve either voluntary or mandatory water conservation goals or targets are common urban water supplier actions. Increases in customers' water rates – either to encourage conservation or to react to increased costs associated with acquiring supplemental water sources or implementing conservation programs – are common drought outcomes. These rate increases in California appear to be widespread in 2009 and appear to be effective in reducing water use.

Table 4 of the Appendix, compiled from information collected by the ACWA, summarizes conservation actions and water use reduction targets of its member agencies.

State Agency Response

Following the 2009 emergency drought proclamation, Cal EMA and DWR convened a "Cabinet Drought Steering Committee" to monitor the social and economic impacts of the drought and to provide drought relief to impacted communities primarily located in the San Joaquin Valley where many agricultural-related job losses occurred. The Committee was comprised of various State agencies which coordinated with local and non-profit agencies on drought relief (see Attachment 1). Bi-monthly food distributions were held for months in various cities and towns in Fresno County. A drought brochure was created listing available social, employment, and other assistance programs for individuals (see Attachment 4). The Committee also coordinated strategic meetings with local agencies to listen to the needs of each county and to provide information on available assistance programs.

Economic drought impacts were most severe in the west side of the San Joaquin Valley where many agricultural-related job losses occurred. At the same time, the national economic crisis had exacerbated the impacts as farmers and businesses faced a downturn in the economy and tighter credit markets. Drought-related impacts were forecasted and estimated using available models such as the Statewide Agricultural Production Model, a regional Input/Output Model, and other tools.

In responding to future droughts or water shortages, the Interagency Drought Task Force will be called upon by DWR and Cal EMA to coordinate with working groups, federal agencies, tribal organizations, and others. The diagram depicted by Figure 1 may serve as a protocol for general agency communication and coordination. Drought assistance programs listed in the drought brochure may be re-initiated and/or administered by responsible agencies. Initial drought response actions may be to issue a Drought Advisory and press release to inform the public of impending drought and to increase water conservation activities and cut back on unnecessary water use. DWR may also activate the Drought Operations Center to serve as a central point of contact for information and emergency assistance requests.

The Task Force will work with local agencies to identify impacts and appropriate responses, recognizing that local agencies will be most familiar with conditions and practices that are impacted by drought. Actions may include coordinating drought relief programs; monitoring the impacts to at-risk small public water systems; scheduling drought workshops and providing technical assistance; seeking funding to provide assistance to water systems in need of infrastructure improvements (for example, well deepening or intake extension); and collecting unemployment, economic, and agricultural impact data to monitor impacts and to support emergency declarations.

Monitoring of drought conditions may increase in frequency during dry periods or if drought conditions worsen significantly. The Drought Monitoring Committee is responsible for providing updated water supply and other information which will be posted on the DWR website. Monthly drought reports and periodic summary reports containing updated water supply data, local assessments and impacts, and mitigation strategies will be provided. Other State agencies may be required to produce their own drought response and impact reports for the Governor's office (see 2009 Drought Proclamation, Attachment 6 of Appendix).

See Table 2 of the Appendix for potential actions agencies may take in responding to a drought. This table contains examples of agency response actions at varying stages of drought; the higher the drought stage, the more intense the drought response would be. Five levels of drought stages are suggested ranging from Level 1 (Abnormally Dry) to Level 5 (Exceptional Drought). Water supply conditions and other indicators that may serve as guidelines to move from one stage to another are also suggested. The Task Force would make a recommendation about advancing to the next stage of drought based on input from the Drought Monitoring Committee and Impact Assessment Work Groups and other stakeholders.

VIII. RECOVERING FROM A DROUGHT

The actions in this phase are intended to provide early recovery from, not long-term mitigation, of drought impacts. These actions sometimes overlap those for drought response because drought impacts often linger long after an end of a drought. Some agency drought response activities may continue to occur as well as continuous monitoring of drought indicators.

State agency actions may include post drought evaluation, replenishment of water supplies, and economic and natural resources recovery. The State and federal government may continue to assist with implementation of State and federal relief programs (for example, food distributions, USDA programs, etc.) for individuals, farmers, and others impacted by the drought until the programs phase out or are called to an end. Follow-up with drought-impacted community water systems may be needed to restore operations and ensure system improvements and modifications are in compliance with applicable standards.

A final meeting of the Task Force (or After Action Debriefing/Report) is needed for debriefing and identifying success, lessons learned, and recommended improvements. Appropriate amendments to legislation will be noted and a debriefing to the Governor's office is required. A final drought report summarizing the agency actions and experience and recommended next steps will be produced by the Task Force.

Table 3 of the Appendix contains potential actions agency may take in recovering from a drought.

APPENDIX

REFERENCES

1. CDWR, California's Drought of 2007-2009: An Overview (Draft), September 2010.

2. CDWR, California Drought, An Update: December 2009.

3. CDWR, California Water Plan Update 2009.

4. Cal EMA, California Drought Concept of Operations, December 31, 2009.

5. Cal EMA, State of California, Emergency Plan, July 2009.

6. CDWR, California's Drought: Water Conditions and Strategies to Reduce Impacts, March 2009.

7. A Retrospective Estimate of the Economic Impacts of Reduced Water Supplies To the San Joaquin Valley in 2009; by Jeffrey Michael, Richard Howitt, Josué Medellín-Azuara, and Duncan MacEwan; 9/28/10.

8. CDWR, 2008b, Urban Drought Guidebook, 2008 Updated Edition.

9. Wilhite, D.A., M.J. Hayes, and C.L. Knutson. 2005. Drought Preparedness Planning: Building Institutional Capacity.

10. Wilhite, D.A. 2005. Drought Policy and Preparedness: The Australian Experience in an International Context.

11. Hawaii Drought Plan, 2005 Update.

12. Arizona Drought Preparedness Plan, Operational Drought Plan, October 8, 2004.

13. Creating a Drought Early Warning System for the 21st Century, The National Integrated Drought Information System, Western Governor's Association, June 2004.

14. Connecticut Drought Preparedness and Response Plan, August 4, 2003.

15. Report of the National Drought Policy Commission, Preparing for Drought in the 21st Century, May 2000.

16. CDWR, 2000, Preparing for California's Next Drought, Changes Since 1987-92.

17. Wilhite, D.A., Improving Drought Management in the West: The Role of Mitigation and Preparedness, January 8, 1997.

Table 1 – Potential Actions by Agencies in Preparing for a Drought

Drought Indicators – Current Water Conditions throughout the State are at normal levels. No drastic water conservation measures are necessary, although water conservation should always be practiced. The state's reservoirs are full or nearly full and runoff across the state is at normal levels.

Action	Agencies with expertise or authority (Lead-L)	Related Documents or References
Monitoring		
Work with local agencies and tribal representatives to develop drought metrics (indicators) with the goal of providing early detection and determination of drought severity	DWR (L), CDFA, NOAA	CWP-DCP
Improve monitoring of key Indicators of drought and drought impacts.	DWR (L), CDFA, NOAA	CWP-DCP
Improve system of stream gaging for the purpose of managing water resources in low flow conditions and improving the accuracy of seasonal runoff and water supply forecasts.	DWR (L), USGS , SWRCB	
Augment real-time monitoring of groundwater data with additional wells statewide.	DWR (L), USGS , SWRCB	DWR Bulletin 118, DWR Groundwater Information Center (website)
Improve wildlife and habitat monitoring and develop an accessible and standardized database for reporting habitat conditions, populations, and human-wildlife contact incidents.	CDFG (L), DWR, CDF, USFWS, USFS	
Improve groundwater monitoring and assessment	DWR (L), USGS, SWRCB, NOAA	DWR Bulletin 118, DWR Groundwater Information Center (website)
Develop reporting method for collection of regional drought impacts data and information.	CDFA (L), DWR(S), Cal EMA, CDPH – Drinking Water	CWP-DCP
Communication/Coordination and Planning		
Update Drought Contingency Plan	DWR (L), Cal EMA, CDFA, CDFG, SWRCB, DPH, Tribal Representatives	CWP-DCP
Develop a "California Drought Status" public information strategy that communicates current drought to the public and decision-makers. Investigate most appropriate mechanism to communicate information, e.g. newspaper, mail, radio, website etc.	DWR (L), Cal EMA	DWR Drought Website, DWR "Save Our Water " campaign
Educate water users & agencies on how to use climate information to plan for mitigation and drought response .	DWR (L), CARB, CEC, SWRCB, DPH	CWP-DCP, CA Emergency Plan
Develop an internet site for California Drought Contingency Plan.	DWR (L)	DWR Drought Website,

Action	**Agencies with expertise or authority (Lead-L)**	**Related Documents or References**
Provide public general information on drought as it relates to wildfire issues.	Cal Fire (L), USFS, USBLM	
Provide ranchers and farmers with workshops on coping with drought.	CDFA (L), UCCE, USDA, Tribal Representatives	
Provide public with information on wildlife issues – especially how to deal with increased interactions.	CDFG (L), USFWS, USFS, CDOF	
Conduct drought preparedness regional workshops for the purpose of : Developing proper indicators for each region Assess potential needs for regional assistance Determine relative risk of regions Capturing Drought component of Urban Water Management Plans	DWR (L), Cal EMA, CDFA, CDPH , Tribal Representatives	Multi Hazards Mitigation Plan, State of CA Emergency Plan, CWP-DCP
Provide public with information on impacts to recreation. Inform public of ways to enjoy recreation with less impact to drought stressed environment.	CDSP (L), DBW, DWR, ACOE, USFS, CSLC, CDPR	CWP_DCP
Prepare and update informational brochure on drought for general public.	DWR (L), Cal EMA, IRWM	DWR "Save Our Water" campaign
Determine precise needs of water providers for information on drought; what types of information are most relevant. This will vary by region and system. Set up system of indicators with triggers to inform decision makers and public on status and severity of drought.	DWR (L), IRWMs, CDFA, Water Contractors and Purveyors	CWP-DCP, DWR Programmatic EIR/EIS for Water Transfers office.
Develop coordination and communication protocol between federal, State and Local, (County, etc) and Tribal entities.	DWR (L), USBR, ACOE, CDFG, USFWS, CDFA, IRWMs, Tribal Representatives	CWP-DCP
Clarify emergency response procedures with State Agencies	Cal EMA (L), DWR, IRWMs	Multi Hazards Mitigation Plan, State of CA Emergency Plan, CWP-DCP
Prepare a handbook or checklist on procedures to expedite needed permits for response to drought.	DWR (L), SWRCB, CDFG, USFWS, USBR, ACOE, DPH	Multi Hazards Mitigation Plan, State of CA Emergency Plan, CWP-DCP
Arrange for funding to support drought relief, groundwater projects, desalination, conservation, recycling and other water management projects to assist regions in dealing with drought.	DWR (L), CDPH	CWP-DCP

Action	Agencies with expertise or authority (Lead-L)	Related Documents or References
Facilitate watershed and local planning for drought		
Develop risk-based vulnerability assessment for each basin /watershed.	DWR (L), IRWMs, CDFG, CDFA, USBR, USGS, NOAA, SWRCB, DPH	CWP-DCP
Prepare a "Map of Drought Vulnerability" showing areas where drought is more likely to upset water supplies.	DWR (L), IRWMs, CDFG, CDFA, USBR, USGS, NOAA,SWRCB, DPH	Multi Hazards Mitigation Plan, State of CA Emergency Plan, CWP-DCP
Develop a water budget for each watershed/basin – integrating inflows and outflows to meet all needs including quantification of carrying capacity.	DWR (L), IRWMs, CDFG, CDFA, USBR, USGS, NOAA, SWRCB	CWP-DCP
Investigate opportunities for regional drought planning through IRWM to facilitate drought response and assist IRWM planning efforts in developing regional responses to drought.	DWR (L), SWRCB, USBR, IRWMs	CWP-DCP
Explore Coordinated Management of Wildlife and Livestock.	CDFA (L), CDFG, DWR, USFS, BLM, USDA	
Direct state resource managers to develop drought plans for State Lands and State Parks	Natural Resources Agency (NRA), DWR, CDSP, CSLC	
Develop program for temporary transfers of water for instream flows to protect native fish and sports fisheries	DWR (L), SWRCB, USBR, ACOE, CDFG, USFWS, (Potential Partnerships with Cal WARN, CUEA, and/or CRWA)	DWR Water Transfers Office Documents and Programmatic EIR/EIS
Initiate partnerships with local water users and regulatory agencies to develop emergency alternative water supplies to habitat for critical species. Look to Urban Water Management Plans for existing information.	DWR (L), SWRCB, USBR, ACOE, CDFG, USFWS	DWR Water Transfers Office Documents and Programmatic EIR/EIS
Evaluate improvements to the institutional mechanism for temporary and voluntary drought related water transfers.	DWR (L), SWRCB, USBR, ACOE, CDFG, USFWS	DWR Water Transfers Office Documents and Programmatic EIR/EIS
Provide plan template and guidance to assist water providers in the development of drought plans and initiate a reporting and review program.	DWR (L), Cal EMA, CDPH, IRWMs	
Provide incentives and funding for comprehensive leak detection efforts.	DWR (L), CDPH	
Local Assistance		
Develop relative risk of regions to drought and the best indicators of droughts and water shortages.	DWR (L), IRWMs, USBR, NOAA, CDFA, CDFG, CDF, USFS, BLM	CWP-DCP
Conduct regional workshops on the best metrics for monitoring droughts.	DWR (L), IRWMs, USBR, NOAA, CDFA, CDFG, CDF,	CWP-DCP

Action	Agencies with expertise or authority (Lead-L)	Related Documents or References
	USFS, BLM	
Negotiate and obtain necessary permits and approvals for both short and long term water transfers.	DWR (L), SWRCB, USBR, ACOE, CDFG, USFWS	DWR Water Transfers Office Documents and Programmatic EIR/EIS
Negotiate contracts for drought contingency water supplies.	DWR (L), SWRCB, USBR ACOE, CDFG, USFWS, IRWM	DWR Water Transfers Office Documents and Programmatic EIR/EIS
Encourage water system interconnections and agreements between agencies	DWR (L), SWRCB, IRWM	DWR Water Transfers Office
Seek funding to provide assistance to water systems in need of developing storage and infrastructure improvements (e.g., well deepening) only if communities have submitted a drought/conservation plan.	DWR (L), SWRCB, USBR, USFWS, IRWM	
Conservation		
Provide incentives and funding for comprehensive leak detection efforts.	DWR (L), IRWMs, USBR, SWRCB, CDOC, CDPH (Potential Partnerships with Cal WARN, CUEA, and/or CRWA)	DWR DRIWM Grant & Funding efforts
Promote increased use of recycled water	DWR (L) IRWMs, USBR, SWRCB, CDPH, (Potential Partnerships with Cal WARN, CUEA, and/or CRWA)	CWP, CWP-DCP, DWR DRIWM Grant & Funding efforts
Invest in improving on-farm efficiencies	CDFA (L), CDOC, DWR, USBR, SWRCB, NRCS, UC & UCCE	DWR DRIWM Grant & Funding efforts, other agency grant efforts.
Implement the 20x2020 Water Conservation Plan (Implementation, monitoring, evaluation, and adjustments phase—2011 to 2020)	DWR (L), IRWMs, USBR, SWRCB, CDPH, Appropriate agencies	CWP-DCP, DWR DRIWM Grant & Funding efforts
Provide technical support and funding for soil tilth efficiency improvement	CDOC(L), CDFA, DWR, USBR, SWRCB, NRCS	
Other		
Estimate budget needs and determine allocation procedures related to drought responses.	Governor's Office, DWR (L), Cal EMA, CDFA, CDF, CDFG	
Follow nationwide and worldwide drought efforts and apply lessons learned to California drought planning and responses.	DWR (L), CDFA, CDFG, CDPH, USBR, NOAA	CWP-DCP
Monitor and support development of new drought resistant crops.	CDFA (L), USDA, DWR, USBR, CDOC, UC & UCCE	
Plan, Design, and Build improvements to the water supply infrastructure that will reduce the risk and severity of water shortages.	DWR (L), SWRCB, IRWM, USBR, USACOE	

Table 2 – Potential Actions by Agencies in Responding to a Drought

Action	Agency(ies) with expertise or authority (Lead-L)	Related Documents or References
Level 1 - Abnormally Dry (Raising Awareness of Drought)		
Drought Indicator – The State's precipitation, snowpack, or runoff is lower than normal, or reservoir levels are below average. Conservation measures should be increased voluntarily, to help manage the state's current water supply		
Communication/Coordination and Planning		
Activate Drought Operations Center at DWR for central point of contact and information	DWR (L), Cal EMA(S), Appropriate Agencies	CWP-DCP
Convene Drought Monitoring Committee and Impact Assessment Work Groups (situation and assessment reports)	DWR (L), Appropriate Agencies	CWP-DCP
Designate agency spokesperson(s) to interact with the public and media	DWR(L), Appropriate Agencies	CWP-DCP
Issue a Drought Advisory and press release	DWR(L), Appropriate Agencies	CWP-DCP
Direct State agencies to conserve water at state facilities	DWR(L), Appropriate agencies	CWP-DCP
Expedite drought-related permit applications	DWR(L) Appropriate agencies	CWP-DCP
Communicate conditions, reinforce general conservation tips. Hold drought preparedness workshops.	DWR (L), Cal EMA, CDPH	20x2020, CWP
Coordinate with Federal, State, Local (County) and Tribal entities	DWR (L), Appropriate Agencies	CWP-DCP
Accelerate work with local governments and water providers on public awareness and outreach.	DWR (L), Appropriate Agencies	CWP-DCP
Review State laws to reduce impediments to providing water supplies to communities in emergency need – modify as necessary. (short-term)	CDPH (L), DWR	CWP-DCP
Monitoring		
Collect regional impact data and information	DWR (L), Appropriate Agencies	CWP-DCP
Publish community and State facility water use information through website, media and other public outreach.	DWR (L), Appropriate Agencies	CWP-DCP

Action	Agency(ies) with expertise or authority (Lead-L)	Related Documents or References
Facilitation of watershed and local planning for drought		
Seek funding to provide assistance to water systems in need of developing storage and infrastructure improvements (e.g., well deepening) only if communities have submitted a drought/conservation plan.	DWR (L), CDPH, US EPA	CWP-DCP
Other		
Hold more water in reservoirs in case next year is a dry one.	DWR (L)	
Level 2 - First Stage Drought (Voluntary Conservation, heightened awareness, increased preparation)		
Drought Indicator – The State's precipitation, snowpack, or runoff is lower than normal, or reservoir levels are below average. Conservation measures should be increased voluntarily, to help manage the state's current water supply		
All actions in Level 1 plus: **Communication/Coordination and Planning**		
Develop Emergency Action Plan including: • Developing information necessary for an Agricultural Emergency Disaster Declaration • Development of mandatory conservation measures • Development of mandatory curtailment measures • Identify priorities for surface water supplies (based on State Law) • Identify priorities for surface water supplies (based on State Law)	DWR (L), Cal EMA, Appropriate Agencies	CWP-DCP, CEP 14.22.10
Communicate drought severity through normal channels.	DWR (L), Appropriate Agencies	CWP-DCP, CEP 14.22.10
Conduct workshops or other methods of communication in drought stricken areas to provide information on assistance available.	DWR (L), Appropriate Agencies	CWP-DCP, CEP 14.22.10
Enhanced Media Outreach and provide assistance to communities for conservation and drought education.	DWR (L), Appropriate Agencies	CWP-DCP, CEP 14.22.10
Monitoring		
See actions in Stage 1 **Local Assistance**		
Prepare to directly assist isolated, rural systems who are at most risk and have the least resources for responding.	DWR(L), CDPH	
Work indirectly through local water agencies and local government in urban areas with robust water management infrastructure, resources and coordination.	DWR(L)	

Action	Agency(ies) with expertise or authority (Lead-L)	Related Documents or References
Facilitation of watershed and local planning for drought		
Expedite water transfers by providing assistance in the form of technical resources, emergency infrastructure, arbitrating supply disputes, etc.	DWR (L), SWRCB	
Conservation		
Increased water savings at federal, State and local facilities	DWR (L), All Agencies	CEP 14.22.10
Initiate heightened Water Conservation efforts (Save our Water Campaign)	DWR (L)	CEP 14.22.10
Encourage State facilities (including universities) to reduce water use by 10%.	DWR (L), All Agencies	CEP 14.22.10
Implement other reductions consistent with and similar to local community reductions.	DWR (L), CDPH, CDFA	CEP 14.22.10
Provide financial assistance to drought impacted sectors	CDOF(L) , All State Agencies w/funding	CEP14.4
Hold more water in reservoirs in case next year is a dry one. Start planning for any needed temporary engineering solutions.	DWR (L)	
Level 3 - Severe Drought (Mandatory conservation, emergency actions)		
Drought Indicator – Reservoirs are low; precipitation, snowpack and runoff are all well-below normal, and forecast to remain so. Mandatory conservation may need to be enacted in communities that do not have adequate water supplies.		
All actions in Level 1 & 2 plus: **Communication/Coordination and Planning**		
Convene Interagency Task Force following Emergency Drought Proclamation by Governor	DWR (L), Appropriate Agencies	CWP-DCP
Identify criteria thresholds for Emergency Proclamation	Cal EMA (L), DWR	California Emergency Plan (CEP)10.7.5
Initiate implementation of Emergency Action Plan and identify enforcement protocol.	DWR (L), Appropriate Agencies	
Coordinate responses to emergency conditions	Cal EMA (L), DWR	California Emergency Plan (CEP)10.7
Increased media outreach (and enhanced assistance to communities for conservation and drought education)	DWR (L), Cal EMA, Appropriate Agencies	CEP 10.5
Communicate conditions, promote general conservation tips, and provide information on drought mitigation and response options.	DWR (L), Cal EMA, Appropriate Agencies	CEP 14.22.10
Continue intelligence gathering and situation reporting	Cal EMA (L), DWR	CEP 10.4
Work with local health directors to assess public health threats and take appropriate actions	CDPH(L), Appropriate Agencies	
Provide regular situation reports to FEMA, ACOE, and appropriate agencies	DWR (L), Cal EMA	CWP-DCP

Action	Agency(ies) with expertise or authority (Lead-L)	Related Documents or References
Prepare a request for Presidential Disaster Declaration to FEMA	Cal EMA (L), DWR, Appropriate Agencies	
Monitoring		
Emergency notifications received by State Warning Center passed on to Drought Coordinators and as necessary other State and Federal Agencies.	Cal EMA (L), DWR	CEP 10.3
Local Assistance		
Coordinate with local and state government to facilitate declaration of Drought Emergency (Governor) in affected area(s).	Cal EMA (L), DWR	
Deploy emergency conveyance/interconnections as needed.	CDPH (L), DWR	CEP 14.12.7
Deploy local water supply augmentation measures as needed: • Atmospheric Water Generators: http://en.wikipedia.org/wiki/Atmospheric_water_generator • Portable Desalinization Systems • Drilling new wells	CDPH (L), DWR	CEP 14.12.7
Coordinate mutual aid assistance	Cal EMA (L), DWR, Local Agencies	CEP 10.6
Conservation		
Encourage State Facilities to reduce water use by 20%.	DWR(L) , DGS (S) All State Agencies	
Other		
Prepare conservation facilities for fish.	CDFG (L)	CEP 14.22.7
Provide watering devices on wildlife ranges	CDFG (L)	CEP 14.22.7
Permit streamlining for drought relief actions	DWR (L) , Appropriate Agencies	
Implement stress management program for water-dependent livelihoods	CDMH (L)	CEP 14.12.6
Hold more water in reservoirs in case next year is a dry one.		
Level 4- Extreme Drought (Maximum mandatory conservation)		
Drought Indicator – Reservoirs are low; precipitation, snowpack and runoff are all well-below normal, and forecast to remain so. Mandatory conservation may need to be enacted in communities that do not have adequate water supplies.		
All actions in Level 1 - 3 plus:		
Local Assistance		
Facilitate the provision of water hauling assistance/relief to communities.	DWR (L), Cal EMA, All Agencies	CEP 14.22.10
Impose restrictions as needed for affected areas – Governor's Emergency Powers.	DWR (L), Cal EMA, All Agencies	CEP 14.22.10

Action	Agency(ies) with expertise or authority (Lead-L)	Related Documents or References
Facilitate voluntary water purchases/transfers from irrigated agriculture or other permit holders for potable water deliveries, Ag use, and environmental protection.	DWR (L), Cal EMA, All Agencies	CEP 14.22.10
Facilitate greater use of recycled water.	DWR (L)	
Conservation		
Work with local water agencies in highest levels of conservation which could include elimination of non essential water use (No outside watering)	DWR (L), Cal EMA, CDPH	
Water rights of low priority cut off from water supply (As provided for in Water Code)	SWRCB (L), Cal EMA, CDPH	
Require State facilities to eliminate watering nonessential outdoor watering (exceptions for wildlife protection).	DWR (L), Cal EMA, CDPH	
Other		
Debris Management Programs	Cal EMA (L), DWR, Local Agencies	California Emergency Plan 11.3
Identifify airborne contaminates exacerbated by drought	CARB (L), CDPH	CEP 14.10.1
Administer emergency water transfers throughout the state	DWR (L), Appropriate Agencies	
Level 5 - Exceptional Drought (Water supplies cut off, maximum response)		
Drought Indicator – Extremely dry conditions persist across the state. Water safety, supply, and quality are all at risk, due to shortages. All sectors of water usage are facing hardship as a result of inadequate supply and dry conditions.		
All actions in Level 1 - 4 plus: **Communication/Coordination and Planning**		
Declare a water supply or water shortage emergency	Governor, Cal EMA (L), DWR	
Activate CA National Guard	Governor	
Invoke a ban on open burning	Local Governments	
Staff the State Emergency Operations Center	Cal EMA (L), Appropriate Agencies	
Facilitate Mutual Aid requests for Assistance to provide increased security by law enforcement due to severe water cutbacks.	Cal EMA (L), CHP, DOJ	California Emergency Plan 14.7
Conservation		

Action	Agency(ies) with expertise or authority (Lead-L)	Related Documents or References
Water use cut back to health and safety needs only	SWRCB(L), DWR	CEP 14.10.6, Water Code
Other		
Coordinate the movement of population out of areas without supply with local government.	BTHA (L), CHP, Cal EMA	California Emergency Plan 14.1
Adjudicate all water rights (groundwater and surface) allow uses for highest beneficial use only.	SWRCB(L), DWR	CEP 14.10.6, Water Code

Table 3 – Potential Actions by Agencies in Recovery from a Drought

Drought Indicators – Current Water Conditions throughout the State are at normal levels. No drastic water conservation measures are necessary, although water conservation should always be practiced. The state's reservoirs are full or nearly full and runoff across the state is at normal levels

Action	Agency(ies) with expertise or authority (Lead - L)	Related Documents or References
Communication/Coordination and Planning		
Identify and communicate when drought restrictions set by the State should ease or cease.	DWR (L)	
Monitoring:		
Ongoing monitoring of recovery (reservoir replenishment and longer term climate data)	DWR (L)	
Assure replenishment of reservoirs and groundwater resources.		
Monitoring of groundwater levels including municipal wells.	CDPH (L), Local agencies	
Monitoring salt-water intrusion in coastal aquifers which may have been accelerated due to drought to assure intrusion is halted or reversed.	DWR (L), Local agencies	
Facilitation of watershed and local planning for drought:		
Manage pasture, rangelands and forest recovery	CDFA (L), State Lands, CAL-FIRE	
Local Assistance		
Reduction-of-herd recovery assistance for dairy and cattle operations.	CDFA (L)	
Return emergency water supply augmentation measures to stockpile. Perform maintenance necessary for proper storage of equipment such as desalination units.	DWR (L), Appropriate other Agencies	
Provide technical assistance to districts requesting help in phasing out drought rates and returning to standard water rates.	DWR (L)	
Pasture rehabilitation - State provides assistance in form of :	CDFA (L)	
Loans and Grants		
Technical Assistance		
Actions to diminish first flush concerns (For example: sediment transport off of denuded lands due to drought and/or wildfire)	SWRCB (L), RWQCB	
Provide deferred maintenance assistance for pumps, farming equipment and other water related infrastructure.	DWR (L), CDFA	
Conservation:		
Maintain drought conservation measures	DWR (L)	

Table 4 – Conservation Actions and Water Use Reduction Targets (As of December 2009)

Agency	Location	Voluntary Conservation	Mandatory Conservation	Drought Response[(A)]
Bella Vista WD	Redding	✓		1, 3
Browns Valley ID	Browns Valley		✓	2, 4
Calaveras County WD	San Andreas	✓		1, 3, 4, 5
California American Water Company	Sacramento	✓ (10%)		1
Calleguas MWD	Thousand Oaks	✓		1
Carlsbad	Carlsbad	✓		1
Carmichael WD	Carmichael	✓		1, 4
Central Basin MWD	Commerce	✓		1, 6, 7, 8
Citrus Heights WD	Citrus Heights	✓ (5-10%)		1
City of Antioch	Antioch		✓ (15%)	2
City of Burbank	Burbank	✓		1, 3, 4, 5
City of Calistoga	Calistoga	✓		1
City of Carlsbad	Carlsbad		✓ (8%)	2, 4
City of Chino Hills	Chino Hills		✓	2
City of Cotati	Cotati	✓ (10%)		1
City of Delano	Delano		✓	2, 4
City of Escondido	Escondido	✓		1, 4
City of Folsom	City of Folsom	✓		1, 4
City of Fresno Water Division	Fresno		✓ (20%)	2, 4
City of Glendale	Glendale	✓		1, 3, 4
City of Glendora Water Division	Glendora	✓ (10%)		1, 4
City of Healdsburg	Healdsburg	✓ (20%)		1
City of Imperial Beach	Imperial Beach	✓ (10%)		1, 3, 5
City of Long Beach Water Dept	Long Beach		✓	2, 4
City of Pittsburgh	Pittsburgh		✓ (15%)	2, 3, 4, 6, 7, 8
City of Roseville	Roseville	✓ (20%)		1, 4
City of Sacramento Utilities Dept	Sacramento	✓		1, 4
City of San Diego Water Dept	San Diego	✓ (20 gal/day/person)		1, 2,3, 4, 5, 6, 7, 8
City of Santa Ana	Santa Ana	✓		1, 4
City of Santa Cruz Water Dept	Santa Cruz		✓	2, 4
City of Santa Rosa – Utilities Dept	Santa Rosa	✓ (15%)		1, 4
City of Simi Valley	Simi Valley		✓	2, 4
City of St. Helena	St. Helena	✓		1, 4
City of Stockton, Muni. Util. Distr.	Stockton	✓		1, 3, 4
City of Thousand Oaks	Thousand Oaks		✓	2, 4
City of Westminster	Westminster	✓ (10%)		1
City of Windsor	Windsor	✓ (15%)		1, 4
Coachella Valley WD	Coachella Valley	✓		1, 5, 6, 7, 8
Contra Costa WD	Concord	✓ (15%)		1, 3, 4, 6, 7, 8
Crescenta Valley WD	La Crescenta		✓	2, 4, 5
Cucamonga Valley WD	Rancho Cucamonga	✓		1, 5, 6, 7, 8
Del Paso Manor WD	Del Paso	✓		1
East Bay MUD	Oakland		✓	2, 3, 5, 6, 7, 8
Eastern MWD	Perris		✓	2, 3, 4, 5, 6, 7, 8
El Dorado ID	Placerville	✓ (15%)		1, 6, 7 ,8
Elsinore Valley MWD	Lake Elsinore	✓		1, 3, 5, 6, 7, 8
Fair Oaks WD	Fair Oaks	✓		1
Fallbrook PUD	Fallbrook		✓	2, 3, 4
Helix WD	La Mesa	✓		1, 3, 5, 6, 7, 8

Agency	Location	Voluntary Conservation	Mandatory Conservation	Drought Response[A]
Imperial ID	Imperial		✓	2
Inland Empire Utilities Agency	Chino Hills	✓		1, 4, 6, 7, 8
Kern County WA	Bakersfield		✓	2
Kings County WD	Hanford	✓		1
Las Virgenes MWD	Calabasas		✓	1, 4
Lincoln Avenue Water Co.	Altadena	✓		1
Los Angeles Co. Waterworks District	Alhambra	✓ (15-20%)		1, 4, 6, 7, 8
Los Angeles DWP	Los Angeles		✓	1, 3, 4, 5, 6, 7, 8
Marin MWD	Corte Madera	✓		1, 6, 7, 8
Metropolitan WD of Southern Cal	Los Angeles	✓		1
Monte Vista	Montclair		✓	2, 4
Moulton Niguel WD	Laguna Niguel		✓	2, 4
Municipal WD of Orange County	Fountain Valley		✓ (10%)	2
Nevada ID	Grass Valley	✓		1
North Marin WD	Novato		✓ (15%)	2, 4
Olivenhain WD	Encinitas	✓		1, 3, 4, 5, 6, 7, 8
Orange County WD	Fountain Valley	✓		1, 3, 6, 7, 8
Orangevale Water Company	Orangevale	✓ (5-10%)		1
Padre Dam MWD	Santee		✓	2, 3, 4, 5
Ramona MWD	Ramona	✓		1, 3, 4, 6, 7, 8
Rancho California WD	Temecula	✓ (10%)		1, 5, 6, 7, 8,
Redwood Valley CWD	Redwood Valley		✓ (50%)	2, 4
Regional Water Authority	Citrus Heights	✓		1
Rio Linda/Elverta Community WD	Rio Linda	✓		1
Sacramento County Water Agency	Sacramento	✓ (10%)		1
Sacramento Suburban WD	Sacramento	✓		1, 4
San Diego County Water Authority	San Diego		✓	2, 4, 6, 7, 8
San Francisco PUC	San Francisco	✓		1, 6, 7, 8
San Juan WD	Granite Bay		✓	2, 4
Santa Clara Valley WD	San Jose		✓	2, 6, 7, 8
Santa Margarita WD	Mission Viejo	✓		1
Sonoma County WA	Santa Rosa	✓		1, 6, 7, 8
Soquel Creek WD	Capitola	✓ (15%)		1, 4
Sweetwater Authority	Chula Vista	✓		1, 3, 4, 5, 6, 7, 8
Triunfo Sanitation District	Ventura	✓		1, 6, 7, 8
Vallecitos WD	San Marcos	✓ (10%)		1
Valley Center WD	Valley Center		✓	2
Ventura Co. Watershed Prot. District	Ventura		✓	2
Vista ID	Vista	✓ (10%)		1, 4
Walnut Valley WD	Walnut	✓		1, 6, 7, 8
West Basin MWD	Carson		✓	2, 3, 5, 6, 7, 8
West Valley WD	Rialto	✓		1
Western MWD	Riverside	✓		1, 4, 6, 7, 8
Westlands	Fresno		✓	2, 3, 4
Zone 7 Water Agency	Livermore	✓ (10%)		1, 6, 7, 8

Source: Compiled by DWR, Information from Association of California Water Agencies (December 2009), acwa.com
(A) Drought Response of Agencies:
1 = Urging voluntary conservation
2 = Mandatory conservation / rationing in effect
3 = Drought surcharges / rate increases
4 = Restrictions on outdoor residential water use
5 = Tiered rate structure adopted
6 = Public conservation outreach campaign
7 = Updating / adopting drought ordinance
8 = Local water emergency / water supply shortage declared

ATTACHMENT 1: Potential Roles and Responsibilities of Federal, State, and Local Agencies and Other Organizations that may be involved in Drought Management or Emergency Assistance

FEDERAL

Office of the President
Declares drought emergencies if needed, allowing areas of the State to receive financial and other assistance from the Federal Emergency Management Agency (FEMA)

Federal Emergency Management Agency (FEMA)
Provides emergency and other assistance to states, communities, and individuals suffering from the drought

National Oceanic and Atmospheric Administration / National Weather Service (NOAA)
Tracks national and regional weather conditions
Provides weather and climatological data

National Park Service
Implements conservation measures at parks where campground water supplies are expected to be limited

U.S. Geological Service (USGS)
Tracks streamflow and groundwater levels

U.S. Department of Agriculture (USDA)
Provides emergency assistance in areas designated a disaster by the Secretary of Agriculture to help agricultural producers recover from production and physical losses
Tracks agricultural financial assistance and acreage statistics

U.S. Bureau of Reclamation (USBR)
Coordinates long-term water transfers activities with DWR
Collaborates with other agencies on data collection
Coordinates with other agencies on operations

U.S. Corps of Engineers
Exercises emergency authorities for hauling water

U.S. Fish and Wildlife Service
Adapts management practices to ensure that water is used to provide the greatest benefit to migratory birds and other wildlife

U.S. Small Business Administration

Administers the economic injury loan program for small businesses adversely affected by community agricultural losses

Bureau of Land Management

Develops a flexible grazing policy in response to drought

STATE

Governor

Provides overall direction for state government drought response
Declares drought emergencies and proclamations
Issues Executive Orders to State agencies for drought response
Requests federal assistance through FEMA

Department of Water Resources (DWR)

Coordinates State agency drought management and response activities
Maintains drought data and information on website
Issues drought advisory and initiate Drought Task Force
Promotes statewide water conservation
Provides technical assistance and conduct drought workshops
Implements water transfers program
Updates periodic California drought status reports and monthly drought Bulletins
Surveys drought impacts, in cooperation with other agencies and organizations.
Advises on water issues and concerns

California Emergency Management Agency (Cal EMA)

Cal EMA Secretary may ask Governor to request a presidential declaration for unemployment assistance, food commodities, crisis counseling assistance and training, legal services and other programs.
Coordinates State agency response activities during drought emergencies
Addresses emergency management needs related to the drought
Develops the Drought Concept of Operations Plan that documents operational activities and tasks carried out by agencies.

Department of Public Health

Protects and conserves, with other agencies, the State's drinking water supply resource
Assess and respond to impacts of water shortages on public health
Collects water samples after an emergency for laboratory analysis to verify that a water supply is safe
Evaluates the adequacy of emergency interconnections among the state's public water systems

Provide technical assistance and continued financial assistance from existing resources to improve or add interconnections
Process requests for financial assistance (through Safe Drinking Water Act funding)
Monitors impacts to at-risk small public water systems
Reevaluation of required drinking water treatment as an on-going necessity to protect public health during drought
Maintains an up-to-date list of approved bottled water purveyors and water haulers
Provides health and nutrition programs for low-income women, infants, and children (WIC)

Department of General Services
Implements a water use reduction plan for state-owned and leased facilities

Department of Food and Agriculture
Monitors and assesses drought impacts on agriculture
Recommends measures to reduce the economic impacts of the drought on agriculture

Department of Boating and Waterway
Provides information on impacts to recreation
Recommends measures to reduce drought impacts on water-based recreation

Department of Social Services
Coordination and oversight of the Emergency Food Assistance Program for drought disaster victims

Department of Mental Health
Provides information on available short-term counseling for emotional or mental health problems caused by the economic impacts of the drought
Applies for and administers the FEMA Crisis Counseling Program grant for a presidentially declared disaster

Department of Community Services and Development
Provides funding for emergency food and other disaster services through its Community Services Block Grant (CSBG) Program

Labor and Workforce Development Agency
Recommends measures to address drought impacts on California's labor market
Collects information on labor impact

Employment Development Department
Provides a variety of employment services to employers and job seekers

Provides Unemployment Insurance (UI) to eligible workers who have lost jobs because of the drought
Reviews and monitors unemployment claims related to the drought

California Public Utilities Commission
Regulates the for-profit water utilities, and oversees their water conservation activities

California Conservation Corps
Coordinates monetary donations during times of disaster
Coordinates volunteer activities related to disaster response and recovery
Provides technical assistance regarding utilization of volunteers in disaster response and recovery

California Volunteers
Coordinates monetary donations during times of disaster
Coordinates volunteer activities related to disaster response and recovery
Provides technical assistance regarding utilization of volunteers in disaster response and recovery

Air Resources Board
Develops mitigation measures related to air quality impacts which may result from fallowed agricultural lands

CALFIRE
Addresses wildfire risks associated with droughts

State Water Resources Control Board
Expedites processing of water transfers during drought emergencies

CA National Guard
Assists with emergency distribution of water
Assists with deploying mobile desalinization

LOCAL

Water Agencies
Update the Urban Water Management Plans
Promote water conservation
Enforce drought response measures

County Agricultural Commissioner's Office
Provides agricultural drought impact estimates to support requests for drought designations by the USDA Secretary

Community Food Banks

Obtain and distribute food donations to those who have lost jobs or income due to the drought and water shortages

County Farm Advisors' Office - University of California Cooperative Extension Service

Provides technical advice and information to local farmers and ranchers on how to cope with the drought

County Farm Bureaus (Non-government groups)

Provides drought-related information to their members, and cooperate with State surveys of drought impacts

Resource Conservation Districts

Provides technical assistance, loans, and grants to help farmers and ranchers cope with some of the short-term and long-term consequences of droughts

Irrigation Districts

Agricultural water purveyors must efficiently distribute reduced surface water supplies, and help their members obtain supplemental water supplies. They provide technical water conservation information to their growers

County and Regional Economic Development Corporations (quasi-governmental organizations)

Cooperates in surveys of water shortage impacts and are involved in long-term planning efforts to help reduce drought impacts

OTHERS

American Red Cross

Provides emergency food, clothing, shelter, and medical assistance to needy individuals and families

Salvation Army

Provides a variety of services including help with food, household needs, clothing, and personal needs

California Utility Emergency Association (CUEA)

Provide notification and support in conservation issues to the private and municipcal providers of water

CalWORKS

Provides cash aid to eligible needy California families to help pay for housing, food, and other necessary expenses

Proteus, Inc.

Provides career counseling, training, education, and English as a Second Language (ESL) programs in Kern, Kings, Fresno and Tulare counties

United Way

Mobilizes staff, volunteer leaders, and resources for disaster response

ATTACHMENT 2: Key Federal drought relief programs

Supplemental Revenue Assistance Payment Program (SURE): SURE provides assistance to farmers who have suffered crop losses due to natural disasters including drought.

Livestock Forage Disaster Program (LFP): LFP provides assistance to livestock producers during droughts.

Tree Assistance Program (TAP): USDA intends to implement TAP in California to assist farmers and orchardists who have lost vines or trees to drought in reestablishing their orchards and vines.

Emergency Assistance for Livestock, Honey Bees and Farm Raise Fish Program (ELAP): Livestock producers, beekeepers and fish producers who suffer a loss not covered under SURE, TAP, and LFP should be able to receive assistance from this program.

Noninsured Crop Disaster Assistance Program (NAP): NAP provides coverage to farmers who grow non-insurable crops and suffer natural disasters.

Emergency Conservation Program (ECP): The ECP provides emergency funding and technical assistance for farmers and ranchers to rehabilitate farmland damages by natural disasters and for carrying out emergency water conservation measures in period of severe drought.

Emergency Farm Loans (EFL): EFL funding is contingent upon Secretarial disaster designations. Emergency loans help producers recover from production and physical losses due to drought and other natural disasters.

Environmental Quality Incentive Program (EQIP): USDA launched a special EQIP drought initiative in 2009 that provided financial assistance to drought stricken producers. The assistance allowed producers to provide temporary coverage in fallowed fields subject to severe wind erosion, to rehabilitate springs for stock water, and to undertake critical water conservation measures. The USDA is ready to develop and launch a successor EQIP program if drought persist in 2010.

ATTACHMENT 3: Droughts Concepts and Impacts in California

This article is a companion piece to the California Drought Contingency Plan, written to prepare California for recurring droughts. The 2010 Drought Contingency Plan lays out a structure for California state government to prepare for drought and reduce drought impacts, along with an extensive list of actions to take at different drought stages. The 2010 Drought Contingency Plan is part of the 2009 California Water Plan Update, and will be revised as part of Water Plan revisions, to incorporate new information the state gains as it addresses drought. This is a companion article that discusses how to improve state resilience to drought, the institutional capacity to respond to drought; the difference between drought and ongoing shortage, and the potential for using drought indices and triggers to measure drought stages.

Understanding Drought

This article discusses three concepts related to drought, then it describes the impacts of drought throughout the state in different sectors. The first concept, resilience, is brought over from the California Climate Change Adaptation Plan, and applied in detail to drought. The second concept, capacity, describes California's ability to respond to drought at the state, regional and local level; this section also points to gaps in the institutional ability to respond to drought. The last concept is an illustration of the difference between drought and shortage, to illustrate the scope of the Drought Contingency Plan and to offer a solution to the confusion that always arises on this issue.

Resilience

Resilience is a major theme of California's climate change adaptation plan and disaster mitigation plans. Building resilience will buffer the state from the effects of drought (or any disaster); a resilient state will feel the effects of drought later, will suffer less from the impacts of drought, and will recover more quickly when drought has passed. Making the state more resilient can be done by increasing the characteristics that make up resilience, such as functional redundancy, holding reserve wealth, preparedness, and diversity of function.

<u>What is Resilience?</u>

There are economic, ecological and engineering definitions of resilience, which focus on slightly different things.

"Resilience" as applied to ecosystems, or to integrated systems of people and the natural environment, has three defining characteristics:

- The amount of change the system can undergo and still retain the same controls on function and structure;
- The degree to which the system is capable of self-organization;
- The ability to build and increase the capacity for learning and adaptation (Quinlan 2003).

An engineering definition of resilience calls out four dimensions of resilience:

- Robustness—avoidance of direct and indirect losses

- Redundancy—untapped or excess capacity (e.g., inventories, suppliers)
- Resourcefulness—stabilizing measures
- Rapidity—optimizing time to return to pre-event functional levels

Pinning down an exact definition of resilience is difficult, but the broad concept is useful. The opposite of a resilient state is a brittle one, in which function collapses early and severely during a disturbance and doesn't recover.

How to make California resilient to drought

California can become more resilient to drought by planning for it, by accelerating the Resource Management Strategies in the California Water Plan that increase resiliency, and by changing policies that make the state brittle.

Planning for drought

First, California can plan for drought. Drought managers in Australia consistently tell us to plan for more extreme events, and take action sooner, during the relatively wealthy pre-drought period. The climate record informs us that we have developed our current society during a relatively wet period; climate change predictions include a future with considerably less run-off and the possibility of historical extreme events.

The joint pressures of climate change and population growth mean that state drought plans must consider and plan for the possibility of droughts happening in quick succession with other catastrophes. Successive extreme events will interact to amplify the effects of each. For example, flood can strip a floodplain of cover and habitat; a drought or fire immediately after will delay restoration of the ecosystem. Further, droughts may occur against a backdrop of ongoing scarcity. For the state, the primary way interacting effects from drought and other climate perturbations will compound each other is that costs will be higher and arrive together. The same year that drought makes water a little more expensive to our cities, it also dries our mountains and grasslands out, making fires larger and more costly to fight. The same year reduced spring runoff means that we have less hydropower, growers throughout the state will be using additional energy to pump from groundwater.

At the state level, this document is an early road-map to developing a state response to drought. Most large urban water agencies write "Shortage Contingency Plans" as part of their Urban Water Management Plans. Three additional sectors of the Californian waterscape would benefit from writing plans to address shortage. Agricultural water districts do considerable drought response; they would be more resilient to droughts if they wrote shortage contingency plans that included district modernization, pricing and cut-back policies. Small urban water districts are acutely vulnerable to drought; they are not required to write Urban Water Management Plans, but they would be well served by having a shortage contingency plan. The third sector that would be more robust if they had Shortage Contingency Plans is large water users in the commercial and industrial sector. Businesses that use more than 10 million gallons per day should write a Shortage Contingency Plan for their process water. Large industrial users are often sheltered from the risks of an unreliable water supply by their water district; they should assess for themselves the reliability of their sources and potential sources, and create plans for responding to a drought-related shortfall of the water they use.

Using Resilience as a Criteria for Implementing Resource Management Strategies
The 2009 Water Plan Update lists 27 projects, programs, or policies to help local agencies and governments manage their water and related resources. Implementing some or all of these Resource Management Strategies can bolster the qualities that make up resilience and promote drought resistance: a diversified water supply, overlapping ecosystem functions, reducing risk of shortfall from each source. Not every Resource Management Strategy bolsters resilience; some offer other benefits and reasons for implementation.

Diversifying water supply improves state and local resilience against drought, because different water sources have different risk profiles, and can be pulled into use when more vulnerable supplies fail. These Resource Management Strategies diversify water supplies:

- Recycled Municipal Water
- Desalination
- Water Transfers
- Cloud seeding (in Other Strategies)
- Groundwater Remediation/Aquifer Remediation

Stable overlapping ecosystem functions make the state more resilient to drought, because if drought interferes with one ecosystem capacity, others may take up some of the same function. For example, if a pasture has a varied plant community, plants that are more vulnerable may fail early in a drought, but others with more drought-tolerance will buffer the drought damage. These Resource Management Strategies promote ecosystem functions:

- Agricultural Lands Stewardship
- Recharge Area Protection
- Watershed Management
- Forest Management
- Ecosystem Restoration
- Flood Risk Management
- Urban Runoff Management
- Salt and Salinity Management
- Pollution Prevention

Some of the Resource Management Strategies, primarily the resource stewardship strategies, are biologically based; they'll become more complex and interlinked as they mature, yielding increasing benefits as they grow and stabilize. These strategies should be accelerated now, so they can provide more benefits sooner.

Making infrastructure more widely distributed and interconnected also increases resilience.

Reducing risk of shortfall by increasing the ability to store water supplies is another way to promote resilience, assuming that the state does not increase demand so that it is dependent on the full capacity of every supply. Similarly, although increasing water use efficiency in residential, agricultural and industrial use will be the fastest and cheapest method of extending current supplies, if the population continues to grow, eventually demand will harden. When water users have conserved as much as they can while maintaining what they consider valuable in their lifestyle, their water use is no longer flexible. Demand hardening decreases resilience if the water freed by efficiency and conservation gets put to uses the state considers mandatory. The Resource Management Strategies that buffer the state from hydrologic variability and reduce risk of shortfall are:

- Water Use Efficiency, urban and agricultural
- Conjunctive Management & Groundwater
- Surface Storage, CALFED and Regional
- Recycled Municipal Water
- Desalination
- Precipitation Enhancement

Changing Policies that Make California Brittle.
The primary direct action the state can take to prepare is to designate funds for a dry day reserve. In a study of what determines resiliency for agriculture, the researchers wrote: “[Farm] drought resilience is strengthened by the possession of liquid assets, access to credit, and the level of technical efficiency in agricultural production.” (Keil et al) This is no less true of the state, which could use that money during a drought as the liquid assets that locals could call on. The state could lend or grant for efficiency improvements, or simply to tide businesses that depend on water through until average-year hydrology returns. Just as California uses dams to move water from wet years forward into dry years, it should put away money in normal and average years to pay for the increased expenses of drought years (fire fighting, emergency response, efficiency improvements, temporary interties or other infrastructure).

Other measures would require policy decisions, but could include mandating that new developments show guaranteed water supplies for not only current average hydrology, but for a future with less run-off and more severe droughts, much as the Department of Public Health does for developments on fractured rock wells. This would preclude people becoming dependent on the average year supply.

Capacity

In this section, capacity to respond to drought means having the knowledge, tools, ability, money and authority to respond to drought. In general, California has a great deal of capacity, in delivery systems, expert staff, and legislative structures for emergency systems. Drought, like any stressor, exposes weaknesses in this capacity; those will be the topic of this section.

State:
The state has a good deal of institutional capacity and expertise to respond to drought. Many departments within the state have staff who have specialized in the factors that come into play when droughts occur (experts on fire, agriculture, economics, biodiversity, rangeland). The state is currently developing coordination efforts between its departments, primarily based in interdepartmental committees to oversee and harmonize large planning efforts, such as the Air Board's greenhouse gas reduction plan (for AB 32) and the Department of Water Resources' Water Plan (Steering Committee). The state also has experience responding to past droughts, much of which is recorded in drought reports. However, the state's institutional knowledge and experience will be diminishing in the next five years, as a large portion of the state workforce retires.

Other than the general California Emergency Plan, the state lacks a well-defined cross-departmental institutional structure for recognizing and responding to droughts. Drought response is coordinated ad hoc by a gubernatorial emergency proclamation, designating actions for state agencies and funds to address the immediate drought. The state doesn't have a standard process for recognizing a drought, nor a standing body designated to respond to droughts. Counties are the regional agencies that alleviate drought stresses on the ground, but state agencies only reimburse counties for their drought response if funds are designated in the governor's emergency proclamation.

The state's does not have funds designated for alleviating additional costs imposed by drought. Droughts increase the frequency and severity of fires, but the state does not maintain reserves for the incremental increase in firefighting costs from drought and climate change. Droughts impose localized hardships on growers and farming communities, which the state does not maintain funds to address. To date, the state has not exercised its financial capacity to proactively address drought.

Local:
Water districts span a huge range of capacity, from large water districts with hundreds of staff, extensive knowledge of their deliveries and well-developed Shortage Contingency Plans, to small rural systems intermittently run by one person, usually with considerable experience but no redundancy nor preparation for unusual events.

For large water districts, increasing capacity to respond to drought involves the efforts that many urban districts have been doing the first two years of the current drought. Many districts turned to their Shortage Contingency Plans (usually last updated in the last drought, in the early '90s) and revised them for current population and water supplies. Many cities passed water conservation ordinances, to be prepared for water rationing if it became necessary. Many realized that their water use data was insufficient to distinguish indoor and outdoor uses, and started to develop programs or calculations to determine those. Others realized they needed improved accounting and outreach tools. Bi-monthly billing creates a significant barrier to communicating with water users; by the time consumers receive their July/August bill, they've already done the bulk of their summer watering. Customers and the district have lost the ability to decrease summer water use in response to higher prices, and customers are shocked and angry at a bill much higher than expected. Districts and cities hired water efficiency staff or re-trained building inspectors to do water audits. All of these capacity improvements will serve them in good stead in the next drought.

Agricultural water districts:
Like urban districts, agricultural water districts span a wide range of capacity, from large modernized agencies to small districts with a minimum of technology and staff. Some of the larger irrigation districts are required to write water management plans, but there is no requirement that agricultural districts write shortage contingency plans. Some, like El Dorado Irrigation District and Placer County Water Agency, have undertaken sophisticated modeling efforts on their own initiative but those are the exceptions. Most agricultural districts are reacting to drought as it unfolds, based on their experience, rather than an advance planning effort.

Small rural water districts:
California also has small, rural water companies or districts with virtually no capacity to respond to drought or other emergency. Some are single-source districts on uncertain wells or rapidly dropping lakes. Some are old, handbuilt delivery systems, with literally no records, neither plans of the infrastructure nor deliveries to the water users. The very small districts are often operated by one man who relies on his extensive knowledge of the system to keep it running, but who hasn't transferred that knowledge to paper. Many small water companies are run by a volunteer board of directors, often retirees who live elsewhere but maintain a second rural residence. These companies may have a handyman or ditchtender to operate water deliveries, but no professional staff to do contingency planning. Few rural water districts maintain a reserve fund for planning and even fewer of them consider that there is sufficient taxable wealth within their service area to create large reserve funds. If a shortage contingency plan were required by the state, a director would have to take that on as an additional uncompensated task. Small rural water districts such as these have essentially no capacity for anything more than the usual daily operations.

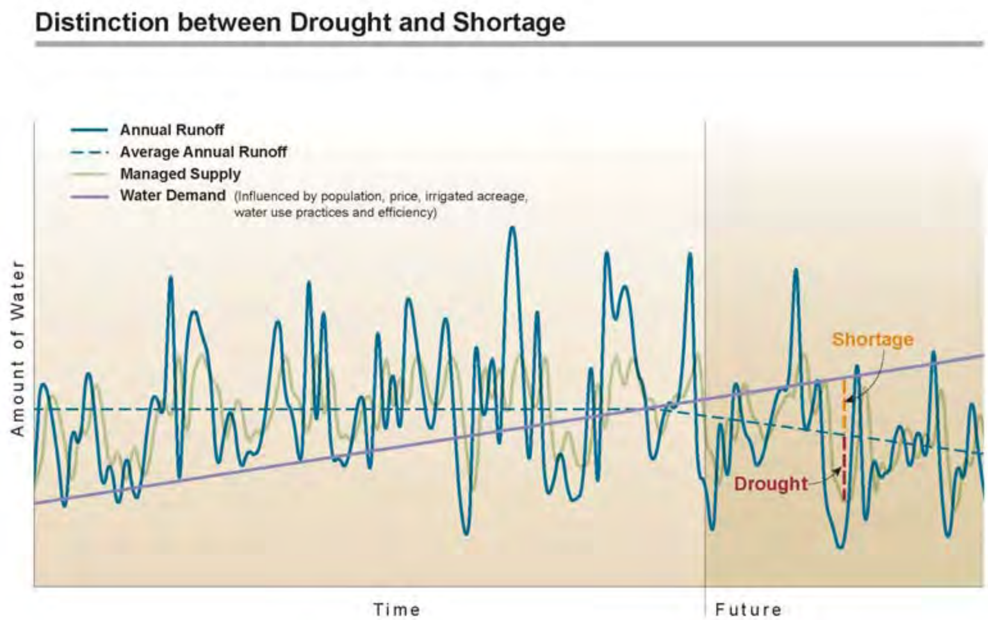
A few hundred of the roughly 4000 smaller water companies in the state face running dry in the second or third year of a drought. Their first recourse is to drill an additional well, if they have access to an aquifer, or to connect to a neighboring district, but actions like these require money, aid agreements, easements or rights of way for emergency mains, contracts and billing. These can be difficult for a volunteer board to negotiate with no professional staff. Their second recourse is their county government, which, in the current budget crisis, is likely understaffed and underfunded for emergency response. The state or county Public Health Department may have to truck in water or coordinate an evacuation. A small rural water district will be hard-pressed to compensate the country for either. Help may come from the California Rural Water Association, which can send emergency aid with planning and response, including soliciting emergency grant money. The CRWA has a few people trained to help small rural water agencies, but not enough to meet the statewide need in the second or third year of drought. When local assistance through the county has been exhausted, the state Department of Public Health can step in with additional assistance.

Individual:
Most residential water users have the capacity to reduce their water use when they turn their attention to it. Repeatedly asking urban water users to reduce their per capita water use and spreading that conserved water among new users from population growth will gradually ratchet down their ability to conserve, but for now, conservation remains the largest potential source of new urban water. Californian urban water users use from 100 to 400 gallons of water per day; Australian urban water users use about 40 gallons of water per day. Gov. Arnold Schwarzenegger has set policy with the goal of a 20% reduction in per capita water use by 2020; DWR and other state agencies are developing a plan to achieve this.

Most urban water users have the capacity to respond to drought by technology substitution and behavior change. Technology substitution, such as changing to low-water using appliances or smart irrigation timers, requires that they know of the available technologies, have the attention and time to make the substitution and that they have the money available to buy them. Behavior change, such as fixing leaks and changing washing patterns, primarily requires the individual's attention. Of the types of capacity, most urban water users need knowledge (of potential substitutes) and money to make the substitutes.

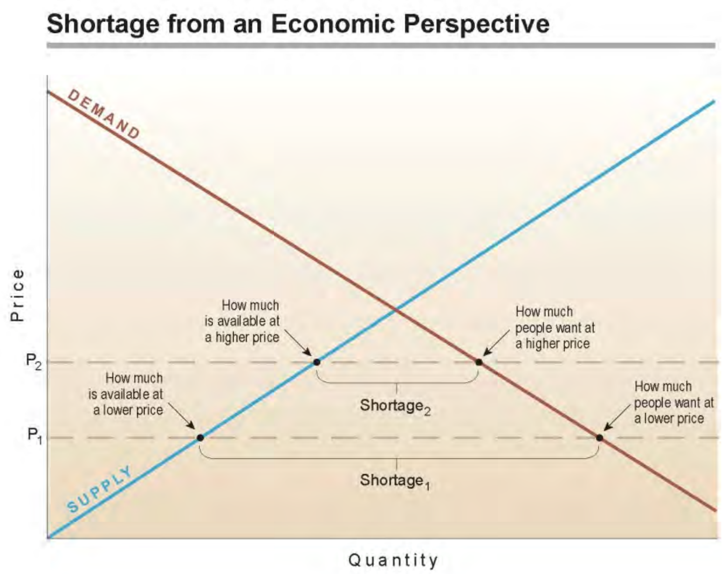
Drought, Scarcity and Shortage
Drought is a meteorological phenomenon, in which natural climate variability produces less precipitation than average within selected geographic boundaries.

Drought by itself means little. An uninhabited island receiving less precipitation than usual would not matter to most people. In practical terms, droughts matter when people have come to rely on receiving most of the water their local climate historically delivered. This is the comparison that makes a drought relevant (how much water people need, compared to supply), and is itself an unstable, normative concept.



This figure displays the difference between shortage and drought. The people of California want to use an amount of water that depends on the population, the extent of irrigated acreage, lifestyle and efficiency. If the amount of water that is available to them is less than that, they perceive a shortage. As climate change decreases the amount of run-off available to the state, and as population grows, this shortage could increase. Although some people refer to this as "permanent drought," a new-long term average precipitation cannot be a drought, which is the state of getting less precipitation than average. The Drought Contingency Plan addresses the incremental impacts from increased dryness in drought years, not ongoing shortage, which is the domain of the California Water Plan.

Economics provides another definition of the term shortage; because this economic jargon is a synonym, it can confuse the lay reader. An economic shortage occurs when people can't obtain something at the price set for it (figure 2). Demand at a low price may exceed supply; in that case, there is a shortage at that price. One solution economists suggest to decrease water shortage is to raise the price for water until demand at the higher price meets supply.



Raising the price (going from P1 to P2) does make the economic shortage smaller; Shortage1 is smaller than Shortage2. This is more of an abstraction than a solution for most water users. Decreasing the hypothetical difference between how much people want and can buy at a price doesn't solve the problem of drought for most water users. It does not increase the supply of water available to the state, nor change urban water user's experience of drought. Most water users think their demand for water is driven by physical necessities, like watering a lawn, irrigating all the acreage on a farm, or taking a shower. If higher prices force them to buy less water, they do not think "at this new price, I want less water, so even though I don't have as much water as I want to use, my economic shortage has decreased." Instead, they feel that they are paying more for less water, which is what they usually think of as a shortage.

Drought Impacts

This section lays out drought impacts in several sectors of the Californian whole. Looking at drought impacts suggests potential state responses.

<u>Public Health</u>

Drinking water

Small water systems have historically experienced the bulk of health and safety impacts, as well as the majority of water shortage emergencies— regardless of water year type. Although small systems serve a low percentage of California's total population, they constitute the majority of the state's public water systems. Small systems tend to be located outside the state's major metropolitan areas, often in lightly populated rural areas where opportunities for interconnections with another system or water transfers are nonexistent. Small systems also have limited financial resources and rate bases that constrain their ability to undertake major capital improvements. Most small system drought problems stem from dependence on an unreliable water source, commonly groundwater in fractured rock systems or in small coastal terrace groundwater basins. Historically, particularly at-risk geographic areas have been foothills of the Sierra Nevada and Coast Range and inland Southern California, and the North and Central Coast regions.

Risks to public health that Californians may face from drought include impacts on water supply and quality, food production (both agricultural and commercial fisheries), and risks of waterborne illness. As the amount of surface water supplies are reduced as a result of drought, the amount of groundwater pumping is expected to increase to make up for the water shortfall.

The increase in groundwater pumping has the potential to lower the water tables and cause land subsidence. Communities that utilize well water will be adversely effected both by drops in water tables or through changes in water quality. Groundwater supplies have higher levels of total dissolved solids compared to surface waters. This introduces a set of effects for consumers, such as repair and maintenance costs associated with mineral deposits in water heaters and other plumbing fixtures, and on public water system infrastructure designed for lower salinity surface water supplies. Drought may also lead to increased concentration of contaminants in drinking water supplies.

Respiratory diseases
Short-term effects of air pollution include irritation to the eyes, nose and throat, as well as increased incidence of upper respiratory inflammation. In addition, short-term air pollution tends to aggravate the medical conditions of individuals with asthma and emphysema. Similar to heat waves, public health impacts from particulate matter are highest among the elderly, followed by infants and young children.
Recent evidence shows that ozone and particulate matter exposures can initiate cardiovascular and lung disease resulting in increased overall mortality. An increase of ground-level (tropospheric) ozone can cause decreases in lung function and increase airway reactivity and inflammation. Particulate matter can aggravate existing respiratory and cardiovascular disease and damage the lungs, leading to premature death; it may also contribute to increased risk of cancer. According to the California Air Resources Board (CARB), current exposures to just two common air pollutants – ozone and particulate matter (PM) cause around 8,800 deaths, 9,500 hospitalizations, 200,000 cases of asthma and lower respiratory symptoms, and nearly 5 million school absences in California each year.

Drought also results in increased frequency and duration of wildfires; another significant risk to public health. Wildfire frequency and intensity is expected to grow as temperatures increase and vegetation dries due to longer dry seasons. In addition to the associated direct risk of fatalities, wildfires can lead to immediate and long-term adverse public health problems due to exposure to smoke. Smoke from wildfires is a mixture of carbon dioxide, water vapor, carbon monoxide, hydrocarbons and other organic chemicals, nitrogen oxides, trace metals, and fine particulate matter from burning trees, plants, and built structures. During wildfires, large populations can be exposed to a complex mixture of pollutant gases and particles, which can have both acute and chronic health impacts. Smoke can irritate the eyes, harm the respiratory system, and worsen chronic heart and lung diseases, including asthma. People with existing cardiopulmonary diseases are generally at the greatest risk from smoke inhalation, with age being a complicating risk factor for the exposed population.

Changes in temperature and precipitation are likely to cause changes both in the geographic distribution and the quantity of vectors (such as ticks and mosquitoes) that carry human disease. In California, three vector-borne diseases are of particular concern: human hantavirus cardiopulmonary syndrome, Lyme disease, and West Nile virus. These diseases vary in their response to climate-related factors such as temperature, humidity, and rainfall. The distribution of vectors may change as humid areas become drier and less suitable habitats, while other areas may become wetter, allowing for the vectors to exist where they previously did not. Abundance of small mammal reservoirs may similarly be affected.

Social and mental health
Health inequities: Declines in crop yields and fisheries may contribute to substantial increases in food prices, which would disproportionately impact low income communities who already spend a higher percentage of their income on food. Reduced agricultural employment will impact low income farm workers and their families.

Biodiversity and Habitat

California is one of the most biologically diverse regions of the world and its vast array of species and habitats make it one of the 25 biodiversity "hotspots" on earth. Hot spots are areas where at least 1,500 species of vascular plants (> 0.5% of the world's total) are endemics and where at least 70% of the original habitat has been lost. Of all 50 states, California has the most unique plant and animal species, as well as the greatest number of endangered species. The state's extensive biodiversity stems from its varied climate and assorted landscapes which have resulted in numerous habitats here species have evolved and adapted over time. The state's ecological communities include coastal mountain ranges, coastal dunes, wetlands, rivers, lakes, streams, deserts, grasslands, chaparral, and inland forested mountains among others. The vast number of endemic species found in California, combined with the high level of threats to their persistence, makes California a 'hotspot' for biodiversity.

California is one of only five regions in the world with a Mediterranean climate. Habitats in these climatic regions are considered to be more threatened by climate change than tropical forests, since over 40% of these lands worldwide have been converted to other uses and less than 5% are protected worldwide. According to some estimates, more than 20% of the naturally occurring species of amphibians, reptiles, birds, and mammals in California are classified as either endangered, threatened, or "of special concern" to state and federal agencies. Therefore, the preservation of California’s unique biological heritage is of ever-increasing importance given the forecasted impacts associated with drought and climate change.

The economy and the natural resources that sustain human life are dependent upon the state’s biodiversity. These species and ecosystems provide numerous goods and services, including provisioning services (e.g., food and timber production, medicines, water and fuels), regulating services (e.g., water purification and carbon sequestration), supporting services (e.g., climate regulation and nutrient cycling) and cultural services (e.g., aesthetic values, and sense of place). Not only do these goods and services support California’s economy but they support numerous recreational activities for residents.

Disturbance events or extreme weather events thought to increase due to climate change generally benefit invasive species given their tolerance to a wide range of environmental conditions. Invasive species often have greater flexibility and can survive under variable and extreme conditions, such as flood events or drought.

Biodiversity in natural ecosystems and working landscapes supports a wide range of ecosystem services that sustain human well-being and the economy of California. Ecosystem services are simply defined as the benefits people obtain from ecosystems. These include carbon sequestration, forage production, timber production, water storage and filtration, crop pollination, soil fertility, fish and game habitat, tourism, recreation and aesthetic values. Ecosystem services can be categorized as provisioning services (food, water, timber, and fiber), regulating services (the regulation of climate, floods, disease, wastes, and water quality), and cultural services such as recreation, aesthetic enjoyment, and spiritual fulfillment; and supporting services such as soil formation, photosynthesis, and nutrient cycling (Millennium Ecosystem Assessment 2005). Warming, changes in precipitation and increases in extreme events (drought, storms, heat waves, etc.) are expected to alter many ecosystem services, due to impacts on biodiversity and on the structure and functioning of ecosystems. Changes in the geographic distribution of individual species and major habitats will alter the distribution of ecosystem services across the state. For example, potential conversion of conifer forest to evergreen woodlands, forecast for regions of the Sierra Nevada and northern Coast Ranges, would reduce and redistribute timber production. Reduced snowpack, changes in water flows, expansion of reservoirs, and warmer water temperatures will impact freshwater ecosystems, with likely negative effects on many native species. Conflicts between human water uses and management of game and non-game fish populations are expected to increase under future climates.

Streams
Flowing water is important because it moves organic material and energy. This movement facilitates the exchange of nutrients between aquatic and terrestrial areas. In terrestrial areas, aquatically derived nutrients help support vegetation and wildlife. Emerging aquatic insects are prey for birds and bats foraging and breeding in riparian areas. Equally important, flowing water moves terrestrial organisms and detritus, which play an important role in aquatic food webs.

As a result of a decrease in snow pack and earlier snowmelt, stream flows are expected to be lower during the summer months and extending into the fall. In addition, reduced stream water depth and higher air temperatures will increase stream water temperatures, to levels that are potentially unhealthy for coldwater fish. Salmonids are temperature-sensitive and rely on precipitation and snow melt. The projected changes in inland water temperatures with changing seasonal flows is projected to place additional stress on these species, contributing to the need for increased resources for monitoring and restoration efforts. It is common for adult fish migrating to spawning grounds to encounter obstacles that require high flow conditions in order to pass. When drought results in reduced stream flows this could impede or halt their progress. A delay in the arrival to spawning grounds may decrease reproductive success and increase fish mortality. Repeated low stream flows during spawning migration periods may naturally select against large adult body sizes.

The projected changes in temperature and precipitation patterns will also affect the distribution and longevity of available surface water. Changes in the composition and structure of riparian communities may result from changes in precipitation and flow and could contribute to increased management conflicts as the needs of humans and wildlife compete for limited resources. Changes in temperature and precipitation associated with climate change may lead to less stored water and will have a direct effect on the survival of aquatic species and the preservation of wetland habitats.

Prolonged periods of drought can make ecosystems vulnerable to pests, non-native species invasions and frequent and intense wildfires. Moreover, reduced rainfall and snowmelt will lead to less water infiltrating the soil, stressing plants and animals. This reduced infiltration rate will also diminish groundwater recharge. Lowered levels of groundwater, combined in coastal areas with saltwater intrusion, will exacerbate dry conditions and further stress species and habitats. As an example, likely reductions in precipitation and higher variability in precipitation, both within and among years are likely to reduce survival of young seedlings, which are particularly susceptible to drought stress and has serious implications for the ability of ecosystems to recover from disturbance both natural and by active restoration (See also Forestry sector). Together, all these changes in water availability can cause landscape transformations as conditions select for species that require less water

Information on specific fishery impacts – such as fish kills or fish stranding -- directly attributable to present dry conditions is sparse and anecdotal. Impacts specifically drought-related have been reported for the Russian River system, where several fish kills in spring 2008 and 2009 that included Endangered Species Act listed species (coho salmon and steelhead) occurred, attributed to wine grape growers' water use for grapevine frost protection. The National Marin Fisheries Service formed a frost protection task force in 2008, and in February 2009 requested emergency regulations from the State Water Control Board (SWRCB). SWRCB held an informational workshop in April 2009 on water use for frost protection; follow-up action will be determined.

Drought is more commonly an additional stressor for fish populations that may already be experiencing long-term declines for multiple reasons including loss of habitat, competition from introduced species, and water quality degradation. In 2008 and 2009, for example, the Pacific Fishery Management Council banned commercial salmon fishing off the coast of California, in reaction to depleted salmon stocks attributed primarily to unfavorable ocean temperature and food availability conditions. Similarly, the status of, and factors affecting, declines in fish populations migrating through or resident in the Delta are being extensively discussed in several forums; review of the this subject is beyond the limited scope of this document.

Central Valley state and federal wildlife refuges included in the Central Valley Project Improvement Act (CVPIA) have received full supplies (100% of so-called Level 2 refuge supplies, the water dedicated from CVP yield for refuges) from the CVP in 2007-2009. CVPIA further directed USBR to purchase additional supplemental water for wildlife refuges (so-called Level 4 refuge supplies). It is presently too soon to determine how much Level 4 refuge water USBR will be able to acquire in 2009; this information will be included in the end-of-year update of this report. If no Level 4 refuge water supplies were purchased, full Level 2 supplies would represent about 71% of the amount of water USBR believes is needed pursuant to CVPIA.

Recreation

Recreation Impacts of the present drought on recreation are not readily discernable at the statewide level, especially when considering the confounding impacts of current economic conditions and recent high gasoline prices. (Poor economic conditions may actually increase attendance at local facilities such as reservoirs, when people choose to curtail longer trips in favor of nearby recreational destinations.) Recreational sectors that may be impacted by drought include ski resorts, reservoir-based activities, and river-based activities (e.g. rafting). Some recreational facilities within these sectors are able to take adaptive measures such as snowmaking, relocating floating boat docks, extending boat ramps, or changing rafting locations to mitigate drought impacts.

Drought impacts on water-based recreation are highly localized, depending not only upon the adaptive capacity of recreational facilities, but also upon the magnitude of site-specific impacts. Taking reservoir-based recreation as an example, only some of the Sierran reservoirs popular with boaters have experienced significantly lower water elevations. At sites such as USBR's Folsom Lake -- where low water levels forced restrictions on boat operations and early curtailment of marina operations in 2007 and 2008 -- the reservoir's proximity to a major urban area still results in high levels of visitor usage for other activities at the site. Many factors influence attendance at these facilities, but drought does not stand out as a causative factor.

Agriculture

The agricultural sector clearly demonstrates the site-specific nature of drought impacts. Agricultural drought impacts are normally felt earliest by those relying on unmanaged water supplies – entities carrying out dryland grazing and non-irrigated crop production (usually grain crops). Impacts to irrigated agriculture depend on the source and nature of the irrigation water supply – local groundwater, local surface water, or imported surface water – and any water rights or contractual provisions that may be associated with the source. The extent to which producers may mitigate water shortage impacts depends on multiple factors, but is heavily influenced by economic considerations. Factors involved in making decisions about mitigating irrigation water shortages include availability and costs of pumping groundwater, price of alternative surface water sources, capital investments associated with maintaining permanent plantings, and status of international crop markets.

Impacts of drought on dryland grazing are difficult to capture well, due to the absence of standardized metrics that provide comparable information across differing agency jurisdictions (e.g. county agricultural commissioners, U.S. Forest Service, U.S. Bureau of Land Management) and industry programs. The California State Office of the U.S. Bureau of Land Management estimates that animal unit months (an indirect measure of forage) on lands under its jurisdiction dropped about 8% from 2006 to 2008, although drought may be only one of several reasons for the decline. (Current economic conditions, for example, could result in permittees stocking less than the maximum number of allowed livestock.) Indirect information on drought impacts to rangeland may be inferred from county-level requests for U.S. Department of Agriculture disaster declarations used to authorize provision of financial assistance; however, many counties are presently still in the process of compiling 2009 impact information for consideration by USDA. A table of county-level disaster declarations and estimated damages will be included in the year-end update of this report, by which time information on designations made in response to spring and summer conditions will be available

Westlands Water District and other CVP contractors on the west side of the San Joaquin Valley were hit disproportionately hard by the 2007-2009 Drought. They are junior water rights holders, heavily-dependent on imported supplies. In 2009, Westlands WD fallowed more than 156,000 acres of their roughly 570,000 farmed acres, and their farmers were unable to harvest more than 41,000 planted acres. Westlands growers fallowed an average of about 69,000 acres each year during the 2000-06 period. During that period they never failed to harvest more than 2,000 acres in a year.

Preliminary and later forecasts of the jobs that would be lost in the San Joaquin Valley due to the water shortages ranged from about 2,000 jobs lost to about 21,000 jobs lost. A September 2010 study of the economic impacts of the 2009 San Joaquin Valley water supply cuts produced estimates of total employment lost due to the direct plus indirect plus induced effects of the water cuts that ranged from 5,567 jobs to 7,434 jobs.(Reference 7). Estimates of total lost regional economic output in 2009 (both direct and indirect, and induced) ranged from about $586 million to $796 million. The authors of the September 2010 report conclude, "… a significant increase in the amount of water transfers was critically important to reducing the negative impacts of water scarcity."

The water shortages, combined with the housing market crash and recession, has added to the poverty in the communities on the west side of the San Joaquin Valley. The cattle industry likewise suffered from having to buy feed in this drought. Low milk prices from the recession combined with the cost of buying additional food to supplement low pasture yields is forcing dairy farmers out of business. Dairy farmers are selling or slaughtering their herds, with plans to slaughter approximately one hundred thousand head of cattle (to constrict the milk supply and raise prices). The flip side of the dairy industry's hardship is that fodder prices hit record highs in 2008 for corn, alfalfa and hay, in an example of drought creating wealth for California growers.

Forestry and Fire

The effects of a prolonged drought on forests will depend on the species present, their life stages, soil texture and depth, and the duration and severity of the drought. A lack of consistently available moisture can impact forest health, although some regions and forest types will be impacted more than others. For example, declines in precipitation may have significant impact on those inland forests that are drier as compared to coastal forests which receive moisture through coastal fog. Climate change may, however, also result in decreased fog regimes.

In the short-term, forest trees will respond to increased drought by limiting growth and reducing water use. While adult trees, with their deeper root system and stored nutrients and carbohydrates, will be able to survive short-term droughts, new seedlings and saplings may be unable to establish. Under prolonged drought trees and shrubs may weaken and become more susceptible to pests, disease and wildfires, and some plant communities may be more vulnerable to invasive species. Reforestation success may be improved by management practices that use more drought tolerant species or genotypes, by changes in stocking, and other silvicultural practices.

Wildlands and Urban Interfaces - Wildfires

Forest and other wildlands in California are strongly affected by drought. Due to either acute short-term or prolonged long-term drought, the potential for catastrophic wildfires to occur increases dramatically. Vegetation moisture decreases; moisture content decreases in live fuels (grasses, brush...); increases fire risk, can intensify wildfire behavior, and prolong the fire season. In recent years, California has experienced an increase of catastrophic wildfires due to drought occurring throughout the state. The resulting impacts from these fires have had a devastating effect on the California economy and environment, while causing great stress to the communities involved due to loss of life and property damages.

Damages associated with wildfires and loss of timber resources can be one of the largest economic impacts of drought. California faces an increasing risk of damages from wildfires as urban development encroaches on the urban/wildland interface. A joint position adopted by the League of California Cities and the California State Association of Counties following Southern California's devastating wildfires in 2003 notes that: "Catastrophic wildfires are one of the most significant threats to communities, forests, and wildlands in California today" (LCC, CSAC 2004). The devastating Southern California wildfires of 2003 -- reported to be the then-costliest in U.S. history, and which followed a multiyear regional drought in Southern California – were mirrored in October 2007, when a combination of dry vegetation and Santa Ana winds created conditions favorable for another massive outbreak of fires in Southern California. Earlier that same year, dry conditions in Northern California had facilitated the spread of another damaging fire -- the Angora Fire near Lake Tahoe, estimated by CAL FIRE to entail more than $11 million in fire fighting costs. Costs of fighting the May 2009 Jesusita Fire in the Santa Barbara area were at least $20M.

Dry conditions, combined with warmer than average annual temperatures over much of the past decade, are leading to a almost year-round wildfire risk in Southern California.

Infrastructure and Energy

Water and energy are closely linked in California; drought makes energy scarcer, creates new energy demands, and heightens the need for conservation of both water and energy. Drought decreases runoff in mountain streams, and correspondingly decreases the potential for generating hydropower. Hydropower is an important component of California's electricity system, representing about 27% of the state's total installed generation capacity. Actual hydropower generation, however, varies greatly in response to hydrologic factors. Between 1990 and 2000, hydropower actually contributed from 9% to 25% of the in-state supply, as a result of annual variations in runoff. In 2001, a drought year, hydropower represented only 10% of the total in-state generation. Over an 18-year period between 1983 and 2001, hydropower represented just over 15% of electricity used within the state, including imports.

The ability to dispatch hydropower on short notice is perhaps an even greater benefit to the state's electrical system than its contribution to the state's overall installed capacity. Unlike many other generation sectors, hydropower units can start up and meet capacity load in a matter of minutes, as well as provide spinning reserve to meet transmission line voltage requirements. Although drought years reduce overall hydropower production, hydropower continues to play an important role in helping the state meet peak demand. Hydropower also contributes to the state's electricity system by providing low-cost energy. Many hydropower facilities in the state produce electricity at less than 2 cents per kilowatt-hour (kWh).

As drought reduces the amount of hydropower to the state, the state will shift production to power plants, which require water for cooling. This increases demand for scarce water. Further, in drought years, growers and municipalities pump more groundwater, creating additional energy demands. Regions that supplement their water portfolios by treating and re-using wastewater or by desalination will also create new energy demand.

Ground subsidence causes other major effects on infrastructure. As people pull water out of aquifers to replace surface water that can't be delivered during drought, the ground settles enough to damage or crack buildings, aqueducts, well casings, bridges, and highway overpasses. In the current drought, subsidence-related cracking in the Delta-Mendota Canal has been reported. Other infrastructure in the same area, such as Highway 5, may be damaged from subsidence caused by groundwater pumping.

Although coastal areas don't experience subsidence, coastal aquifers may suffer increased saltwater intrusion if overlying users pump additional freshwater in drought years.

Drought Indices and Triggers

Indicators are variables which describe drought (examples - precipitation, stream flow, groundwater, reservoir levels, soil moisture, etc.). An index is a bundle of important indicators, combined into one value for ease of use. Triggers are defined as specific values of an index that initiate and terminate each drought status level, and suggested management responses. Below we discuss the types of drought indicators and outline a procedure which could be undertaken to develop indices and triggers for each region in California.

Types of Drought Indicators

Ultimately, drought of any type can be traced to the sole natural moisture input of the hydrologic cycle - precipitation. Likewise, a good measure of the overriding natural removal of water from a hydrologic system is the potential for evaporation, for which the surrogate of air temperature is most often used. Fortunately for drought monitoring, air temperature and precipitation are the two most commonly measured climatic variables. Often these two parameters are combined to produce relative measures of drought. Other indicators that are commonly used to monitor drought include: snowpack, reservoir elevations and current storage, soil moisture, stream flow, groundwater levels, fire and fuel load, and information obtained through observations from local conditions of soil moisture, vegetation and forage, stock ponds, and wildlife habitat.

California has extensive historical data for some of these indicators, especially indicators based on our managed water delivery system (reservoir conditions, streamflows at gaging stations). However, the state hasn't assembled the indicators into indices that provide a consistent and measure of the extent of drought. Further, a single drought index for the state could well disguise different degrees of drought throughout California. California is a large state; regions may experience very different levels of drought in the same event. For these reasons the State should determine whether and how to assemble indicators into indices for the regions of California.

If California develops drought indices, the index can have threshold triggers to indicate the extent of the drought, from mild to extreme. Crossing the thresholds for the triggers indicates that it is time to initiate the additional drought responses listed in the Drought Action tables of the 2010 Drought Contingency plan.

ATTACHMENT 4: Cal EMA Drought Brochure

TAX ADVICE AND ASSISTANCE

Employment Tax Requests for Extension to Report and Pay:
Employers statewide directly impacted by the recent drought disaster may request an extension of up to 60 days to file their state payroll reports and to deposit state payroll taxes with EDD, without penalty or interest. For further information, call EDD's Taxpayer Assistance Center at 1-888-745-3886 or visit EDD's website at: www.edd.ca.gov

EMERGENCY NEEDS REFERRAL

The American Red Cross:
The American Red Cross (ARC) provides emergency food, clothing, shelter, and medical assistance to needy individuals and families. Contact the ARC at 1-866-GETINFO (438-4636).

The Salvation Army:
The Salvation Army provides a variety of services including help with food, household needs, clothing and personal needs. For more information call 1-800-SALARMY (725-2769) or visit the website at: www.tsatoday.org

Department of Community Services & Development:
The Department of Community Services & Development (CSD) provides funding to more than 100 local community organizations that offer assistance with clothing, motel vouchers, blankets, shelters, energy assistance and emergency food. For more information, contact 916-341-4200. For information on the Home Energy Assistance Program (HEAP), call 1-866-675-6623.

PROGRAMS FOR FARMERS, RANCHERS AND OTHER BUSINESSES

U.S. Department of Agriculture, Farm Service Agency:
The U.S. Department of Agriculture's (USDA) Farm Service Agency (FSA) provides emergency loans in areas designated a disaster by the Secretary of Agriculture to help producers recover from production and physical losses. Contact the FSA office listed in your local telephone directory, or visit FSA's website at: www.fsa.usda.gov

U.S. Small Business Administration, Economic Injury Disaster Loans:
Economic Injury Disaster Loans (EIDLs) are low-interest working capital loans to help small businesses, small agricultural cooperatives and certain private, non-profit organizations of all sizes meet their ordinary and necessary financial obligations that cannot be met as a direct result of a disaster, such as a drought. These loans are intended to assist through the disaster recovery period. The U.S. Small Business Administration (SBA) makes EIDLs available after a drought when the U.S. Secretary of Agriculture designates an agricultural disaster. Businesses primarily engaged in farming or ranching are not eligible for SBA disaster assistance; however, in drought disasters nurseries are eligible. Eligible businesses may qualify for working capital loans of up to $2 million to help meet financial obligations and operating expenses which could have been met had the adverse weather condition not occurred. For more information call SBA toll-free at 1-800-659-2955, or visit SBA's website at: www.sba.gov/services/disasterassistance Hearing impaired individuals may call 1-800-877-8339.

(For individuals who are deaf, hard of hearing, or speech-disabled, please call the California Relay Service at 711 and ask to be put in touch with the California Emergency Management Agency at 916-845-8400.)

If you have been affected by the recent Drought, here is some information that may be helpful

This publication distributed by:
California Emergency Management Agency (Cal EMA)
www.calema.ca.gov

03/20/09

ASSISTANCE PROGRAMS

Food Assistance:
California Emergency Food Assistance Program (EFAP) provides federal commodities to 50 food banks with over 2300 distribution sites statewide. Food is then distributed to individuals that meet income eligibility requirements. For locating a distribution site serving your area call 1-800-283-9000, or visit the website at: www.cdss.ca.gov/cdssweb/PG55.htm

Supplemental Nutrition Assistance Program:
If you have been affected by the drought and are in need of food assistance due to a loss of income, you can apply for benefits through the Food Stamp Program from your local county welfare/social services office. For more information visit the website at: www.cdss.ca.gov/foodstamps/

CalWORKs:
CalWORKs provides cash aid to eligible needy California families to help pay for housing, food, and other necessary expenses. For information contact your local county welfare/social services department. To find your local office visit the website at: http://www.cwda.org/links/chsa.php or for more information on this program, visit the cash aid website at: http://www.dss.cahwnet.gov/cdssweb/PG54.htm

Women, Infants, and Children Supplemental Nutrition Program:
The Woman, Infants, and Children (WIC) program helps low-to-moderate-income pregnant women, new mothers and their babies and young children to eat well and stay healthy. WIC provides:

- Special checks to buy healthy foods such as milk, juice, eggs, cheese; and starting in October 2009--fruits, vegetables, baby foods and whole grains;
- Information about nutrition and health;
- Breastfeeding support and referrals to health care and community services.

For more information, visit the website at: http://www.cdph.ca.gov/programs/wicworks/Pages/default.aspx and click on "Find a Local WIC Agency" under Program Information.

Migrant Education Program:
The Migrant Education Program (MEP) provides supplementary education and support services to identified migrant children and youth, ages 3-21, to help them meet the state's academic content standards and to help them graduate from high school. For regional contact information, call 916-319-0851 or visit the website at: www.cde.ca.gov/sp/me/mt/

Local Utility Companies:
Many local utility companies have programs to assist eligible low-income households pay their energy bills or prevent service from being shut off during winter and during heat emergencies. Contact your local utility providers for available services.

Services for Seniors:
The California Department of Aging contracts with and provides leadership and direction to Area Agencies on Aging (AAA) that coordinate a wide array of services to seniors and adults with disabilities. You can locate an AAA in your area by calling 1-800-510-2020 or visit the website at: http://www.aging.ca.gov/local_aaa/AAA_listing.asp

The Senior Farmers' Market Nutrition Program (SFMNP) provides low-income seniors with coupon books used to purchase fresh fruits, vegetables, herbs and honey at Certified Farmers' Markets (CFM). The program begins in May and runs through November. The California Department of Food and Agriculture (CDFA) partners with California's AAA to distribute the coupon books. For more information contact 916-657-3231 or e-mail grants@cdfa.ca.gov

HEALTH CARE SERVICES

Access for Infants and Mothers Program:
The Access for Infants and Mothers (AIM) program provides low-cost health insurance coverage to uninsured middle-income pregnant women. For a copy of the AIM Handbook and application, please call 1-800-433-2611, or visit the website at: www.AIM.ca.gov

Healthy Families Program:
The Healthy Families Program (HFP) provides low-cost comprehensive health, dental and vision coverage to uninsured children and teens whose family income is too high to qualify for Medi-Cal. For a copy of the HFP Handbook & application, please call toll free 1-800-880-5305 or visit the website at: http://www.healthyfamilies.ca.gov

Medi-Cal Health Coverage:
Medi-Cal is a public health insurance program that provides comprehensive medical, dental and vision care coverage to low-income individuals, including families with children, seniors, persons with disabilities, pregnant women and low-income people with specific diseases, such as tuberculosis, breast cancer or HIV/AIDS. For more information, contact your county welfare/social services department.

Local, Maternal, Child, and Adolescent Health Program
The Maternal, Child, and Adolescent Health (MCAH) program helps low-income, uninsured, and underinsured families access health care services to address a broad range of public health problems. For more information on services visit the website at: www.cdph.ca.gov/programs/mcah
To access a list of local MCAH Department call 1-866-241-0395 or visit the website at: http://www.cdph.ca.gov/programs/mcah/Pages/MCAHDirectorsandLocalTollFreeNumbers.aspx

Crisis Counseling:
Short-term counseling may be available for emotional or mental health problems caused by the economic impacts of the drought. For more information, visit www.dmh.ca.gov

Health Information:
For information on health concerns related to the drought, please visit the California Department of Public Health website: http://www.bepreparedcalifornia.ca.gov

EMPLOYMENT SERVICES

Unemployment Insurance:
Workers who have lost their jobs because of the drought may be eligible for Unemployment Insurance (UI). The quickest and easiest way to apply is online. Visit Employment Development Department's (EDD) website at: www.edd.ca.gov Click on the "Unemployment" link, then on "Apply Online" (eApply4UI) at the top right of the page.

UI claims also can be filed by telephone at 1-800-300-5616. (For Spanish, call 1-800-326-8937 For TTY, call 1-800-815-9387.) UI benefits are provided to workers who are unemployed due to no fault of their own, or working less than full time, have a legal right to work in the U.S., and are ready, willing, and able to work.

Job Services:
Job seekers and employers will find a wide variety of employment services offered by EDD and local partners at One-Stop Career Centers and EDD Workforce Services Offices throughout the state. Using these job search and training services, job seekers with a legal right to work in the U.S. can connect with thousands of available jobs through the automated system CalJOBS. For more information, visit EDD's website at: www.edd.ca.gov

ATTACHMENT 5 - 2008 Executive Order and Emergency Drought Proclamation

Office of the Governor ARNOLD SCHWARZENEGGER THE PEOPLE'S GOVERNOR

EXECUTIVE ORDER S-06-08

06/04/2008

WHEREAS Statewide rainfall has been below normal in 2007 and 2008, with many Southern California communities receiving only 20 percent of normal rainfall in 2007, and Northern California this year experiencing the driest spring on record with most communities receiving less than 20 percent of normal rainfall from March through May; and

WHEREAS California is experiencing critically dry water conditions in the Sacramento and San Joaquin River basins and the statewide runoff forecast for 2008 is estimated to be 41 percent below average; and

WHEREAS water storage in many of the state's major reservoirs is far below normal including Lake Oroville, which supplies the State Water Project, at 50 percent of capacity, Lake Shasta at 61 percent of capacity and Folsom Lake at 63 percent of capacity; and

WHEREAS the Colorado River Basin has just experienced a record eight-year drought resulting in current reservoir storage throughout the river system reduced to just over 50 percent of total storage capacity; and

WHEREAS climate change will increasingly impact California's hydrology and is expected to reduce snowpack, alter the timing of runoff and increase the intensity and frequency of droughts in the western United States; and

WHEREAS diversions from the Sacramento-San Joaquin River Delta for the State Water Project (SWP) and federal Central Valley Project (CVP) are being greatly restricted due to various factors including federal court actions to protect fish species, resulting in estimated SWP deliveries of only 35 percent, and CVP deliveries of only 40 percent, of local agencies' requested amounts for 2008; and

WHEREAS dry conditions have created a situation of extreme fire danger in California, and these conditions resulted in devastating fires last year, resulting in proclamations of emergency for the counties of El Dorado, Los Angeles, Orange, Ventura, Santa Barbara, Riverside, San Bernardino, Santa Clara, Santa Cruz and San Diego, with wildfires there causing millions of dollars in damages; and

WHEREAS on May 9, 2008, I signed an Executive Order directing various agencies and departments within my administration to respond to these dry conditions and prepare for another potentially severe wildfire season; and

WHEREAS the current drought conditions are harming urban and rural economies, and the state's overall economic prosperity; and

WHEREAS some communities are restricting new development and mandating water conservation and rationing, and some farmers have idled permanent crops and are not planting seasonal crops this year, because of unreliable or uncertain water supplies; and

WHEREAS recent supply reductions have jeopardized agricultural production in the San Joaquin Valley; an

WHEREAS it is not possible to predict the duration of present drought conditions; and

WHEREAS while communities throughout the state have worked to significantly improve their drought preparedness, the readiness to cope with current and future drought conditions varies widely; and

WHEREAS immediate water conservation measures are needed this year to address current conditions and prepare for a dry 2009; and

WHEREAS the State of California is committed to enhancing drought response and drought preparedness and to protecting the state's economy and its environment.

NOW, THEREFORE, I, ARNOLD SCHWARZENEGGER, Governor of the State of California, do hereby proclaim a condition of statewide drought, and in accordance with the authority vested in me by the Constitution and statutes of the State of California, do hereby issue the following orders to become effective immediately.

IT IS HEREBY ORDERED that the Department of Water Resources (DWR) shall take immediate action to address the serious drought conditions and water delivery limitations that currently exist in California, and that are anticipated in the future, by taking the following actions:

1. Expedite existing grant programs for local water districts and agencies for new or ongoing water conservation and water use reduction programs and projects that are capable of timely implementation to ease drought conditions in 2008 or 2009.
2. Facilitate water transfers in 2008 to timely respond to potential emergency water shortages and water quality degradation, and prepare to operate a dry year water purchasing program in 2009.
3. In cooperation with local water agencies and other water-related organizations, conduct an aggressive water conservation and outreach campaign.
4. Immediately convene the Climate Variability Advisory Committee to prioritize and expedite drought-related climate research that will assist in responding to current drought conditions and help prepare for a potentially dry 2009.
5. Provide technical assistance for drought response to local water agencies and districts for improving landscape and agricultural irrigation efficiencies, leak detection and other measures as appropriate.
6. Review the water shortage contingency elements of Urban Water Management Plans and work cooperatively with water suppliers to implement improvements.
7. Coordinate and implement State Water Project operations and water exchanges to alleviate critical impacts to San Joaquin Valley agriculture.
8. Implement additional actions to facilitate drought response, preparedness and promote water conservation in 2008 and 2009, and which will contribute to achieving long term reductions in water use.

IT IS FURTHER ORDERED that DWR and the Department of Public Health (DPH) prioritize processing of loan and grant contracts for water suppliers and public water systems demonstrating drought-related hardships.

IT IS FURTHER ORDERED that DWR and DPH coordinate with the State Office of Emergency Services and local offices of emergency services to identify public water systems at risk of experiencing health and safety impacts due to drought conditions and water delivery limitations, and to mitigate such impacts.

IT IS FURTHER ORDERED that DWR and DPH work with local water districts to evaluate system interconnections among the state's large water purveyors, review the status or availability of mutual aid agreements among those large water purveyors, and work with the parties to those mutual aid agreements to correct any deficiencies that restrict the movement of water in an emergency situation.

IT IS FURTHER ORDERED that DWR coordinate with the California Public Utilities Commission to identify investor-owned water utility systems at risk of experiencing health and safety impacts due to drought conditions and water delivery limitations, and to mitigate such impacts.

IT IS FURTHER ORDERED that DWR work with the Department of Food and Agriculture (CDFA), the United States Department of Agriculture and the United States Bureau of Reclamation to identify potential federal funding for local water agencies and farmers to facilitate the rapid installation of best available irrigation management and conservation systems.

IT IS FURTHER ORDERED that the CDFA work with county Agricultural Commissioners and others as necessary to identify and gather data on crop losses and other adverse economic impacts caused by the drought and, when necessary, transmit that information to the appropriate federal and state agencies.

IT IS FURTHER STRONGLY ENCOURAGED that local water agencies and districts work cooperatively on the regional and state level to take aggressive, immediate action to reduce water consumption locally and regionally for the remainder of 2008 and prepare for potential worsening water conditions in 2009.

This Order is not intended to, and does not, create any rights or benefits, substantive or procedural, enforceable at law or in equity, against the State of California, its agencies, departments, entities, officers, employees, or any other person.

I FURTHER DIRECT that as soon as hereafter possible, this Executive Order be filed in the Office of the Secretary of State and that widespread publicity and notice be given to this Executive Order.

IN WITNESS WHEREOF I have hereunto set my hand and caused the Great Seal of the State of California to be affixed this 4th day of June 2008.

ARNOLD SCHWARZENEGGER
Governor of California

ATTEST

DEBRA BOWEN
Secretary of State

Office of the Governor ARNOLD SCHWARZENEGGER THE PEOPLE'S GOVERNOR

PROCLAMATION

06/12/2008

State of Emergency - Central Valley Region

PROCLAMATION
by the
Governor of the State of California

WHEREAS on June 4, 2008, I issued an Executive Order proclaiming a statewide drought; and

WHEREAS in my June 4 Executive Order, I called on all Californians to conserve water, and I directed state agencies and departments to take immediate action to address the serious drought conditions and water delivery reductions that exist in California; and

WHEREAS in issuing my June 4 Executive Order, I said that I would proclaim a state of emergency in any county where emergency conditions exist due to the drought, in an effort to protect the people and property of California, including the businesses, workers and communities that depend on water deliveries for their livelihood and survival; and

WHEREAS since issuing my June 4 Executive Order, I have determined that emergency conditions exist in Central Valley counties caused by the continuing drought conditions in California and the reductions in water deliveries; and

WHEREAS statewide rainfall has been below normal in 2007 and 2008, with many Southern California communities receiving only 20 percent of normal rainfall in 2007, and Northern California this year experiencing the driest spring on record with most communities receiving less than 20 percent of normal rainfall from March through May; and

WHEREAS California is experiencing critically dry water conditions in the Sacramento and San Joaquin River basins and the statewide runoff forecast for 2008 is estimated to be 41 percent below average; and

WHEREAS water storage in many of the reservoirs serving the Central Valley are far below normal including San Luis reservoir which is at 53 percent of capacity, Lake Shasta at 61 percent of capacity and Lake Oroville at just 50 percent of capacity; and

WHEREAS diversions from the Sacramento-San Joaquin River Delta for the State Water Project (SWP) and federal Central Valley Project (CVP) are being greatly restricted due to various factors including federal court actions to protect fish species, resulting in estimated SWP deliveries of only 35 percent, and CVP deliveries of only 40 percent, of local agencies' requested amounts for 2008; and

WHEREAS the United States Bureau of Reclamation (USBR) recently announced an unexpected reduction in its water supply allocations to Central Valley Project (CVP) contractors within the San Luis Delta Mendota Water Agency Service Area from 45 percent to 40 percent; and

WHEREAS this unanticipated reduction will result in crop loss, increased unemployment and other direct and indirect economic impacts to Central Valley counties; and

WHEREAS water rationing has been ordered by the City of Long Beach, the City of Roseville, and the East

Bay Municipal Utility District, which serves 1.3 million people in Alameda and Contra Costa counties; and

WHEREAS on June 10, 2008, the Metropolitan Water District of Southern California, which supplies water for 26 cities and water agencies serving 18 million people in six southern California counties, declared a water supply alert in an effort to sustain their water reserves; and

WHEREAS some communities are also restricting new residential and commercial development because of unreliable or uncertain water supplies, and this is causing harm to the economy; and

WHEREAS dry conditions have created a situation of extreme fire danger in California, and these conditions resulted in devastating fires last year, with wildfires causing millions of dollars in damages; and

WHEREAS San Joaquin Valley agriculture constitutes a $20 billion industry, and serves as an essential part of California's economy; and

WHEREAS the lack of water will cause devastating harm to the communities that rely on this important industry, as growers lack sufficient water to finish the growing season, are forced to abandon planted crops, and are forced to dismiss workers; and

WHEREAS the lack of water is causing agricultural workers in the Central Valley to lose their jobs, resulting in a loss of livelihood, an inability to provide for their families, and increased negative social and economic impacts on the communities that depend on them; and

WHEREAS San Joaquin Valley agricultural production and processing industries account for almost 40 percent of regional employment, and every dollar produced on the farm generates more than three dollars in the local and regional economies, and the loss of these dollars is devastating communities; and

WHEREAS almost 20 percent of San Joaquin Valley residents already live in poverty, and it consistently ranks as the top region in the nation in foreclosures; and

WHEREAS as workers lose their jobs because of the lack of water, they often move their families away from the communities, resulting in further harm to local economies, lower enrollments in local schools and reduced funding for schools; and

WHEREAS the city of Fresno received only 54 percent of normal rainfall in 2007 and 76 percent of normal in 2008, and had its fourth driest spring on record; and

WHEREAS on June 11, 2008, the Fresno County Board of Supervisors passed a resolution declaring a local state of emergency due to the severe drought conditions, stating among other things that the lack of water has resulted in water rationing by Fresno County water districts; that these reductions are causing abandonment of current planted seasonal crops and permanent crops; that the cumulative crop reductions will result in job losses in Fresno County communities; that the loss of revenue has negatively impacted Fresno County businesses and Fresno County government tax revenue; and that there will be a substantial negative economic impact to the community; and

WHEREAS the Fresno County Board of Supervisors also requested that I declare a state of emergency due to the drought conditions; and

WHEREAS the Central Valley cities of Bakersfield, Modesto, Stockton, and Sacramento experienced their driest spring on record in 2008, and additional Central Valley counties are experiencing similar emergency conditions caused by drought and lack of water deliveries; and

WHEREAS to date, almost $65 million in losses have been reported by 19 counties due to reduced rangeland grasses that are used to graze livestock, and those reductions have been caused by drought; and

WHEREAS statewide and local conditions collectively have led to the rationing of water by affected water districts to their member farmers and these further reductions are resulting in abandonment of current planted seasonal crops and permanent crops; and

WHEREAS the crop losses will cause increased food prices, which will negatively impact families and economies throughout California and beyond our borders; and

WHEREAS the lack of water deliveries has forced local communities to draw water from their emergency water reserves, putting communities at risk of further catastrophe if emergency reserves are depleted or cut off; and

WHEREAS the circumstances of the severe drought conditions, by reason of their magnitude, are beyond the control of the services, personnel, equipment and facilities of any single county, city and county, or city and require the combined forces of a mutual aid region or regions to combat; and

WHEREAS under the provisions of section 8558(b) of the California Government Code, I find that conditions of extreme peril to the safety of persons and property exist within the counties of Sacramento, San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, Tulare and Kern, caused by the current and continuing severe drought conditions.

NOW, THEREFORE, I, ARNOLD SCHWARZENEGGER, Governor of the State of California, in accordance with the authority vested in me by the California Constitution and the California Emergency Services Act, and in particular, section 8625 of the California Government Code, **HEREBY PROCLAIM A STATE OF EMERGENCY** to exist within the counties of Sacramento, San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, Tulare and Kern.

IT IS HEREBY ORDERED that all agencies of the state government utilize and employ state personnel, equipment and facilities for the performance of any and all activities consistent with the direction of my Office of Emergency Services (OES) and the State Emergency Plan, and that OES provide local government assistance under the authority of the California Disaster Assistance Act, and that the emergency exemptions in sections 21080(b)(3) and 21172 of the Public Resources Code shall apply to all activities and projects ordered and directed under this proclamation, to the fullest extent allowed by law.

I FURTHER DIRECT THAT:

1. OES shall provide assistance under the authority of the California Disaster Assistance Act, by assisting public water agencies with drilling of groundwater wells or the improvement of existing wells and water delivery systems for human consumption, sanitation, and emergency protective measures, such as fire fighting.
2. The Department of Water Resources (DWR) shall transfer groundwater of appropriate quality through the use of the California Aqueduct to benefit farmers in the San Joaquin Valley
3. DWR and the State Water Resources Control Board (SWRCB) shall expedite the processing of water transfer requests.
4. DWR, in cooperation with USBR, shall make operational changes to State Water Project facilities, including the San Luis Reservoir and Southern California reservoirs, that will permit additional water deliveries to the San Joaquin Valley.
5. DWR shall prepare and file necessary water right urgency change petitions to facilitate surface water transfers and the use of joint point of diversion by the SWP and Central Valley Project.
6. SWRCB shall expedite the processing and consideration of water rights urgency change petitions filed by DWR and other water agencies to facilitate water transfers to the San Joaquin Valley.

I FURTHER DIRECT that as soon as hereafter possible, this proclamation be filed in the Office of the Secretary of State and that widespread publicity and notice be given of this proclamation.

IN WITNESS WHEREOF I have hereunto set my hand and caused the Great Seal of the State of California to be affixed this 12th day of June, 2008.

ARNOLD SCHWARZENEGGER
Governor of California

ATTEST:

DEBRA BOWEN
Secretary of State

ATTACHMENT 6 - 2009 Executive Order and Emergency Drought Proclamation

Office of the Governor ARNOLD SCHWARZENEGGER THE PEOPLE'S GOVERNOR

EXECUTIVE ORDER S-11-09

06/19/2009

WHEREAS on June 4, 2008, I issued an Executive Order proclaiming a statewide drought, and I ordered my administration to take immediate action to address the water shortage; and

WHEREAS on June 12, 2008, I proclaimed a state of emergency for nine Central Valley counties because the drought had caused conditions of extreme peril to the safety of persons and property; and

WHEREAS on February 27, 2009, I proclaimed a state of emergency for the entire state as the severe drought conditions continued and the impacts were well beyond the Central Valley; and

WHEREAS the February 27, 2009 state of emergency proclamation provided specific orders and directions to my Department of Water Resources, State Water Resources Control Board, Department of General Services, Department of Public Health, California Department of Food and Agriculture, and Labor and Workforce Development Agency to reduce and mitigate the human, environmental, and economic impact of the drought; and

WHEREAS I have supported state and local water managers' efforts to increase the availability of water, directed efforts to better integrate regional water management practices to balance water demand with water supply, directed expedited water transfers, ordered increased job training, and substantially increased statewide water conservation; and

WHEREAS I have requested and we have received United States Department of Agriculture disaster designations for 21 counties for drought; and

WHEREAS the drought conditions have exacerbated unemployment and the local emergency food banks are struggling to meet the demands of hungry families.

NOW, THEREFORE, I, ARNOLD SCHWARZENEGGER, Governor of the State of California, in accordance with the authority vested in me by the state Constitution and statutes, activate the California Disaster Assistance Act to provide temporary supplemental assistance to the local governments and non-profit organizations that provide food and other aid to those who are impacted by the drought statewide.

IT IS HEREBY ORDERED that my California Emergency Management Agency, Department of Social Services, Labor and Workforce Development Agency, and California Department of Food and Agricultural develop a comprehensive strategy by July 15, 2009, to provide adequate nutrition for those individuals who are temporarily unable to afford food as a result of the drought conditions.

IT IS FURTHER ORDERED THAT the provisions of California Unemployment Insurance Code section 1253 imposing a one-week waiting period for unemployment insurance applicants are suspended as to all applicants who are unemployed as a specific result of the drought conditions, who apply for unemployment insurance benefits during the time period beginning June 19, 2009, and ending on the close of business on November 1, 2009, and who are otherwise eligible for unemployment insurance benefits in California.

I FURTHER DIRECT that as soon as hereafter possible, this Order be filed in the Office of the Secretary of State and that widespread publicity and notice be given this Order.

IN WITNESS WHEREOF I have hereunto set my hand and caused the Great Seal of the State of California to be affixed this 19th Day of June 2009.

ARNOLD SCHWARZENEGGER
Governor of California

ATTEST:
DEBRA BOWEN
Secretary of State

Office of the Governor ARNOLD SCHWARZENEGGER THE PEOPLE'S GOVERNOR

PROCLAMATION

02/27/2009

State of Emergency - Water Shortage

PROCLAMATION
by the
Governor of the State of California

WHEREAS the State of California is now in its third consecutive year of drought; and

WHEREAS in each year of the current drought, annual rainfall and the water content in the Sierra snowpack have been significantly below the amounts needed to fill California's reservoir system; and

WHEREAS the rainfall and snowpack deficits in each year of the current drought have put California further and further behind in meeting its essential water needs; and

WHEREAS statewide, 2008 was the driest spring and summer on record, with rainfall 76 percent below average; and

WHEREAS the Sacramento and San Joaquin River systems, which provide much of the state's reservoir inflow, were classified as Critically Dry for the 2008 water year; and

WHEREAS in the second year of this continuous drought, on June 4, 2008, I issued an Executive Order proclaiming a statewide drought, and I ordered my administration to begin taking action to address the water shortage; and

WHEREAS because emergency conditions existed in the Central Valley in the second year of the drought, I issued an Emergency Proclamation on June 12, 2008, finding that conditions of extreme peril to the safety of persons and property existed in the counties of Sacramento, San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, Tulare, and Kern caused by severe drought conditions, and I ordered my administration to take emergency action to assist the Central Valley; and

WHEREAS the drought conditions and water delivery limitations identified in my prior Executive Order and Emergency Proclamation still exist, and have become worse in this third year of drought, creating emergency conditions not just in the Central Valley, but throughout the State of California, as the adverse environmental, economic, and social impacts of the drought cause widespread harm to people, businesses, property, communities, wildlife and recreation; and

WHEREAS despite the recent rain and snow, the three year cumulative water deficit is so large there is only a 15 percent chance that California will replenish its water supply this year; and

WHEREAS in the time since the state's last major drought in 1991, California added 9 million new residents, experienced a significant increase in the planting of permanent, high-value crops not subject to fallowing, and was subjected to new biological opinions that reduced the flexibility of water operations throughout the year; and

WHEREAS because there is no way to know when the drought will end, further urgent action is needed to address the water shortage and protect the people and property in California; and

WHEREAS rainfall levels statewide for the 2008-2009 water year are 24 percent below average as of the February

1, 2009 measurement; and

WHEREAS the second snow pack survey of the 2009 winter season indicated that snow pack water content is 39 percent below normal; and

WHEREAS as of February 23, 2009, storage in the state's reservoir system is at a historic low, with Lake Oroville 70 percent below capacity, Shasta Lake 66 percent below capacity, Folsom Lake 72 percent below capacity, and San Luis Reservoir 64 percent below capacity; and

WHEREAS low water levels in the state's reservoir system have significantly reduced the ability to generate hydropower, including a 62 percent reduction in hydropower generation at Lake Oroville from October 1, 2008 to January 31, 2009; and

WHEREAS a biological opinion issued by the United States Fish and Wildlife Service on December 15, 2008, imposed a 30 percent restriction on water deliveries from the State Water Project and the Central Valley Project to protect Delta Smelt; and

WHEREAS State Water Project water allocations have now been reduced to 15 percent of requested deliveries, matching 1991 as the lowest water allocation year in State Water Project history, and Central Valley Project water allocations for agricultural users have now been reduced to zero; and

WHEREAS the lack of water has forced California farmers to abandon or leave unplanted more than 100,000 acres of agricultural land; and

WHEREAS California farmers provide nearly half of the fresh fruits, nuts and vegetables consumed by Americans, and the crop losses caused by the drought will increase food prices, which will further adversely impact families and economies throughout California and beyond our borders; and

WHEREAS agricultural revenue losses exceed $300 million to date and could exceed $2 billion in the coming season, with a total economic loss of nearly $3 billion in 2009; and

WHEREAS it is expected that State Water Project and Central Valley Project water delivery reductions will cause more than 80,000 lost jobs; and

WHEREAS the income and job losses will adversely impact entire communities and diverse sectors of the economy supported by those jobs and income, including the housing market and commercial business; and

WHEREAS these conditions are causing a loss of livelihood for many thousands of people, an inability to provide for families, and increased harm to the communities that depend on them; and

WHEREAS this loss of income and jobs will increase the number of defaults, foreclosures and bankruptcies, and will cause a loss of businesses and property at a time when Californians are already struggling with a nationwide and worldwide economic downturn; and

WHEREAS the Central Valley town of Mendota, as one example, already reports an unemployment rate of more than 40 percent and lines of a thousand or more for food distribution; and

WHEREAS when jobs, property and businesses are lost, some families will move away from their communities, causing further harm to local economies, lower enrollments in local schools and reduced funding for schools; and

WHEREAS at least 18 local water agencies throughout the state have already implemented mandatory water conservation measures, and 57 agencies have implemented other water conservation programs or restrictions on water deliveries, with many agencies considering additional rationing and water supply reductions in 2009; and

WHEREAS the lack of water has forced local communities to draw water from their emergency water reserves, putting communities at risk of further catastrophe if emergency reserves are depleted or cut off; and

WHEREAS the state recently endured one of its worst wildfire seasons in history and the continuing drought conditions increase the risk of devastating fires and reduced water supplies for fire suppression; and

WHEREAS on February 26, 2009, the United States Department of Agriculture and the United States Department of Interior created a Federal Drought Action Team to assist California to minimize the social, economic, and environmental impacts of the current drought; and

WHEREAS the circumstances of the severe drought conditions, by reason of their magnitude, are beyond the control of the services, personnel, equipment and facilities of any single county, city and county, or city and require the combined forces of a mutual aid region or regions to combat; and

WHEREAS under the provisions of section 8558(b) of the California Government Code, I find that conditions of extreme peril to the safety of persons and property exist in California caused by the current and continuing severe drought conditions and water delivery restrictions.

NOW, THEREFORE, I, ARNOLD SCHWARZENEGGER, Governor of the State of California, in accordance with the authority vested in me by the California Constitution and the California Emergency Services Act, and in particular California Government Code sections 8625 and 8571, **HEREBY PROCLAIM A STATE OF EMERGENCY** to exist in California.

IT IS HEREBY ORDERED that all agencies of the state government utilize and employ state personnel, equipment and facilities for the performance of any and all activities consistent with the direction of the California Emergency Management Agency (CalEMA) and the State Emergency Plan.

I FURTHER DIRECT THAT:

1. The California Department of Water Resources (DWR) shall, in partnership with other appropriate agencies, launch a statewide water conservation campaign calling for all Californians to immediately decrease their water use.

2. DWR shall implement the relevant mitigation measures identified in the Environmental Water Account Environmental Impact Report, Environmental Impact Statement, Supplement, and Addendums for the water transfers made through the 2009 Drought Water Bank. In addition, the California Air Resources Board shall, in cooperation with DWR and other agencies, expedite permitting and development of mitigation measures related to air quality impacts which may result from groundwater substitution transfers.

3. DWR and the State Water Resources Control Board (SWRCB) shall expedite the processing of water transfers and related efforts by water users and suppliers that cannot participate in the 2009 Drought Water Bank, provided the water users and suppliers can demonstrate that the transfer will not injure other legal users of water or cause unreasonable effects on fish and wildlife.

4. The SWRCB shall expedite the processing and consideration of the request by DWR for approval of the consolidation of the places of use and points of diversion for the State Water Project and federal Central Valley Project to allow flexibility among the projects and to facilitate water transfers and exchanges.

5. DWR shall implement short-term efforts to protect water quality or water supply, such as the installation of temporary barriers in the Delta or temporary water supply connections.

6. The SWRCB shall expedite the processing and consideration of requests by DWR to address water quality standards in the Delta to help preserve cold water pools in upstream reservoirs for salmon preservation and water supply.

7. To the extent allowed by applicable law, state agencies within my administration shall prioritize and streamline permitting and regulatory compliance actions for desalination, water conservation and recycling projects that provide drought relief.

8. The Department of General Services shall, in cooperation with other state agencies, immediately implement a water use reduction plan for all state agencies and facilities. The plan shall include immediate water conservation actions and retrofit programs for state facilities. A moratorium shall be placed on all new landscaping projects at state facilities and on state highways and roads except for those that use water efficient irrigation, drought tolerant plants or non-irrigated erosion control.

9. As a condition to receiving state drought financial assistance or water transfers provided in response to this emergency, urban water suppliers in the state shall be required to implement a water shortage contingency analysis, as required by California Water Code section 10632. DWR shall offer workshops and technical assistance to any agency that has not yet prepared or implemented the water shortage contingency analysis required by California law.

10. DWR shall offer technical assistance to agricultural water suppliers and agricultural water users, including information on managing water supplies to minimize economic impacts, implementing efficient water management practices, and using technology such as the California Irrigation Management Information System (CIMIS) to get the greatest benefit from available water supplies.

11. The Department of Public Health shall evaluate the adequacy of emergency interconnections among the state's public water systems, and provide technical assistance and continued financial assistance from existing resources to improve or add interconnections.

12. DWR shall continue to monitor the state's groundwater conditions, and shall collect groundwater-level data and other relevant information from water agencies, counties, and cities. It is requested that water agencies, counties and cities cooperate with DWR by providing the information needed to comply with this Proclamation.

13. DWR and the Department of Food and Agriculture shall recommend, within 30 days from the date of this Proclamation, measures to reduce the economic impacts of the drought, including but not limited to, water transfers, through-Delta emergency transfers, water conservation measures, efficient irrigation practices, and improvements to CIMIS.

14. The Department of Boating and Waterways shall recommend, within 30 days from the date of this Proclamation, and in cooperation with the Department of Parks and Recreation, measures to reduce the impacts of the drought conditions to water-based recreation, including but not limited to, the relocation or extension of boat ramps and assistance to marina owners.

15. The Labor and Workforce Development Agency shall recommend, within 30 days from the date of this Proclamation, measures to address the impact of the drought conditions on California's labor market, including but not limited to, identifying impacted areas, providing one-stop service, assisting employers and workers facing layoffs, and providing job training and financial assistance.

16. DWR and the Department of Food and Agriculture shall be the lead agencies in working with the Federal Drought Action Team to coordinate federal and state drought response activities.

17. The emergency exemptions in Public Resources Code sections 21080(b)(3), 21080(b)(4) and 21172, and in California Code of Regulations, title 14, section 15269(c), shall apply to all actions or efforts consistent with this Proclamation that are taken to mitigate or respond to this emergency. In addition, Water Code section 13247 is suspended to allow expedited responses to this emergency that are consistent with this Proclamation. The Secretary for the California Environmental Protection Agency and the Secretary for the California Natural Resources Agency shall determine which efforts fall within these exemptions and suspension, ensuring that these exemptions and suspension serve the purposes of this Proclamation while protecting the public and the environment. The Secretaries shall maintain on their web sites a list of the actions taken in reliance on these exemptions and suspension.

18. By March 30, 2009, DWR shall provide me with an updated report on the state's drought conditions and water availability. If the emergency conditions have not been sufficiently mitigated, I will consider issuing additional orders, which may include orders pertaining to the following:

(a) institution of mandatory water rationing and mandatory reductions in water use;

(b) reoperation of major reservoirs in the state to minimize impacts of the drought;

(c) additional regulatory relief or permit streamlining as allowed under the Emergency Services Act; and

(d) other actions necessary to prevent, remedy or mitigate the effects of the extreme drought conditions.

I FURTHER REQUEST THAT:

19. All urban water users immediately increase their water conservation activities in an effort to reduce their individual water use by 20 percent.

20. All agricultural water suppliers and agricultural water users continue to implement, and seek additional opportunities to immediately implement, appropriate efficient water management practices in order to minimize economic impacts to agriculture and make the best use of available water supplies.

21. Federal and local agencies also implement water use reduction plans for facilities within their control, including

immediate water conservation efforts.

I FURTHER DIRECT that as soon as hereafter possible, this proclamation be filed in the Office of the Secretary of State and that widespread publicity and notice be given of this proclamation.

IN WITNESS WHEREOF I have hereunto set my hand and caused the Great Seal of the State of California to be affixed this 27th day of February, 2009.

ARNOLD SCHWARZENEGGER
Governor of California

ATTEST:
DEBRA BOWEN
Secretary of State

ATTACHMENT 7 - Acronyms and Initializations

ACOE – Army Corps of Engineers
BTHA - Business, Transportation and Housing Agency
CARB – California Air Resources Board
Cal Boating – Department of Boating and Waterways
Cal EMA – California Emergency Management Agency
Cal Fire – California Department of Forestry and Fire Protection
Cal WARN - California Water/Wastewater Agency Response Network
CDFA – California Department of Food and Agriculture
CDFG – California Department of Fish and Game
CDOC– California Department of Conservation
CDOF – California Department of Finance
CDPH – California Department of Public Health
CDPR - California Department of Pesticide Regulation
CDSP – California Department of State Parks
CEC – California Energy Commission
CHP – California Highway Patrol
CDMH – California Department of Mental Health
CNG – California National Guard
CNRA – California Natural Resources Agency
CRWA - California Rural Water Association
CSLC – California State Lands Commission
CUEA - California Utility Emergency Association
DOJ – Department of Justice
DWR – Department of Water Resources
IRWMs – Integrated Regional Water Management Plans
NOAA – National Oceanic and Atmospheric Administration
RWQCB – Regional Water Quality Control Boards
SWRCB – State Water Resources Control Board
UCCE – University of California Cooperative Extension
USBR – United States Bureau of Reclamation
USDA – United States Department of Agriculture
USEPA- United State Environmental Protection Agency
USFS – United States Forest Service
USFWS – United States Fish and Wildlife Service
USGS – United States Geological Survey

CALIFORNIA DEPARTMENT OF WATER RESOURCES
1416 Ninth Street, Sacramento, CA 95814

http://www.water.ca.gov/drought/

Indian Organizations
Indirect Cost Negotiation Agreement

EIN: 94-1728348

Organization:

Tule River Indian Tribe
P.O. Box 589
Porterville, CA 93258-0589

Date: July 8, 2014

Report No(s).: 14-A-0898(13)
14-A-0899(14)
14-A-0900(15)

Filing Ref.:
Last Negotiation Agreement
dated September 25, 2012

The indirect cost rates contained herein are for use on grants, contracts, and other agreements with the Federal Government to which Public Law 93-638 and 2 CFR 225 (OMB Circular A-87) apply, subject to the limitations contained in 25 CFR 900 and in Section II.A. of this agreement. The rates were negotiated by the U.S. Department of the Interior, Interior Business Center, and the subject organization in accordance with the authority contained in 2 CFR 225.

Section I: Rates

	Effective Period				Applicable
Type	From	To	Rate*	Locations	To
Fixed Carryforward	10/01/12	09/30/13	12.51%	All	All Programs
Fixed Carryforward	10/01/13	09/30/14	15.86%	All	All Programs
Fixed Carryforward	10/01/14	09/30/15	15.86%	All	All Programs

***Base**: Total direct costs, less capital expenditures and passthrough funds. Passthrough funds are normally defined as major subcontracts, payments to participants, stipends to eligible recipients, and subgrants, all of which normally require minimal administrative effort.

Treatment of fringe benefits: Fringe benefits applicable to direct salaries and wages are treated as direct costs; fringe benefits applicable to indirect salaries and wages are treated as indirect costs.

Section II: General

A. **Limitations:** Use of the rate contained in this agreement is subject to any applicable statutory limitations. Acceptance of the rate agreed to herein is predicated upon these conditions: (1) no costs other than those incurred by the subject organization were included in its indirect cost rate proposal, (2) all such costs are the legal obligations of the grantee/contractor, (3) similar types of costs have been accorded consistent treatment, and (4) the same costs that have been treated as indirect costs have not been claimed as direct costs (for example, supplies can be charged directly to a program or activity as long as these costs are not part of the supply costs included in the indirect cost pool for central administration).

B. **Audit:** All costs (direct and indirect, federal and non-federal) are subject to audit. Adjustments to amounts resulting from audit of the cost allocation plan or indirect cost rate proposal upon which the negotiation of this agreement was based will be compensated for in a subsequent negotiation agreement.

C. **Changes:** The rate contained in this agreement is based on the organizational structure and the accounting system in effect at the time the proposal was submitted. Changes in organizational structure, or changes in the method of accounting for costs that affect the amount of reimbursement resulting from use of the rate in this agreement, require the prior approval of the responsible negotiation agency. Failure to obtain such approval may result in subsequent audit disallowance.

D.
1. **Fixed Carryforward Rate:** The fixed carryforward rate is based on an estimate of costs that will be incurred during the period for which the rate applies. When the actual costs for such period have been determined, an adjustment will be made to the rate for a future period, if necessary, to compensate for the difference between the costs used to establish the fixed rate and the actual costs.

2. **Provisional/Final Rate:** Within 6 months after year end, a final indirect cost rate proposal must be submitted based on actual costs. Billings and charges to contracts and grants must be adjusted if the final rate varies from the provisional rate. If the final rate is greater than the provisional rate and there are no funds available to cover the additional indirect costs, the organization may not recover all indirect costs. Conversely, if the final rate is less than the provisional rate, the organization will be required to pay back the difference to the funding agency.

E. **Agency Notification:** Copies of this document may be provided to other federal offices as a means of notifying them of the agreement contained herein.

F. **Record Keeping:** Organizations must maintain accounting records that demonstrate that each type of cost has been treated consistently either as a direct cost or an indirect cost. Records pertaining to the costs of program administration, such as salaries, travel, and related costs, should be kept on an annual basis.

G. **Reimbursement Ceilings:** Grantee/contractor program agreements providing for ceilings on indirect cost rates or reimbursement amounts are subject to the ceilings stipulated in the contract or grant agreements. If the ceiling rate is higher than the negotiated rate in Section I of this agreement, the negotiated rate will be used to determine the maximum allowable indirect cost.

H. **Use of Other Rates:** If any federal programs are reimbursing indirect costs to this grantee/contractor by a measure other than the approved rate in this agreement, the grantee/contractor should credit such costs to the affected programs, and the approved rate should be used to identify the maximum amount of indirect cost allocable to these programs.

I. **Central Service Costs:** Where central service costs are estimated for the calculation of indirect cost rates, adjustments will be made to reflect the difference between provisional and final amounts.

J. **Other:**
1. The purpose of an indirect cost rate is to facilitate the allocation and billing of indirect costs. Approval of the indirect cost rate does not mean that an organization can recover more than the actual costs of a particular program or activity.

2. Programs received or initiated by the organization subsequent to the negotiation of this agreement are subject to the approved indirect cost rate if the programs receive administrative support from the indirect cost pool. It should be noted that this could result in an adjustment to a future rate.

3. New indirect cost proposals are necessary to obtain approved indirect cost rates for future fiscal or calendar years. The proposals are due in our office 6 months prior to the beginning of the year to which the proposed rates will apply.

Section III: Acceptance

Listed below are the signatures of acceptance for this agreement:

By the Indian Organization:

Tule River Indian Tribe
Tribal Government

Neil Peyron /s/
Signature

Neil Peyron
Name (Type or Print)

Chairman
Title

7/2/2014
Date

By the Cognizant Federal Government Agency:

U.S. Department of the Interior
Interior Business Center
Agency

Mark W. Stout /s/
Signature

for Deborah A. Moberly
Name

Office Chief
Office of Indirect Cost Services
Title

JUL 08 2014
Date

Negotiated by Sujoy Mukhopadhyay
Telephone (916) 566-7009

Tule River Indian Tribe

Water Settlement Technical Report

Submitted on behalf of:

Tule River Indian Tribe
340 N Reservation Rd
Porterville, CA 93257

Submitted by:

NRCE®
GEI Consultants
NARF
Native American Rights Fund
Kenney & Associates

June 2013

Table of Contents

List of Figures

List of Tables

List of Appendices

Executive Summary

The Tule River Indian Tribe (Tribe) relies on water resources in the South Tule River Basin to meet water demands on the 55,396-acre Tule River Indian Reservation (Reservation) in south-central California. Both surface and groundwater resources are currently used to meet water demands on the Reservation; however, the Tribe is only using a small portion of the available surface water supply to which the Tribe is entitled. Groundwater supplies that are available to the Tribe are limited and are not always of acceptable quality for domestic use.

The Tribe's water treatment plant currently has the capacity for providing 501,700 gallons per day (562 acre-feet per year) at maximum production. The Tribe typically tries to run the treatment plant at maximum capacity and uses groundwater sources to help make up shortfalls. In many years, the Tribe does not have adequate water supplies in the late summer and early fall to meet the current minimum 100,000 gallons per day of water demand.

Many of the residents on the Reservation continue to have a relatively low standard of living in substantial part due to the absence of an adequate and reliable potable water supply and delivery system. Inadequate water supplies have resulted in reduced opportunities for economic development to occur on the Reservation and may prevent off-Reservation Tribal members from relocating to the Reservation.

The estimated future water demand of the Reservation in the year 2112 is 7,103 acre-feet per year. Of this total, it is estimated 1,974 acre-feet per year would be allocated for domestic, commercial, municipal and industrial (DCMI) uses and 5,129 acre-feet per year would be allocated for irrigation. These water demand figures are based on reasonably conservative projections of future potential Reservation population growth and economic development. To meet a portion of this water demand, the Tribe is proposing to develop Phase 1 of a dam and reservoir project in conjunction with other water infrastructure projects. The Phase 1 dam would impound a 5,000 acre-foot reservoir, which would meet the year 2112 projected DCMI demand and a portion of the future irrigation water demand of irrigable lands on the Reservation.

Other options besides a dam project are not adequate to meet the Reservation's future needs. For example, if water storage tanks were to be used to store South Fork Tule River water instead of a dam, several thousand tanks would need to be constructed. Those groundwater wells on the Reservation that produce potable water generally have low yields (less than 20 gallons per minute) so groundwater can only be viewed as a short-term source. In addition, climate change studies generally predict increased variability in precipitation and runoff from year to year in the future, making the need for a sizeable storage project on the Reservation even more critical.

There are a number of sites along the South Fork of the Tule River on the Reservation that are judged to be viable for construction of a concrete gravity dam using roller-compacted concrete (RCC) construction methods. Further studies and subsurface explorations would need to be performed to confirm current findings and provide the basis for final project planning and design of the dam and its appurtenant facilities.

The preferred dam and reservoir location is the Lower Bear Creek site on the South Fork of the Tule River just downstream from the confluence with Bear Creek. The average demand that could be met from construction of this reservoir is 2,871 acre-feet per year, which would provide water for all of the DCMI demand (1,974 acre-feet per year) and irrigation of 220 acres. Three other sites for a dam were evaluated; however, the Lower Bear Creek site is preferred by the Tribe, based on the results of a Screening Workshop held on March 6-7, 2013.

In addition to the dam and reservoir, the Phase 1 project would include a raw water conveyance pipeline from the reservoir to a new or expanded water treatment plant, which is also part of the project. Distribution system improvements are also planned to be implemented as part of the project. Construction of the dam and raw water pipeline would require improvements to the main road existing through the Reservation, as well as new access roads.

The estimate of total project cost for the preferred alternative (dam and reservoir at the Lower Bear Creek site) is $159 million, in December 2012 dollars, as shown below:

Estimate of Total Project Cost – Storage Developed at Lower Bear Creek Site	
Itemized Construction Costs (ICC)	
Dam and Reservoir	$59,469,000
Road Improvements	$11,048,000
Raw Water Pipeline	$3,111,000
Water Treatment Plant Expansion	$1,890,000
Water Distribution System	$8,320,000
Itemized Construction Cost Subtotal (ICCS):	**$83,838,000**
Design Contingency	
Dam and Reservoir (20% to 22% ICC)	$11,894,000
Road Improvements (20% to 22% ICC)	$2,210,000
Raw Water Pipeline (25% ICC)	$778,000
Water Treatment Plant Expansion (30% ICC)	$567,000
Water Distribution System (30% ICC)	$2,496,000
Base Construction Subtotal (BCS)	**$101,783,000**
Mobilization, Bonds & Insurance (9% BCS)	$9,160,000
Construction Contingency (15% BCS)	$15,267,000
Direct Construction Subtotal (DCS)	**$126,210,000**

Estimate of Total Project Cost – Storage Developed at Lower Bear Creek Site	
Design Engineering (8% DCS)	$10,097,000
Construction Administration & Engineering (8% DCS)	$10,097,000
Legal, Permitting, Mitigation (10% DCS)	$12,621,000
Total Opinion of Probable Project Cost (OPPC)	**$159,025,000**

Note 1: ICC= Itemized Construction Cost for individual project features.
Note 2: ICCS = Itemized Construction Costs Subtotal, sum of all 5 project features.
Note 3: BCS = Base Construction Subtotal, sum of ICCS and design contingency.
Note 4: DCS = Direct Construction Subtotal, sum of BCS, mobilization, bond, insurance, construction contingency
Note 5: The cost estimates in this report are considered to be Class 4 estimates per the Association for the Advancement of Cost Engineering (AACE) International Cost Estimate Classification System.

1.0 Introduction

1.1 Purpose and Scope

The purpose of this study is to provide a compilation and analysis of the studies developed to provide a technical foundation for the construction of a dam, reservoir, and other water infrastructure on the Reservation associated with the Tule River Indian Water Rights Settlement.

1.2 Federal Authority to Participate and Conduct Study

The Secretary of the Interior is given the authority to pursue technical studies pursuant to U.S. Bureau of Reclamation (Reclamation) law (Section 1, Act of June 17, 1902, 32 Stat. 388; and Section 9, Reclamation Act of 1939; 53 Stat. 1193) for the purpose of evaluating the technical viability of water development in the Reclamation states. The Reservation is located in California, a Reclamation state. This report has been developed with the advice and assistance from Reclamation.

1.3 Background

1.3.1 Location and Setting

The Reservation is located in south-central California, approximately 75 miles south of Fresno in Tulare County, as shown on Figure 1-1.

The Reservation is situated on the western slope of the Sierra Nevada Mountains and lies almost entirely within the South Fork Tule River drainage basin. The South Fork Tule River flows into the Tule River at Success Reservoir, which is located about ten miles west of the Reservation. There are no significant water users upstream of the Reservation. The topography is generally steep, with elevations ranging from about 900 feet near the Reservation's western boundary to 7,500 feet near the Reservation's eastern boundary. Most of the inhabited land is situated along the lower reach of the South Fork Tule River on the western side of the Reservation. The current acreage of the reservation held in trust by the United States covers 55,396 acres. The Tribe also owns, in fee, additional acreage contiguous to the Reservation, and a small parcel outside the South Tule River basin held in trust by the United States.

The climate on the Reservation can vary considerably by season and is strongly correlated with elevation. The average daily high temperature within the Reservation is about 77°F throughout the lower elevations and 55°F at higher elevations. Concurrently, the average low temperature ranges from about 55°F throughout the lower parts of the Reservation to 27°F at higher elevations. The majority of the precipitation on the Reservation falls along the upper reaches of the South Fork Tule River watershed (average of 45 inches annually). Precipitation along the lower reaches averages about 20 inches annually. The Reservation's lower foothill areas are generally covered with grasses and chaparral. Oak, sycamore, alder, and other deciduous trees are common adjacent to the streambed. At higher elevations, there are stands of pine, fir, spruce, cedar, and giant sequoia.

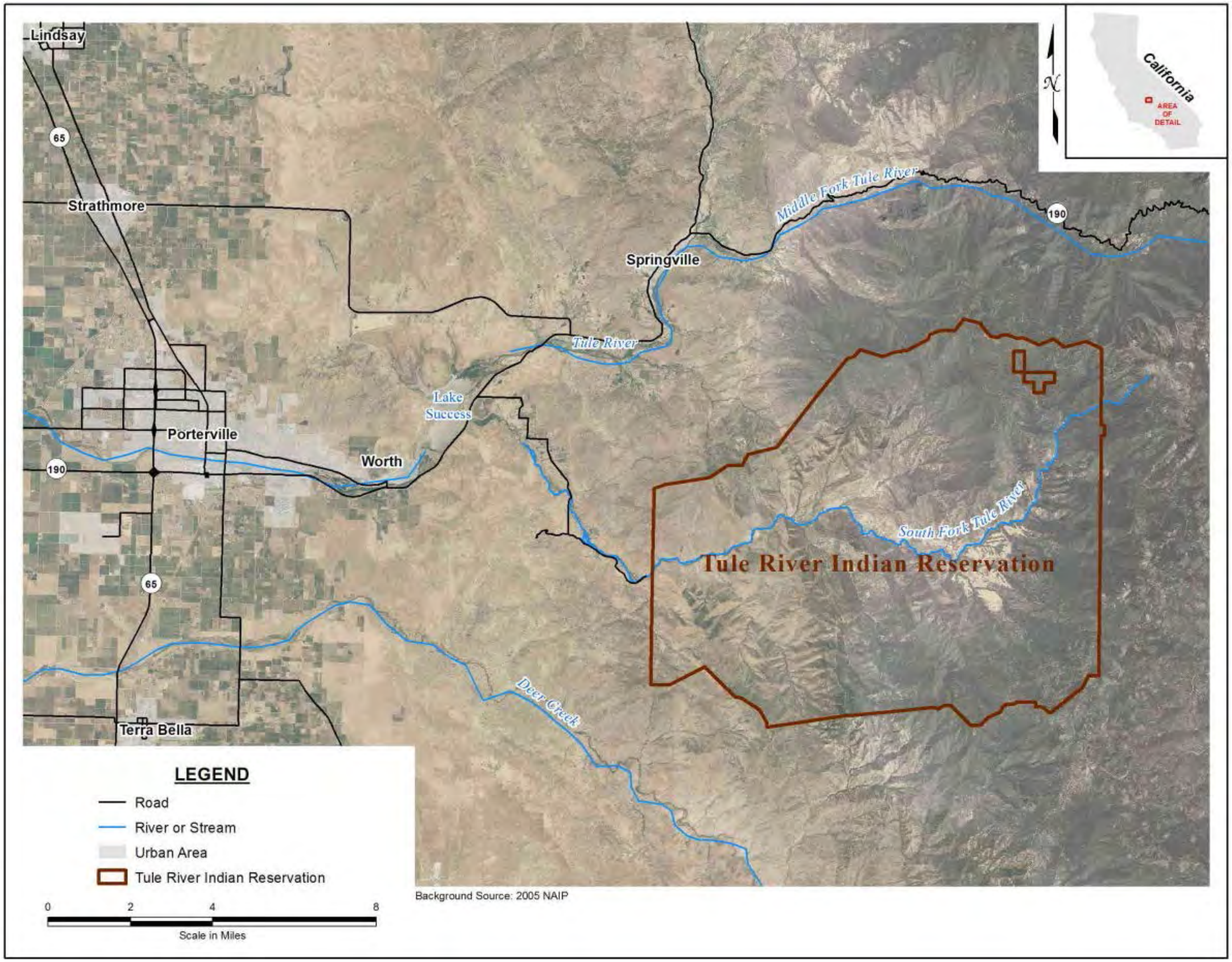
1.3.2 Socioeconomic Characteristics

The Tule River Indian Reservation is the homeland of the Tule River Tribe. They are descendants of the Yokuts Indians, a large group of linguistically-related people who occupied the San Joaquin Valley in California for thousands of years prior to contact with Euro-American settlers.

The current Tribe has a population of 1,720 people, of which 970 live on the Reservation. In general, a significant segment of the tribal population lives at or below the poverty line.

The injustices and inequities of the past are still present and continue to affect the Tule River Tribe. The Tribe has been plagued with unemployment and mortality rates substantially higher - and a standard of living substantially lower - than is experienced by non-Indian communities near the Reservation. For example, while on-Reservation socioeconomic conditions have improved over time, the estimated on-Reservation poverty rate has continued to exceed regional averages. In fact, as recently as 2005, the poverty rate for employed members of the Tule River Tribe was about 48 percent (BIA 2005). This compares to an approximately 12 percent poverty rate within Tulare County that same year (US Census 2005). As a result, the Reservation's residents suffer from a relatively low standard of living, which may be in part attributed to the absence of an adequate and reliable potable water supply and delivery system.

Figure 1-1: Reservation Location Map



2.0 Existing Water Supply and Infrastructure

2.1.1 General

The Tule River Reservation water system relies upon a series of wells, springs, and water drawn directly from the South Fork Tule River, which is treated to meet potable water standards. The Tribe's documented water usage is constrained by the availability of water supplies and the water distribution system and, therefore, is not representative of the actual demands for water.

The amount of water diverted annually from the South Fork Tule River is not known, as past diversions by the Tribe have been unmeasured. The quality of river water is affected by grazing upstream, as well as other land uses and activities in the watershed.

Natural springs are evident throughout the Reservation and these are being used for a combination of agricultural irrigation and drinking water augmentation. Several large springs show high levels of carbon dioxide and are therefore restricted to agricultural usage.

Wells are located throughout the Reservation, but are concentrated in the Reservation's Lower Valley where they augment the treated surface water serving the community. Less than a quarter of wells that have been drilled on the Reservation are operational due to either a lack of production or water quality concerns. Well yields tend to be modest, with most producing less than 30 gallons per minute (gpm).

2.1.2 Water Quality

Water quality within the South Fork Tule River watershed is generally good although the river water does at times exceed federal Safe Drinking Water Act (SDWA) standards for certain constituents and the groundwater at certain locations is unsuitable for potable use. The Tribe currently conducts daily turbidity measurements of water leaving the treatment plant as well as monthly coliform tests at various locations within the distribution system following federal SDWA guidelines. The Tribe complies with the U.S. Environmental Protection Agency (EPA) sampling requirements for annual and biannual water quality testing.

In addition, the Tribe conducts water quality sampling at 30 established locations within the South Fork Tule River watershed. The Tribe currently has a Quality Assurance Program Plan (QAPP), approved by EPA, to obtain and test these samples, as well as a Sampling and Analysis Program Plan (SAPP). The SAPP can be found in Appendix D. About one year ago, the Tribe was funded by EPA to expand the number of sampling locations, which now includes some locations near the proposed dam sites described in Section 5 of this report. The Tribe takes samples to test for various water quality parameters and also takes field readings for pH, turbidity, conductivity, temperature and bacteria. The Tribe expects to develop new QAPP and SAPP documents in the near future to cover the expanded sampling scope. The new QAPP is being developed following EPA guidelines, as documented in EPA QA/R-5, *EPA Requirements for Quality Assurance Project Plans* (http://www.epa.gov/quality/qs-docs/r5-final.pdf).

Water quality exceedances in the South Fork Tule River are generally from turbidity and bacteria. These exceedances are believed to result from nonpoint sources, primarily livestock grazing, with other likely contributors being construction earthwork activities, erosion and sedimentation from unpaved roads, septic tanks located near the river in areas of thin soils and/or shallow groundwater, and activities associated with road maintenance.

Although there are only limited sampling data from the South Fork Tule River near the proposed dam sites at this time, bacteria levels in the river are known to generally increase from upstream to downstream. Noticeable increases in bacteria concentrations occur at locations where there are greater numbers of houses and when river flows are low.

2.1.3 Groundwater Supply

Groundwater occurs in the shallow alluvial deposits along the main stem of the South Fork Tule River and in the cracks and fractures of the granite bedrock underlying the Reservation. Of the twenty-two (22) wells inventoried on the Reservation, only five are operational at this time. Wells were taken out of production due mainly to water quality problems and insufficient yields. Well yield is influenced by proximity to fractures and fissures in the local granite bedrock, but can be affected by the presence of underground limestone and marble. Yields of most wells drilled into the bedrock on the Reservation range from near zero to 50 gpm. The three wells that pump into the main public water system have capacities of 25 gpm, 10 gpm, and 30 gpm. Of the remaining two wells, one serves the Apple Valley and the other serves the Cow Mountain area. Those wells have capacities of 17 gpm and 13 gpm, respectively.

Although groundwater availability on the Reservation is not adequate for large-scale agriculture potential, groundwater yields may be adequate to meet a portion of future domestic water demand.

The quality of water in local wells is an issue. Approximately 30-percent of the 280 septic systems on the Reservation are approaching a state of failure with a few already discharging to the surface. Most developed wells either lack an annular seal or have one that is not sufficiently deep to protect the well. Wells are located in areas close to grazing lands, near buildings and areas of human activity, or close to septic systems. Most of the wells are old, have a variety of pumps and piping, and are maintained only when problems occur.

2.1.4 Water Treatment System

River water, delivered through a ten inch pipe at an upstream location, is not metered. An older turbine meter installed above the plant inlet has become non-functional. The plant is old, but has been upgraded with limited new equipment.

The Tribe's water treatment plant was upgraded in 2004-05 to increase its capacity from 150 gpm to approximately 300 to 350 gpm. The projected maximum day demand for the Reservation is approximately 1,050 gpm. The Tribe’s water treatment plant currently has the capacity for 501,700 gallons per day 562 acre-feet per year at maximum production. This limit along with the unreliable water supply constrains current water usage and future development on the Reservation. The Tribe typically tries to run the treatment plant at maximum capacity and uses wells to help make up any shortfalls.

2.1.5 Water Storage and Distribution System

The overall water system is not considered to be adequate to meet current Tribal needs. Water cannot be delivered to all homes on a year-round basis. Some homes do not have water supply in the early summer months because of inadequate supply and distribution system capacity issues. Water shortages are becoming increasingly common as more and more tribal members move back to the reservation into new homes. There is not enough water to meet the demand, especially in the summer. The Tribe's Public Works Department has issued water conservation notices for the last five years, requesting that tribal members use water sparingly, and report leaks, to prevent shortages to the domestic water supply. Despite these notices, tribal members still continue to run out of water every year. The outages vary from one day to one week. There is no “gray water” system presently on the Reservation, although discussions aimed at developing one have begun.

The water storage system consists of a series of tanks ranging in size from 3,000 gallons to 200,000 gallons. The tanks do not function as a coordinated storage system and, in some cases, were improperly designed. Plans are underway to add a new 400,000 gallon tank, to be interconnected with two existing smaller tanks. The new tank would serve a proposed Justice Center, which will soon be under construction. It should be noted that this new tank provides for only some short-term development on the Reservation and is not adequate to serve the Tribe’s long-term development plans. The water storage system is not regularly monitored for water in storage or for structural conditions.

The distribution system consists of ±50-year-old, 4-inch-diameter asbestos cement pipe and includes 6- and 8-inch-diameter pipes of varying ages. Some of the pipes have deteriorating seals, cracked or eroded sections and occasionally poorly constructed house connections. The system is relatively unmonitored although the system is monitored visually for signs of leakage.

House connections are generally 1-inch-diameter, although more than one home may be served by a single connection. One 2-inch-diameter connection system was found to be serving at least five houses.

Individual houses are not metered. They are also not inspected for leaking pipes and/or fixtures. A significant amount of water may be lost due to system leakage; however, the absence of metering makes the quantity of loss very difficult to estimate.

The storage capacity is not adequate to meet peak use domestic consumption and fire flow demands. Even with direct pumping, insufficient water is available for a major structure fire. Grass fires are routine during the summer, but often require the use of potable resources.

3.0 Future Population and Water Demand

3.1 Current Population

While recent Tribal population data from the Tribe, U.S. Bureau of Census and Bureau of Indian Affairs (BIA) are inconsistent, together they indicate that as of December 2012 approximately 1,200 people lived on the Reservation, including an estimated 235 non-tribal members. As of December 2012, the total enrolled membership of the Tribe was 1,720 people. Therefore, an estimated approximately 56-percent of the Tribe's members presently live on the Reservation.

3.2 Future Population

To a large extent, the existing and future water needs on the Reservation correlate directly to the Reservation's population. In conformance with the provisions and goals of the negotiated water rights settlements, and therefore for purposes of this study, the future water needs on the Reservation are based on a 100-year population projection beginning in the year 2013.

The potential Reservation population was estimated because the overall intent of the needs assessment analysis is to estimate the quantity of water the Tribe would require in the year 2112 to create a homeland for all its peoples. As such, population projections and water demand were calculated such that all Tribal members, and associated non-tribal members, could live on the Reservation if they chose to do so. Water demand quantities calculated are sufficient to meet the domestic, commercial, municipal, industrial and agricultural water needs of the Tribe as a whole. To perform the population projection analysis, demographic data for the Tribe was obtained from the Tribe, U.S. Census Bureau, BIA, Tulare County and Indian Health Services (IHS).

A cohort-survival model was used to estimate the potential population of the Reservation in the year 2112. Such a model is designed to project the evolution of a community's population based on its initial size and age structure in combination with information on the population's recent female member average birth rates for different child-bearing age ranges, and the population's recent mortality rates by age.

The model starts with a community's current female population broken down by age and applies birth rate estimates by age cohort to estimate the number of births that will occur in the first year of the projection. The estimated number of births is then divided between males and females based on the overall proportion of males to females within the community's current population. The female population is then shifted forward one year and the estimated number of female births added in the age zero slot. The female population in each year is also adjusted to account for expected mortality. The same calculation of births and shifting of the population is done 100 times to develop a projection of the community's female population 100 years out. Concurrently, the community's current male population is shifted forward each year over 100 years adding the estimated male births generated from the female population model and adjusting to account for estimated mortality.

Based on the data obtained from these sources, and as noted earlier, it was estimated that at the end of 2012 the Tribe's total membership was 1,720 people. This total was then broken down by sex and five year age cohort based on recent demographic data for the Tribe published by the U.S. Census Bureau. Tulare County county-wide average birth rates (from the U.S. Census Bureau) in combination with recent Tule River Tribe mortality data provided by the Tribe was then applied to this population breakdown to project the Tribe's membership population year-by-year through the year 2112 applying a cohort-survival projection framework. Birth rate assumptions were not derived from birth rate data provided by the Tribe because that data lacked the necessary level of detail for inclusion in the analysis. Tulare County county-wide birth rate trends reflect a generally higher standard of living than historically experienced by the average Tule River tribal member living on the Reservation. As the Tribe further develops its reservation's economy, particularly due to the continued success of its gaming operations and, importantly, acquires a reliable potable water supply, it would be expected that the Reservation's standard of living will quickly improve to a level comparable to surrounding non-Indian communities. Accordingly, the Tulare County birth rate data is presumed to be a reasonable reflection of the future birth rates that will be realized by the Tribe.

The cohort-survival model indicates that by the year 2112 the Tribe's total membership will reach about 6,035 people. This translates to an average annual cumulative rate of growth of 1.3-percent over the 100 year projection period. This rate of growth is consistent with the U.S. Census Bureau's recent long-term population growth projections for Native Americans for the United States as a whole.[1] In addition, there are currently an estimated 235 non-tribal members living on the Reservation. This means that there is approximately one non-member living on the Reservation for about every seven tribal members (living both on and off the Reservation). Assuming the ratio holds into the future, this translates to an estimated 825 non-members living on the Reservation in the year 2112 (a conservative number as it does not give weight to off-Reservation members who may have non-member family now or in the future). Thus, the total potential population of the Reservation in the year 2112 is projected, on the low end, to reach approximately 6,860 people. On the high end, factoring in off-Reservation tribal members with non-member family, the total population is projected to reach approximately 7,495 people.

Data from the U.S. Census Bureau's 2010 Census of Population indicates that the Indian population on the Tule River Reservation averaged about 3.5 persons per household and that

[1] In 2010 the U.S. Census Bureau projected that the Alaska and Native American population of the United States would increase from an estimated approximately 3.2 million to almost 5.5 million by the year 2050. This translates to an annual average cumulative rate of growth of 1.35% over the 40 year projection period.

there were 476 single and multi-family housing units on the Reservation (U.S. Census Bureau, 2010). Using this rate as representative of average future residential occupancy on the Reservation, it is estimated that in the year 2112 approximately 1,960 homes will be needed to accommodate all of the Reservation's minimum projected potential population of 6,860 people.

3.3 Reservation Water Needs

The following analysis is based upon a projected population of 6,860 people. Future Reservation water needs are separately evaluated by water use category: Domestic, Commercial, Municipal, Industrial, and Agricultural.

3.3.1 Domestic Water Use

The Tribe's on-Reservation future domestic water needs will depend directly on the Reservation's future population. According to tribal representatives, many tribal members desire to live on the Reservation are unable to do so because of a lack of on-Reservation housing. Historically, available housing on the Reservation has fallen well short of demand. Consequently, construction of new housing has long been a priority of the Tribe. Working with the Department of Housing and Urban Development (HUD) and other funding sources, the Tribe has developed several housing programs for its members and designated over 2,000 acres of Reservation land for future housing development. New housing continues to be built, but the rate of construction is inadequately low and primarily limited by insufficient available water supply.

3.3.1.1 Indoor Water Demand

Brown and Caldwell (1984) conducted a study for HUD and estimated indoor water use by homes with no water-conserving devices averages 78 gallons per capita per day (gpcd), while those with high-efficiency conservation devices average 60 gpcd (Wilson, et al., 2003). The California Department of Water Resources (CDWR) reports that overall interior water use in California remained near an average of 80 gpcd during the 1980's (CDWR, 1994a). The Reservoir does not require water conservation devices in residences and it is therefore assumed that 80 gpcd is a reasonable estimate of the future average indoor water use of Reservation residents.

Accordingly, and based on a projected total potential population of 6,860 people, the year 2112 average indoor residential water needs of the Reservation are estimated to be approximately 548,900 gallons per day (615 acre-feet per year).

3.3.1.2 Outdoor Water Demand

In addition to indoor water use, each Reservation household should have sufficient water available to it for outdoor purposes, including gardens and landscape irrigation.

A study of 20 residences in Las Cruces, New Mexico reported irrigated land ranged from 3,328 square feet to 5,219 square feet per household (Wilson et. al., 2003). The water claim negotiated for the Jicarilla Apache Reservation was based in part on an irrigated area of 3,200 square feet per household (Jicarilla Apache Indian Reservation, no date). Based on these figures it is assumed that households on the Tule River Indian Reservation will average 3,500 square feet (0.08 acres) of garden and/or irrigated area. This may prove conservative since the availability of land within areas of the Reservation designated for future residential development is significant.

According to the work of Natural Resources Consulting Engineers (NRCE), the cultivation of turf on the Reservation's lower areas has an average crop water requirement of 4.3 acre-feet per acre per year (NRCE, 2012). Based on this figure, the estimated annual year 2112 household outdoor (landscape/garden) water needs of the Reservation are estimated at approximately 674 acre-feet per year.

In addition to landscape/garden water use, many tribal households use residential water for small-scale stock watering. In the mid-1990's it was estimated that about 100 horses were provided water from the community water system on the Reservation. This is about one horse for every two reservation households at that time (Dabney, 1996). A more current estimate of the Reservation's horse population is not available. Horses require approximately 12 gallons of water per day (U.S. Department of Agriculture, 1983). Therefore, assuming that the historical ratio of about one horse to every two houses remains unchanged into the future, it is anticipated that in the year 2112 approximately 980 horses will live on the Reservation. Therefore, it is estimated water demand for horses is about 11,760 gallons per day (13.2 acre-feet per year).

3.3.1.3 Total Domestic Water Demands

In summary, the total projected year 2112 combined indoor and outdoor domestic water needs of the Tule River Reservation are approximately 1,302 acre-feet per year (about 0.66 acre-feet per year per household).

3.3.2 Commercial Water Use

Presently, commercial development on the Reservation is limited to the Tribe's casino and a few small sundry/grocery outlets. However, in the future, with continued population growth and increased visitation to the Reservation it is anticipated that on-Reservation commercial services, such as a gasoline station and larger grocery store, will be developed. In its 1997 economic development plan, the Tribe identified several commercial ventures it proposes to implement on the Reservation such as a laundromat and larger grocery store (Overall Economic Development Plan, 1997). In addition, the Tribe may pursue commercial development on tribal land south of the current Reservation.

According to the CDWR, commercial water uses represent about 20-percent of total municipal water use in the Tulare Lake region of California or about 30-percent of domestic use (CDWR, 1994b). It was assumed that the Reservation's future commercial water needs will be 30-percent of its domestic needs or about 391 acre-feet per year of water in the year 2112.

3.3.3 Municipal Water Use

The municipal water needs assessment is broken down into two categories: general municipal needs and fire protection needs.

3.3.3.1 General Municipal Demand

The Tule River Tribe owns and operates administrative and community buildings and infrastructure that use water. Furthermore, the Tribe needs water to provide vital services to its residents such as street and sewer cleaning, infrastructure construction, and maintenance. There is very little available data on current general municipal water use on the Reservation, and the information which is available is mostly anecdotal. The existing community water system provides water to approximately ten tribal buildings, including the Tribe's council offices and health clinic. In 1996, the Tribe estimated that the total average water use of Reservation structures connected to the community water system, including the Reservation's approximately 200 homes (at that time), ten public facilities and the Eagle Mountain Casino, ranged from about 125,000 to 455,000 gallons per day (Dabney, 1996), depending on the time of year. At the time, as is the case today, there were significant leaks, inefficiencies and metering inaccuracies in the water system such that the estimated actual water use excluding waste was extremely difficult to measure. Accordingly, data on actual general municipal water use on the Reservation does not provide an accurate basis for projecting future municipal water use with an efficient and metered water storage, treatment and delivery system. According to a 2010 report on water use in Canada, combined commercial and institutional water use is about 34-percent of domestic use (Environment Canada, 2010). Assuming, as discussed above, that the Reservation's future commercial water needs will equal 30-percent of its domestic needs, the Reservation's projected future general municipal water needs are assumed equal to 4-percent of its domestic needs based on the Canadian experience. The estimated year 2112 general municipal water on the Reservation is 52 acre-feet per year.

3.3.3.2 Fire Protection Demand

The Reservation lacks a community fire protection system using water tenders and fire personnel. Current urban fire protection services are provided to the Reservation by the Tulare County fire department using water trucks. In the past, this has proven inadequate. In 1996 the Reservation's tribal council and administrative building caught fire and the fire department response time was insufficient to prevent the building from burning.

The National Fire Protection Agency provides minimum standards for residential fire protection water supplies irrespective of structure dimension. In the case of single or multi-resident structures with exposure hazards like those found on the Reservation (i.e., brush and trees), the minimum fire protection water supply requirement is 3,000 gallons per residence. If there are 1,960 residences on the Reservation in the year 2112, the Reservation's minimum water supply needs for residential fire protection would be about 18 acre-feet per year.

Additional water supplies will also be necessary for the fire protection of non-residential structures such as the tribal council offices, housing office, casino, etc. This water is assumed included in the future general municipal water needs of the Reservation as estimated previously.

3.3.3.3 Total Municipal Water Demand

The projected total municipal water need of the Tule River Indian Reservation in the year 2112 is 70 acre-feet per year.

3.3.4 Industrial Water Use

The Tribe has on-Reservation mining development opportunities that will require the consumptive use of water once operational. The Tribe has designated approximately 405 acres of the Reservation land for mining and processing of the minerals limestone and dolomite and has an interest in developing a sand and gravel operation.

According to the Department of Energy (2003), water use in mining operations can be divided into three categories: mining, processing, and mineral conveyance. In most types of mining, relatively little water is used in actual ore extraction. Water is used in crushing, mainly for dust control. Screening, grinding, and milling can require significant amounts of water, depending on the scale of operation. Once ore is crushed, the mined product can be transported through a pipeline as aqueous slurry to a processing plant some distance away. Water use depends on the flow properties of the slurry and, in some cases, the purity or contaminants in the water used to prepare the slurry.

3.3.4.1 Mining: Limestone and Dolomite

Deposits of both limestone and dolomite (magnesium rich limestone) are located on the Reservation. Limestone is used by farmers as a soil amendment to reduce soil acidity and is used in glass manufacturing and as roofing gravel. The agricultural sector is a primary end-market for limestone. Dolomite has applications in agriculture and is commonly used as a cattle feed supplement because it is high in magnesium, an essential nutrient in growing and finishing cattle and for promoting cow gestation and lactation (National Research Council, 1996). Outside of agriculture, dolomite is used in fiberglass and steel production and as a softening agent in water treatment.

3.3.4.2 Mining: Sand and Gravel

The Tribe has also expressed interest in developing a sand and gravel operation on the Reservation and according to a 1978 report published by the BIA, the Tribe has developable areas of sand and gravel along the South Fork Tule River near the Reservation's western boundary. However, due to high transportation costs, most sand and gravel operations serve local and regional markets. Accordingly, sand and gravel mining on the Reservation would serve on-Reservation and nearby construction-related demand. Given the projected potential population growth of the Reservation and continued strong regional population growth, there may be a ready source of demand for future sand and gravel production on and near the Reservation.

3.3.4.3 Total Industrial Water Demand

There is no direct basis available to reasonably estimate the amount of water that may be required by the Tribe for its potential future mining activities on the Reservation due to a lack of information on the probable intensity of this mining and the amount of water required per unit of production or acre excavated. This noted, according to the USGS, water use for mining in California in 2005 was approximately 14.9-percent the amount of water used for domestic purposes (USGS, 2009). Applying this percentage to the projected year 2112 potential annual domestic water needs on the Reservation of 1,302acre-feet per year, the projected potential future industrial (mining)-related water needs of about 194 acre-feet per year.

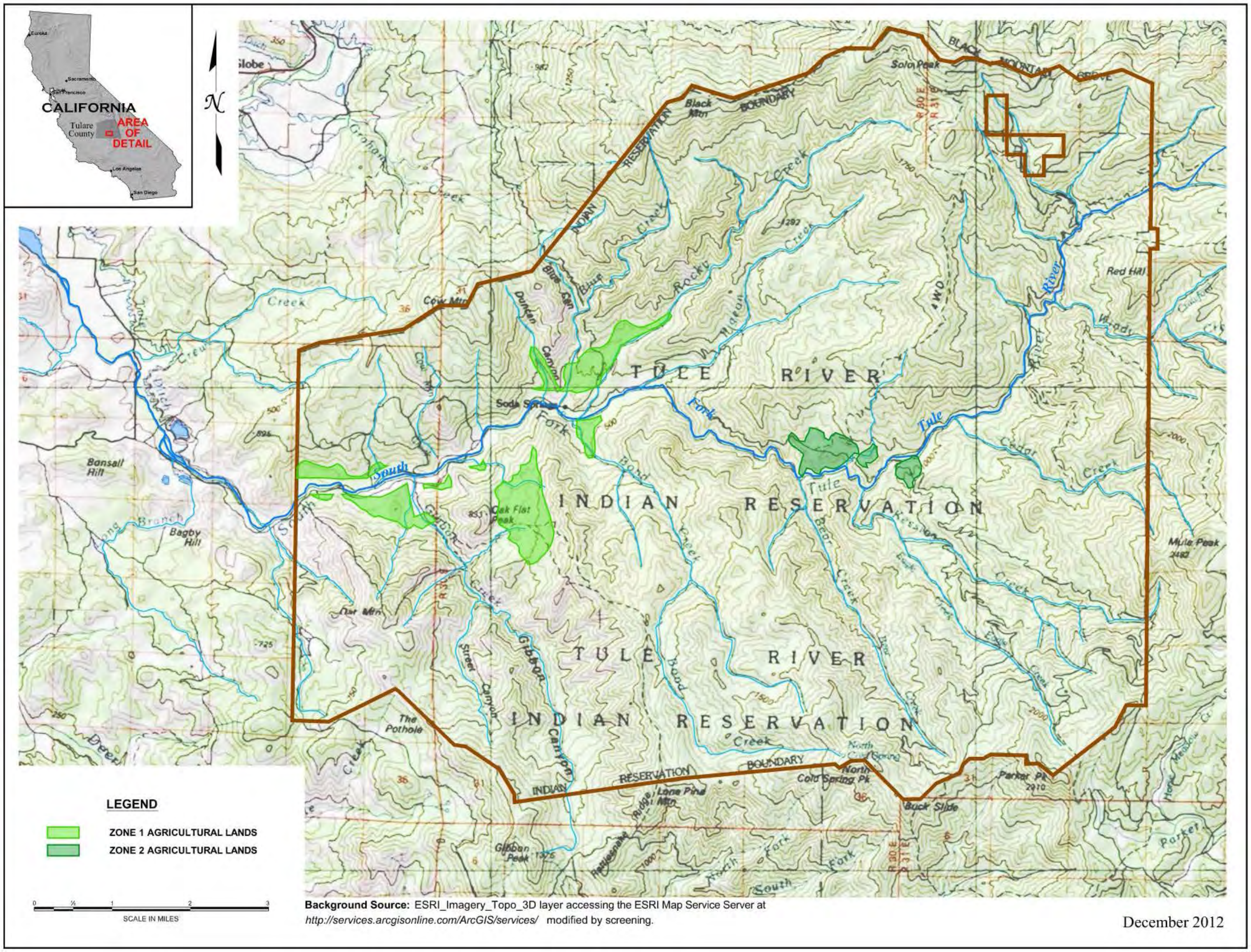
3.3.5 Agricultural Water Use

The Reservation has a significant resource base of arable land and timber resources which offer the Tribe significant economic opportunity. In the past, the development of the Tribe's natural resources, particularly its arable land base, has been largely constrained by a lack of a significant and reliable developed water supply.

3.3.5.1 Irrigation Water Demand

The Tribe has designated approximately 1,257 acres of the Reservation for irrigated agriculture. These lands are shown in Figure 3-1. Although there are additional lands on the Reservation that are also suitable for sustained irrigation, the Tribe has preliminarily designated those lands for other uses (such as housing, rangeland or open space). Should the Tribe decide in the future to convert more Reservation land to irrigated agriculture, its agricultural water needs would change accordingly.

Figure 3-1: Current Designated Agriculture Lands



The Tribe has identified a number of crops it may produce on its agricultural lands in the future including alfalfa hay, apples, olives, pistachios, grapes and Christmas trees. All these crops, except Christmas trees, are grown in large quantities in the region and have highly developed and accessible local marketing outlets.

For the purposes of this study, it is assumed that 50-percent of the Reservation lands proposed for agriculture will be planted in field crops and the other 50-percent in permanent crops. This cropping pattern is reasonably representative of the County-wide cropping pattern. The representative field crop selected for this evaluation is alfalfa. The representative permanent crops consist of an equal amount of pistachios, olives, and wine grapes.

The total annual diversion requirements for each of the representative crops were determined by NRCE as reported in a separate memorandum (NRCE, 2012). The weighted average diversion requirement for the cropping pattern described above is 48.9 inches (4.08 acre-feet per acre). Multiplying this diversion requirement by the 1,257 acres of designated irrigated agriculture on the Reservation yields a total annual diversion requirement at full production of about 5,129 acre-feet per year of water.

3.3.5.2 Livestock Water Demand

Livestock is a major sub-sector of the Tulare County agricultural economy and an important activity on the Reservation. According to the Tribe, there are about 1,000 head of cattle on the Reservation. These 1,000 cattle fully utilize the capacity of Reservation lands designed for grazing. It is anticipated that the quantity of range land on the Reservation will not change in the future, and therefore, the number of cattle on the Reservation in the year 2112 will remain at 1,000 head. Typically one animal-unit requires between 10 and 15 gallons of water per day depending on conditions (U.S. Department of Agriculture, 1983). Assuming an average water requirement for cattle at the upper end of this range, the total annual water needs of range cattle on the Reservation is estimated at approximately 17 acre-feet per year.

3.3.5.3 Total Agricultural Water Demand

The projected agricultural water needs of the Tule River Indian Reservation will be about 5,146 acre-feet per year.

3.3.6 Total Future Reservation Water Demand

The total estimated future consumptive water need of the Tule River Indian Reservation in the year 2112 is 7,103 acre-feet per year as shown in Table 3-1. This water quantity is based on reasonable projections of future potential Reservation population growth and economic development.

Table 3-1: Estimated Future Tribal Water Demand

Water Need	Projected Water Need (acre-feet per year)
Domestic	1,302
Commercial	391
Municipal	70
Industrial	194
Agricultural	5,146
Total	**7,103**

4.0 South Fork Tule River Historical and Extended Streamflow Records

4.1 General

The Reservation is drained almost entirely by the South Fork Tule River, which constitutes the surface water supply available to the Tribe. Because the Reservation incorporates the majority of the headwaters of the South Tule River, the Tribe has historically had access to the un-depleted flow of the river.

Four streamflow gages are located on the South Fork Tule River near the Reservation boundary. The Tribe, in conjunction with the USGS, arranged for the installation and operation of Gages 11203580 and 11204100. These gages went online on different dates, but the period when both gages are recording has been continuous since October 1, 2000. Streamflow data are available for the period of October 1, 2000 through September 30, 2011 (2001-2011 water years). Table 4-1 lists the existing and discontinued stream gages on the South Fork Tule River along with the average annual flow recorded at those gages.

Table 4-1: Stream Gages on the South Fork Tule River

Gage No.	Gage Name	Period of Record (Complete Water Years)	No. of Years of Complete Record	Average Flow (acre-feet per year)
11204500	South Fork Tule River near Lake Success	1931 – 1954 1957 – 2011	79	32,800
11204000	South Fork Tule River near Porterville	1911 – 1916 1919 – 1921 1928 – 1932	14	25,100
11204100	South Fork Tule River near Reservation Boundary near Porterville	2001 – 2011	11	26,400
11203580	South Fork Tule River near Cholollo Campground near Porterville	2001 – 2011	11	12,400

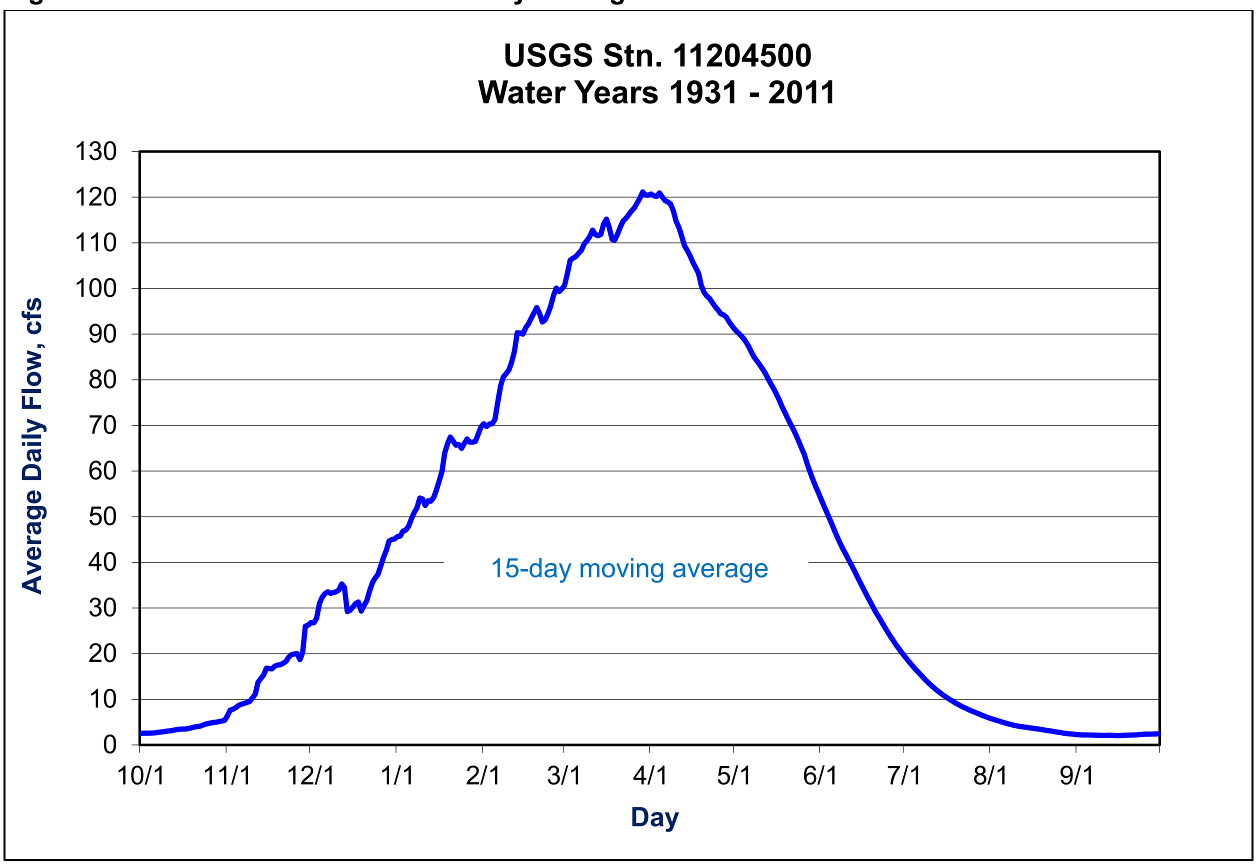
Gage 3580 is located on the South Fork Tule River above the Cedar Creek confluence near the Cholollo Campground. Gage 4100 measures the streamflow of the South Fork Tule River near where it exits the Reservation. Gage 4100 is located near the discontinued Gage 4000, which was located on the Reservation upstream of the Gibbon Creek confluence. Records from Gage 4000 exist intermittently over water years 1911 to 1932.

The only long-term gage on the South Fork Tule River is Gage 4500, "South Fork Tule River near Lake Success", which is located 3.2 miles downstream of the Reservation boundary. The USGS operated the gage from water year 1930 to water year 1990. After that period, the U.S. Army Corps of Engineers (COE) took responsibility for the gage. The COE uses flow data from Gage 4500 to assist in operating Lake Success Dam. The streamflow records include 79 complete years of data, which include records overlapping the entire periods of record for Gages 4100 and 3580.

4.2 Streamflow Characteristics

Figure 4-1 shows a 15-day moving average of the average daily streamflow of the South Fork Tule River. The daily average streamflow follows a distinct seasonal pattern typical of rivers along the western Sierra Nevada Mountains. Beginning around November, streamflow increases with increasing precipitation. Peak flows generally occur around the end of March, representing the peak runoff from snowmelt. As temperatures increase and precipitation decreases during summer months, streamflow rates steadily drop until reaching minimum flows around September. The average September streamflow is approximately 2-percent of the average streamflow in March.

Figure 4-1: South Fork Tule River Daily Average Streamflow



4.3 Streamflow Extension

In order to thoroughly examine the hydrology of the South Fork Tule River basin, it is desirable to extend the record of the two on-Reservation gages over a longer period than the actual recorded data. Extending the flow records at the gages helps to ensure that they contain sufficient variation in flows to be representative of the long-term hydrology in the basin and is useful for planning purposes - such as the sizing of a future reservoir.

The period of record for the two on-Reservation gages covers complete water years 2001-2011 (eleven years). Through the flow extension analysis the period of record at both gages is increased to the period covering water years 1949 to 2011. Water years 1955 and 1956 are excluded due to missing data. The extended period of record is 61 years.

4.3.1 Streamflow Record Extension of Gage 4100

The record of Gage 4100 is extended using the data from Gage 4500. Figure 4-2 plots the measured streamflow at Gage 4500 against the corresponding measured flow at Gages 4000 and 4100 for the entire overlapping period of record (1931-32, 2001-11)[2]. Close examination of this figure reveals changes in the relationship between the two locations at different flow magnitudes. In order to best capture the correlation between flows at Gage 4500 and the western Reservation boundary, the flow records were split up into three ranges generally corresponding to low, medium, and high flow ranges as determined by the flow magnitude at Gage 4500 (Table 4-2). This was done to better represent the behavior of the river under the range of flow conditions typically experienced.

[2] Flow data from Gages 4100 and 4000 are used to represent a single location in this analysis, which is essentially the river near the western Reservation boundary.

Figure 4-2: Flow at Gage 4500 v. Gage 4000/4100 (≤ 300 cfs), WY 1931, 1932, 2001-2011

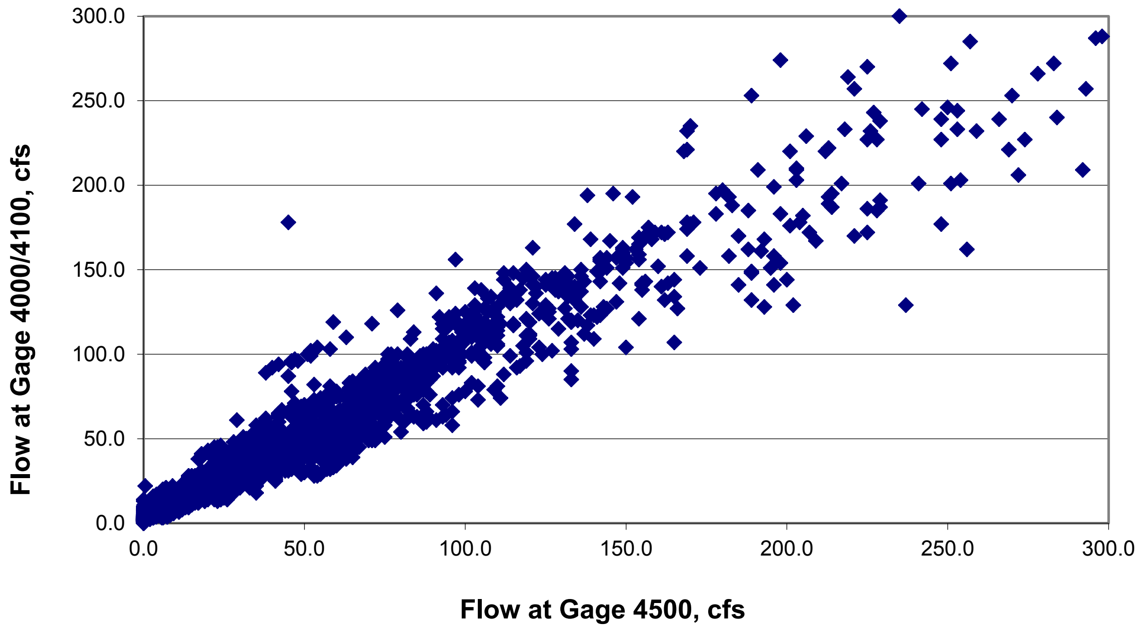


Table 4-2: Flow Ranges for Extension of Gage 4100

Flow Range	Flow Limits*
Low	$Q_{4500} \leq 5$ cfs
Medium	5 cfs < $Q_{4500} \leq 60$ cfs
High	$Q_{4500} > 60$ cfs

*Q_{4500} is the daily discharge at Gage 4500, in cfs.

4.3.1.1 Low-Flow Record Extension

Low flows, defined as flows at Gage 4500 less than or equal to approximately 5 cfs, are highly influenced by seepage and depletion by riparian vegetation. In addition, the South Tule Independent Ditch Company (STIDC) is capable of diverting most, if not all, of these low flows during certain times of the year. While there are numerous days of recorded zero flow at Gage 4500, there are very few days of zero flow at Gage 4000 and no recorded days of zero flow at Gage 4100. Therefore, poor correlation exists for the low-flow range (Figure 4-3) making regression techniques impractical. Instead, the average daily flow value at Gage 4100 was estimated for each month during those days when the flow at Gage 4500 was less than or equal to 5 cfs and assigned these average low-flows under the same flow conditions. These average low-flow values are listed in Table 4-3. For February and March, there were no recorded instances of flow less than or equal to 5 cfs at Gage 4500 during the overlapping period of record. For these two months, the average low-flow value was estimated as the average of the January and April values.

Figure 4-3: Flows at Gage 4500 v. Gage 4000/4100 (< 5 cfs), WY 1931, 1932, 2001-2011

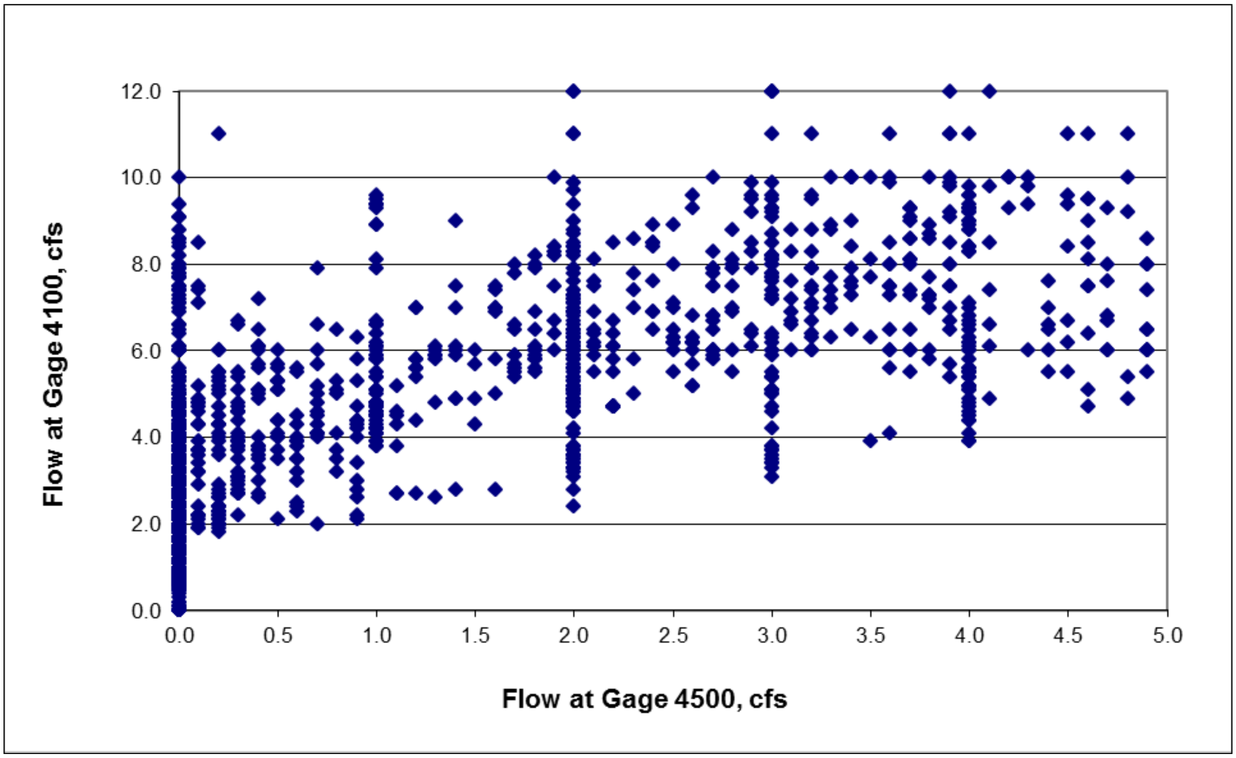


Table 4-3: Average Daily Low-Flows for Extension of Gage 4100, cfs

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
4.2	5.0	6.0	7.4	7.8*	7.8*	8.2	6.7	6.3	4.6	3.3	3.3

*February and March low flows estimated as average of January and April values.

4.3.1.2 Medium Flow Record Extension

For medium flows (5 cfs < Q_{4500} < 60 cfs), the natural logarithm transformed regression was used in the following form (Maidment, 1993):

$$\hat{Q}_{4100} = e^{\left(k + bX + 0.5s^2\right)}$$

where: $\hat{Q}_{4100}$ = *Estimated daily flow at Gage 4100, cfs*
X = *Natural log of daily flow at Gage 4500, ln(Q_{4500})*
k = *Regression constant = 0.444*
b = *Regression coefficient = 0.880*
s^2 = *Standard error of regression = 0.0580*

The R^2 factor is a regression parameter that indicates the goodness of fit of the regression equation measured against the actual data. An R^2 of 1 indicates that the flows at Gage 4100 are correlated perfectly with flows at Gage 4500, while an R^2 of 0 indicates no relationship between the flows at the two gages. The R^2 value for the medium flow regression analysis is 0.86.

4.3.1.3 High Flow Record Extension

For high flows ($Q_{4500} > 60$ cfs), Gage 4100 was extended using normal linear regression in the following form:

$$\hat{Q}_{4100} = k + bQ_{4500}$$

where:
$\hat{Q}_{4100}$ = *Estimated daily flow at Gage 4100, cfs*
Q_{4500} = *Daily flow at Gage 4500, cfs*
k = *Regression constant = 5.22*
b = *Regression coefficient = 0.955*

The R^2 value for the high flow regression analysis is 0.88.

4.3.2 Streamflow Record Extension of Gage 3580

Examining the eleven complete years of overlapping data for Gages 4100 and 3580 reveals that although the flows at the two gages are closely related, there is a systematic difference that should be recognized. Figure 4-4a, 4-4b, 4-4c and 4-4d display the daily flow at Gages 3580 and 4100 for water years 2001 through 2011. The figures show that streamflows at the two gages generally follow the same pattern but differ in magnitude. Analysis of the data reveals a two-season relationship. The first season corresponds to the rising limb of the hydrograph, typically November up to the beginning of May, at which time the flow peaks. During this period, the flows at Gage 4100 are consistently larger than the flows at Gage 3580. The second season occurs during the falling-limb of the hydrograph, typically May through October. During this period, the relative magnitude of flows at Gage 4100 rapidly declines and closely approximates the flow at Gage 3580 by mid- to late-summer. Figures 4-5 and 4-6 plot the daily flows at Gage 4100 against the corresponding flows at Gage 3580 for the rising-limb and falling-limb seasons, respectively.

This two-season relationship occurs because during the winter and spring leading up to the year's peak flow (i.e., the rising-limb of the hydrograph), flow is predominantly snowmelt and there are contributions from most of the tributaries, including those between the two gages. Thus, flow increases as you move downstream. During the falling-limb season, most of the flow transitions from snowmelt to base flow and there is likely significant depletion by riparian vegetation relative to the flow. Contributions from the lower tributaries during this time (mainly the summer and early fall) are minimal.

Separate regression equations for the rising-limb and falling-limb seasons were used to account for the variations between the two-seasons. During the transition between the rising-limb to the falling-limb, the regression equations are applied on a weighted basis each year during a three-day transition period (April 30 to May 2). Table 4-4 shows the ratio of the regression equations used during the transition period. No transition period was found to be necessary between the two periods at the end of October.

Figure 4-4a: South Fork Tule River On-Reservation Daily Gage Flow (WY 2001-2003)

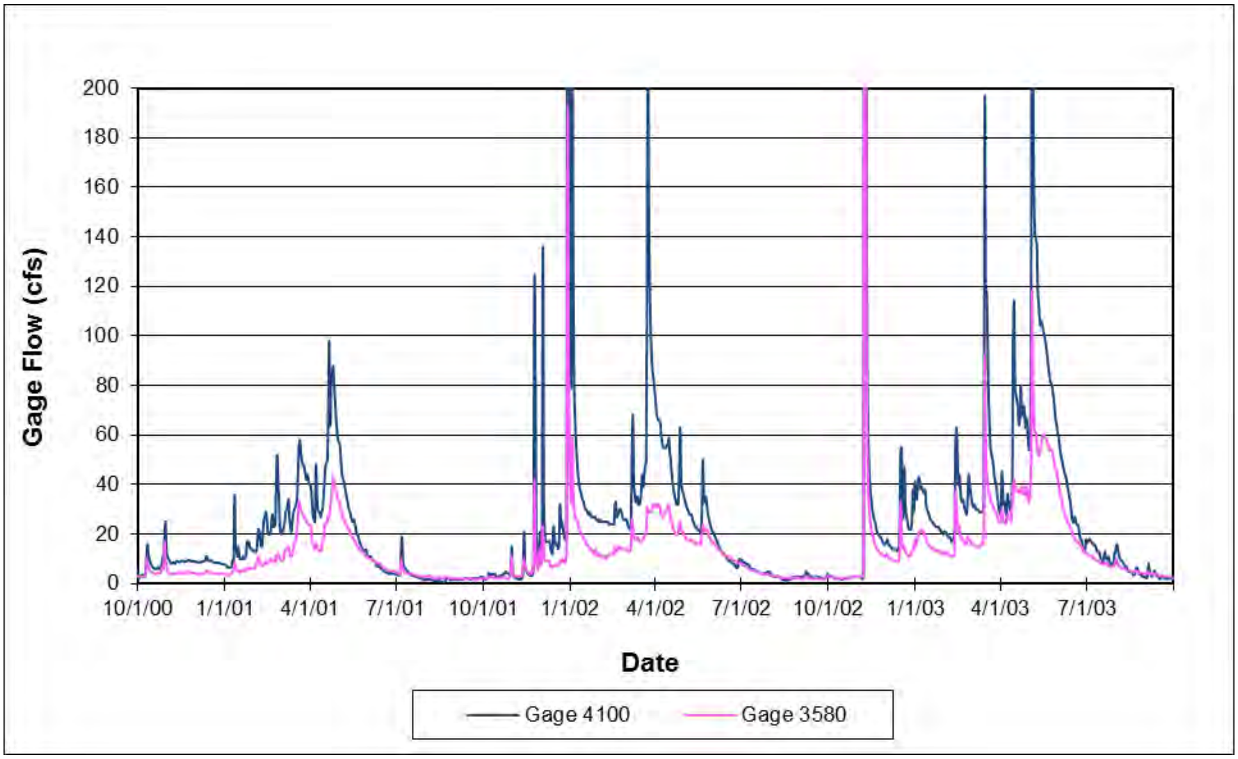


Figure 4-4b: South Fork Tule River On-Reservation Daily Gage Flow (WY 2004-2006)

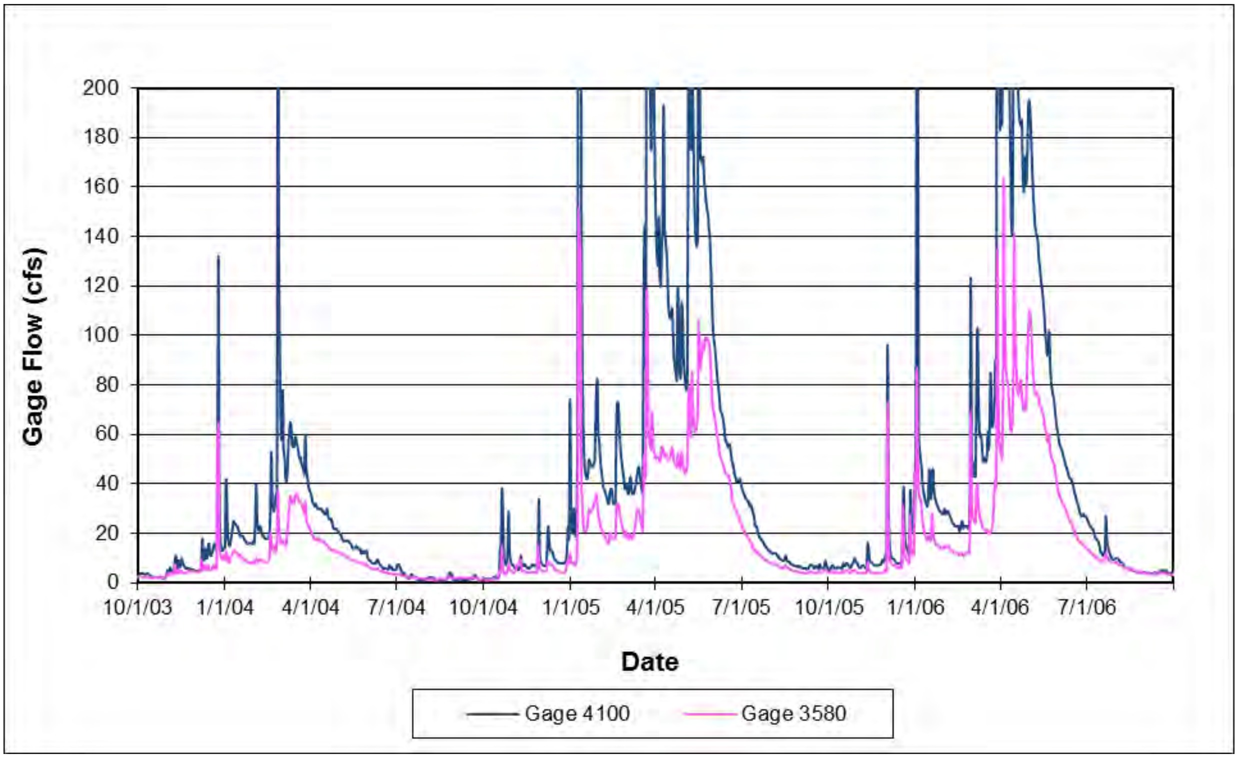


Figure 4-4c: South Fork Tule River On-Reservation Daily Gage Flow (WY 2007-2009)

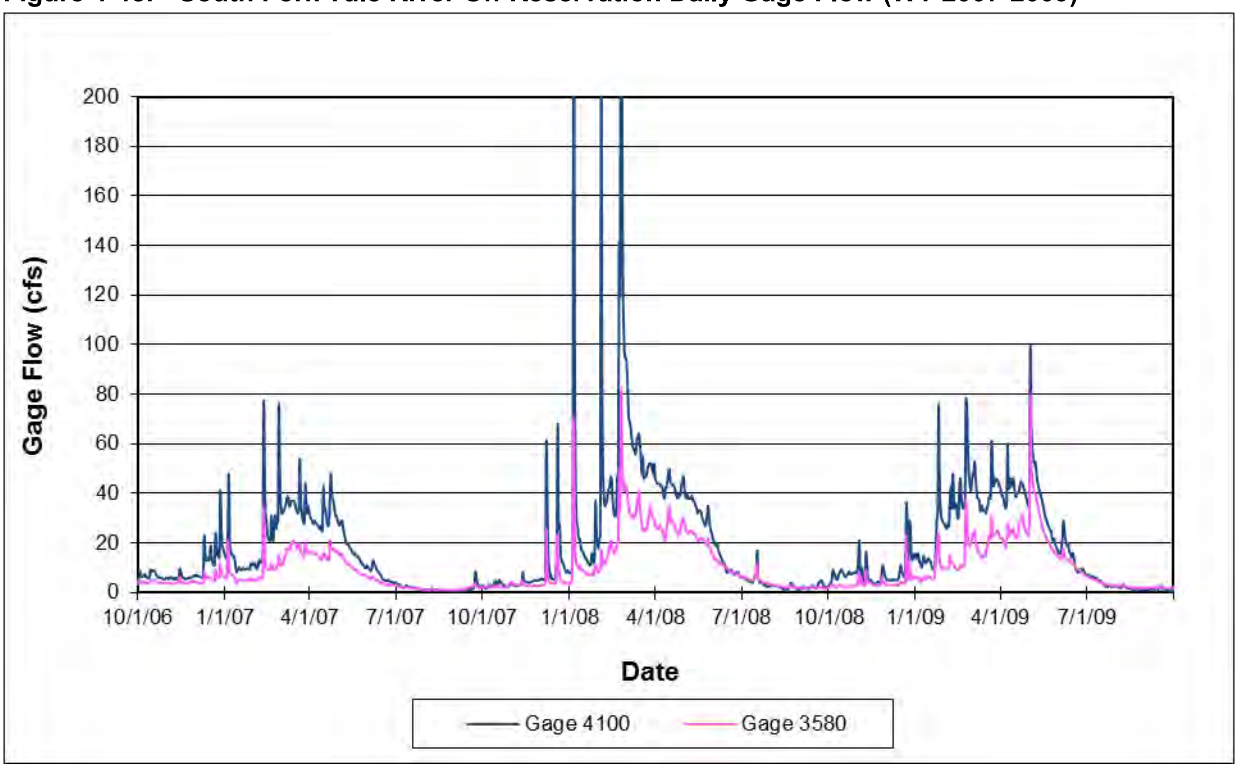


Figure 4-4d: South Fork Tule River On-Reservation Daily Gage Flow (WY 2010-2011)

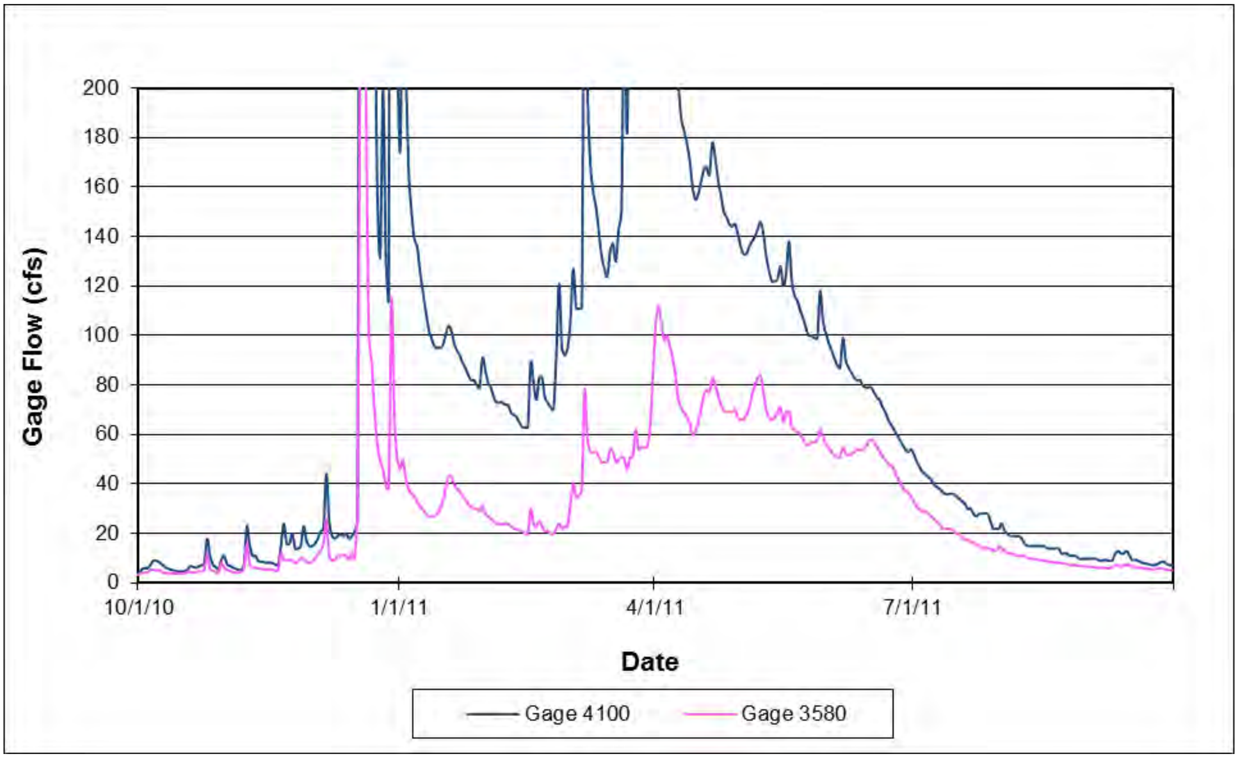


Figure 4-5: Flow at Gage 4100 v. Gage 3580, Rising-Limb Season, WY 2001-2011

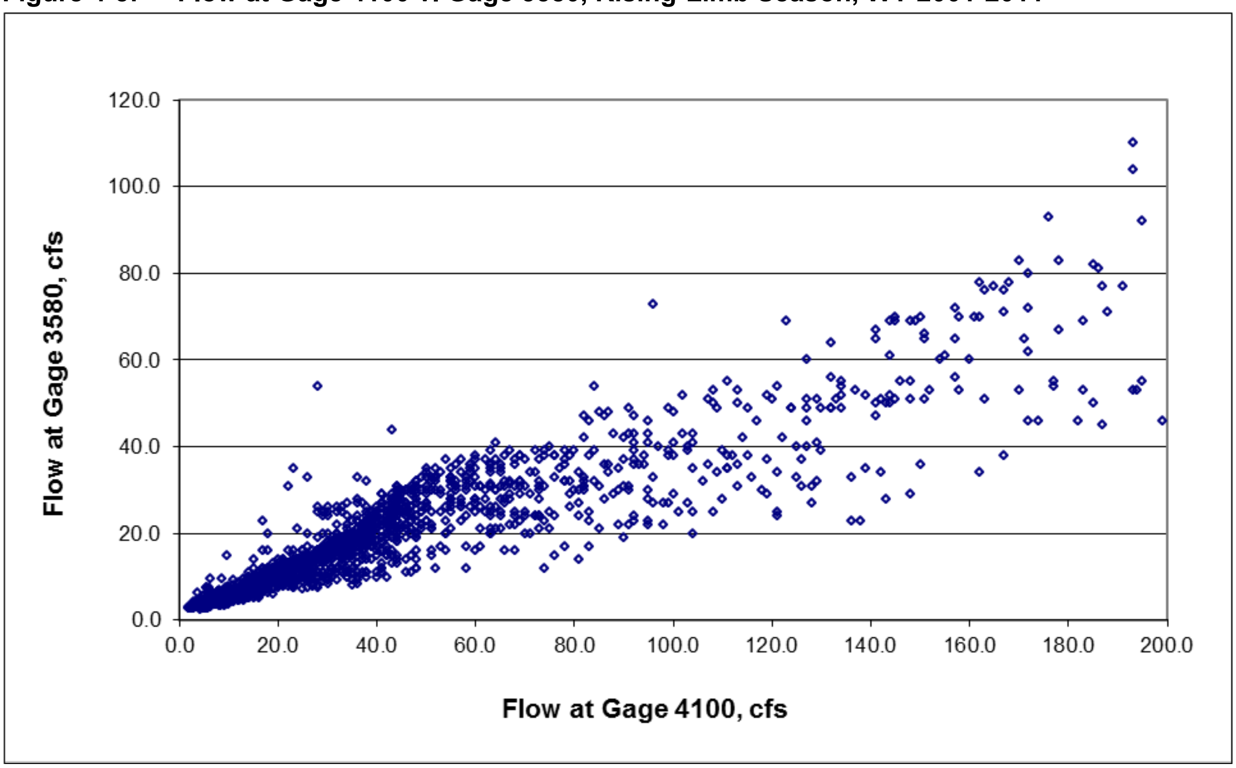


Figure 4-6: Flow at Gage 4100 v. Gage 3580, Falling-Limb Season, WY 2001-2011

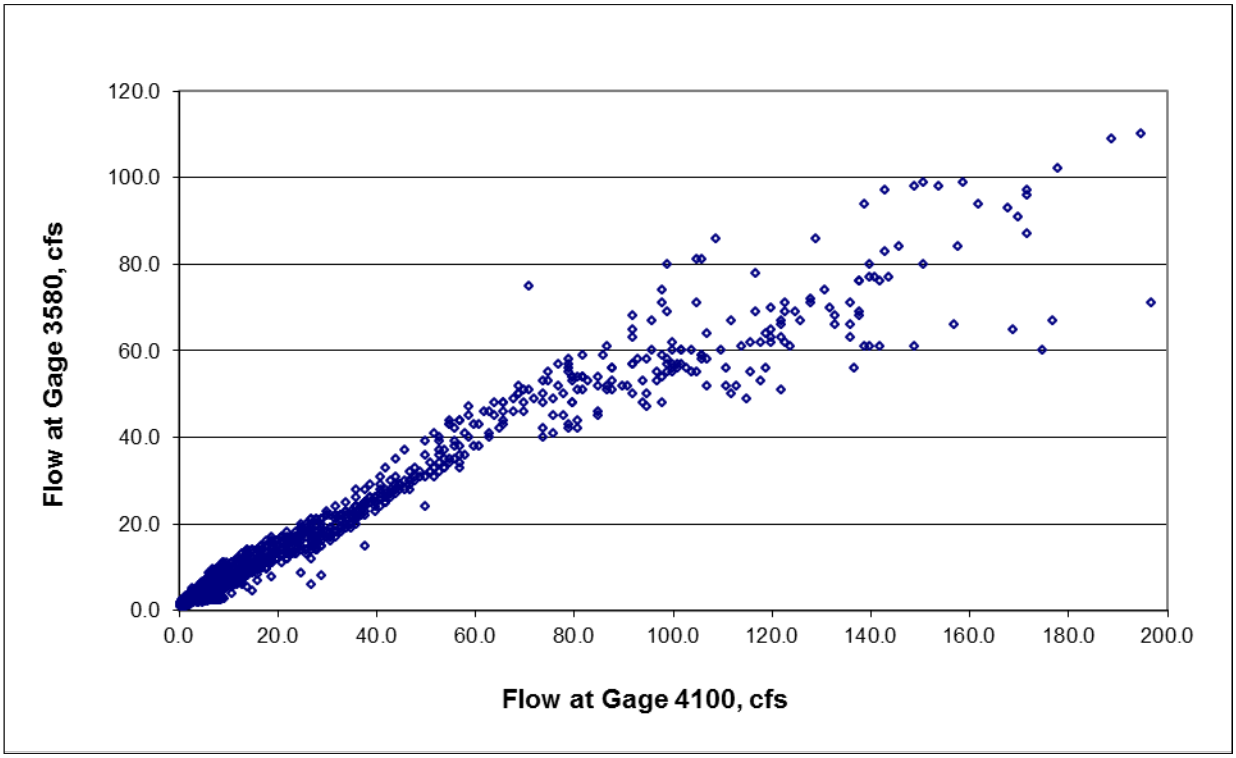


Table 4-4: Ratio of the Regression Equations applied during the Transition Period.

Transition Date	Ratio High Flow : Low Flow
April 30	2:1
May 1	1:1
May 2	1:2

4.3.2.1 Rising- and Falling-Limb Regression Equation Analysis

At Gage 3580, the flows are separated into rising-limb and falling-limb ranges. The rising-limb season is considered from November 1 to April 30 and the falling-limb season from May 1 to October 31.[3] For each of these two parts, a regression relationship was developed to best fit the observed data.

[3] Since the regression equations are applied on a ratio basis for the transition period from April 30 to May 2, these three days are included in both the rising-limb and falling-limb regression analyses.

4.3.2.2 Rising-Limb Season

For the rising-limb season, Gage 3580 was extended using natural logarithm transformed regression in the following form (Maidment, 1993):

$$\hat{Q}_{3580} = e^{\left(k + bX + 0.5s^2\right)}$$

where:

$\hat{Q}_{3580}$ = *Estimated daily flow at Gage 3580, cfs*
X = *Natural log of daily flow at Gage 4100, ln(Q_{4100})*
k = *Regression constant = -0.032*
b = *Regression coefficient = 0.796*
s = *Standard error of regression = 0.067*

The R^2 value for the Part A regression analysis is 0.92.

4.3.2.3 Falling-Limb Season

For the falling-limb season, a second order regression relationship was applied in the following form:

$$\hat{Q}_{3580} = k + b1Q_{4100} + b2(Q_{4100})^2$$

where:

k = *Regression constant = 0.614*
$b1$ = *First regression coefficient = 0.694*
$b2$ = *Second regression coefficient = -0.00116*

The R^2 value for the Part B regression analysis is 0.97.

4.3.3 Results

The flow characteristics for Gage 4100 and Gage 3580 resulting from the gage flow extension analysis are summarized in Table 4-5. Flows recorded at Gage 4100 are assumed to be approximately equal to the flows at the Reservation's western boundary.

Table 4-5: South Fork Tule River Extended Gage Flow Characteristics

Gage No.	Average Flow (acre-feet per year)	50% Exceedance Flow (acre-feet per year)	80% Exceedance Flow (acre-feet per year)
4100	33,900	23,100	12,000
3580	14,400	11,100	6,600

Note: Record extension period is WY 1949-2011, excluding 1955-56.

4.3.3.1 Gage 4100 Flow Extension

The predicted and measured flows for Gage 4100 are presented in Figure 4-7a, 4-7b, 4-7c and 4-7d. As shown in these figures, the flows predicted by the regression equations reasonably approximate the actual flows, although there are periods of both over- and under-estimation. It should be noted that for purposes of reservoir evaluation modeling, it is the low and medium flows that have the largest impact on reservoir sizing.

Figure 4-7a: Predicted versus Measured Flow at Gage 4100, WY 2001-2003

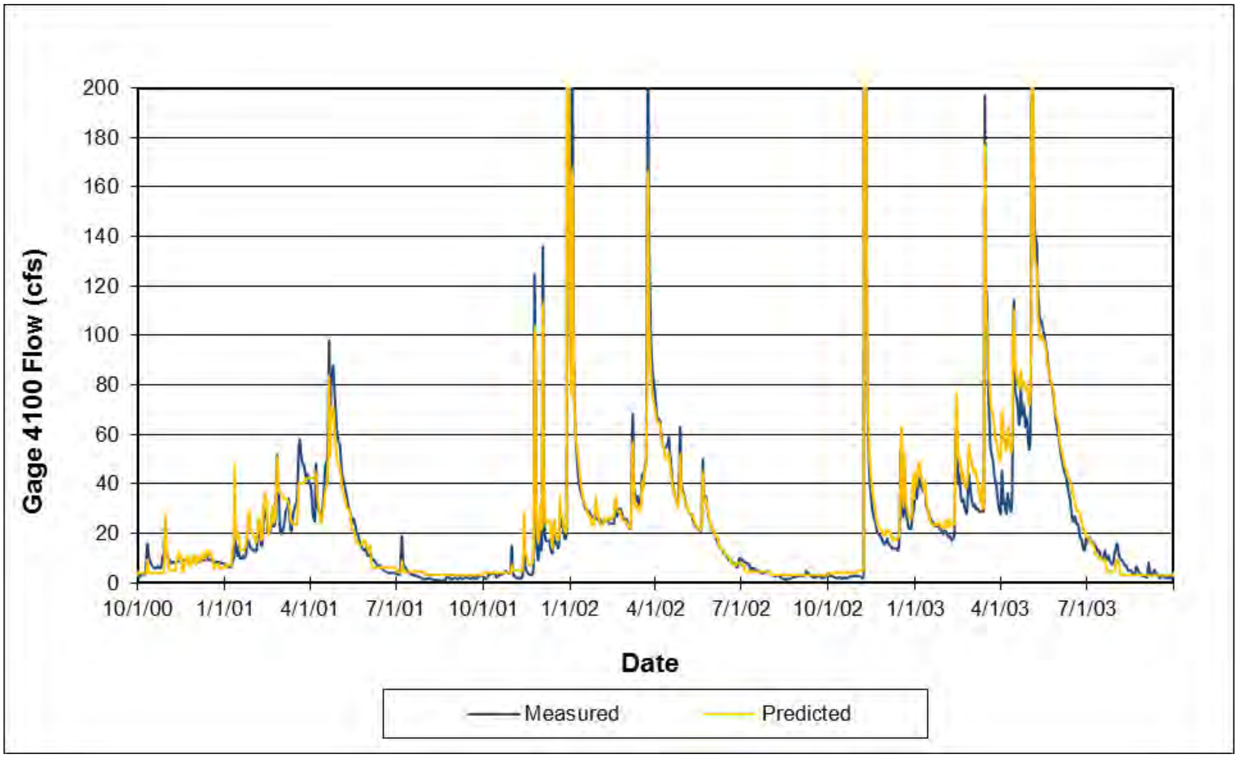


Figure 4-7b: Predicted versus Measured Flow at Gage 4100, WY 2004-2006

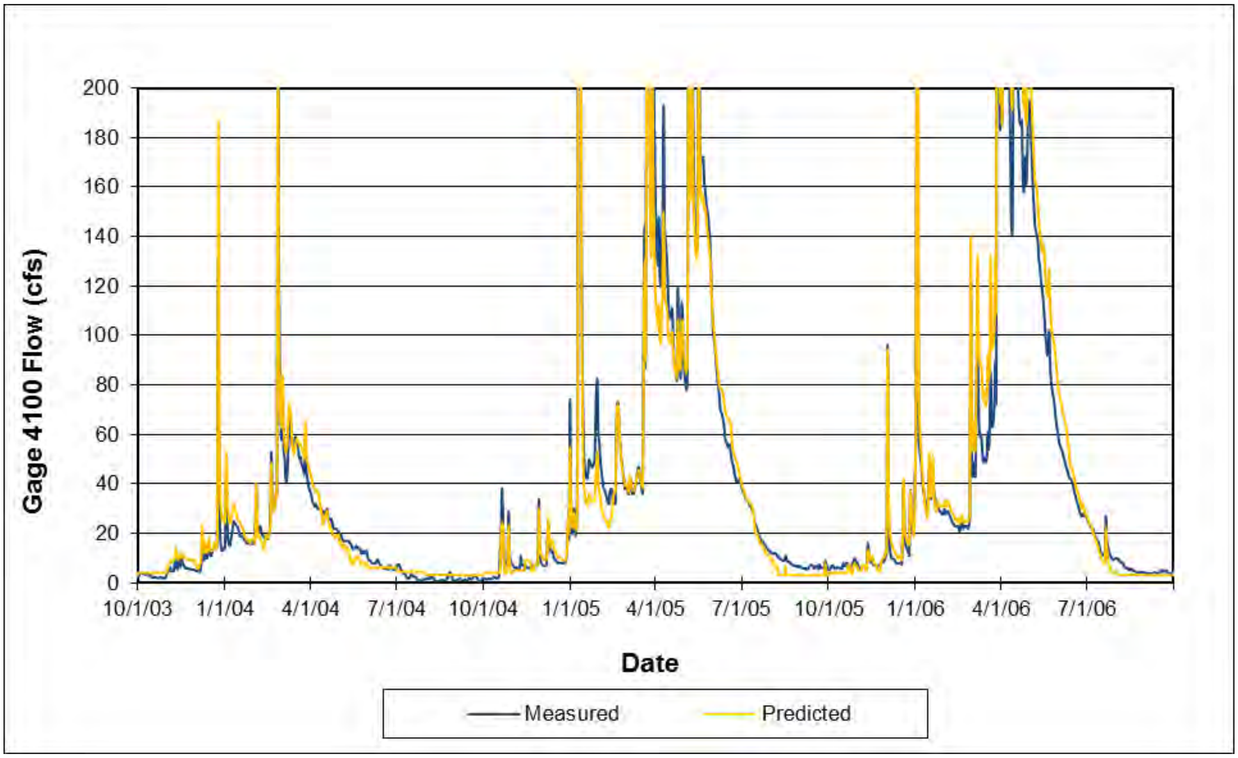


Figure 4-7c: Predicted versus Measured Flow at Gage 4100, WY 2007-2009

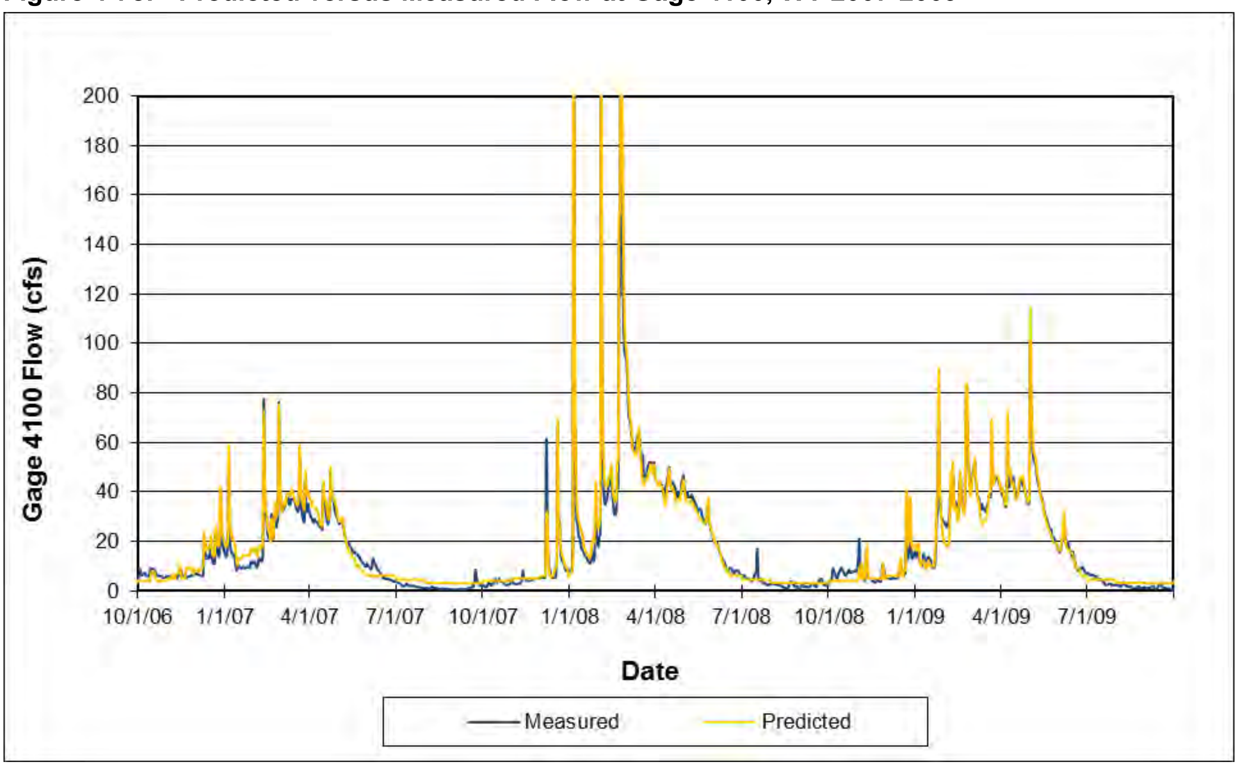
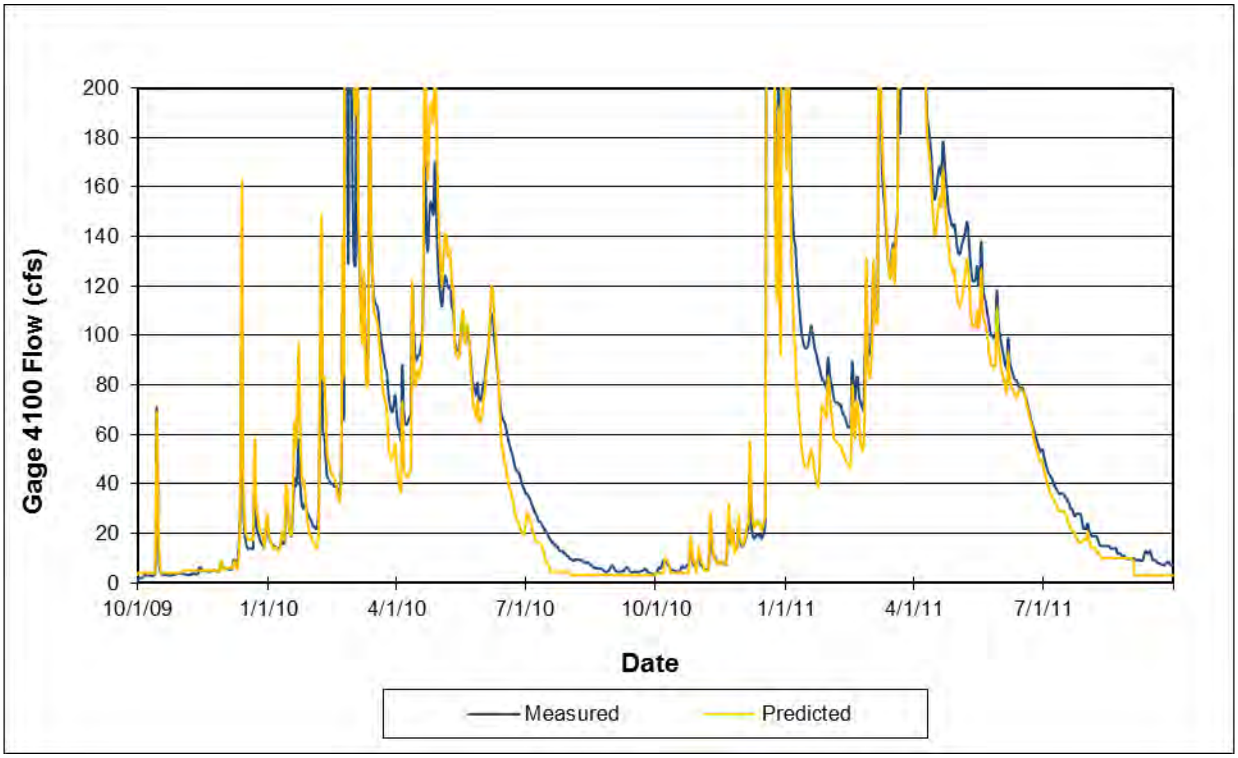


Figure 4-7d: Predicted versus Measured Flow at Gage 4100, WY 2010-2011



4.3.3.2 Gage 3580 Flow Extension

Figure 4-8a, 4-8b, 4-8c and 4-8d display the predicted flows at Gage 3580 for water years 2001-2011, as well as the measured flows during this same period for comparison. The predicted flows accurately approximate the measured flows for both the rising and falling limbs of the hydrograph, although there are periods of both over- and under-estimation.

Figure 4-8a: Predicted versus Measured Flow at Gage 3580, WY 2001-2003

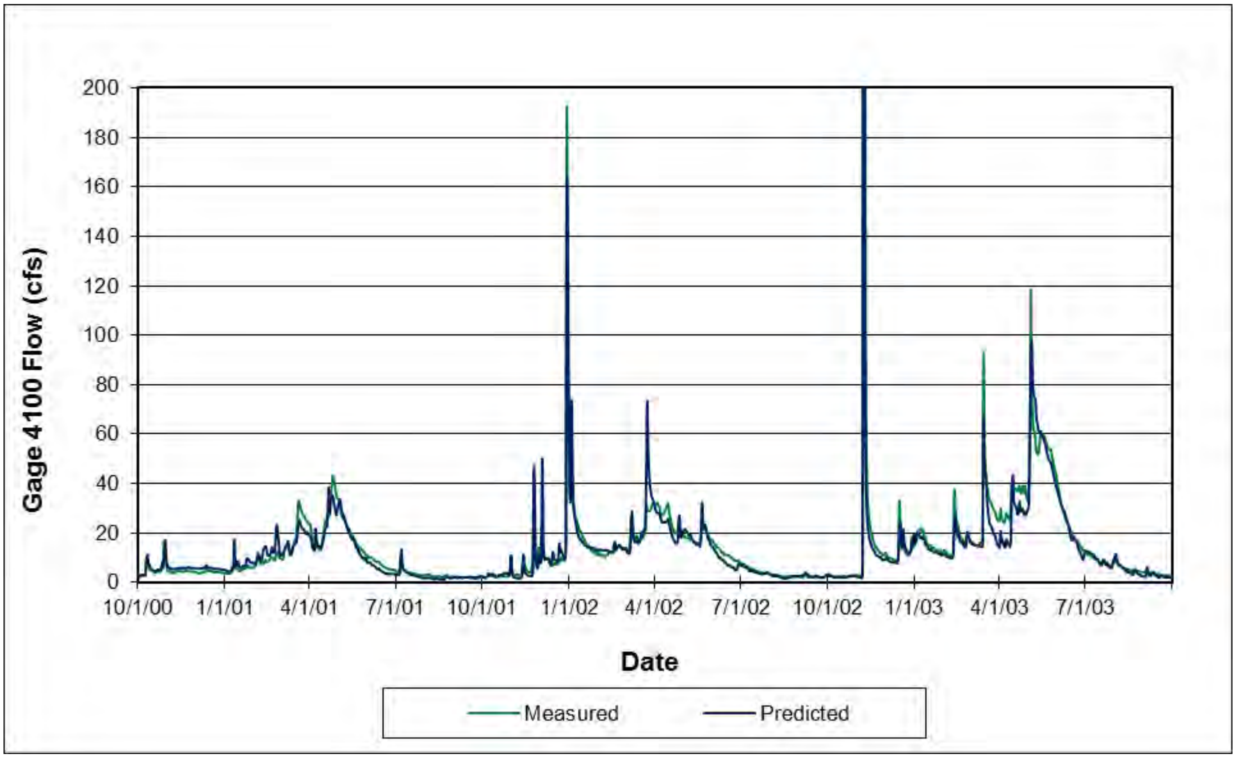


Figure 4-8b: Predicted versus Measured Flow at Gage 3580, WY 2004-2006

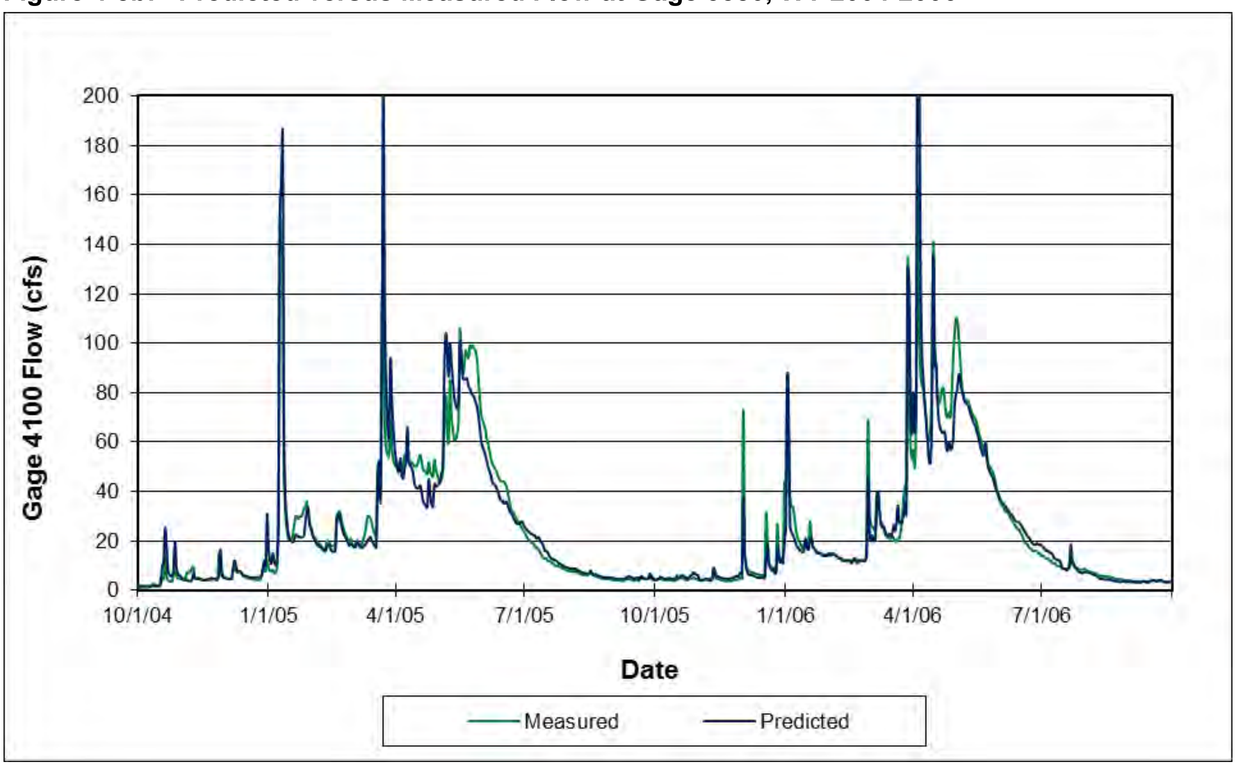


Figure 4-8c: Predicted versus Measured Flow at Gage 3580, WY 2007-2009

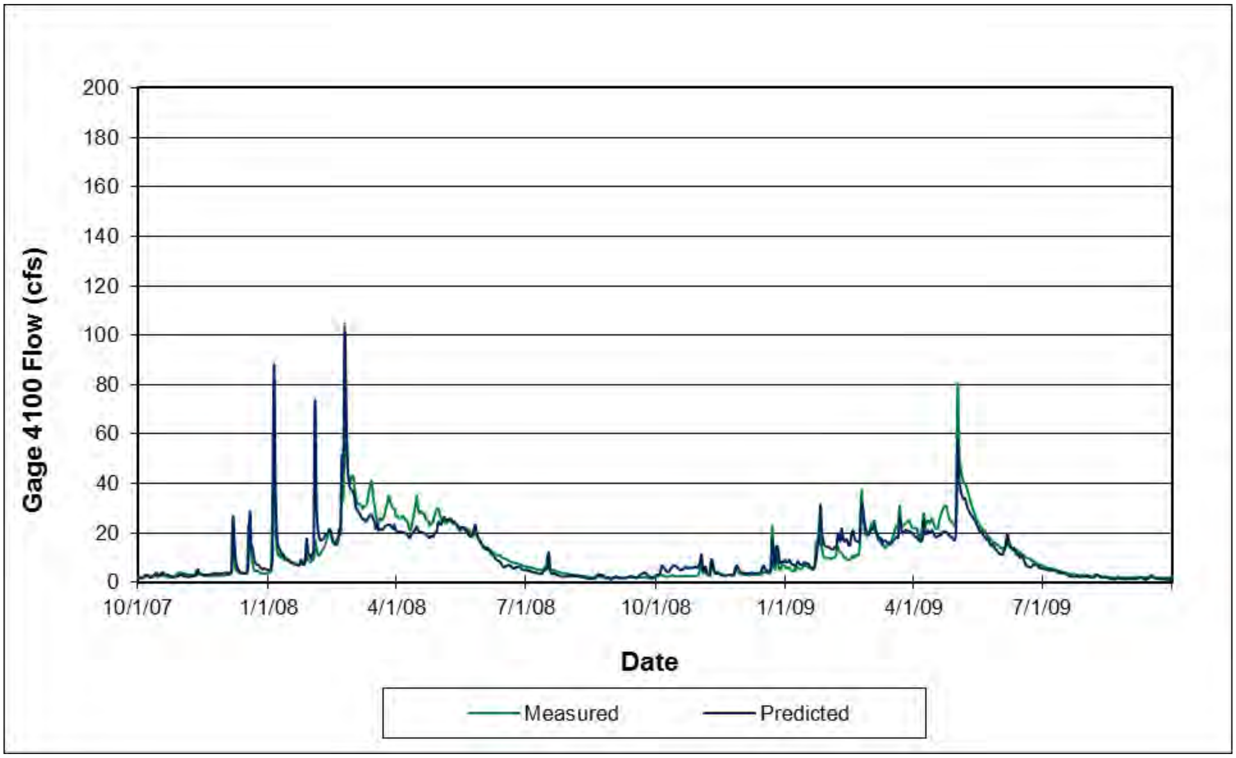
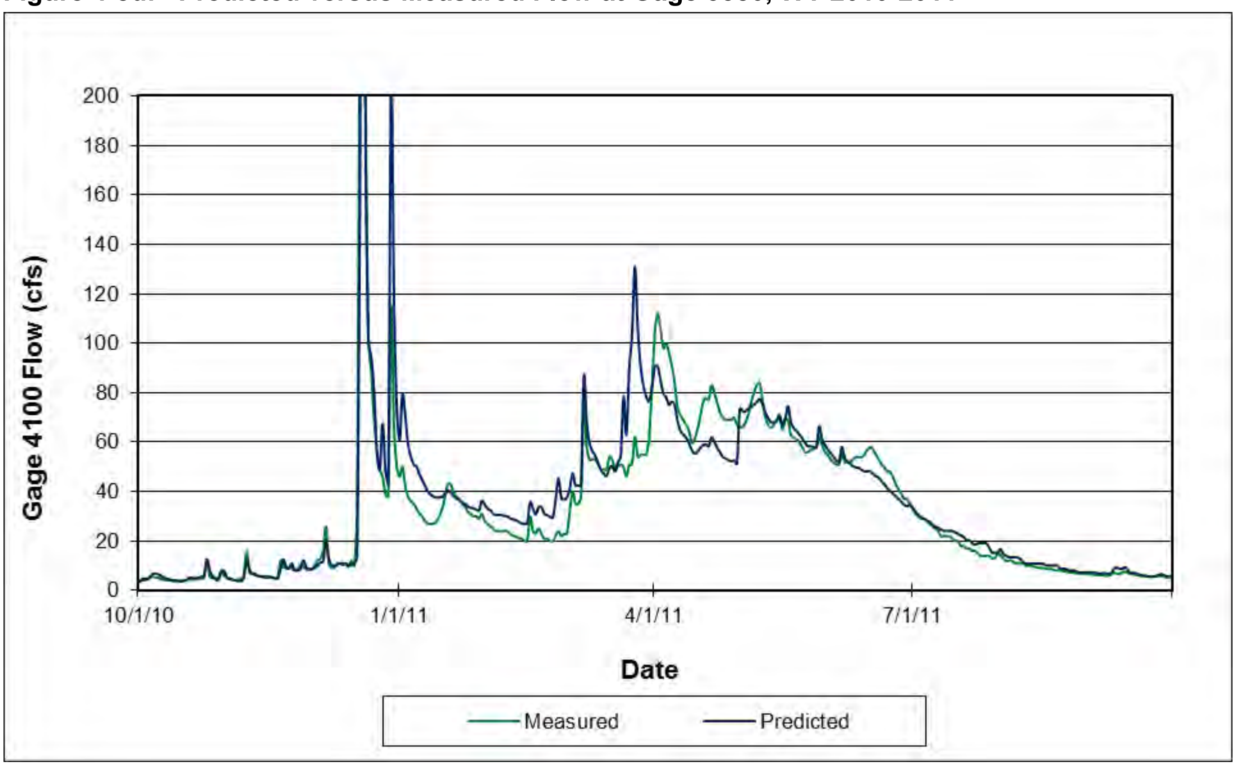


Figure 4-8d: Predicted versus Measured Flow at Gage 3580, WY 2010-2011



4.4 Climate Change Considerations

Reclamation has been studying the effects of climate change in relation to water supply and demand in the western United States for many years. Based on this ongoing work, Reclamation offered the following discussion of climate change considerations specific to the Central Valley, the Tulare Lake Basin, and the Tule River Indian Tribe.

4.4.1 Historical and Current Conditions

The South Fork Tule River drainage basin is located on the southeastern boundary of the Central Valley of California. The Central Valley is divided into three regions including the Sacramento, San Joaquin and Tulare Lake Basins. The South Fork Tule River flows into the Tule River which drains into the Tulare Lake Basin. The Sacramento River drains the northern portion and the San Joaquin drains the central and southern portions of the Central Valley. Both of these rivers flow into the Sacramento-San Joaquin Delta. Typically, the Tulare Lake Basin is internally drained. However, in some wetter than normal years, flow from the Tulare Lake region reaches the San Joaquin River.

The historic climate of the Central Valley is characterized by hot and dry summers and cool and damp winters. Basin average mean-annual temperature has increased by approximately 2 °F for the area during the course of 20th century. The Sacramento Valley receives greater precipitation than the San Joaquin and Tulare Lake basins. In winter, temperatures below freezing may occur, but snow in the valley lowlands is rare. Stream flow in the Sacramento River and San Joaquin River basins has historically varied considerably from year to year. Runoff is generally greater during the winter to early summer months, with winter runoff generally originating from rainfall-runoff events and spring to early summer runoff generally supported by snowmelt from the Cascade Mountains and Sierra Nevada. During the course of 20th century a decline in spring runoff and an increase in winter runoff were observed in the basin.

4.4.2 Studies of Future Climate and Hydrology

There exists a potential for climate change to adversely impact existing and planned water supplies via changes in precipitation, temperature, snow water equivalent (SWE), and stream flows (in both timing and magnitude). Future changes in Central Valley climate and hydrology have been the subject of numerous studies. A good summary of studies completed prior to 2006 was published by Vicuna and Dracup (2007). For the Central Valley watersheds, Moser et al. (2009) reports specifically on future climate possibilities over California and suggest that warmer temperatures are expected during the 21st century, with an end-of-century increase of 3-10.5 °F.

The effects of projected changes in future climate were assessed by Maurer (2007) for four river basins in the western Sierra Nevada contributing to runoff in the Central Valley. These results indicate a tendency toward increased winter precipitation; this was quite variable among the models, while temperature increases and associated SWE projections were more consistent. The effect of increased temperature was shown by Kapnick and Hall (2009) to result in a shift in the date of peak of snowpack accumulation to 4-14 days earlier in the winter season by the end of the century. Null et al. (2010) reported on climate change impacts for 15 western-slope watersheds in the Sierra Nevada under warming scenarios of 2, 4, and 6 °C increase in mean-annual air temperature relative to historical conditions. Under these scenarios, total runoff decreased; earlier runoff was projected in all watersheds relative to increasing temperature scenarios; and the high elevation southern-central region was more susceptible to earlier runoff.

4.4.2.1 Reclamation Studies of Future Climate and Hydrology

The potential risk that climate change poses to water supply is the motivation behind Public Law 111-11, Subtitle F (SECURE Water Act), section 9503 which authorizes the U.S. Department of Interior's Bureau of Reclamation (Reclamation) to assess climate change risks for water and environmental resources in "major Reclamation river basins." This assessment is being carried out through Reclamation's WaterSMART Basin Study Program. Of the eight major river basins being studied by Reclamation through WaterSMART, the San Joaquin River Basin is the one in closest proximity (and thus of greatest relevance) to the South Fork Tule River drainage basin in which development of water supplies are being evaluated for the Tule River Indian Tribe.

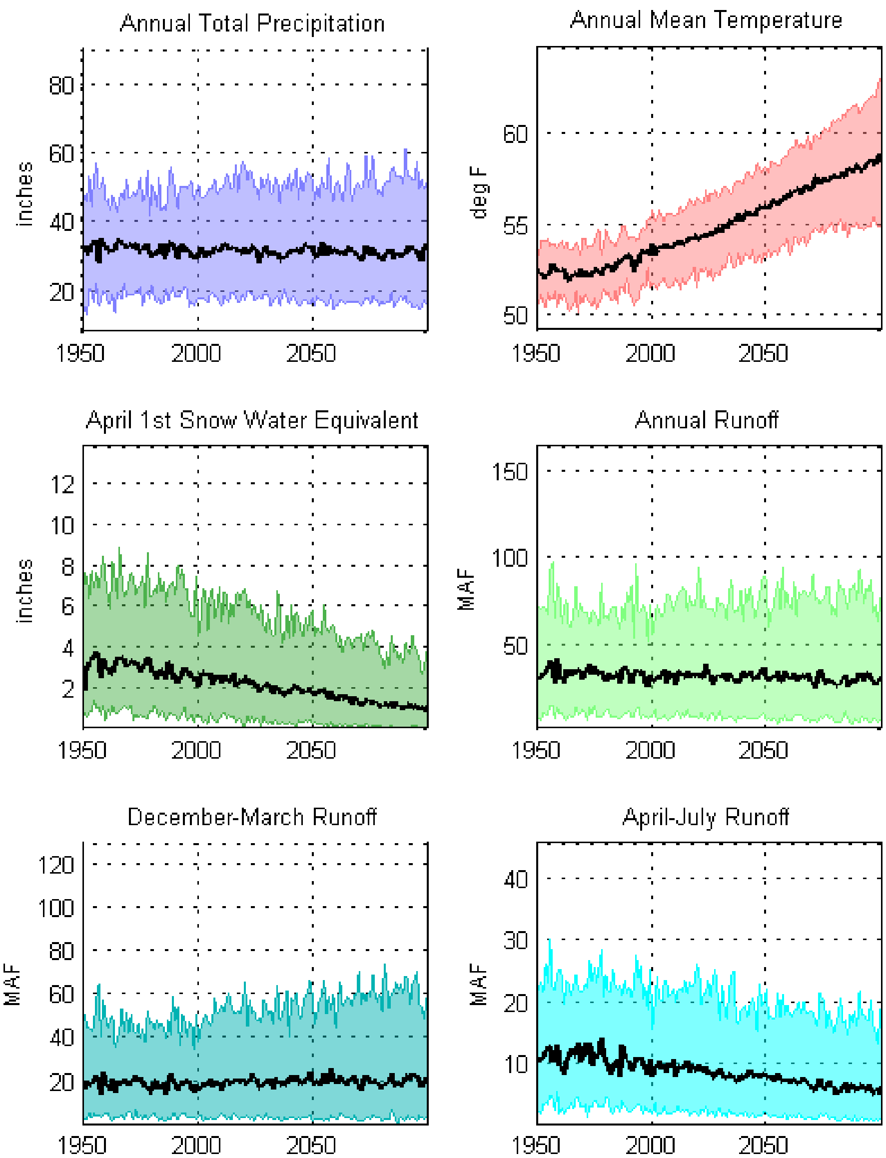
An initial report assessing climate change risks in the eight major basins has been released by Reclamation as Technical Memorandum (TM) No. 86-68210–2011-01**:** West-Wide Climate Risk Assessments: Bias-Corrected and Spatially Downscaled Surface Water Projections (2011a). This section on potential impacts of climate change describes the assessment of TM No. 86-68210–2011-01 with a focus on the San Joaquin Basin and the possible implications for the South Fork Tule River drainage basin. While this information is provided to assist in planning for and adapting to potential risks to the Tribe's water supply due to climate change, it is not intended to represent a quantitative analysis of such risks. While some quantitative estimates from TM No. 86-68210–2011-01 are presented for the San Joaquin Basin, they are intended to provide a qualitative assessment for the South Fork Tule River drainage basin specifically.

4.4.2.2 Hydroclimate Projections

TM No. 86-68210–2011-01 provides projections of the following hydroclimate variables: precipitation, temperature, snow water equivalent (SWE), and stream flow. These projections are based on climate projections from the World Climate Research Programme Coupled Model Intercomparison Project3 (WCRP CMIP3) that has been bias-corrected and spatially downscaled. These climate projections in turn were the basis for hydrologic projections based on watershed applications of the Variable Infiltration Capacity (VIC) macroscale hydrology model (Liang, et al., 1996). From these time-series climate and hydrologic projections (or hydroclimate projections), changes in hydroclimate variables were computed for three future decades: 2020s (water years 2020–2029), 2050s (water years 2050–2059) and 2070 (water years 2070–2079) from the reference 1990s' decade (water years 1990–1999). The reference 1990s refers to the ensemble of simulated historical hydroclimates, not the observed 1990s.

Figure 4-9 shows ensembles of hydroclimate projections for the combined Sacramento and San Joaquin Basins for six different hydroclimate variables: annual total precipitation (top left), annual mean temperature (top right), April 1st SWE (middle left), annual runoff (middle right), December–March runoff season (bottom left), and April–July runoff season (bottom right). The heavy black line is the annual time series of 50 percentile values (i.e., ensemble-median). The shaded area is the annual time series of 5th to 95th percentile.

Figure 4-9: Sacramento and San Joaquin Basins – Hydroclimate Projections.



The notable trends gleaned from Figure 4-9 are as follows. Annual mean temperature shows an increasing trend starting in the mid-1970s and continuing throughout the 21st century. The projected median temperature change in 2099 is about +5°F relative to 2000. For annual total precipitation, while Figure 4-9 shows a relatively steady (nominally decreasing) trend , it is important to note that other studies have shown that increases in precipitation are expected in the northern portion of the Central Valley while decreases are expected in the southern portion where the South Fork Tule River is located (Reclamation, 2011b). From the 1970s throughout the 21st century, April 1st SWE shows a decreasing trend. However, annual runoff shows only a nominally decreasing trend mirroring annual precipitation. Winter season runoff shows a nominally increasing trend, and the April–July runoff shows a decreasing trend reflecting the decrease in the spring snowpack and the greater proportion of total precipitation falling as rain rather than snow.

Figure 4-10 shows the spatial distribution of simulated decadal precipitation in the basin above the Sacramento and San Joaquin Rivers at the Delta: simulated 1990s' distribution of ensemble-median decadal mean condition (upper middle) and changes in decadal mean condition for three look ahead (2020s, 2050s, 2070s relative to 1990s) and at three change percentiles within the ensemble (25, 50, and 75). The ensemble-median change shows some increase in precipitation over the basin during the 2020s' decade from the 1990s' reference. By the 2050s, the northern part of the basin still continues to show precipitation increases from the 1990s' reference, but the southern parts of the basin show a decline in precipitation from the 1990s' reference decade. By the 2070s, precipitation across the entire basin shows a decline from the 1990s' reference.

Figure 4-10: Sacramento and San Joaquin Basins – Spatial Distribution of Simulated Decadal Precipitation.

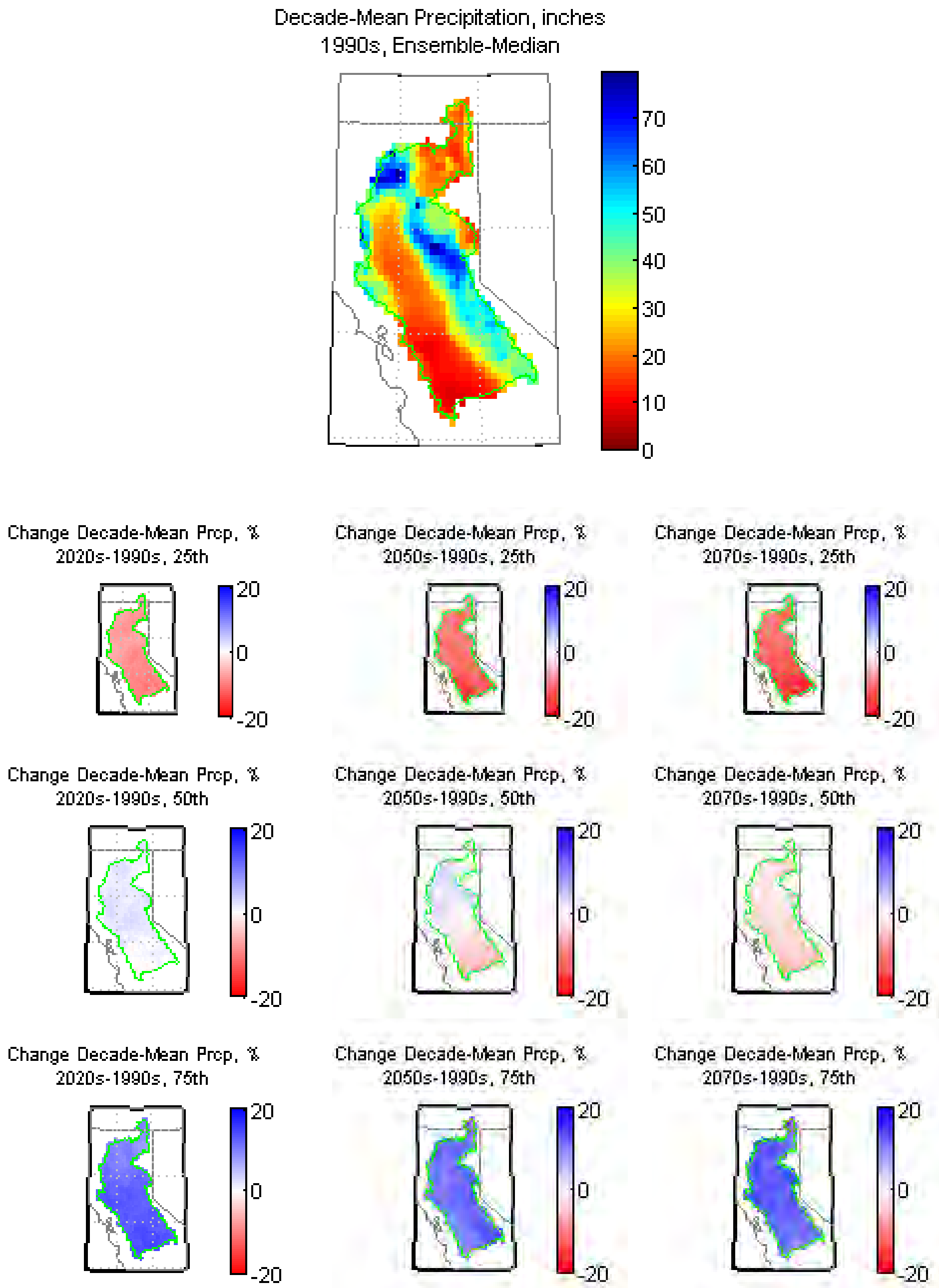


Figure 4-11 shows the spatial distribution of simulated decade mean temperature for the combined Sacramento and San Joaquin Basins: simulated 1990s' distribution of ensemble-median decadal mean condition (upper middle) and changes in decadal mean condition for three projected decades (2020s, 2050s, 2070s relative to 1990s) and at three change percentiles within the ensemble (25, 50, and 75). The median change for the 2020s', 2050s', and 2070s' decades relative to the 1990s shows an increasing temperature value throughout the basin.

Figure 4-11: Sacramento and San Joaquin Basins – Spatial Distribution of Simulated Decadal Temperature.

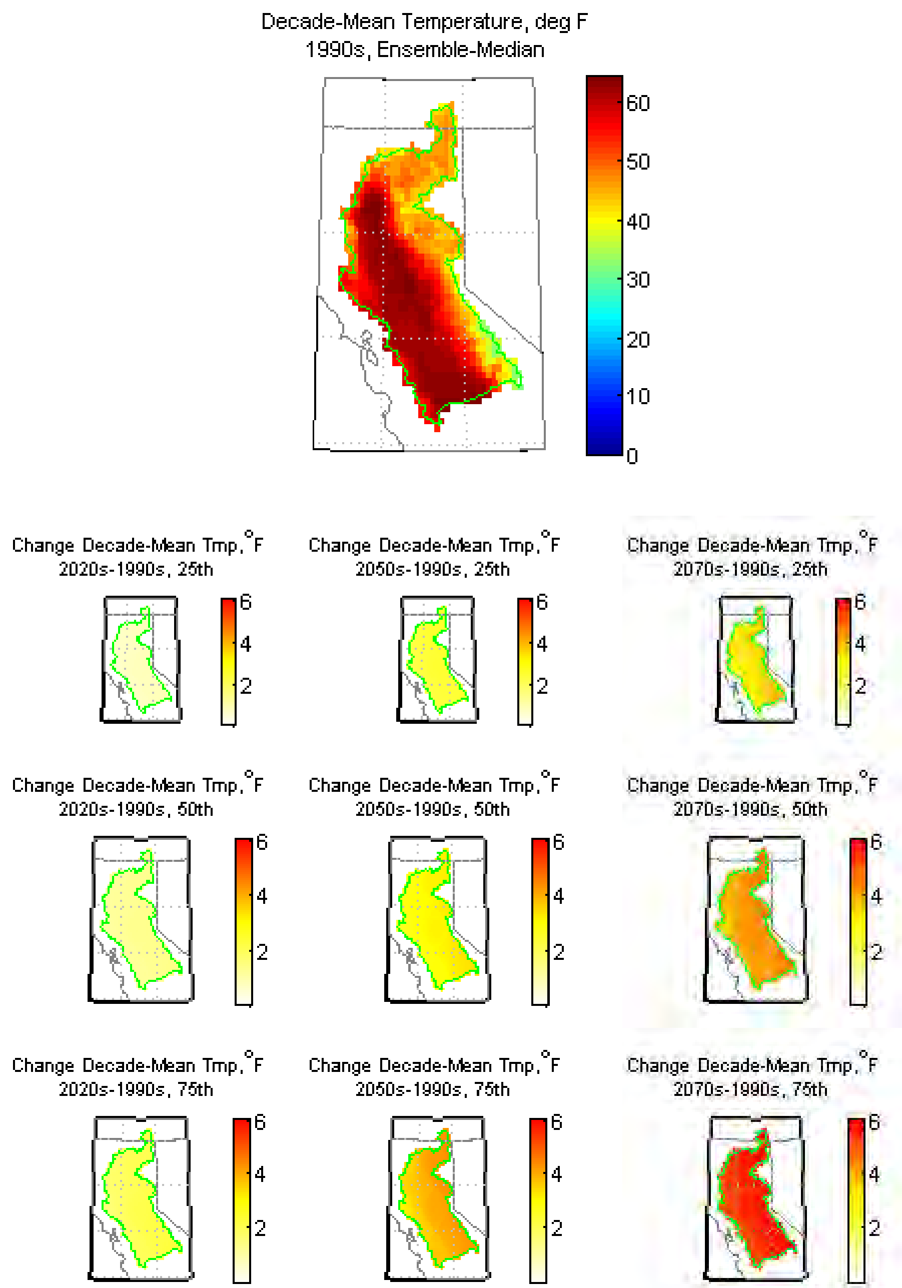
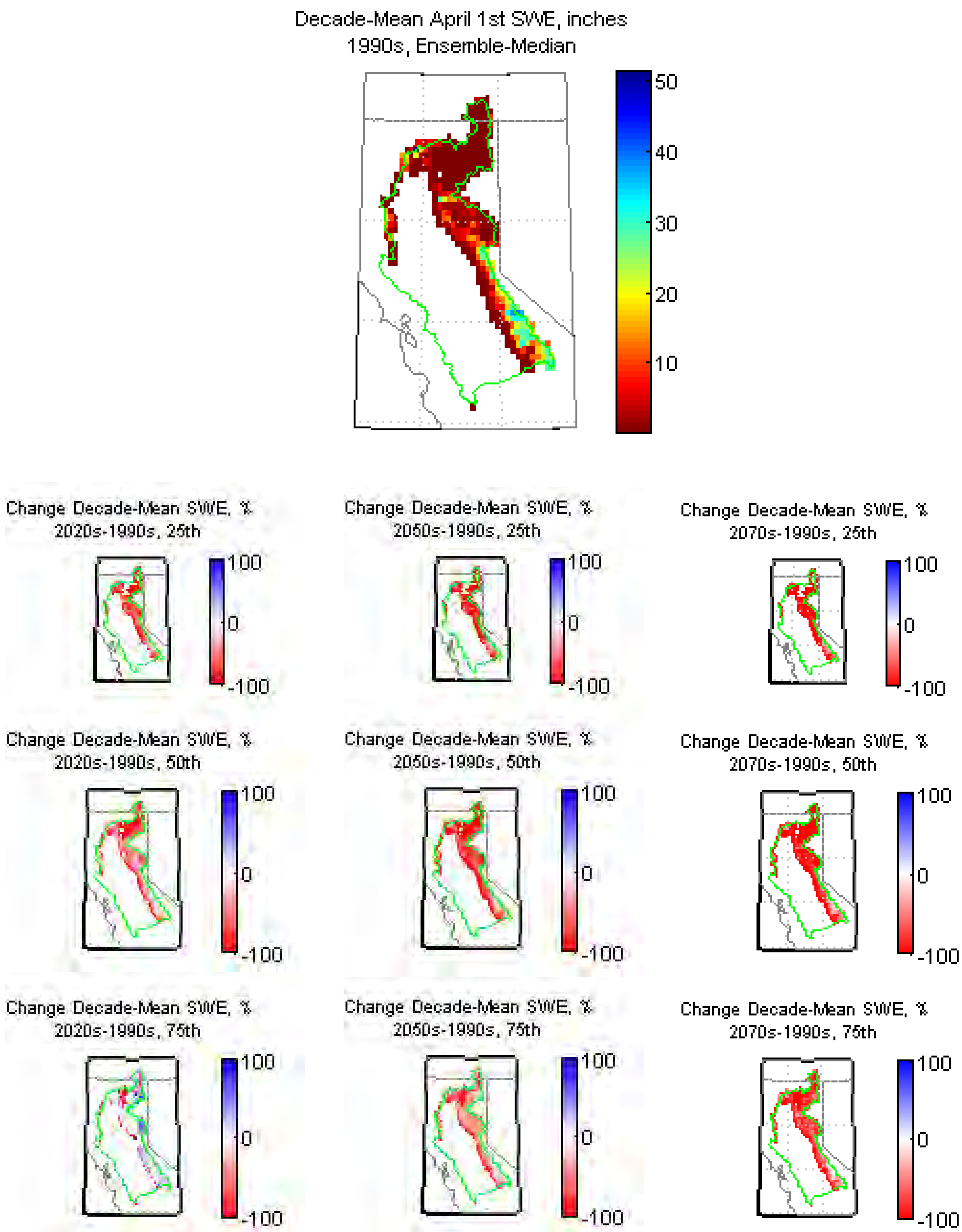


Figure 4-12 shows the spatial distribution of April 1st SWE in the combined Sacramento and San Joaquin Basins: simulated 1990s' distribution of ensemble-median decadal mean condition (upper middle) and ensemble-median change in decadal mean condition for three projected future decades (2020s, 2050s, 2070s relative to 1990s). The April 1st SWE shows persistent decline through the future decades from the 1990s' distribution.

Figure 4-12: Sacramento and San Joaquin Basins – Spatial Distribution of Simulated Decadal April 1st SWE.



4.4.2.3 Impacts on Surface Runoff and Stream Flow Timing

Figure 4-13 shows ensemble-median mean-monthly values (heavy lines) for the 1990s, 2020s, 2050s, and 2070s and the decadal-spread of mean-monthly runoff for the 1990s (black shaded area) and 2070s (magenta shaded area) where spread is bound by the ensemble's 5th to 95th percentile values for each month. For all the locations including Buena Vista Lake in the Tulare Lake Basin, there appears to be an earlier shift in the peak runoff timing; and for some locations, for example the Stanislaus River at New Melones Dam and the San Joaquin River near Vernalis, there is significant earlier shift to the peak runoff timing.

Figure 4-13: Sacramento, San Joaquin and Tulare Lake Basins – Simulated Mean-Monthly Runoff for Various Subbasins.

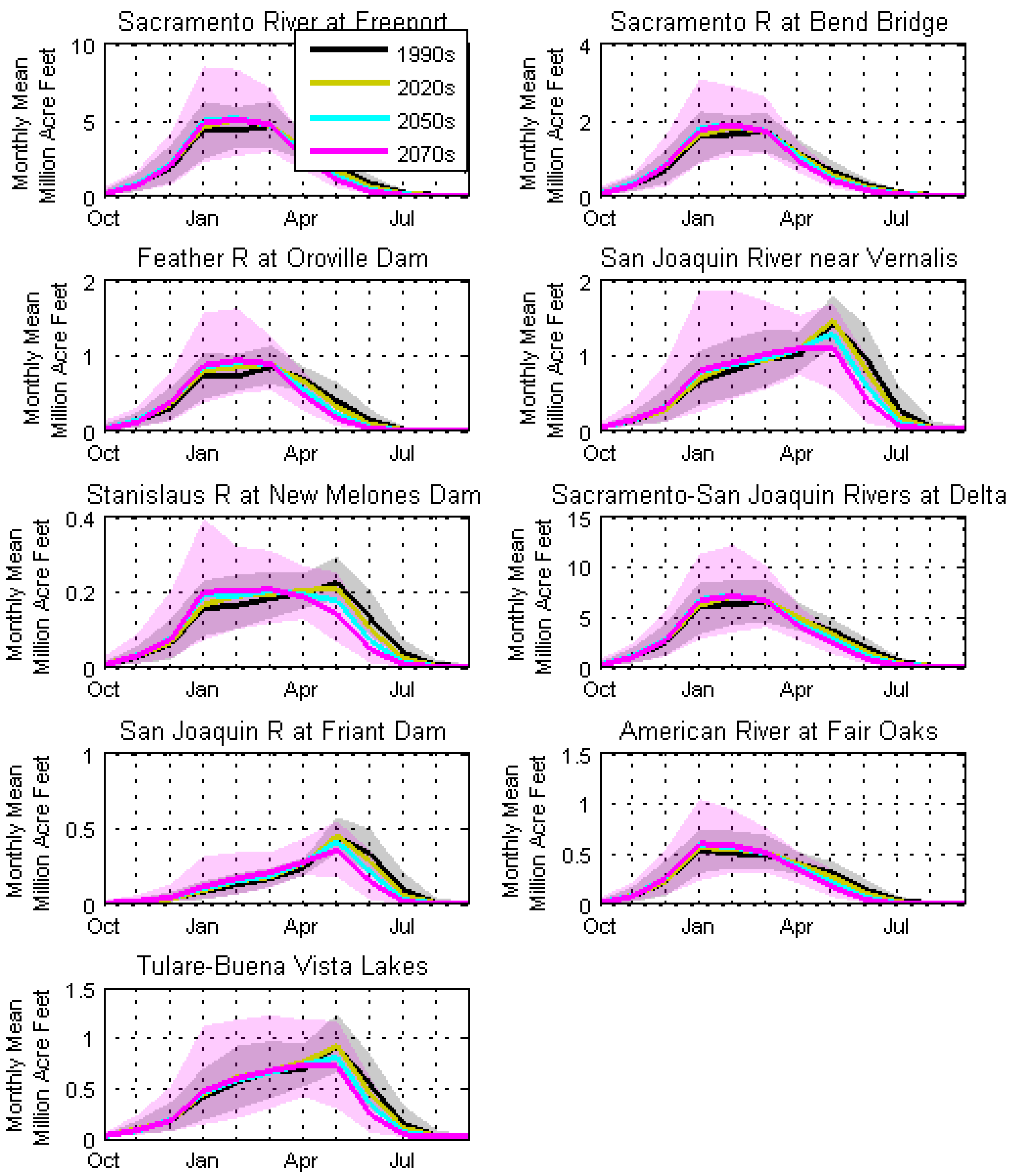
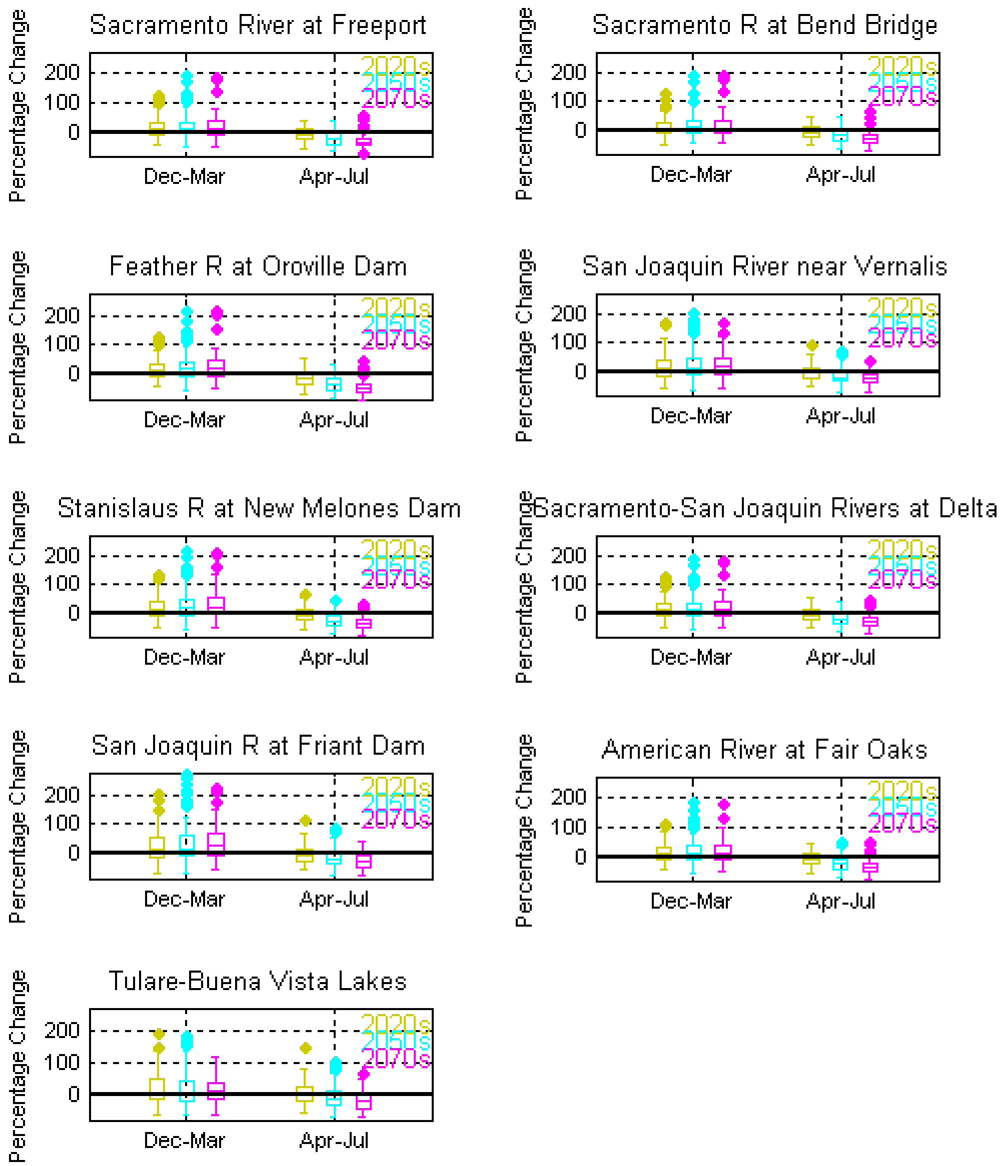


Figure 4-14 shows an ensemble-distribution (boxplot) of changes in mean-seasonal values (heavy lines) for the 2020s, 2050s, and 2070s relative to the 1990s, where the boxplots' box represents the ensemble's interquartile range and the box-midline represents ensemble-median. All locations show increases in median flow (horizontal line in the boxplot) for the December–March winter runoff season, and decrease in median flow for the April–July spring–summer runoff season.

Figure 4-14: Sacramento and San Joaquin Basins – Simulated Mean-Seasonal Runoff for Various Subbasins.



4.4.3 Climate Change Considerations Summary

While the estimates presented above for the Sacramento/San Joaquin Basins from TM No. 86-68210–2011-01 cannot be considered as quantitative projections of the hydroclimate variables for the South Fork Tule River drainage basin, they do provide qualitative expectations of the trends suggested by the current state of climate science and associated hydrologic analysis. To summarize, the following trends in hydroclimate variables can be reasonably expected:

1. April 1st SWE can be expected to decrease.
2. Winter runoff can be expected to increase.
3. April–July runoff can be expected to decrease.

The magnitude of these changes is subject to uncertainty which presents a challenge to the planning of water supply projects. Nonetheless, consideration of the expected trends may be worthwhile in the planning of the Tule River Indian Tribe's water supply project. Of particular concern is the fact that an increased rainfall to snow ratio means that a smaller fraction of the overall precipitation (occurring mostly in the winter) would be able to be stored and captured in reservoirs; this is because the natural storage of the snowpack is reduced (as evidenced by the decreased April 1st SWE values) and the higher volume of winter rainfall either infiltrates the soil or becomes runoff evading capture by the planned water system. And if the total volume of precipitation also decreases, then of course there is less overall water to store by any means.

Reclamation is continuing work on updating such hydroclimate projections (including incorporation of the latest World Climate Research Programme Coupled Model Intercomparison Project climate projections), and developing improved guidance and tools for the quantitative assessment of climate change risks to water resources and the development of adaptation strategies for water management projects.

4.4.3.1 Climate Change Impacts on Tule River Water Supply

As noted above, the general trends due to climate change in the region of the Tule River Indian Reservation predict less water stored in the snowpack during the winter due to warmer temperatures. This suggests that runoff during the year would occur in more concentrated periods of time (i.e., large flow events) in the future than experienced historically. Even if mean annual runoff remains the same, it appears that more variability in precipitation and runoff from year to year can be expected leading to greater uncertainty in the Tribe's water resources planning. Therefore, the need for storage on the Reservation becomes even more critical when climate change factors are considered.

5.0 Identification of Alternatives

5.1 Project Alternatives and Features

In accordance with the express provisions of the Tule River Water Rights Settlement Agreement, and the long-term needs for water supply on the Reservation, the only viable project alternative for water supply is a reservoir located on the Reservation. Based on the water demands identified in Section 3.0, it was determined that a Phase 1 dam and reservoir on the South Fork Tule River within the Reservation should be sized to provide 5,000 acre-feet of storage capacity. Depending on its location along the river, a reservoir of this size would provide somewhat varying amounts of firm yield to meet future water demands on the Reservation.

Other non-dam projects are deemed inadequate or impractical to meet the Phase 1 water demands. Assuming the South Fork Tule River is the primary source of the Tribe's future water supply, the amount of required storage is too large to be met through storage tank construction alone. For example, assuming a tank size of 400,000 gallons based on the new tank discussed in Section 2.1.5, over 4,000 tanks would need to be installed to provide 5,000 acre-feet of storage.

The Reservation's future needs cannot be met by groundwater. The design flow for the future water treatment plant is 1,050 gpm (see Section 2.1.4). The majority of wells that have been drilled on the Reservation are inoperable due to either low yields or poor water quality. Those wells that are in operation have production rates that range from 0 to 50 gpm, with most producing less than 30 gpm. Assuming an optimistic average well yield of 30 gpm, 35 wells would be required to provide this same design flow. There is no indication that anything approaching this number of wells could be successfully drilled and developed on the Reservation.

In addition to the dam and reservoir to provide the 5,000 acre-feet of storage, other key features of the project include a new raw water transmission pipeline from the dam to the treatment plant, an upgraded or expanded treatment plant, and extension of the existing water distribution system. Construction of the new dam, reservoir, and transmission pipeline would also require improvements to the existing access roads or new roads from the Reservation boundary to the project site areas.

Seven (7) potential dam and reservoir sites were originally identified, as follows (from downstream to upstream):

- Painted Rock
- Lower Bear Creek
- Upper Bear Creek
- Lower Cedar Creek

- Original Cedar Creek
- Upper Cedar Creek
- Cholollo

The locations of the Bear Creek and Cedar creek sites are shown on Figures 1 and 2 in Appendix B. The Tule Tribal Council elected to discard the Painted Rock and Chololo sites due to negative impacts to social, cultural, and archaeological resource areas. The Original Cedar Creek site was replaced by the Lower Cedar Creek site due to a narrower valley section at the latter site and by extension, presumably a lower cost alternative. Additional information of the remaining four dam sites currently under consideration is contained in Section 5.4.

A new raw water supply pipeline is needed to transport water from the new reservoir to the water treatment plant and to supply irrigation water. This pipeline would generally be located along the existing main road from the town center to the Chololo Campground. Additional information on this proposed pipeline is contained in Section 5.7.1.

The Tribe's existing water treatment plant would be expanded or a new facility would be constructed adjacent to the existing facilities to meet additional demands for potable water. Additional information on the new water treatment facilities is contained in Section 5.7.2.

The existing treated water distribution system would be improved to address identified deficiencies in the tribal water system, and the existing system would be expanded to serve the proposed future housing areas. Additional information on the water distribution system is contained in Section 5.7.3.

5.2 Dam and Reservoir Site Locations

The four potential dam sites have been named for their relation to the confluence with one of two South Fork Tule River tributaries: Bear Creek and Cedar Creek. Cedar Creek joins the South Fork Tule River approximately 2.3 river miles upstream of the Bear Creek confluence. The Lower Bear Creek and Upper Bear Creek dam sites are located 0.5 river miles downstream and 0.25 river miles upstream of the Bear Creek confluence, respectively. The Lower Cedar Creek and Upper Cedar Creek dam sites are 0.15 river miles downstream and 0.25 river miles upstream of the Cedar Creek confluence. The locations of the potential dam and reservoir sites are shown on Figures 1 and 2 in Appendix B.

5.3 Geology and Seismicity

The regional and site-specific geologic characteristics were reviewed by technical experts from the U.S. Department of Interior, Reclamation on a four-day site visit beginning on July 26, 2010. Results of that geologic site reconnaissance were presented in a report titled *Engineering Geologic Inspection of Potential Dam sites on the South Fork Tule River*

(Reclamation, 2010). The following geologic information was taken primarily from that report.

5.3.1 Regional Geology

The entire project area is located in the rugged western foothills of the southern Sierra Nevada Mountains. In this area, the dominant rock type is granitic in nature, extending from a few miles east of Porterville to the Owens Valley (over 50 miles to the east). Widely scattered within the granitic batholith are numerous discontinuous zones of metamorphic rock, each typically no more than a few to 10 miles in length.

Granite is the dominant rock type in the entire Cedar Creek Area, the upstream Bear Creek area and the Painted Rock dam site. Metamorphic rock is the dominant rock type in the downstream Bear Creek area. Both granite and metamorphic rock are hard, slightly fractured and fresh where exposed in the South Fork Tule River bottom and are weathered and more intensely fractured on the canyon slopes. Road cuts along the Main Road typically expose decomposed granite surrounding large granite core stones.

5.3.2 Faulting and Seismicity

The nearest major potentially active fault, the north-trending Kern Canyon Fault, is located just over 20 miles east of the project area. Major active faults such as the San Andreas, Garlock and White Wolf Faults are located 50 to over 80 miles from the project area.

The linear trend of Bear Creek and the foliated character of the metamorphic rock exposed in the creek bottom are strong indicators that the creek has developed along a northwest-trending shear zone. This shear zone is shown on the 1977 Geologic Map of California as being about 12 miles long and as one of several discontinuous and widely spaced northwest-trending shears. It is not considered to be an active fault.

There is currently no site-specific seismicity information for the proposed project. The project area is about 10 miles west of Lake Success Dam and about 30 miles north of Lake Isabella Dam, two dam facilities owned and operated by the COE, and have recently been heavily studied for potential seismic dam failure modes. It is likely that a high seismic design load will be required for design of a dam on the Reservation. For conceptual and final design, GEI recommends that a site-specific, probabilistic seismic hazard analysis be performed to evaluate the appropriate seismic design loads.

5.3.3 Dam Site Geology

Dam site geology for the four alternative dam sites currently under consideration is based on the previously referenced Reclamation geology report (2010). All four of the sites are located on the South Fork Tule River near the confluence of the Bear Creek Canyon and Cedar Creek Canyon. In general, only limited geologic information is provided in the

Reclamation report for all of the dam sites, and more-detailed field geologic reconnaissance is needed for each of the dam sites.

The geologic observations in the Bear Creek Canyon are described here, since Reclamation did not travel any distance up the Cedar Creek Canyon during their visit in July 2010. The Bear Creek Canyon was observed for a distance about one-half mile upstream of its confluence with the South Fork Tule River. Metamorphic rock is exposed in the northwest-trending linear creek bottom of Bear Creek, with a consistent foliation with N15°W strike and 60°northeast dip. Localized rock outcrops are separated by longer intervals of cobbles and boulders covering the creek bottom. Creek flows were absent in the cobble and boulder sections, because creek flows disappeared below the surface through these very pervious materials and formed small pools in areas of impervious rock outcrops.

The following are general descriptions of the surficial geology at each of the four potential dam sites.

5.3.3.1.1 *Upper Bear Creek Dam site*

The river bottom is typically characterized by cobbles and boulders and discontinuous outcrops of hard, fresh, water-scoured granite. Rock is poorly exposed on steep to moderate, well-vegetated canyon slopes. An area of continuous, hard, slightly-fractured fresh granite outcrops is located about 0.4 miles upstream of the Bear Creek Road. Outcrops extend 30 to over 50 feet vertically up from the river bottom on both canyon slopes.

5.3.3.1.2 *Lower Bear Creek Canyon Dam site*

Fresh, hard metamorphic rick forms continuous water-scoured outcrops along the river bottom for a distance of over one mile downstream of the Bear Creek road and numerous extensive outcrops on the very steep, high, lightly vegetated north canyon slopes. Rock outcrops are prominent near the river on the south canyon wall, but are obscured by dense vegetation o the upper slopes. The South Fork Tule River makes a sharp bend around the narrow ridge on the left side (looking downstream) of the canyon.

5.3.3.1.3 *Upper Cedar Creek Dam site*

The river bottom is characterized by cobbles, boulders and scattered hard, predominantly granitic outcrops with several areas of continuous outcrop located in the first 0.2 miles upstream of Cedar Creek Road. A few relatively extensive benches (river terraces) locally flank the riverbed. Rock is exposed as scattered outcrops in the well-vegetated canyon walls. A large area of continuous granite outcrops, located approximately 0.3 miles upstream of the Cedar Creek Road, is viewed as an excellent foundation for a concrete gravity dam.

5.3.3.1.4 *Lower Cedar Creek Dam site*

Most of the river bottom is characterized by long stretches of continuous, hard, water-scoured outcrops interspersed by shorter sections of cobbles, boulders, and scattered outcrops. Rock is poorly exposed on most well-vegetated canyon slopes. An approximately 1000-foot-long area of continuous granite outcrop is located about 0.4 miles southwest (downstream) of Cedar Creek Road. Outcrops on the south canyon slope extend from the river bottom to at least 60 vertical feet above the river. This outcrop is viewed as an excellent foundation for a concrete gravity dam.

5.4 Design Concepts of Dam and Reservoir Sites

This section presents the design of the proposed dams and appurtenant structures (spillway and outlet works) for Upper and Lower Bear Creek Dam and Upper and Lower Cedar Creek Dams, which are proposed to be constructed as roller-compacted concrete (RCC) dams[4]. The design concepts are appraisal level, with the primary purpose of establishing the major construction quantities and identifying major cost components for the construction cost estimate.

5.4.1 Selection of Dam Type

A dam type was first selected for these sites. Possible dam types include RCC gravity and rock-fill embankment. The RCC dam type was selected for all of these sites for the following reasons:

- Adequate earth-fill borrow materials do not appear to be available locally within the reservoir basin. Therefore, an earth-fill dam for these sites would not be economical.
- These sites appear to have an adequate rock foundation for a concrete gravity dam, such as an RCC dam, and therefore sites would be suitable for a rock-fill dam as well.
- Adequate borrow materials appear to be available for both rock-fill embankment and RCC dams. For a steep valley with a narrow valley bottom prevailing at all of these sites, it is GEI's experience that an RCC dam is generally more economical than a rock-fill embankment.
- The spillway for an RCC dam can be incorporated in the dam, with a significant cost saving on mass excavation in one of the abutments for a spillway channel that would be required for the rock-fill dam option.

5.4.2 General Design of RCC Dam and Appurtenant Structures

The storage capacity of 5,000 acre-feet was used as the basis to establish the heights of the RCC dams. This storage capacity includes an estimated sediment volume of about 150 acre-feet. For a normal storage of 5,000 acre-feet, the reservoir elevations were determined based on reservoir elevation-area-capacity curves (Figures 5-1, 5-2, 5-3, and 5-4).

[4] Roller compacted concrete, or RCC, is a construction technology used to construct a concrete gravity dam. RCC is a zero-slump concrete placed in lifts with conventional earthwork equipment.

The design dam crest elevations were determined by assuming a normal freeboard of 15 feet above the normal pool elevation. Required freeboard is determined based on routing of the inflow design flood (IDF). The IDF and flood routing studies would need to be performed during a subsequent feasibility study.

Figure 5-1: Upper Bear Creek Elevation-Area-Capacity Curve

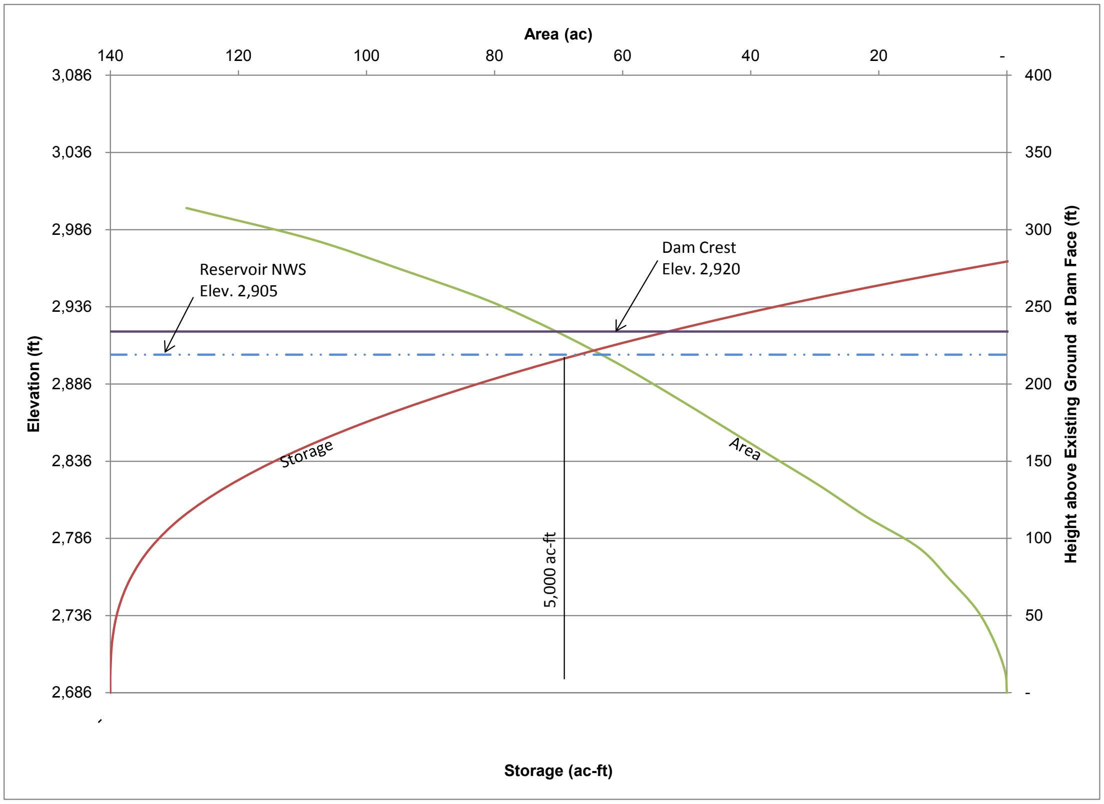


Figure 5-2: Lower Bear Creek Elevation-Area-Capacity Curve

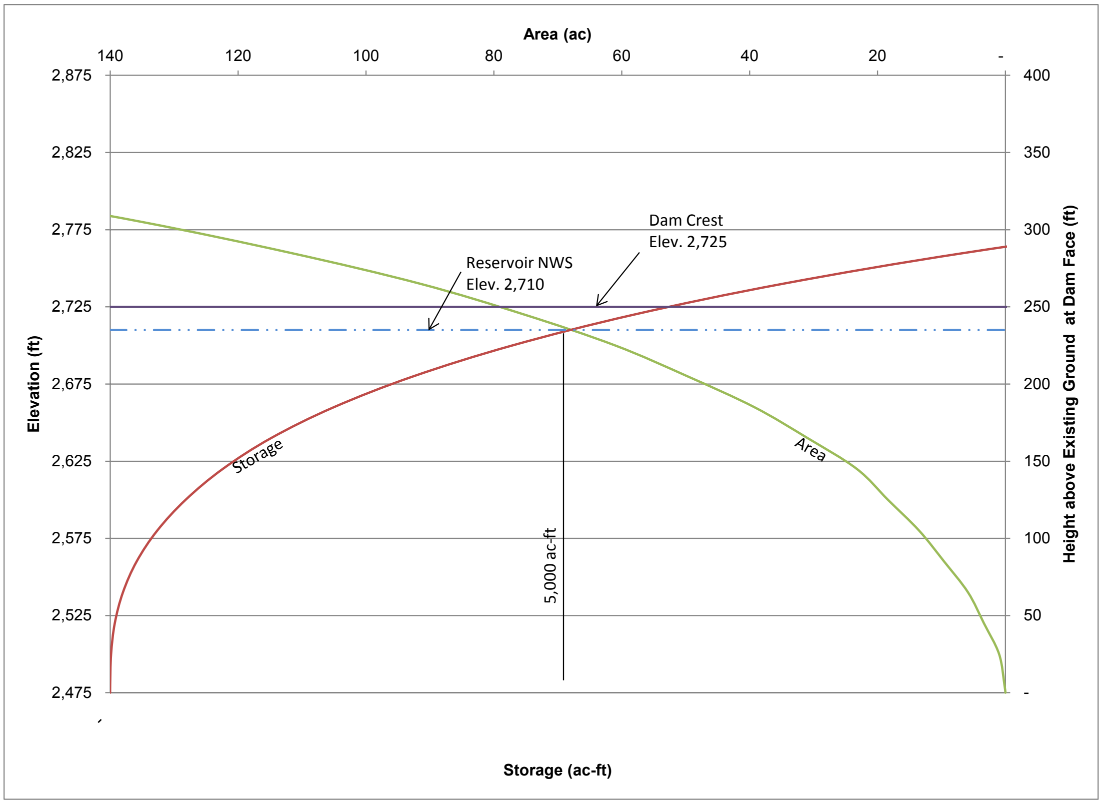


Figure 5-3: Upper Cedar Creek Elevation-Area-Capacity Curve

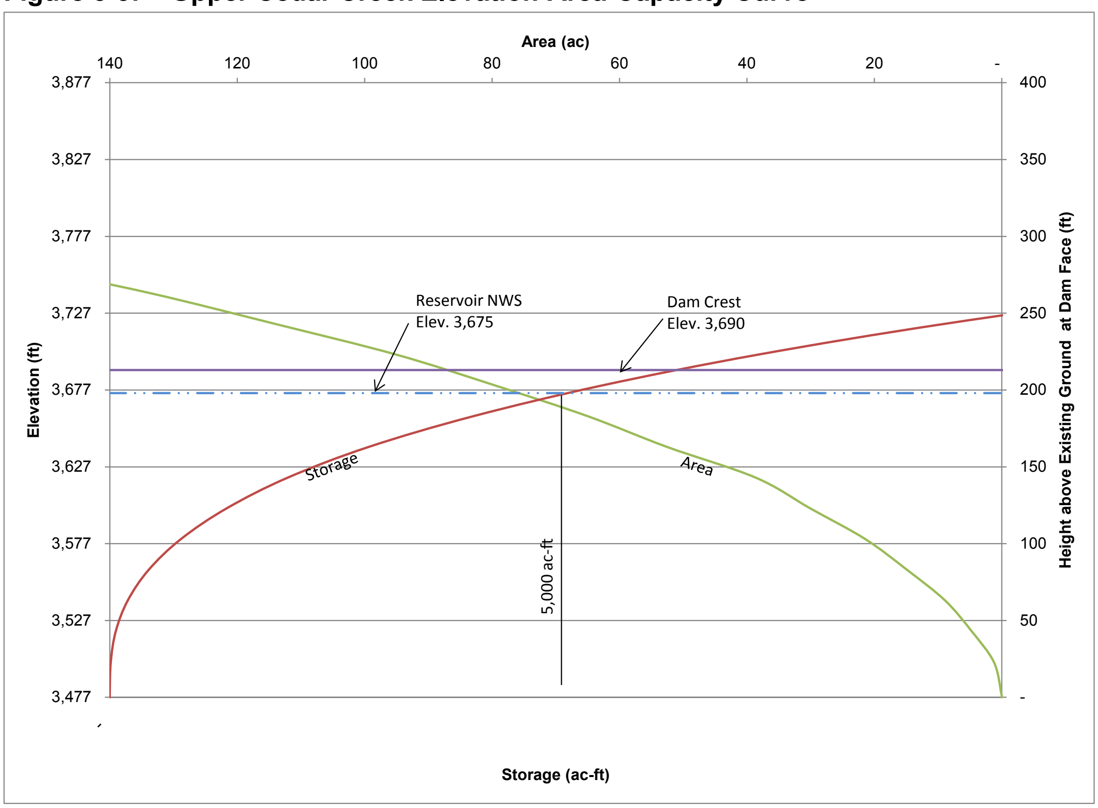
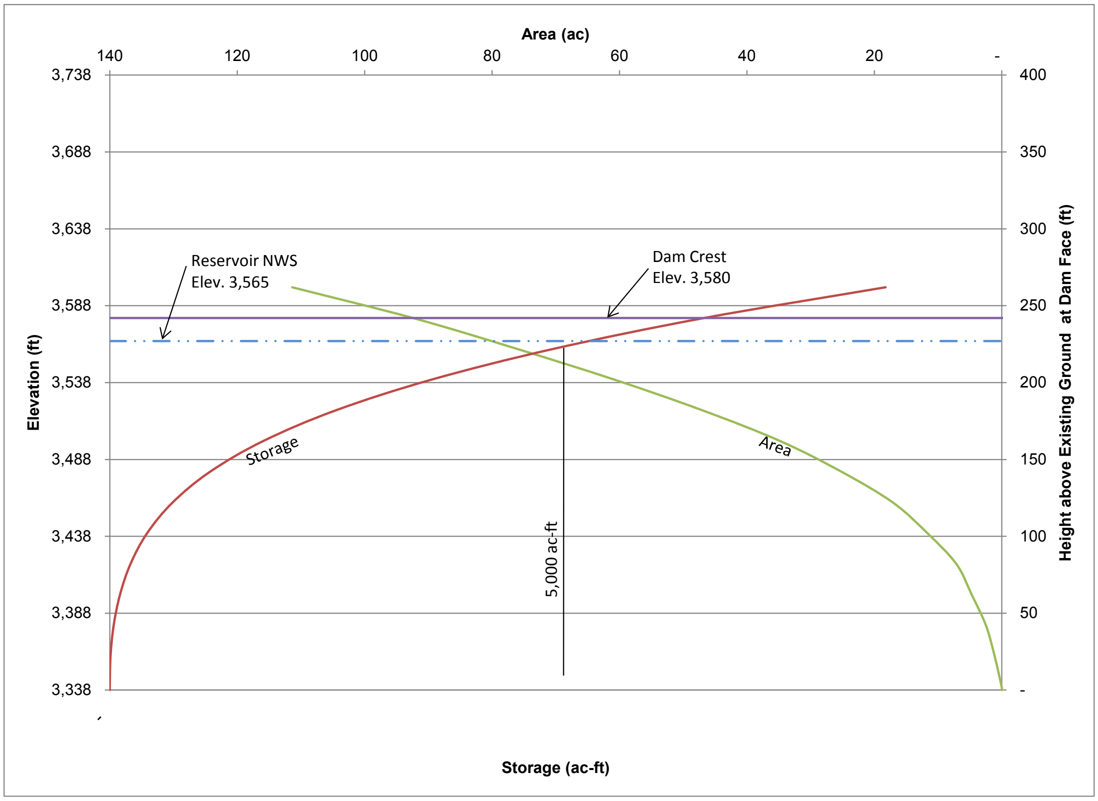


Figure 5-4: Lower Cedar Creek Elevation-Area-Capacity Curve



The figures presented in Appendix B include a Project Location Map, site location map, and a plan, profile and typical cross-section for each of the proposed dam and reservoir sites. The RCC dams would have structural heights[5] ranging from approximately 223 feet to 255 feet and hydraulic heights[6] ranging from approximately 198 feet to 235 feet. The depths of excavation vary for the dam sites and are consistent with Reclamation's recommendations as reported in *Engineering Geologic Inspection of Potential Dam Sites on South Fork Tule River* (Reclamation, 2010). The non-overflow section of the dam has a vertical upstream face, a 20-foot wide crest, and a 0.8H:1V downstream face. The cross sections of the dam are based on GEI's judgment and experience on similar structures. No stability analysis was performed to size the dam cross section. A reinforced concrete parapet wall would be constructed on the upstream and downstream end of the dam crest for public safety.

Topography used in this study was developed from a United States Geologic Survey (USGS) 7.5-minute, 1:24,000 scale, raster profile Digital Elevation Model (DEM) with 10-meter vertical resolution. This level of accuracy is considered acceptable for this planning-level study; however we recommend obtaining higher resolution topography for the final design phase. Coordinates used in this study are referenced to North American Datum (NAD) 27,

[5] The structural height is defined as the distance between the dam crest and the deepest part of the foundation excavation.
[6] The hydraulic height is defined as the distance between the dam crest and the lowest point on the existing ground surface along the dam axis.

Universal Transverse Mercator (UTM) Coordinate System, Zone 11, and U.S. Survey Feet. Elevations used in this study are referenced to National Geodetic Vertical Datum (NGVD) 1929, Feet.

Table 5-1 presents a summary of the primary conceptual dam size characteristics that were developed and used in this study.

Table 5-1: Summary of Proposed Dam Site Information

Dam Site Description	Gross Reservoir Storage (ac-ft)	Elevations		Freeboard (ft)	Dam Crest Width (ft)	Slope of Downstream Face (XH:1V)	Dam Height (ft)		Dam Axis Length (ft)	Gross Concrete Fill (2) (CY)
		Normal Water Surface	Nominal Dam Crest(1)				Hydraulic	Structural		
Upper Bear Creek	5,000	2,905	2,920	15	20	0.8	219	239	1,325	363,000
Lower Bear Creek	5,000	2,710	2,725	15	20	0.8	235	255	1,030	348,000
Upper Cedar Creek	5,000	3,675	3,690	15	20	0.8	198	223	1,380	416,000
Lower Cedar Creek	5,000	3,565	3,580	15	20	0.8	227	252	1,470	492,000

1. Based on recommendations presented in Tule River Tribe Proposed Water Storage Project DEC Review, Nov. 2009, by US Bureau of Reclamation.
2. Gross Dam Concrete Volume includes RCC and facing concrete. Not including concrete for the dam crest parapet walls, spillway training walls, or outlet works pipeline encasement and intake tower.

5.4.2.1 Foundation Treatment

Foundation treatment at the sites would consist of curtain grouting and consolidation grouting. The grout curtain would extend approximately one half of the structural dam height into the foundation. The grout curtain is provided to minimize foundation seepage through cracks and other flaws in the rock foundation. Immediately downstream of the grout curtain, foundation drains would be drilled from the gallery in the dam and extending roughly one-third of the structural dam height into the foundation.

5.4.2.2 Seepage Collection and Control

Drainage provisions would include a level and sloping drainage gallery, dam drains, and foundation drains. The foundation drains would serve to relieve uplift pressure on the dam base by providing a safe flow path beyond the grout curtain. In addition, interior dam drain holes would be drilled vertically through the dam, centered on the contraction joints and extending between the dam crest and the gallery to relieve any pressure buildup due to seepage through the vertical joints in the dam.

5.4.2.3 Grout-enriched RCC

Both the upstream dam face and downstream dam face would be formed and constructed with grout-enriched RCC (GERCC). The primary function of the upstream concrete facing is to serve as the primary seepage barrier, and also to protect the RCC from freeze-thaw damages. The primary function of the downstream facing in the non-overflow section is to provide freeze-thaw protection, while the GERCC within the spillway section is to provide freeze-thaw protection as well as resistance to hydraulic forces from the spillway discharge. In addition, the entire upstream face would be sealed with a geomembrane similar to what was used in the recently completed Olivenhain Dam in San Diego County to further protect the dam against seepage. The provision was included in GEI's conceptual design because of the anticipated high seismic design load and because the State of California may require similar seepage protection as for Olivenhain Dam.

5.4.2.4 Spillway

The spillway is an uncontrolled overflow structure constructed near the center of the RCC dam, with conventional mass concrete ogee crest and reinforced concrete training walls. The spillway width was assumed to be 200 feet at each dam location. This spillway crest width would be adequate to discharge a routed outflow of about 40,000 cfs, without overtopping of the dam crest.

An RCC dam is typically constructed in horizontal steps, and the exposed steps on the downstream face (spillway chute) would dissipate a significant amount of hydraulic energy, thus requiring a smaller stilling basin. For this study, GEI assumed a stilling basin length of 150 feet for all of the dams. The stilling basin foundation slab was assumed to consist of 2-foot-thick conventional concrete overlying 5-feet of RCC. A vehicular bridge with reinforced concrete piers was assumed to be provided over the spillway to allow access from one abutment to another.

5.4.2.5 Outlet Works

The outlet works would likely consist of a multi-level intake tower constructed with reinforced concrete and affixed to the upstream face of the RCC dam, and a 36-inch-diameter concrete encased welded steel outlet conduit. Each of the intake openings through the tower would be fitted with a trash rack and hydraulically operated gate, and the 36-inch outlet conduit would be guarded by a 36-inch hydraulic sluice gate. The outlet conduit would be founded on bedrock near the valley bottom on one of the two abutments adjacent to the spillway. A bifurcation of the outlet works conduit near the downstream dam toe, guarded by a 12-inch butterfly valve, would provide for diversion of water into a 12-inch-diameter ductile iron pipeline for raw water transmission to the planned water treatment plant near the existing Lumber Mill. The raw-water transmission pipeline is currently assumed to share the main gravel road alignment back to the Lumber Mill; however alternative alignments may result in cost savings. Further review of alignments will be performed during the feasibility phase of work. Additional discussion about the raw water transmission pipeline is provided in Section 5.7.1.

A second penetration into the 36-inch outlet conduit would also be provided to release minimum stream flows downstream of the dam. A sleeve valve, with upstream butterfly valve of the same diameter, would be provided to release the minimum flow. The 36-inch-diameter conduit would discharge into the spillway stilling basin via a pipe penetration through the sidewall of the basin. The conduit outlet would be equipped with a

36-inch butterfly valve (guard valve) and a 36-inch fixed-cone valve for releasing flows in excess of minimum stream flows.

5.5 Site Access Improvements

Access road improvements will be necessary for providing sufficient road widths and turning radius for construction and delivery vehicles. The Main Road to the Cholollo Campground is currently unpaved and narrow, with many switchbacks. The limits and scope of improvements are somewhat unknown at this point. Our current understanding is that pre-construction improvements to the gravel roads from the lumber mill (primary staging area) to the dam site, and post construction improvements to the paved road from the reservation boundary to the primary staging area would be necessary.

Pre-construction improvements to the gravel road between the primary staging area and the dam site would include road widening, adding turnouts for temporary vehicle stops, and improving the river crossings for heavy vehicles. Additionally, pre-construction improvements to the paved road from the Reservation boundary to the primary staging, including road widening to add 3-foot gravel shoulders and full-width shoulder pull offs for temporary vehicle stops, may also be necessary.

Post-construction improvements to the paved roads would likely be necessary to repair rutting and other damage resulting from heavy vehicle loads over the span of the construction period. Improvements would most likely range from local asphalt repairs to milling and overlaying or possibly full road section replacements if the damage is severe.

There is also the possibility that repairs may be necessary on Reservation Road beyond the Reservation boundary, extending as far as the intersection with Highway 190. Because this is a County road, however, the details of how those potential improvements are funded and executed are unknown. Early coordination with Tulare County is recommended so the Tribe can plan for and secure additional funding if necessary.

5.6 Site Access and Construction Considerations

This section addresses the following key design and construction issues that are important to the technical and economic feasibility of developing a new RCC dam and reservoir at any of the dam sites:

- Site access considerations;
- Construction staging areas;
- On-site quarry sources;
- Sources of cement and fly ash; and
- Off-site commercial material sources.

The information provided in this section is based on the report titled *Engineering Geologic Inspection of Potential Dam Sites on South Fork Tule River* (Reclamation, 2010).

5.6.1 Site Access Considerations

The assessment of access conditions to each of the potential dam sites is referenced from the Main Road, and would be applicable primarily for future field investigation work, such as drilling and test pit excavation. Further field work and topographic mapping will be required to undertake detailed studies of alignments for construction access.

5.6.1.1 Upper Bear Creek Dam site

The approximately 0.5-mile-long Bear Creek Road leaves the Main Road at about El. 2800 and ends near the South Fork Tule River at about El. 2550, about 0.2 miles northwest (downstream) of the confluence of the two streams. The road has a number of tight switchback turns, and is best driven in a high-clearance four-wheel-drive vehicle. Two of the switchbacks are flanked by flat shoulders that would provide excellent sites for exploratory drill holes, as would a flat area at the bottom of the road. Some tree trimming and road work would be required to make the road passable to a truck-mounted drill rig. Existing ranch roads are present on both the north and south sides of the South Fork Tule River Canyon. Some road improvement would be required to make the roads passable to a drill rig. The south side road crosses the river at a natural ford located about 0.3 miles upstream of Bear Creek Road.

5.6.1.2 Lower Bear Creek Dam site

Access from the upstream direction is via Bear Creek Road described in the Upper Bear Creek Dam Site. A second access route could be constructed down a moderately sloping, open ridgeline located about one-half mile downstream from Bear Creek Road. The south side of the South Fork Tule River is inaccessible to vehicles. Construction of an access road to the south side would be challenging.

5.6.1.3 Upper Cedar Creek Dam site

The approximately 0.1-mile-long Cedar Creek Road leaves the Main Road at about El. 3600 and ends near the South Fork Tule River at about El. 3450, about 0.2 miles northeast (upstream) of the confluence of the two streams. An evaporation gage next to the road is an easily recognizable landmark. The road has one tight switchback turn and is best driven in a high-clearance four-wheel-drive vehicle. Some road work would be required to make the road passable to a truck-mounted drill rig. The south side of the canyon can be accessed via a very rough, unimproved jeep trail that crosses the river at an unmaintained natural ford.

5.6.1.4 Lower Cedar Creek Dam site

The site is currently reached by walking downslope (south) to the South Fork Tule River from the Main Road at a point approximately 0.4 miles downstream of Cedar Creek Road. The south side of the canyon may be accessed by vehicle from the Main Road by taking Clubhouse Crossing (approximately 1.25 miles downstream of Cedar Creek Road and 0.8 miles downstream of the Upper Cedar Creek Dam site to a complex of ranch roads. An access road to the south canyon slope, which is the left abutment of the Upper Cedar Creek Dam site, could be constructed along the El. 3600 contour line from the ranch roads to the dam site.

5.6.2 Possible Construction Staging Areas

We anticipate that a main staging area and a secondary staging area would be required for the construction of the RCC dam. The main staging area would be the same for all four potential dam sites, and would likely be located at the existing Lumber Mill. The main staging area would be used for the following purpose:

- Office trailers for the contractor;
- Office trailers for the owner and engineer (Government use);
- Central receiving and storage for imported materials, equipment and supplies;
- Storage of contractor's construction equipment; and
- Vehicle parking.

The secondary staging area locations vary from dam site to dam site, and would be multiple-use area for the following uses:

- Concrete mixing plants for RCC and conventional concrete materials;
- Storage bins for cementitious materials (cement and fly ash);
- Power generators and maintenance trailers;
- Processing facilities for RCC aggregate, conventional concrete aggregate, and aggregate base course;
- Stockpiles of various processed aggregate materials;
- Storage of construction and haul equipment; and
- Contractor and construction management parking.

In general, it is preferable that all of these facilities be located close together; however, that is not always possible. It is desirable from a cost standpoint to have the aggregate processing facilities, aggregate stockpiles, and concrete mixing plants in close proximity to each other to minimize transportation and hauling costs. The following possible secondary staging areas were identified in the Reclamation geology report:

5.6.2.1 Upper and Lower Bear Creek Dam sites

Three areas were identified: (a) near the top of Bear Creek Road; (b) south of Wheatons; (c) south side of the canyon. The combined area of all three sites is estimated at over 8 acres.

5.6.2.2 Upper and Lower Cedar Creek Dam sites

Two areas were identified: (b) south side of the canyon at about El. 3500; (b) above the Main Road on the north side of the canyon. The combined area of the two staging areas is estimated at over 20 acres.

5.6.3 On-Site Rock Quarries

The economic and possibly environmental feasibility of an RCC dam at the four potential sites depend on the availability of rock quarries to manufacture aggregates for the RCC and conventional concrete. Based on preliminary site reconnaissance by Reclamation, it appears that on-site rock quarries are available for all of the potential dam sites to produce good quality coarse and fine aggregates. The granitic and metamorphic bedrock was described as hard and fresh with minor weathering, and these parent source rocks are known to produce aggregates that meet ASTM C33 requirements. Site-specific subsurface investigations and laboratory testing should be performed to obtain field and laboratory data for future conceptual and final designs.

The following possible quarry locations were identified in the Reclamation geology report for the four potential dam sites:

5.6.3.1 Upper and Lower Bear Creek Dam sites

Two areas: (a) along the South Fork Tule River and in the canyon walls just upstream of the Upper Bear Creek dam site; (b) above the Main Road about 0.3 miles downstream from its intersection with Bear Creek Road.

5.6.3.2 Upper and Lower Cedar Creek Dam sites

Above the Main Road about 0.4miles northwest of its intersection with the Cedar Creek Road, directly north of the north side staging area.

5.6.4 Sources of Cement and Fly Ash

Cement and fly ash (Class F) will be required for batching RCC and conventional concrete on site. These materials would most likely be transported from off-site sources in bulk and stored near the concrete plants on site. The nearest off-site sources of these materials have not been identified, and should be identified to establish the basis for construction cost estimates. Typically, fly ash is produced in coal-fired power plants, but it is important to identify those power plants that produce Class F fly ash.

5.6.5 Off-site Commercial Sand and Gravel Sources

Although it is not practical or economical to import sand and gravel materials (including RCC aggregate) for constructing the new dam for this project, four off-site areas with commercial operations or potential new quarries were identified in the Reclamation geology report:

5.6.5.1 East Porterville Area

The only active alluvial sand and gravel pit in the East Porterville area is the Mitch Brown Pit located about one mile downstream of Success Dam, within the Tule River flood plain.

Inactive alluvial sand and gravel pits are located between the Mitch Brown Pit and East Porterville. A potential alluvial sand and gravel source is located between Highway 190 and the Tule River near the southeastern corner of East Porterville, but the zoning and ownership of this land is unknown.

5.6.5.2 Reservation Road

Hard granite is being quarried and crushed into aggregates for road construction. This quarry is located on the side of a hill adjacent to Reservation Road, approximately 1.25 miles south of the Highway 190/Reservation Road intersection.

5.6.5.3 Lake Success-Northeast Areas

A large but depleted alluvial sand and gravel pit is located within the Tule River flood plain about three miles northeast of Success Dam. This pit may date back to the construction of Success Dam by the U.S. Army Corps of Engineers in 1961.

5.6.5.4 Deer Creek

The active Deer Creek Aggregate Pit is located on Avenue 120, about 7.75 miles southeast of Porterville and three miles east of Road 252. This pit is currently quarrying and crushing volcanic rock into aggregate, primarily for road construction. In general, the quality of volcanic rock is lower than that of granitic rock.

5.7 Water System

In addition to the dam and reservoir, a number of water system improvements would be needed to make use of the water impounded by the proposed dam and reservoir. Required improvements include:

- A new raw water line to convey stored water to the water treatment plant and proposed irrigation projects near Wheaton and on lower Pigeon Creek;
- Increased capacity at the water treatment plant; and
- Improvements to the existing distribution system to remedy existing deficiencies, including expansion of the water distribution system to supply water to identified Tribal housing areas.

In consideration of the local topography and the location of the proposed facilities, the Tribe may want to consider incorporating hydroelectric generation facilities into this project. More information regarding the proposed water system improvements and a brief discussion of hydroelectric generation potential is provided in Section 5.7.4.

5.7.1 Raw Water Pipeline

A raw water supply pipeline is needed to convey water from dam and reservoir to the water treatment plant and to irrigation water users. Design flow for the raw water pipeline is expected to be 1,850 gpm (4.1 cfs). This capacity is based on projected domestic, commercial, municipal and irrigation (DCMI) demands. Assuming a design velocity in the range of 5 to 6 feet per second (fps), the pipe diameter would be 12-inches. Ductile iron (DI) or polyvinylchloride (PVC) pipe would be the preferred pipe materials for the raw water pipeline. DI pipe has proven long-term performance history in many types of applications, but may require some form of corrosion protection. PVC pipe is significantly lighter in weight and resistant to corrosion. Recent price trends suggest that these two pipe materials may be cost-competitive. Class 350 DI pipe was assumed for the raw pipeline.

The elevation drop between the reservoirs and the water treatment plant (WTP) would vary from over 2100 feet (Upper Cedar Creek) to over 1100 feet (Lower Bear Creek). While some of the head between the reservoir and the WTP would be dissipated by pipe friction and other losses, pressure reducing valves would be required in order to maintain acceptable pressure within the pipe. Pipeline lengths and other key information for the dam and reservoir alternatives are summarized in Table 5-2 below.

Table 5-2: Approximate Raw Water Transmission Pipeline Layout Information

Dam and Reservoir Alternative	Length to WTP feet/miles	Elevation Drop (1) feet	No. of PRVs Required (2)
Upper Cedar Creek	46,800/8.9	2115	4
Lower Cedar Creek	43,500/8.2	2005	4
Upper Bear Creek	31,600/6.0	1360	2
Lower Bear Creek	27,100/5.1	1150	2

1. From maximum normal pool elevation to estimated WTP El.1560.
2. Assumes Class 350 DI Pipe and maximum pressure of 250 psi (100 psi safety margin).

Construction of the pipeline is expected to occur after the dam construction is complete because the road along which the pipeline would be located is required for construction access. The road is narrow and has several switchbacks; therefore, constructing the pipeline while the dam constriction is underway would be expected to hinder dam construction progress.

The pipeline would be located on the uphill side of the road. The pipeline would be placed in a trench, a significant portion of which may be excavated into rock. Depending on vertical alignment and rock conditions certain sections of the pipe might be placed above existing grade and covered with fill material. Thrust blocks and restraints would likely be required at critical changes in horizontal and vertical alignment. Combination air-vacuum valves and blow-off valves would be required.

5.7.2 Water Treatment

The Tribe's water treatment plant was upgraded in 2004-05 under IHS project CA 00-L30. The plant was expanded to increase its capacity from 150 gpm to approximately 300 to

350 gpm. The projected maximum day demand for the Reservation is approximately 1,050 gpm. Therefore, further expansion of the water treatment plant is required to treat an additional 700 gpm. Based on communication with Tribal personnel, a new treatment facility would be constructed in the vicinity of the existing facilities in order to accommodate the additional demand.

5.7.3 Water Distribution

A 2004 IHS study addressed deficiencies in the existing tribal water system (Indian Health Service, 2004). The existing water system comprises pipelines of mainly 4-inch and 6-inch diameters, two large storage tanks with a capacity of 200,000 gallons each, and 7 smaller storage tanks ranging in size from 3,000 to 40,000 gallons, with a combined capacity of 153,000 gallons.

The IHS report recommended the following improvements:

- The replacement all of the 4-inch water mains in the entire water distribution system with either 8-inch or 6-inch pipelines;
- Four smaller tanks to be replaced by a single 300,000 gallon tank;
- The installation of pressure reducing stations downstream of the proposed 300,000 gallon tank; and
- The replacement of a booster pump.

A funding request for the construction of these facilities is still pending based on information provided by the Tule River Tribe. No further improvements beyond the IHS recommendations are believed to be required to provide reliable service to the current service area.

Expansion of the water distribution system is required to serve the proposed future housing areas on the Reservation. New water transmission pipelines would connect to the existing distribution system and convey water to new storage tanks. New pipeline distribution systems would then deliver water from the storage tanks to the housing areas. All new pipelines would be C900 PVC pipe. Booster pumps would be needed at the connection points to the existing water system to pump water into storage tanks.

Pipeline lengths and elevations were obtained from USGS Quadrangle maps and geographic information system (GIS) analysis. A pipeline pressure limit of 150 pounds per square inch (psi) was used to size and locate the booster pump stations. The pipe friction losses were determined using the Hazen-Williams equation with a Hazen-Williams C-factor of 140. Design flow velocities in the transmission pipelines were limited to 5 fps.

The storage tanks would be constructed at locations with sufficient elevation to allow for gravity flow to the new housing areas. The tanks would be sized to provide operation storage, emergency storage, and fire suppression storage. Operation storage was estimated at 25-percent of the maximum day demand. Emergency storage was estimated at the average day demand. Storage for fire suppression was estimated at a flow rate of 750 gpm for 2-hour duration.

5.7.4 Hydroelectric Generation Potential

While this study does not currently include provisions for hydroelectric generation, the height of the dam and the elevation drop from the proposed reservoir sites to the water treatment plant presents at least two potential alternatives for hydroelectric generation facilities.

The Tribe could choose to evaluate either or both of the following options since the two systems could operate independently from each other. Installing both systems in parallel could provide the Tribe with nearly 1.0 megawatt (MW) of clean, renewable energy. However at a minimum, each option would require its own powerhouse, substation, and transmission facilities, and therefore the upfront and long-term costs would need to be carefully evaluated and weighed against the immediate and long-term benefits before any decisions are finalized.

5.7.4.1 Outlet Works Hydropower Option

The Tribe could take advantage of the required minimum stream discharge and the elevation drop from the reservoir normal water surface to the outlet works discharge location by adding hydroelectric facilities at the downstream end of the outlet works near the toe of the dam. Assuming a required minimum reservoir discharge of 20 cfs for stream and 85-percent efficiency provided by an appropriately sized Francis turbine, this hydropower alternative could feasibly generate between 260 and 340 kilowatts (kW)[7]. Adding hydropower generation capacity at this location could be accomplished with minimal modifications to the presently proposed facilities, including a second bifurcation from the primary outlet works conduit to reroute the discharge flows to a hydroelectric turbine in a new powerhouse adjacent to the proposed outlet works discharge location.

5.7.4.2 Raw Water Transmission Pipeline Hydropower Option

Another hydropower option for the Tribe's consideration includes taking advantage of the 1,100- to 2,100-foot elevation drop from the proposed dam sites to the water treatment plant by installing hydroelectric facilities immediately upstream of the water treatment plant. Hydroelectric facilities at this location could feasibly generate as much as 650 kilowatts (kW)[7] of renewable energy under the planned 4.1 cfs discharge capacity of the raw water delivery pipeline.

---

[7] Pipe entrance losses, friction losses due to bends in the pipeline, and other minor hydraulic losses have been neglected at this level of analysis. A detailed analysis of the hydroelectric generation potential would need to be performed during a more advanced stage of design to properly quantify and evaluate the costs and benefits of adding hydroelectric generation capacity.

Evaluation of this option prior to selection of a preferred dam site is recommended in consideration of:

- The difference in available elevation drop between the presently proposed dam sites and the water treatment plant for each of the proposed alternative dam sites; and
- The required modifications to the presently envisioned pipeline concept, including elimination of the pressure reducing valves to maximize pressure head at the hydroelectric generation unit(s) and thicker pipe walls to accommodate the high water pressures in the downstream pipeline reaches.

6.0 Hydrologic Evaluation of Storage Alternatives

6.1 General

This chapter discusses a hydrologic evaluation of the alternative dam sites. The purpose of the hydrologic evaluation is to assess the ability of each of the proposed dam sites to serve the projected water demands of the Tribe. The hydrologic evaluation consists of both a flow estimation analysis and reservoir modeling. The flow estimation analysis is performed to generate river flows estimates at the four alternative dam sites. The reservoir evaluation model is then used to evaluate the adequacy of the proposed reservoirs to meet the projected water demands.

The flow estimation analysis is performed by taking the extended gage flow data at the two on-Reservation gages (Section 3.0) and adjusting those flows to the different dam locations based on watershed area.

Once the flow estimation analysis was completed, a reservoir model was run for each of the proposed dam sites. The model provides a means to determine the yield from the alternative reservoir sites.

6.2 Hydrology for Alternatives Evaluation

The goal of flow estimation analysis is to create daily flow records at three ungaged sites located between USGS Gage 3580 and 4100 on the South Fork Tule River. These three sites correspond to the locations of the Lower Cedar Creek Site, Upper Bear Creek Site, and Lower Bear Creek Site. Gage 3580 records the flow at the Upper Cedar Creek Site. Inflow estimates are required at each of the potential reservoir sites to determine their respective reservoir yield. The ungaged sites are each located just downstream of the confluence with a major tributary of the South Fork Tule River. Table 6-1shows the locations of the three ungaged sites and major tributaries listed below.

- Cedar Creek (Lower Cedar Creek Site)
- Kessing Creek (Upper Bear Creek Site)
- Bear Creek (Lower Bear Creek Site)

6.2.1 Available Data

The available flow records from the two on-reservation USGS gages are described in Section 4.1. The extension of the gage flow records was described in Section 4.3. Gage 4100 is located at an elevation of 970 ft. Gage 3580 is at an elevation of 3700 ft.

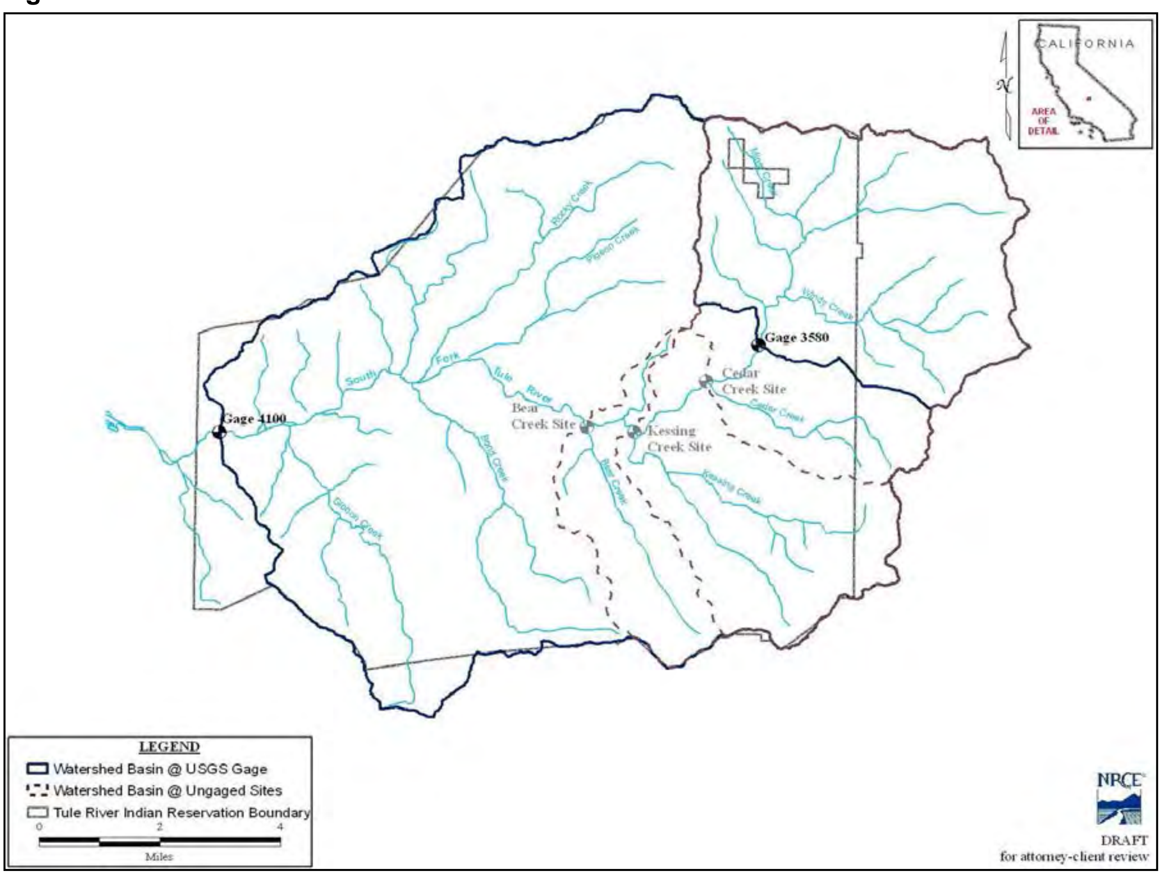
6.2.2 Basin Drainage Area

The watershed boundaries upstream from Gage 3580, Gage 4100 and the three ungaged sites were delineated to obtain basin drainage area. The boundaries of these watersheds were digitized using GIS software. The South Fork Tule River basin delineation obtained from United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) was further divided into the sub-basins of interest using contours on the 1:24,000 USGS topographic maps. An aerial image background was also used to periodically check for spatial accuracy and identify any physical anomalies that may impede water drainage. The basin areas for the five sites are shown in Table 6-1. The basin delineations are shown on Figure 6-1.

Table 6-1: Basin Area of Select Sites on the South Fork Tule River

Site	Basin Area (ac)
Gage 3580	13,080
Cedar Creek Site	17,274
Kessing Creek Site	25,267
Bear Creek Site	29,249
Gage 4100	61,505

Figure 6-1: Basin Delineations for Selected Sites on the South Fork Tule River



6.2.3 Flow Estimation Methodology

The flows at the ungaged dam sites are estimated using the drainage area ratio method. Since the three ungaged sites all lie between Gages 3580 and 4100, the flows at these sites can be estimated as a combination of the flows at the two gages. The combination is determined by assigning weighting factors to the flows at Gages 3580 and 4100 based on drainage area.

The daily gage flows at the three ungaged sites are determined using the equation below:

$$Q_{ungaged} = \frac{Q_{3580}(DA_{4100} - DA_{ungaged}) + Q_{4100}(DA_{ungaged} - DA_{3580})}{DA_{4100} - DA_{3580}}$$

where: $Q_{ungaged}$ = flow at ungaged site, cfs

Q_{3580} = flow at Gage 3580, cfs

Q_{4100} = flow at Gage 4100, cfs

$DA_{ungaged}$ = drainage area of basin at ungaged site, acres

DA_{3580} = drainage area of basin at Gage 3580, acres

DA_{4100} = drainage area of basin at Gage 4100, acres

6.2.4 Results

A summary of the results of the analysis at each of the four alternative dam sites for the time period 1949 to 2011 (excluding 1955 and 1956) is shown in Table 6-2.

The annual estimated gage flows at each dam site are provided in Table 6-2.

Table 6-2: Estimated Annual Flows at the Alternative Dam Sites

Location	Average (acre-feet per year)	50% Exceedance (acre-feet per year)	80% Exceedance (acre-feet per year)
Upper Cedar Creek (Gage 3580)	14,400	11,100	6,600
Lower Cedar Creek	16,100	12,100	7,000
Upper Bear Creek	19,300	13,900	7,900
Lower Bear Creek	20,900	14,900	8,300

6.3 Reservoir Operation Model Development

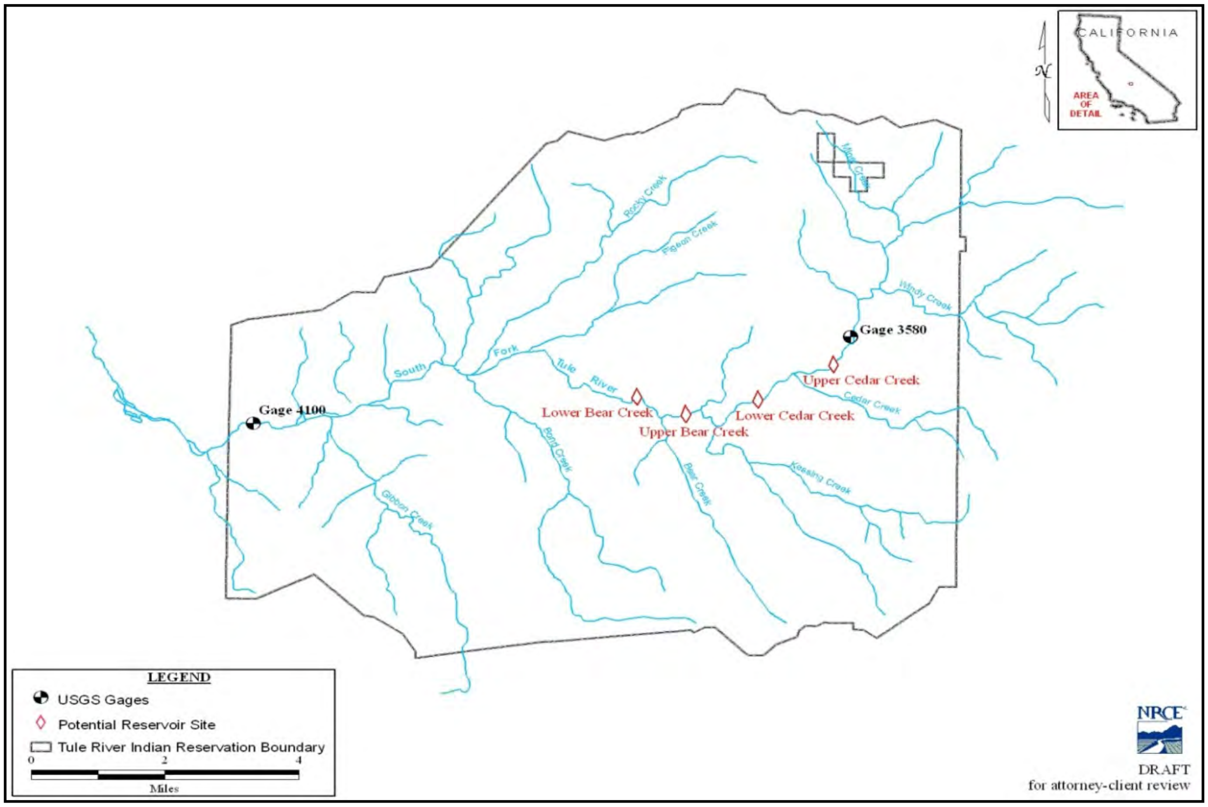
6.3.1 Model Purpose

The general purpose of the reservoir evaluation model (REM) is to determine the yield from a given size future reservoir at each potential site on the South Fork Tule River and to compare that yield to projected future tribal water demands. Four potential reservoir sites have been identified, as described in Section 5.0:

- Upper Cedar Creek
- Lower Cedar Creek
- Upper Bear Creek
- Lower Bear Creek

In order to determine the size of a future reservoir at these sites, it is important to estimate the reservoir inflows. The inflow for the Upper Cedar Creek site is the flow recorded by Gage 3580. For the remaining sites, daily inflows were estimated by using a combination of recorded flows at Gages 3580 and 4100. Figure 6-2 shows the location of Gage 3580, Gage 4100 and the four alternative reservoir sites.

Figure 6-2: USGS Gage Sites and Potential Reservoir Sites



6.3.2 Future Water Needs for Modeling Purposes

For the purposes of the REM, the target water demand to be served by the Phase I Project reservoir is the sum of the domestic, commercial, municipal, and industrial needs shown in

Table 3-1 plus some additional water for irrigation. The amount of irrigation is limited by the yield of the given reservoir.

For this study, it is assumed that the Phase 1 Project will serve an irrigation project consisting of a cropping pattern of 1/2 alfalfa, 1/6 pistachios, 1/6 olives, and 1/6 wine grapes as discussed in Section 3.3.5. The weighted average diversion requirement for this cropping pattern is 4.08 acre-feet/acre. The amount of irrigated acreage served by the Phase 1 Project varies depending on the dam site and is determined through the REM yield analysis. A summary of the Phase 1 Project water demands is shown in Table 6-3.

Table 6-3: Tule River Indian Reservation Phase 1 Project Water Demand

Description	Annual Water Use (acre-feet per year)
Domestic/Municipal	1,372
Commercial	391
Stock watering/Mining/Sand and Gravel	211
Irrigation	TBD
Total	**1,974 + Irrigation**

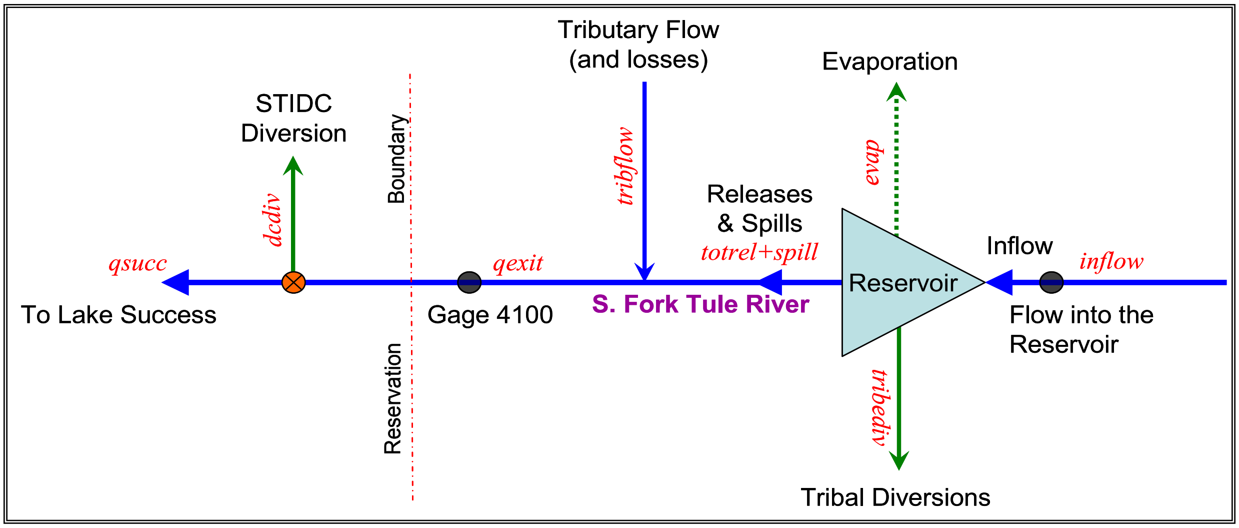
6.3.3 Model Formulation

The REM was developed by NRCE in-house and written in FORTRAN. The REM is run on a daily basis over the period 1949 to 2011 (water years) excluding 1955 and 1956 (61 years).

Figure 6-3 is a schematic representation of the REM. This figure shows the main variables that define the reservoir water balance. A short description of these variables is given below.

- Inflow - Flow entering the proposed reservoir. Determined through the flow estimation analysis for each of the dam sites.
- Evaporation (*evap*) – Reservoir evaporation
- Tribal Diversions (*tribediv*) – Total Tribal diversion. This is the sum of all applicable Tribal diversions and may include residential, domestic, and public uses (*rdpdiv*), agricultural use (*agdiv*), irrigated pasture (*pdiv*), commercial and industrial uses (*cidiv*), stockwatering use (*swdiv*), and sand and gravel use (*sgdiv*).
- Releases and Spills (*totrel* + *spill*) – Total reservoir release and spills.
- Tributary Flow (*tribflow*) – Tributary flow (gains and losses) downstream of the proposed reservoir and upstream of Gage 4100.
- STIDC Diversion (*dcdiv*) – Downstream STIDC diversion.
- Lake Success flow (*qsucc*) – South Fork Tule River flow downstream of the STIDC diversion that heads toward Lake Success.

Figure 6-3: Schematic of the Reservoir Evaluation Model



The reservoir water balance equation can be written as:

$$\text{In} - \text{Out} = \Delta \text{S (storage)}$$

where:

$$In \;=\; inflow$$
$$Out \;=\; totrel + spill + tribediv + evap$$
$$\Delta S \;=\; previous\ day\ storage - current\ day\ storage$$

6.3.4 Model Execution

The REM can be run to either solve for reservoir size or reservoir yield. The required input for each run includes reservoir inflow and downstream flow, shortage limits, reservoir operation rules, and reservoir stage/volume/surface area relationships. Each day, the model performs the water balance on the reservoir as described above. If solving for reservoir size, the user is required to provide the project water demands. If solving for reservoir yield, the user is required to provide the reservoir size.

6.3.4.1.1 *Shortage Limits*

The maximum allowable shortage limits specified when evaluating the reservoir sites are annual irrigation shortage, 10-year moving average irrigation shortage, and annual residential, domestic and public shortage. The model calculates annual shortage for each year of the model period. If any of these shortage limits are exceeded, the model automatically adjusts by either increasing the reservoir size or decreasing the project water demand.

For this analysis the maximum allowable DCMI shortage was set to 0-percent, meaning that the reservoir project must be sufficient to supply the entirety of that demand every year (i.e., firm yield). The irrigation shortage limits were set to 30-percent for a single year and 10-percent for the 10-year moving average.

6.3.4.1.2 Reservoir Operation Rules

The reservoir operation rules include minimum reservoir releases based on the flow entering the reservoir as well as limited reservoir fill schedule during dry years. These reservoir operation rules were determined as part of the Tribe's water rights negotiations.

These minimum releases, shown in Table 6-4, are used in the REM so that the downstream STIDC water demand is satisfied. The minimum releases are separated into two periods during the year, corresponding to the low flow season (June 1 – October 1) and all other times.

Table 6-4: Reservoir Operation Rules

Dates	Inflow into the Reservoir, cfs	Minimum Reservoir Release, cfs
June 1-October 1	≤ 3.5	3.5
	> 3.5 and ≤ 10	Inflow
	> 10	10
All other times	≤ 4	2.5
	> 4	4

In addition to the minimum releases to satisfy the STIDC water demands, the reservoir operation rules also call for mitigating impacts to the users of water out of Lake Success during dry years. This is accomplished by limiting the filling of the Tribe's reservoir to 9 acre-feet per day during March 1 – October 31 of dry years so as to allow some of the flow of the South Fork Tule River to continue on downstream. Dry years are determined as those water years in which the cumulative flow in the South Fork Tule River during the October through February period is less than the long-term 60-percent exceedance flow for that same period, as determined at Gage 3580.

6.3.4.1.4 Reservoir Stage/Volume/Surface Area Relationships

The reservoir stage/volume and volume/surface area relationship equations are obtained through regression analysis using data from Section 5.4.2. The regression equations can be expressed as follows:

$$Log(S) = sv_1 Log(V) + sv_c$$

$$Log(A) = av_1 Log(V) + av_c$$

where: S = *reservoir stage, ft*
V = *reservoir volume, ac-ft*
A = *reservoir surface area, ac*

The regression coefficients for use in these equations are shown in Table 6-5.

Table 6-5: Dam Stage/Volume/Surface Area Regression Coefficients

Site	Stage (H)/Volume (V) Regression Coefficients		Surface Area (A)/Volume (V) Regression Coefficients	
	sv_1	sv_c	av_1	av_c
Upper Cedar Creek Site	0.3637	0.9376	0.6766	-0.6271
Lower Cedar Creek Site	0.3664	1.0058	0.7172	-0.7876
Upper Bear Creek Site	0.4067	0.8031	0.6288	-0.5182
Lower Bear Creek Site	0.3776	0.9582	0.6904	-0.7251

6.3.5 Reservoir Evaporation

The REM estimates reservoir evaporation based on unit net evaporation estimates and the daily calculations of reservoir surface area. There are no direct evaporation estimates for the Tule River Indian Reservation. Therefore, a theoretical method to estimate evaporation was used. The Hargreaves equation was selected for this purpose because it only requires minimum and maximum daily temperatures to determine monthly gross evaporation rates (Jensen, et al., 1990). Temperature and precipitation data were obtained from the Glenville Climate Station.

The Hargreaves Equation is as follows:

$$E_t = 0.0023 \frac{R_A}{\lambda} (T + 17.8) TD^{\frac{1}{2}}$$

Where: E_t = *evaporation rate in mm/day*
R_A = *extraterrestrial radiation in MJ m-2d-1*
λ = *latent heat of vaporization in MJ kg-1*
T = *average daily temperature in °C*
TD = *the difference in maximum and minimum daily temperature in °C.*

The extraterrestrial radiation, R_A, is expressed as:

$$R_A = \left(\frac{24*60}{\pi}\right) G_{sc}\, d_r \left(\omega_s \sin\phi \sin\delta + \cos\phi \cos\delta \sin\omega_s\right)$$

Where: G_{sc} = *solar constant, equivalent to 0.0820 MJ m-2 min-1*
ϕ = *latitude in radians, negative for southern latitudes*
δ = *declination in radians*
d_r = *relative distance of the earth from the sun*
ω_s = *sunset hour angle in radians*

The declination, δ, in radians, is estimated as:

$$\delta = 0.4093 \sin\left(\frac{2\pi(284+J)}{365}\right)$$

Where: J = *Julian day*

The term d_r is the relative distance of the earth from the sun, or

$$d_r = 1 + 0.033 \cos\left(\frac{2\pi J}{365}\right)$$

The sunset hour angle, ω_s, in radians is expressed as,

$$\omega_s = \arccos(-\tan\phi \tan\delta)$$

The average annual unit net evaporation on the Reservation estimated using the Hargreaves method is 36.3 inches. Average monthly values are shown in Table 6-6.

Table 6-6: Estimated Average Monthly Evaporation, Precipitation, and Net Evaporation, inches

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Evap	3.87	2.24	1.75	1.87	2.19	3.26	4.43	6.21	7.48	8.57	7.72	5.78
Precip	0.82	2.16	2.85	3.61	3.13	3.05	1.79	0.73	0.13	0.12	0.20	0.70
Net Evap	3.04	0.09	-1.11	-1.75	-0.94	0.21	2.65	5.48	7.34	8.43	7.52	5.06

6.4 Alternatives Analysis Modeling

In this study the REM was run to solve for reservoir yield given a 5,000 acre-feet reservoir. Five runs were performed, corresponding to the four alternative dam sites plus the No Action alternative (i.e., no future reservoir). The model results are shown in Table 6-7. All four of the reservoirs at the alternative dam sites are able to provide the full Phase 1 Project DCMI demand without any shortage. The reservoirs vary in the amount of irrigated acreage served, mainly due to differences in reservoir inflow.

Table 6-7: Reservoir Evaluation Model Results – Yield Analysis

Project Site	DCMI Demand Served (acre-feet per year)	Irrigated Acreage Served (acres)	Total Water Demand Served (acre-feet per year)	Average Reservoir Evaporation (acre-feet per year)
Upper Cedar Creek	1,974	80	2,300	194
Lower Cedar Creek	1,974	120	2,464	194
Upper Bear Creek	1,974	200	2,790	193
Lower Bear Creek	1,974	220	2,871	193
No Action Alternative	569	0	569	NA

6.4.1 Reservoir Filling

The REM is run under the assumption that the reservoir is half full (2,500 acre-feet) at the start of the simulation period. This is done in order to avoid the model results being unduly influenced by water supply shortages in the first year of the simulation. However, it is recognized that a period of time will be required following dam construction to fill the reservoir to that initial amount. It is anticipated that during this initial fill period there will be no diversions out of the reservoir for water supply purposes but the operational rules described in Section 6.3.4 will be in effect.

In order to estimate the length of time required to fill the reservoir to an initial volume of 2,500 acre-feet, the inflows and outflows to each of the four alternative dam sites were investigated. The difference between daily inflow and outflow gives an approximation of the amount of water that can be added to storage each day.[8] Table 6-8 shows the number of individual years within the 61-year model period where the available storage was able to reach 2,500 acre-feet.[9] In all cases, the reservoir was able to reach 2,500 acre-feet within any two consecutive years of the model period.

[8] The analysis neglects evaporation and seepage losses.
[9] While in all years of the model period for all dam sites the total annual inflow exceeds 2,500 AF, not all of this flow can be stored due to minimum release requirements and maximum daily storage limits during dry years.

Table 6-8: Reservoir Initial Fill Analysis

Project Site	No. of Years Able to Store 2,500 acre-feet	Percentage
Upper Cedar Creek	38	62%
Lower Cedar Creek Site	41	67%
Upper Bear Creek Site	48	79%
Lower Bear Creek Site	52	85%

As seen in Table 6-8, the chances of requiring two years for the initial halfway fill instead of one decrease as the dam sites move downstream. For example, in 38 years out of the total 61 year period the Upper Cedar Creek site would have filled to 2,500 acre feet. This is roughly equivalent to saying that there is a 62 percent chance that this dam site would need one year to fill halfway as opposed to two. The most downstream site, Lower Bear Creek, by comparison was able to fill halfway in 52 out of the 61 years, which is about an 85 percent chance.

7.0 Cost Evaluation of Alternatives

7.1 General

This section presents estimates of project costs for each of the four potential dam and reservoir sites, and includes the following components:

- Construction cost of the new dam and appurtenant structures;
- Construction cost of the new raw water transmission pipeline;
- Construction cost of the expansion of the existing water treatment plant;
- Construction cost of the expanded treated water distribution system;
- Construction cost of improvements to the existing access roads; and
- Program costs for the Tule River Tribe.

The basic design concepts described in Section 3.0 were used as the basis for the construction cost estimates. GEI prepared construction quantity estimates and developed the unit prices and lump sum prices for the major construction cost items. Design and construction contingencies were included in the construction cost to account for a variety of uncertainties and unknowns as described in more details below.

7.2 Overview of Cost Evaluation Process

The cost estimates were developed by GEI to enable relative comparisons among the proposed alternatives presented in this report and to provide a range of project implementation costs

Previous studies by Reclamation (1998) and NRCE (2007) provided cost estimates for alternative dam sites based on a dam cross section developed and provided by Reclamation in 1998. GEI reviewed this cross section and other cost components, and maintains the opinion that the costs from previous studies are not conservative for this level of study. Therefore, GEI has developed these cost opinions based on a modified cross section with a more conservative downstream slope.

The following cost estimates are based on GEI's experience on similar projects and evaluation of the major construction items appropriate to complete the work. Unit price breakdowns and quantity estimates were developed and are provided in Appendix C. Quantity estimates were based on the layouts provided in Appendix B. Lump sum prices are based on estimates of the work required and the corresponding cost.

Estimation of the prices was based on the following approach and assumptions:

- Estimated values corresponded to 2012 dollars, and would need to be escalated for future construction;

- Labor costs included provisions for base salary, benefits, workman's compensation and general liability insurance, payroll tax, field supervision, field office cost, temporary construction costs, small tools, other distributable costs and contractor overhead and profit;
- No hazardous materials were evident on the sites or included in the estimate for remediation;
- Material pricing was Free on Board (FOB) on site;
- For RCC dams, aggregates for concrete (except for cement and fly ash) were assumed to be from on-site sources; and
- Budgetary pricing was obtained from appropriate vendors and published reference for gates and valves, and other construction materials.

7.2.1 Allowances for Contingencies

For the Bear Creek alternatives (Upper and Lower Bear Creek Dam), the estimated construction costs include an allowance for design contingencies equal to 20-percent of the listed items. For the Cedar Creek alternatives (Upper and Lower Cedar Creek Dam), this allowance was increased to 22-percent of the listed items in consideration of the additional distance from the construction workers' living quarters and primary staging area to the dam site as compared to the Bear Creek sites. This extra distance may have cost implications including additional fuel costs for construction equipment and material deliveries, and increased labor costs due to lost time spent commuting to the dam site. While this additional cost is very difficult to estimate at this time, an additional cost allowance of two (2) percent was provided in the design contingencies.

Additional design contingencies beyond the 20-to 22-percent were applied to the raw water transmission pipeline (25-percent), water treatment plant expansion (30-percent), and water distribution system expansion (30-percent). The increased design contingency was applied to account for the preliminary level of the proposed design concepts for these facilities relative to the development of the design concepts for the dam and access road facilities.

In any case, the purpose of the design contingency is to account for the preliminary nature of the design, unknown site conditions, and approximate quantities. This design contingency will decrease as project development progresses towards final design and construction bidding.

The sum of the listed items plus the unlisted items allowance is defined for this study as the "Base Construction Subtotal" (BCS). An allowance for the construction contractor's costs for mobilization, bonds and insurance is included as a percentage of the BCS. For the Tule River Dam and Reservoir cost estimates, this allowance is assumed to be 9-percent of the BCS.

The cost estimates also include an allowance for construction contingencies. This allowance is for managing the financial risk of a project and is based on the risk management approach taken during bidding and construction. Construction contingencies are typically included to allow for project construction cost increases that could result from a variety of factors including:

- Unforeseen conditions at the site;
- Change orders during construction that are in addition to the original project scope; and
- Uncertainties and additional work associated with weather delays and construction on an active stream.

The total allowance for construction contingencies used in the cost estimates is 15-percent of the BCS.

The sum of the BCS, mobilization, bonds and insurance, and construction contingencies is defined as the "Direct Construction Subtotal" (DCS).

7.2.1.1.1 Owner's Program Costs

The Total Opinion of Probable Project Cost (OPPC), which is equal to the DCS plus allowances for selected program costs such as design engineering (8-percent); construction engineering and administration (8-percent); and legal, permitting and land acquisition (10-percent); is provided for each project alternative. These program costs do not include allowances for environmental mitigation and potential improvements to access roads beyond the Reservation boundary.

7.2.2 Limitations

The opinions of probable construction costs presented in this report are based on GEI's professional opinion of the cost to develop and construct the project as described in this report. The estimated costs are based on the sources of information described above, and our knowledge of current construction cost conditions in the locality of the project. Actual project construction and development costs are affected by a number of factors beyond our control such as supply and demand for the types of construction required at the time of bidding and in the project vicinity; changes in material supplier costs; changes in labor rates; the competitiveness of contractors and suppliers; changes in applicable regulatory requirements; changes in design standards; and environmental mitigation requirements and other conditions of project permitting. Therefore, conditions and factors that arise as project development proceeds through construction may result in construction costs that differ from the estimates documented in this report.

7.3 Dam Construction Costs for Alternative Sites

For this study, the estimated dam construction cost for each of the alternative dam sites can be broken down into four (4) major categories:

1. Site civil costs – These costs include site development and improvements for the borrow areas, river diversion and cofferdam, and reservoir clearing. Details of selected listed items under this category are discussed below:
   - The combined area of the primary and secondary staging areas is assumed to be 10 acres.
   - The total area of the rock quarry sources is assumed to be 8 acres. The rock quarry sources are expected to be located below the normal pool elevation of the reservoir in order to minimize reclamation costs.
   - No construction flood diversion analysis was performed on the cofferdam and stream diversion cost. Both the level of construction flood protection and the stream flow diversion would need to be evaluated and determined in future studies. For this study, we assume a temporary 50-foot-high rock fill upstream cofferdam, and a 36-inch temporary stream diversion pipe.
   - A significant portion of the reservoir area below normal pool elevation would need to be cleared based on the heavily vegetated conditions observed during previous site observations. For reservoir clearing, we assume the trees will be cleared and disposed of outside of the reservoir, but the stumps will be left in place.
2. Roller Compacted Concrete (RCC) Dam costs – These costs include foundation dewatering, excavation and treatment, foundation grouting, RCC dam and facing concrete, dam drainage provisions, geomembrane facing, and instrumentation. Details of selected listed items under this category are discussed below:
   - Drill and blast method will be required for foundation rock excavation. We assume that the excavated rock will not be suitable to be processed as concrete aggregate, and will be disposed in the reservoir.
   - The cost of borrowing and processing the RCC aggregate from the on-site quarry includes the equipment and labor to manufacture the hard granite or metamorphic rock into an aggregate that meets ASTM C33 durability requirements for concrete. The work includes excavating quarry rock, crushing and screening, and stockpiling processed aggregate. We assume that the aggregate will have a maximum particle size of 2 inches and fine contents (percent finer than No. 200 sieve) in the range of 5-to 10-percent. No more than three stockpiled sizes are anticipated.
   - This unit price of RCC consists of furnishing cement and fly ash, and batching, mixing, transporting, spreading, compacting, and curing RCC. The unit price also includes a bedding mix concrete applied on each RCC lift for the upstream 25 feet of the lift. The cement will be Type I/II low alkali, and the fly ash will

be Class F. The site is located in a high seismic area, and high strength is required for seismic stability. Based on GEI's design experience on RCC dams located in similar high seismic areas, we assume a mix with 150 pounds of cement and 150 pounds of fly ash per cubic yard of RCC. Cost allowance is provided in the unit price for cooling the RCC during mixing because of the anticipated hot placement environment at the site.

- An RCC test section will be required in the secondary staging area to evaluate the RCC trial mixes, contractor's equipment and procedure to construct various key design features, and to finalize the RCC design mix. This test section will be left in place upon completion.
- The unit price for the grout-enriched RCC facing consists of batching, mixing, transporting, spreading RCC in the facing areas; furnishing and placing cement grout; and compacting and curing the grout-enriched RCC. The average width of the upstream facing and downstream facing is assumed to be 24 inches. The cement grout will be a neat cement with a water: cement ratio of 1:1 by weight. The neat cement grout will first be poured over uncompacted RCC and allowed to soak into the RCC, and then immersion vibrators will be used to consolidate the grout. The surface of the consolidated RCC surface will then be compacted with a vibratory roller.
- The lump sum price for the gallery and adits consists of constructing level and sloping gallery, and two access adits. The gallery and adit section is assumed to have a width of 6 feet and a clear height of 10 feet. The level gallery is below the spillway section, with sloping gallery extending up each abutment on each side of the spillway. The roof and each side of the gallery will be formed RCC with no conventional concrete facing. The floor of the gallery will have a 12-inch-thick unreinforced concrete slab with a formed gutter for drainage collection. Appurtenances in the gallery and adit will consist of lighting, forced air ventilation, and handrails (one side only) along the sloping gallery.

3. <u>Outlet Works Structure costs</u> – The costs include the concrete gate tower, concrete-encased 36 inch steel outlet conduit, miscellaneous gates and valves, and control building, and power generator. Details of selected listed items under this category are discussed below:
   - No structural analysis was performed to size the gate tower and base. Based on GEI's design experience on similar structures, we assume the tower to be 15 feet by 15 feet on plan, with an average thickness of 2 feet and a base of 25 feet by 25 feet.
   - Three intake ports were assumed for multiple-level withdrawal: a low level, an intermediate level, and a high level. Each intake opening consists of a trash rack and a power-assisted sluice gate. A power-assisted sluice gate at the bottom of the tower serves as the guard gate for the outlet conduit.

4. Spillway costs – These costs include the ogee crest, concrete training walls, concrete stilling basin, and a vehicle access bridge across the spillway. Details of selected listed items under this category are discussed below:
   - The ogee crest, training walls, bridge piers, and stilling basin will be constructed of conventional concrete.
   - The spillway bridge cost was based on precast concrete deck and girder system, published Department of Transportation cost data.
   - The stilling basin slab was assumed to consist of 2-foot-thick conventional concrete overlying 5 feet of RCC.

Detailed cost spreadsheets prepared for each of the four (4) alternative dam sites are provided in Appendix C. Table 7-1 presents a summary of the estimated itemized construction costs (ICC) for the dam facilities, which exclude design contingencies, mobilization, bond and insurance, construction contingencies, and owner's program costs:

Table 7-1: Estimated Itemized Construction Costs for Dam Construction

	Upper Bear Creek	Lower Bear Creek	Upper Cedar Creek	Lower Cedar Creek
Site Civil	$2.3 million	$2.5 million	$2.8 million	$2.6 million
RCC Dam	$55.1 million	$51.8 million	$60.5 million	$69.9 million
Outlet Works	$2.1 million	$2.1 million	$1.7 million	$1.8 million
Spillway	$3.0 million	$3.1 million	$3.0 million	$3.0 million
Subtotal, Itemized Construction Costs (ICC):	**$62.1 million**	**$59.5 million**	**$67.9 million**	**$77.4 million**

7.4 Access Road Improvement Costs

No appraisal level designs and layouts were performed to estimate the construction costs for access road improvements. The access road improvements reflected in the cost tables include: pre-construction road widening to add 3-foot gravel shoulders to the paved roads and additional width to the gravel roads to provide 24-foot road widths, new permanent gravel roads from the main road to the dam sites, new temporary gravel roads for construction access around the dam site, and post-construction mill and overlay improvements to the paved roads to repair rutting and other damage that occurs due to the dam and pipeline construction activities.

There is also the possibility that repairs may be necessary on Reservation Road beyond the Reservation boundary, extending as far as the intersection with Highway 190. Since this is a County road, however, the details of how those potential improvements are funded are unknown. Costs for these improvements are not included in these cost opinions, however are believed to range between $5 and $20 million dollars, depending on the scope of work required. Early coordination with Tulare County is recommended so the Tribe can plan for and secure additional funding if necessary.

Table 7-2 presents a summary of the access road related ICCs, which exclude design contingencies, mobilization, bond and insurance, construction contingencies, and owner's program costs.

Table 7-2: Estimated Base Construction Costs for Road Improvements

Alternative Dam Site	Itemized Construction Cost (ICC)
Upper Bear Creek Dam site	$11.0 million
Lower Bear Creek Dam site	$11.0 million
Upper Cedar Creek Dam site	$14.1 million
Lower Cedar Creek Dam site	$14.1 million

7.5 Raw Water Transmission Pipeline Costs

The raw water transmission pipeline construction costs presented in Table 7-3 were derived from the proposed pipeline alignments described in Section 5.7.1. These costs exclude design contingencies, mobilization, bond and insurance, construction contingencies, and owner's program costs.

Table 7-3: Estimated Itemized Construction Costs for Raw Water Pipeline

Alternative Dam Site	Itemized Construction Cost (ICC)
Upper Bear Creek Dam site	$3.1 million
Lower Bear Creek Dam site	$3.1 million
Upper Cedar Creek Dam site	$4.9 million
Lower Cedar Creek Dam site	$4.9 million

7.6 Water Treatment Plant Expansion Costs

The water treatment plant expansion construction costs presented in Table 7-4 are based on costs developed by NRCE (NRCE, 2007). The original costs were generated from construction costs for the 2005 expansion of the Tribe's existing water treatment plant. Additional information regarding the proposed water treatment plant expansion is provided in Section 5.7.2. The ICCs presented in Table 7-4 have been escalated at a rate of 3-percent per year from 2007 to 2012, and exclude design contingencies, mobilization, bond and insurance, construction contingencies, and owner's program costs. The 3-percent escalation rate is probably conservatively high for the 2007-2012 period.

Table 7-4: Estimated Itemized Construction Costs for Water Treatment Plant Improvements

Alternative Dam Site	Itemized Construction Cost (ICC)
Upper Bear Creek Dam site	$1.9 million
Lower Bear Creek Dam site	$1.9 million
Upper Cedar Creek Dam site	$1.9 million
Lower Cedar Creek Dam site	$1.9 million

7.7 Water Distribution System Expansion Costs

The water distribution system expansion costs presented in Table 7-5 are based on costs developed by NRCE (NRCE, 2007). The original costs were based on recommendations developed to address deficiencies identified in a 2004 IHS study (Indian Health Service, 2004). Additional information regarding the proposed water distribution system expansion is provided in Section 5.7.3. The ICCs presented in Table 7-5 have been escalated at a rate of 3-percent per year from 2007 to 2012, and exclude design contingencies, mobilization, bond and insurance, construction contingencies, and owner's program costs.

Table 7-5: Estimated Itemized Construction Costs for Water Distribution Improvements

Alternative Dam Site	Itemized Construction Cost (ICC)
Upper Bear Creek Dam site	$8.3 million
Lower Bear Creek Dam site	$8.3 million
Upper Cedar Creek Dam site	$8.3 million
Lower Cedar Creek Dam site	$8.3 million

7.8 Summary of Project Costs

Table 7-6 presents a summary of the estimated project costs, including all ICCs and design and construction contingencies described in Section 7.2.1. The costs presented under "Project Totals" represent our opinion of the Tribe's entire program costs to develop the proposed water storage facilities, raw water transmission pipeline, water treatment plant expansion, and water distribution system expansion.

Table 7-6: Estimates of Total Project Costs

	Lower Bear Creek Dam	Upper Bear Creek Dam	Lower Cedar Creek Dam	Upper Cedar Creek Dam
Itemized Construction Costs (ICC)				
Dam and Reservoir	$59,469,000	$62,483,000	$77,391,000	$67,908,000
Road Improvements	$11,048,000	$11,048,000	$14,093,000	$14,093,000
Raw Water Pipeline	$3,111,000	$3,111,000	$4,908,000	$4,908,000
Water Treatment Plant Expansion	$1,890,000	$1,890,000	$1,890,000	$1,890,000
Water Distribution System	$8,320,000	$8,320,000	$8,320,000	$8,320,000
Itemized Construction Cost Subtotal (ICCS):	**$83,838,000**	**$86,852,000**	**$106,602,000**	**$97,119,000**
Design Contingency				
Dam and Reservoir (20% to 22%)	$11,893,800	$12,496,600	$17,026,020	$14,939,760
Road Improvements (20% to 22%)	$2,209,600	$2,209,600	$3,100,460	$3,100,460
Raw Water Pipeline (25%)	$777,750	$777,750	$1,227,000	$1,227,000
Water Treatment Plant Expansion (30%)	$567,000	$567,000	$567,000	$567,000
Water Distribution System (30%)	$2,496,000	$2,496,000	$2,496,000	$2,496,000
Base Construction Subtotal (BCS)	**$101,782,150**	**$105,398,950**	**$131,018,480**	**$119,449,220**
Mobilization, Bonds & Insurance (9% BCS)	$9,160,394	$9,485,906	$11,791,663	$10,750,430
Construction Contingency (15% BCS)	$15,267,323	$15,809,843	$19,652,772	$17,917,383
Direct Construction Subtotal (DCS)	**$126,209,866**	**$130,694,698**	**$162,462,915**	**$148,117,033**
Design Engineering (8% DCS)	$10,096,789	$10,455,576	$12,997,033	$11,849,363
Construction Administration & Engineering (8% DCS)	$10,096,789	$10,455,576	$12,997,033	$11,849,363
Legal, Permitting, Mitigation (10% DCS)	$12,620,987	$13,069,470	$16,246,292	$14,811,703
Total Opinion of Probable Project Cost (OPPC)	**$159,024,431**	**$164,675,319**	**$204,703,273**	**$186,627,461**

Note 1: ICC= Itemized Construction Cost for individual project features.
Note 2: ICCS = Itemized Construction Costs Subtotal, sum of all 5 project features.
Note 3: BCS = Base Construction Subtotal, sum of ICCS and design contingency.
Note 4: DCS = Direct Construction Subtotal, sum of BCS, mobilization, bond, insurance, construction contingency
Note 5: The cost estimates in this report are considered to be Class 4 estimates per the Association for the Advancement of Cost Engineering (AACE) International Cost Estimate Classification System.

8.0 Screening Analysis of Alternatives

8.1 Background

The alternatives screening process was first discussed with Tribal representatives in a meeting held in September 2010. A Technical Memorandum (*Tule River Indian Reservation -- Proposed Water Storage Project -- Dam Site Selection Criteria)* was prepared by Reclamation (Mid-Pacific Regional Office, Division of Design and Construction) to document the meeting. That memorandum summarizes the results of the September 2010 brain-storming session, which involved representatives from the Tribe, Reclamation, BIA, and the Tribal Water Team and its consultants. The screening factors discussed at the meeting and presented in that memorandum were grouped, as follows:

- Factor 1 – Social and Cultural
- Factor 2 – Environmental and Permitting
- Factor 3 – Dam Design and Construction Issues
  - Site Access
  - Staging and Stockpile Areas
  - Development of Concrete Aggregates

Numerous issues related to constructing a dam and reservoir were discussed at the meeting and the memorandum identified suggested weighting factor ranges for the criteria and in the case of Criterion 3, weighting ranges for three sub-criteria. Most of the dam design and construction issues identified at the meeting will ultimately be reflected in the cost estimates developed for each of the alternatives.

8.2 Screening Analysis

The framework developed for evaluation of water supply project alternatives on the Tule River Reservation includes definition of: the over-arching goals for the project; the objectives that must be achieved to attain these goals; and the criteria that must be met to achieve the objectives and goals. Performance measures were used to determine how well each of the criteria is met under a specific alternative. This process was designed to be "reproducible and defensible" in order to be compliant with requirements of Section 404(b) of the Clean Water act (CWA) and to assure that various Tribal interests are fairly considered. Ultimately, the alternatives screening and justification for selection of a preferred alternative will need to become part of the documentation for a Corps of Engineers 404 Permit and documentation of compliance with requirements of the National Environmental Policy Act (NEPA).

The alternatives evaluation framework developed for the project allows input from stakeholders to be accepted, quantified as appropriate, and used in the screening and comparison of project alternatives in very systematic way. The sensitivity of screening and ranking of alternatives to changes in the importance of various weighting factors can be systematically evaluated.

While the process is "numerical" in nature, it provides opportunities for discussion among decision-makers and for consensus- building among potentially diverse project stakeholders. The weighting factors are established in a group setting. This process allows for discussion of important factors and it often elicits valuable insights affecting ultimate design of the project features. The goals and criteria are established to be independent, and when possible, are based on quantifiable measures. Relative weights are assigned to each goal, objective and criterion.

The alternatives evaluation framework developed for the screening of alternatives for the Tule River Tribal Water Settlement Project is presented on Figure 8-1. The goals are fairly similar to the three main factors identified in Reclamation's December 2010 memorandum on selection criteria. However, there are some differences. For example, the goals of minimizing environmental impacts relates directly to the CWA Section 404(b) requirement that, to be selected as a preferred water supply option, an alternative should be the "least environmentally damaging alternative".

All project alternatives under consideration are required to supply, at a minimum, the Tribe's future DCMI water needs based on the 100-year projections described in Section 3.3. The alternatives are further evaluated with respect to water supply based on their ability to serve irrigation water demand in addition to the DCMI demand.

As noted above, factors related to dam design and construction incorporate a large number of considerations that are reflected in the cost of the project alternatives. An alternative that is too expensive, in relation to other alternatives, is not expected pass the test of practicability under Section 404(b) of the CWA

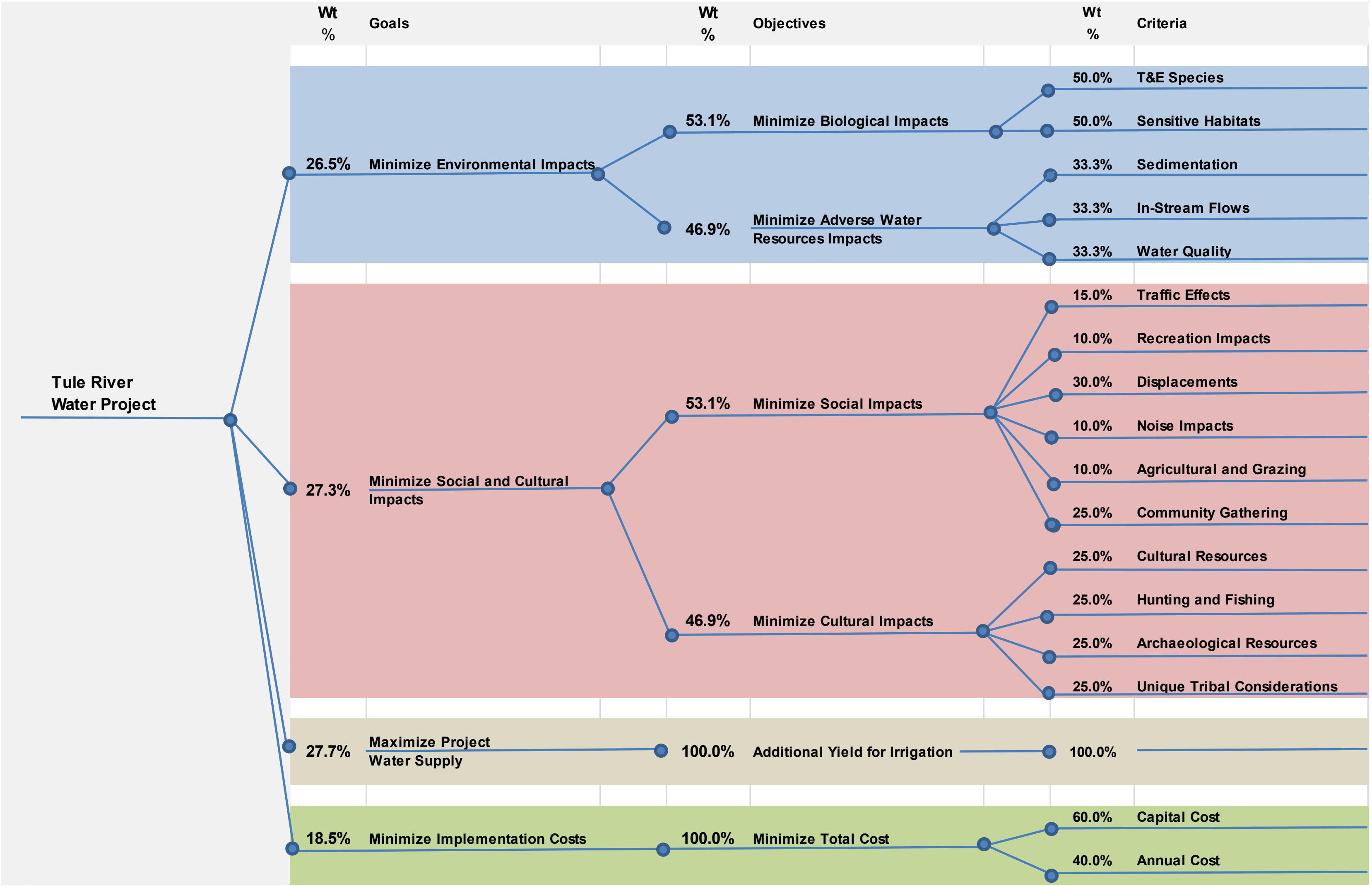
Many issues were discussed at the December 2010 meeting and these issues served as a general basis for establishing the goals, objectives, and criteria in the screening framework presented on Figure 8-1 and summarized in Table 8-1 below:

Table 8-1: Objectives and Criteria for Screening

Goals	Objectives	Criteria
Minimize Environmental Impacts	Minimize Biological Impacts	T&E Species
		Sensitive Habitats
	Minimize Water Resources Impacts	Sedimentation
		Instream Flows
		Water Quality
Minimize Social and Cultural Impacts	Minimize Social impacts	Traffic Effects
		Recreation Impacts
		Displacements
		Noise Impacts
		Agricultural and Grazing
		Community Gathering
	Minimize Cultural impacts	Cultural Resources
		Hunting and Fishing
		Archaeological Resources
		Unique Tribal Considerations
Maximize Water Supply	Additional Yield for Irrigation	Additional Yield for Irrigation
Minimize Costs	Minimize Costs	Capital Cost
		Annual Cost

The framework shown on Figure 8-1 was presented to the Tribal Water Team prior to the Screening Workshop, which was held at the Tribal Headquarters on March 6-7, 2013. During the Workshop, the Tribal Council, with assistance from representatives of key departments, participated in a process to establish the relative weights of the goals and objectives and to qualitatively score the alternatives in terms of their performance relative to the identified criteria.

Figure 8-1: Alternatives Screening Framework



8.2.1 Environmental Impact Considerations

The goal of minimizing environmental impacts was weighted by the Tribal Council at 26.5-percent, based on averaging of scores provided by members. This weighting is close to those given for social and cultural considerations and maximizing water supply for the Tribe. The objective of minimizing biological impacts (53.1-percent) was weighted nearly the same as the objective of minimizing water resources impacts (46.9-percent). The Tribal Council and representatives of the Tribal Natural Resources Department indicated that dam and reservoir projects developed at any of the sites would not have significant biological resource impacts nor would such impacts vary significantly from site to site. In terms of water resources impacts (sedimentation, in-stream flow changes, and water quality), the consensus during the Screening Workshop was that the sites lower in the watershed would have the potential for more negative impacts than sites higher in the watershed. Water resources impacts relate to sedimentation, channel maintenance, in-stream flows, and water quality. The scores (from 1 to 5) for each criterion reflect these considerations, with 5 representing the least impact and 1 the most impact. Weighting of the individual criteria were assumed to be equal, based on discussions at the Workshop.

8.2.2 Social and Cultural Impact Considerations

The goal of minimizing social and cultural impacts was weighted by the Tribal Council at 27.3-percent, based on averaging of scores provided by members. This weighting is close to those given for environmental considerations and maximizing water supply. The objective of minimizing social impacts (53.1-percent) was weighted nearly the same as the objective of minimizing water resources impacts (46.9-percent).

The Tribal Council and representatives of the Tribal various Tribal departments indicated that dam and reservoir projects developed at any of the sites would not have significant social impacts other than traffic and noise impacts. These impacts would be more significant for sites higher in the watershed due to increased travel distances for construction equipment and personnel and closer proximity to sites that are more heavily used for recreation and social gathering. Also, the upper sites near Cedar Creek would produce greater adverse impacts to recreational uses of the Reservation lands because access to the South Fork Tule River is easier and these locations are used more often by Tribal members for community gathering and stock grazing. The scores (from 1 to 5) for each criterion reflect these considerations, with 5 representing the least impact and 1 the most impact. Weighting of the individual criteria were developed based on discussions at the Workshop. Individual scores for each criterion were obtained from the participating Tribal Council members and averaged.

The Tribal Council and representatives of the various Tribal departments indicated that dam and reservoir projects developed at any of the sites would not have significant cultural impacts, but that whatever impacts might occur would generally be somewhat more significant for sites higher in the watershed. Also, the upper sites near Cedar Creek would produce greater adverse impacts to hunting and fishing because access to the South Fork Tule

River is easier at these locations. The scores (from 1 to 5) for each criterion reflect these considerations, with 5 representing the least impact and 1 representing the most impact. Weighting of the individual criteria were developed by GEI, based on discussions at the Workshop. Individual scores for each criterion were obtained from the participating Tribal Council members and averaged.

8.2.3 Water Supply Considerations

The goal of maximizing water supply was weighted by the Tribal Council at 27.7-percent, based on averaging of scores provided by members. This weighting is close to those given for environmental considerations and social and cultural considerations. As configured and described in Section 5.0 and 6.0, each of the dams will create a reservoir with 5,000 acre-feet of capacity. The Bear Creek sites would capture more of the runoff from the South Fork Tule River watershed than the Cedar Creek sites and therefore received higher point scores, because reservoirs at these locations will provide more water for irrigation while meeting the DCMI demands.

8.2.4 Cost Considerations

The cost consideration was ranked by the Tribal Council as the least important goal at 18.5-percent. The scores developed by the Tribal Council reflect the relative cost ranking of the four dam and reservoir projects, with Lower Bear creek receiving a score of 5 for capital cost and Lower Cedar creek a score of 1. Annual O&M costs for the Cedar Creek sites will be relatively higher than the Bear Creek sites because they are more remote from the town. O&M costs were assessed on a qualitative basis for the screening.

8.3 Screening Analysis Conclusions

The relative weighting established in the Screening Workshop and the point scores given in each category for each alternative are provided in Table 8-2 and graphically on Figure 8-2. Development of a dam and reservoir at the Lower Bear creek site was identified as the preferred project to meet future water needs of the Tribe. The primary reasons for this preference are summarized below:

- Lower Bear Creek captures runoff from the greatest watershed area and provides the greatest supply of water for the 5,000 acre-feet of storage planned for Phase I.
- While Lower Bear Creek may have the greatest potential for adverse impacts to sedimentation and water quality (reduced flushing flows from currently unregulated tributaries), these impacts are judged to be relatively minor and may be mitigated, at least in part, by reservoir operations. The Tribal Council does not consider there to be significant differences among the alternative dam and reservoir sites from the standpoint of other potential environmental impacts.
- At this time, Tribal Council does not believe that development at any of the sites would significantly impact social or cultural resources. However, the Cedar Creek

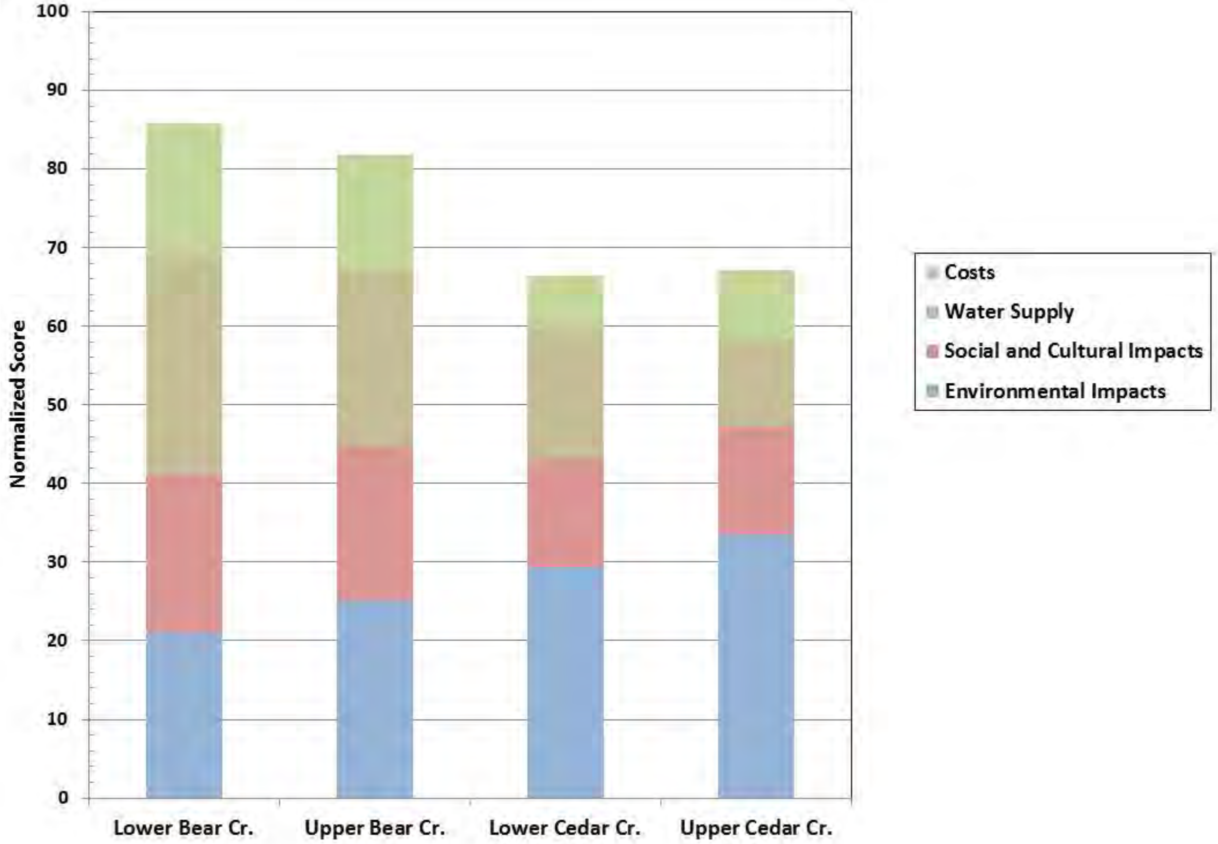
sites are currently more used by Tribal members for a variety of recreational and community-oriented activities.

- In comparison to the Bear Creek sites, the Cedar Creek sites will involve greater commuting distance for construction traffic and greater potential for conflicts between construction traffic and non-construction traffic on the main road from town to the upper portions of the watershed. Construction duration and noise and air quality impacts will be greater for the Cedar creek sites.
- Development at the Lower Bear Creek site will have the lowest construction cost, based on the estimates presented in Chapter 4. The lower cost is attributable not only to the dam, but also to the reduced length of the water supply pipeline from the dam to the water treatment plant. The reduced pipeline length will mean reduced pipeline maintenance costs and likely reduced risks of a potential service disruption.

Table 8-2: Screening Workshop Results

Base Case Evaluation of Alternatives for Tule River Water Project *Weights Established at 3/6-7/13 Workshop*	Goal Weight	Objective Weigl	Criteria Weight	Alternative 1 Lower Bear Creek	Alternative 2 Upper Bear Creek	Alternative 3 Lower Cedar Creek	Alternative 4 Upper Cedar Creek
Minimize Environmental Impacts	26.5%						
Minimize Biological impacts		53.1%					
T&E Species			50.0%	5	5	5	5
Sensitive Habitats			50.0%	5	5	5	5
Minimize Water Resources Impacts		46.9%					
Sedimentation			33.3%	1	2	3	4
Instream Flows			33.3%	1	2	3	4
Water Quality			33.3%	1	2	3	4
Minimize Social and Cultural Impacts	27.3%						
Minimize Social impacts		53.1%					
Traffic Effects			15.0%	3	3	1	1
Recreation Impacts			10.0%	4	4	2	2
Displacements			30.0%	4	4	3	3
Noise Impacts			10.0%	4	4	3	3
Agricultural and Grazing			10.0%	3	3	2	3
Community Gathering			25.0%	4	4	3	2
Minimize Cultural impacts		46.9%					
Cultural Resources			25.0%	4	4	3	3
Hunting and Fishing			25.0%	3	3	2	2
Archaeological Resources			25.0%	4	4	3	3
Unique Tribal Considerations			25.0%	4	4	3	3
Maximize Water Supply	27.7%						
Additional Yield for Irrigation		100.0%					
Additional Yield for Irrigation			100.0%	5	4	3	2
Minimize Costs	18.5%						
Minimize Costs		100.0%					
Capital Cost			60.0%	5	4	1	2
Annual Cost			40.0%	4	4	3	3
Weighted Scores	100.0%			4.29	4.09	3.32	3.36
Normalized Scores				85.8	81.8	66.4	67.2

Figure 8-2: Results of Alternatives Screening



9.0 Conclusions and Recommendations

9.1 Conclusions

The Tule River Tribe relies on water resources in the South Fork Tule River Basin to meet the water demands on its 55,396-acre Reservation in south-central California. Both surface and groundwater resources are currently used to meet water demands on the Reservation; however, the Tribe is only using a small portion of the available surface water supply to which the Tribe is entitled. Groundwater supplies that are available to the Tribe are limited and are not always of acceptable quality for domestic use.

The total estimated future consumptive water demand of the Tule River Indian Reservation in the year 2112 is 7,103 acre-feet per year, assuming full development of its irrigated agriculture potential. Of this total, 1,974 acre-feet is for domestic, commercial, municipal and industrial use and 5,129 acre-feet is for irrigation. These water demand figures are based upon reasonable projections of future potential Reservation population growth and economic development. To meet a portion of this water demand the Tribe is proposing to develop Phase 1 of a dam and reservoir project. The Phase 1dam will impound a 5,000 acre-foot reservoir, which will meet the entire year 2112 projected DCMI demand and a portion of the future irrigation water demand of irrigable lands on the Reservation while also providing minimum flow releases for downstream water users.

The water supply evaluation of the alternative dam sites in this report is based on the assumption that the future hydroclimate and hydrology of the South Fork Tule River basin will be similar to past conditions. However, studies of climate change generally predict less water stored in the snowpack during the winter and more concentrated periods of runoff with increased variability in precipitation and runoff from year to year. This uncertainty makes the need for storage on the Reservation even more critical.

There are a number of sites along the South Fork Tule River on the Reservation that are judged to be viable for construction of a concrete gravity dam using roller-compacted concrete (RCC) construction methods. Further studies and subsurface explorations will need to be performed to confirm current findings and provide the basis for final project planning and design of the dam and its appurtenant facilities.

The preferred dam and reservoir location is the Lower Bear Creek site on the South Fork Tule River just downstream from the confluence with Bear Creek. The average demand that could be met from this reservoir is 2,871 acre-feet per year, comprising 1,974 acre-feet of DCMI demand and irrigation of 220 acres. Three other sites for a dam were evaluated; however, the Lower Bear Creek site is preferred by the Tribe, based on the results of a Screening Workshop held on March 6-7, 2013.

In addition to the dam and reservoir, the Water Settlement Project would include a raw water conveyance pipeline from the reservoir to a new or expanded water treatment plant, which is also part of the project. Distribution system improvements are also planned to be implemented as part of the project. Construction of the dam and raw water pipeline would require improvements to the main road existing through the Reservation, as well as new access roads.

The opinion of total project cost for the preferred alternative (dam and reservoir at the Lower Bear Creek site) is $159 million, in December 2012 dollars.

9.2 Recommendations

The next steps in engineering and technical analyses for the project should include the following:

- Geologic reconnaissance and mapping of the Lower Bear Creek dam site and reservoir basin, as well as other potential sites that have been identified.
- Preliminary subsurface explorations at the Lower Bear Creek site to characterize foundation conditions and borrow materials in order to confirm that there are no conditions at this site that would preclude construction of the proposed dam and reservoir.
- Hydrologic studies to establish the inflow design flood and flood frequency relationships for dam design and construction planning.
- Evaluation of hydroelectric generation potentials at the dam, on the conveyance pipeline between the dam and the water treatment plant, and at the water treatment plant.
- Collection of surface water quality and sediment data to permit evaluation of impacts of project implementation and operations on water quality downstream of the dam and reservoir.
- Collection of environmental baseline information that will be needed to evaluate the impacts during construction and operation of the project.
- Collection of baseline socio-economic and social and cultural resources information that will be needed to evaluate the impacts resulting from construction and operation of the project.

The above engineering technical studies will provide information needed to advance the project into the detailed feasibility stage and prepare for the NEPA compliance processes and related permitting activities.

10.0 References

California Department of Water Resources, 1994a. California Water Plan Update. *Bulletin 160-93.*

California Department of Water Resources, 1994b. Urban Water Use in California. *Bulletin 166-4.*

Dabney, J., 1996, 1997, 1998. *Tule River Tribe Water Resources Director* [Interview] 1996, 1997, 1998.

Environment Canada, 2010. *2010 Municipal Water Use Report - Municipal Water Use, 2006 Statistics.* [Online]
Available at: http://www.ec.gc.ca/Publications/596A7EDF-471D-444C-BCEC-2CB9E730FFF9/2010MunicipalWaterUseReportMunicipalWaterUse2006Statistics.pdf

Garfield, R., 2009. *Testimony of Ryan Garfield Supporting S. 789 The Tule River Tribe Water Development Act,* s.l.: s.n.

GEI Consultants, Inc, 2011. *Tule River Dam and Reservoir Appraisal-Level Cost Opinion Technical Memorandum,* s.l.: s.n.

Indian Health Service, 2004. *Tule River Water Improvements,* s.l.: s.n.

Jensen, M. E., Burman, R. D. & Allen, R. G., 1990. Evapotranspiration and Irrigation Water Requirements. *ASCE Manuals and Reports on Engineering Practice*, Volume No. 70.

Jicarilla Apache Indian Reservation, n.d. *Quantification of Water Requirements for Uses of Irrigated Agriculture, Stockponds, Commercial, Public Water Supply, Domestic, Recreation and Reservoir Evaporation,* San Juan and Navajo River Basins in Rio Arriba and Sandoval County, New Mexico: s.n.

Kapnick, S. & Hall, A., 2009. *Observed Changes in the Sierra Nevada Snowpack: Potential Causes and Concerns,* s.l.: California Energy Commission.

Liang, X., Wood, E. & Lettenmaier, D., 1996. Surface Soil Moisture parameterization of the VIC-2L model: Evaluation and Modifications. *Glob Planet Chang,* Issue 13, pp. 195-206.

Maidment, D. R. e. i. c., 1993. *Handbook of Hydrology.* s.l.:s.n.

Maurer, E., 2007. Uncertainty in hydrologic impacts of climate change in the Sierra Nevada, California under two emission scenarios. *Climatic Change,* 82(3-4), pp. 309-325.

Moser, S. et al., 2009. *The Future is Now: An Update on Climate CHange Science Impacts and Response Options for California,* s.l.: California Energy Commission, PIER Energy Related Environmental Research Program.

National Fire Protection Agency, 1993. *NFPA 1231: Standards on Water Supplies for Suburban and Rural Fire Fighting,* s.l.: s.n.

Natural Resources Consulting Engineers, Inc., 1999. *Potential for Groundwater Development on the Tule River Indian Reservation Reconnaissance Level Investigation,* s.l.: s.n.

Natural Resources Consulting Engineers, Inc., 2007. *Updated Phase I Water Project Cost Estimate,* s.l.: s.n.

Natural Resources Consulting Engineers, Inc., 2008. *Updated South Fork Tule River Flow Extension Analysis,* s.l.: s.n.

Natural Resources Consulting Engineers, Inc., 2010. *Reservoir Operations Modeling,* s.l.: s.n.

Natural Resources Consulting Engineers, Inc., 2012. *Irrigation Water Requirements Investigation,* s.l.: s.n.

Null, S., Viers, J. & Mount, J., 2010. Hydrologic Response and Watershed Sensitivity to Climate Warming in California's Sierra Nevada. *PLoS One,* 5(4).

Reclamation, 1998. *Preliminary Assessment of Three Dam Sites,* s.l.: s.n.

Reclamation, 2009. *Tule River Tribe Proposed Storage Project DEC Review,* s.l.: s.n.

Reclamation, 2010. *Engineering Geologic Inspection of Potential Dam Sites on South Fork Tule River,* s.l.: s.n.

Reclamation, 2010. *Engineering Geologic Inspection of Potential Dam Sites on South Fork Tule River,* s.l.: s.n.

Reclamation, 2010. *Technical Service Center Travel Report,* s.l.: s.n.

Reclamation, 2010. *Tule River Indian Reservation Proposed Water Storage Project Dam Site Selection Criteria,* s.l.: s.n.

Reclamation, 2011a. *Reclamation Technical Memorandum (TM) No. 86-68210-2011-01, West-Wide Climate Risk Assessments: Bias-Corrected and Spatially Downscaled Surface Water Projections,* s.l.: s.n.

Reclamation, 2011b. *SECURE Water Act Section 9503(c) - Reclamation Climate Change and Water, Report to Congress,* s.l.: s.n.

Tule River Indian Tribe, 1997. *Overall Economic Development Program, 1997 Annual Report,* s.l.: s.n.

United States Census Bureau, 2010. *American Fact Finder, Detailed American Indian Tribe Data, Tule River Tribe,* s.l.: s.n.

United States Census Bureau, 2010. *American Fact Finder, Tulare County, California,* s.l.: s.n.

United States Department of Agriculture, Economic Research Service, 1983. Handbook of Water Harvesting. In: *Ag. Handbook #600.* s.l.:s.n., p. 7.

Vicuna, S. & Dracup, J., 2007. The Evolution of Climate Change Impact Studies on Hydrology and Water Resources in California. *Climatic Change,* 82(3-4), pp. 327-350.

Wilson, B., Lucero, A. & Romero, P., 2003. Water Use by Categories in New Mexico Counties and River Basins, and Irrigated Acreage in 2000. *NMOSE Technical Report 51.*

Appendix A Water Supply and Needs Supporting Technical Information

Appendix B   Figures

Appendix C Cost Analysis Supporting Technical Information

Appendix D Sampling Analysis Program Plan

June 24, 2015

To: U.S. Department of the Interior
Policy and Administration
Bureau of Reclamation

Subject: Letter of Support for the Tule River Tribe

Dear Sir:

This is to state our full support for the Tule River Tribe's application to the *WaterSmart: Drought Resiliency Project Grants for FY: 2015.* We have been working in partnership with the Tule River Tribe for a number of years in developing long range plans for housing and economic development. As part of that effort, we have come to understand the seriousness and implications of the drought conditions within the Reservation and surrounding Tribal property. The Tule River Indian Reservation is one of the oldest federally-recognized tribes in California and we have a deep appreciation for their commitment to the stewardship of their homelands.

We will continue to work with the Tribe in matters of water management, drought response, as well as, emergency response situations such as wildfires. We fully support this effort and encourage you to give this application serious consideration for approval.

Sincerely,

Charles Clouse, AICP, PTP
Principal

P:\PROJECTS\1307 Tule River Master Planning\Correspondence\Water support letter.docx

FRONT RANGE OFFICE
1950 W. LITTLETON BLVD,
SUITE 101
LITTLETON, COLO. 80120

WESTERN OFFICE
7451 N. REMINGTON AVE,
SUITE 100
FRESNO, CA. 93711

COASTAL OFFICE
3765 S. HIGUERA ST.,
SUITE 102
SAN LUIS OBISPO, CA. 93401

CORP PHONE:
720.502.7236

DEPARTMENT OF TRANSPORTATION
DISTRICT 6
1352 WEST OLIVE AVENUE
P.O. BOX 12616
FRESNO, CA 93778-2616
PHONE (559) 488-4168
FAX (559) 445-5875
TTY 711
www.dot.ca.gov

Serious drought.
Help save water!

June 24, 2015

Mr. Neil Peyron
Tribal Chairman
Tule River Indian Tribe
340 North Reservation Road
Porterville, CA 93257

Subject: Tule River Indian Tribe's WaterSmart Grant Application, Letter of Support

Dear Mr. Peyron:

This is to state a full support for the Tule River Tribe's application to the *WaterSmart: Drought Resiliency Project Grants for FY: 2015.* Caltrans understands the seriousness of drought conditions and climate change as noted in Director's Policy that reads, "Caltrans strives to be consistent with EO S-20-06, EO S-13-08, EO B-18-12, and is an active participant in the Climate Action Team (CAT), which coordinates State agencies' climate change efforts. Caltrans shall, as appropriate and feasible, incorporate climate change mitigation and adaptation considerations into all facets of operations, and will work to partner with local, State, Federal entities, and other stakeholders as appropriate to coordinate climate change related activities." An important part of this work has been the efforts to reduce green-house gas emissions as a way to remedy climate conditions.

Caltrans has worked in partnership with the Tule River Tribe for a number of years and have seen tribal transportation planning efforts that contribute to emissions reductions. Caltrans has witnessed Tule River Indian Tribe's ability to develop project concepts, execute planning processes to refine concepts into specific project improvements, secure program funding and implement project improvements. The Tule River Indian Reservation takes the utmost responsibility as stewards of their homelands.

Caltrans will continue to consult and coordinate with the Tule River Indian Tribe in matters of mutual importance. Please give this application serious consideration and support. I can be contacted at (559) 488-4168, or marta.frausto@dot.ca.gov, if there are any questions.

Thank you,

MARTA FRAUSTO
Native American Liaison
Office of Transportation Planning & Local Assistance
Caltrans District 6

USDA United States Department of Agriculture

Forest Service

Sequoia National Forest and Giant Sequoia National Monument

1839 South Newcomb Street
Porterville, CA 93257
559-784-1500
TDD: 559-781-6650
FAX: 559-781-4744

File Code: 1560
Date: JUN 24 2015

U.S. Department of the Interior
Policy and Administration
Bureau of Reclamation

RE: Letter of Support for the Tule River Tribe

Dear Sirs:

This is to state our full support for the Tule River Tribe's application to the *WaterSmart: Drought Resiliency Project Grants for FY 2015.* We have been working in partnership with the Tule River Tribe for a number of years and fully realize the seriousness and full implications of drought conditions, coupled with rapid climate change – especially in the Central San Joaquin Valley. The Tule River Indian Reservation is one of the oldest federally-recognized tribes in California and takes the utmost responsibility as 'stewards of their homelands.'

We will continue to work with them in matters of drought and training in emergency response situations such as wildfires, which are always a threat as temperatures increase and the flow of river waters decrease.

Please give this application serious consideration for full support.

Sincerely,

KEVIN B. ELLIOTT
Forest Supervisor