

Re-managing the Flow

The major rivers and streams of the Sacramento River Basin provide essential pathways for spawning salmon and steelhead. Flow agreements to benefit these fish are on every major watercourse in the Sacramento River Basin.



Trinity and **Shasta Lakes** are important sources of cold water storage. Timing the release of this cold water into the rivers is vital if spawning fish are to thrive.

Trinity Lake

Shasta Lake

Whiskeytown Reservoir

Keswick Reservoir

Sacramento River Tributaries

Various flow agreements benefit spring run salmon.

Clear Creek

In May and June, water is pulsed into Clear Creek to attract Spring-run salmon from the Sacramento River. From June through October, water released from Whiskeytown Reservoir keeps water temperatures cool.

Feather River

A water quality certification adopted in 2010 provides for specific flow and temperature requirements to accommodate spawning salmon and steelhead.

Sacramento River below Keswick Dam

In 1960, flow objectives were established for the protection of fish and wildlife. In 1990 and 1991 this policy was modified requiring more cold water when warmer temperatures would be harmful to fish.

Yuba River

In 2008, the Yuba River Accord increased the streamflow requirements over previous levels, which benefits fish while insuring sufficient water supplies for irrigation and municipal uses.

Sacramento River at Wilkins Slough

The Rivers and Harbors Act of 1935 mandated a specific flow rate at Wilkins Slough be maintained. The primary goals at that time were navigation and flood control. In 1992, Congress made protection of fish and wildlife a secondary goal and this requirement was updated in 2009.

New Bullards Bar Reservoir

Sutter Buttes

Folsom Lake



NCWA
Northern California Water Association

For more details visit www.norcalwater.org/efficient-water-management/instream-flows/

American River below Nimbus Dam

In 2000, the Flow Management Standard was developed, which established minimum flow standards to improve the conditions for fall-run Chinook salmon and steelhead. Additionally, releases are adjusted to maintain sufficiently low water temperatures for steelhead rearing in summer and Chinook spawning in the fall.

Re-managed Instream Flows in the Sacramento River Basin



Updated: November 2019

This briefing paper describes the existing instream flow requirements for the major rivers and streams in the Sacramento River Basin. This includes the American, Feather, Sacramento (and its tributaries), and Yuba Rivers, as well as the Bay-Delta. These requirements include provisions in State Water Resources Control Board (SWRCB) decisions, biological opinions, streamflow agreements, and other processes. The California Department of Fish and Wildlife (CDFW) has been part of all these arrangements. New processes to adjust or develop different flow requirements should consider and take into account these existing flow requirements.

American River

The American River provides important fish and wildlife habitat, a high-quality water source, a critical floodway, and a spectacular regional recreational parkway. The Bureau of Reclamation (Reclamation) operates Folsom and Nimbus Dams to provide flood control and water for irrigation, municipal and industrial uses, hydroelectric power, recreation, water quality, and the protection of aquatic resources. Facilities include the Folsom Dam, reservoir (977 TAF capacity), the temperature control shutters on the power plant intakes for Folsom Dam, power plant, urban water supply temperature control device, and the Joint Federal Project auxiliary spillway as well as the Nimbus Dam, Lake Natoma, Nimbus Power Plant, and Folsom South Canal.

1. SACRAMENTO WATER FORUM AGREEMENT

In April of 2000, a diverse group of over 40 local business and agricultural leaders, citizen groups, environmentalists, water managers and local governments in the Sacramento region ended decades of conflict concerning the American River by signing the Water Forum Agreement (WFA). The foundational elements of the WFA are two coequal objectives: to provide a reliable safe water supply for the region and to preserve fishery, wildlife, recreational, and aesthetic values of the lower American River.

2. LOWER AMERICAN RIVER GROUP

The lower American River is a significant resource of considerable interest to fishery management agencies, the public, and Reclamation. The United States Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS) and California Department of Fish and Wildlife (CDFW) are agencies with trust responsibilities for fishery resources in the lower American River. Reclamation is responsible for operating the Folsom/Nimbus Dam complex to meet local and downstream water demands, regulatory requirements, and fish habitat needs. Reclamation has a need to consider its operations as they relate to lower American River instream resources, and other concerns of fisheries agencies that have regulatory and fish management responsibilities, as well as to provide the public with a forum to provide and exchange information.

The Lower American River Group (ARG) is an advisory group consisting of agency representatives convened regularly by Reclamation. The mission of the ARG is to conduct open discussion and deliberation of the biological and operational status of the lower American River, and to provide useful information and formulate recommendations for protection of fisheries and other instream resources consistent with the Flow Management Standard, and for the operation of the Folsom/Nimbus Dam complex as a unit of the overall CVP.

3. OCTOBER 21, 2019 NMFS BIOLOGICAL OPINION

The National Marine Fisheries Service's (NMFS) October 21, 2019, Biological Opinion on the Long-Term Operation of the Central Valley Project and State Water Project (2019 NMFS BiOp) contains numerous terms and conditions addressing instream flows on the American River. The 2019 NMFS BiOp improves on the previous 2006 Flow Management Standard by providing greater protection of the American River Basin water resources for water supply and environmental purposes, while avoiding re-directed impacts to the Sacramento River.

Table 1: Components of the 2019 NMFS Biological Opinion

Title	Site Specific Programmatic	Implementation Approach
American River Division		
2017 Flow Management Standard Releases and "Planning Minimum"	Site-specific	Core
Seasonal Operations	Site-specific	Core
American River Pulse Flows	Site-specific	Scheduling
Spawning and Rearing Habitat Restoration	Programmatic	Collaborative Planning
Nimbus Hatchery Genetic Management Plans	Programmatic	Collaborative Planning
Drought Temperature Management	Programmatic	Core
Yellow-billed Cuckoo Surveys	Programmatic	Collaborative Planning

2017 FLOW MANAGEMENT STANDARD RELEASES

For lower American River flows (below Nimbus Dam), Reclamation has adopted the minimum flow schedule and approach proposed by the Water Forum in the 2017 Flow Management Standard Releases (2017 FMS) and a Planning Minimum. Flows range from 500 to 2000 cfs based on time of year and annual hydrology. The flow schedule is intended to improve cold water pool and habitat conditions for Steelhead and Fall-Run Chinook Salmon. Specific flows are determined using an index intended to define the current and recent hydrology.

> Hydrologic Indices

Hydrologic indices of water availability are used in the 2017 FMS to scale the MRR flows to water year type. Lower MRRs are prescribed in drier years and higher MRRs are prescribed in wetter years. The MRRs are updated each month from January through May based on updated forecasts and indices for the water year. During the latter portion of the year (June through December), MRRs are based on the May index, because at that time the majority of the precipitation has occurred in the watershed (i.e., the amount of water available is fairly certain). The two indices that were selected to specify the MRR were the Sacramento River Index (SRI) for the month of January, and the American River Index (ARI) for the months of February through December.

> Determination of the Monthly Minimum Release Requirements

The monthly MRR at Nimbus Dam is determined using SRI index values (for January) and ARI index values (for February through December), and the MRR implementation curves. Table 2 summarizes the specified values associated with points A, B, and C of the MRR implementation curves. The MRR for index values between points specified on the table are calculated by linearly interpolating between specified points. At any point on the curves, the MRR value would specify the minimum release, but would not preclude releases at rates above the MRR.

Table 2: Summary of Hydrologic Indices and Specified Values for the Minimum Release Requirements.

Months	Hydrologic Index Used	Point A		Point B		Point C		
		Index Value (TAF)	MRR Value (cfs)	Index Value (TAF)	MRR Value (cfs)	Index Value (TAF)	MRR Value (cfs)	
Jan	SRI	5,500	500	7,800	800	11,500	1,750	
Feb – Mar	ARI	800		1,000		1,500	1,958	1,750
Apr – Jun							2,210	1,500
Jul – Sep ¹							1,958	1,750
Oct							1,914	1,500
Nov – Dec							2,210	2,000

1. The July through September curve includes an additional point between points B and C, corresponding to an ARI of 1,200 TAF and an MRR of 1,500 cfs.

➤ **Redd Dewatering Protective Adjustments**

Redd dewatering protective adjustments (RDPAs) were imposed on the MRR to limit potential redd dewatering due to reductions in the MRR during the January through May period. The RDPAs should limit the amount the MRR can be reduced during this period. Two RDPAs were included: (1) the Chinook salmon RDPA in January and February; and (2) the steelhead RDPA in February through May. After calculation of the index-based MRR (as determined by the appropriate hydrologic index, SRI or ARI) the RDPA-based MRR would be calculated. The MRR with the higher value, the index-based MRR or the RDPA-based MRR, would determine the final MRR. RDPAs should limit the amount of dewatering due to a reduction of the MRR, not the actual river release (which often would be higher than the MRR) and, as such, would not always minimize dewatering impacts to the same extent. The prohibition on the January MRR being above the December MRR is also intended to avoid dewatering of redds due to uncertainty with the hydrologic forecast in January.

➤ **Spring Pulse Flows**

Spring releases will be controlled by flood control requirements or, in drier hydrology, Delta requirements and water supply. Reclamation proposes to operate Folsom Dam in a manner designed to maximize capture of the spring runoff to fill as close to full as possible. The 2017 FMS provides for a pulse flow event at some time during the period from March 15 to April 15 by supplementing normal operational releases from Folsom Dam under certain conditions when no such flow event has occurred between the preceding February 1 and March 1 time frame. The purpose of providing pulse flows in the lower American River would be to provide a juvenile salmonid (fall-run Chinook salmon and steelhead) emigration cue before relatively low flow conditions and associated unsuitable thermal conditions later in the spring in the river, and downstream in the lower Sacramento River.

The pulse flow event should be provided only when the MRR from March 1 through March 31 ranged from 1,000 cfs to 1,500 cfs. This range of MRRs during this time period generally corresponds to dry and below normal water year types. The peak magnitude of the pulse flow should be three times the MRR base flows (pre-pulse flows), not to exceed a peak magnitude of 4,000 cfs. If a pulse flow were to occur, the MRR (or RDPA-based MRR) for April, May, and June would be reduced by the volume of the pulse over the March MRR, distributed evenly across all three months so that the implementation of the pulse flow should not result in any net reduction in Folsom Reservoir storage by the end of June.

PLANNING MINIMUM

Reclamation proposes to work together with the American River water agencies to define an appropriate amount of storage in Folsom Reservoir that represents the lower bound for typical forecasting processes at the end of calendar year (the “planning minimum”). The planning minimum brings Reclamation’s forecasting process together with potential local actions that either increase Folsom storage or reduce demand out of Folsom Reservoir. The implementation of a planning minimum allows Reclamation to work with the ARG to identify conditions when local water actions may be necessary to ensure storage is adequate for diversion from the municipal water intake at Folsom Dam and/or the extreme hydrology presents a risk that needs to be properly communicated to the public and surrounding communities. This planning minimum will be a single value (or potentially a series of values for different hydrologic year

types) to be used for each year's forecasting process into the future. The objective of incorporating the planning minimum into the forecasting process is to provide releases of salmonid-suitable temperatures to the lower American River and reliable deliveries (using the existing water supply intakes and conveyance systems) to American River water agencies that are dependent on deliveries or releases from Folsom Reservoir. This planning minimum will be continuously evaluated between Reclamation and the Water Forum throughout implementation.

TEMPERATURE MANAGEMENT

Reclamation proposes to prepare a draft Temperature Management Plan by May 15 for the summer through fall temperature management season using the best available (as determined by Reclamation) decision support tools. The information provided by the Operations Forecast will be used in the development of the Temperature Plan. The draft plan will contain: (1) forecasts of hydrology and storage; and (2) a modeling run or runs, using these forecasts, demonstrating what temperature compliance schedule can be attained. Reclamation will use an iterative approach, varying shutter configurations, with the objective to attain the best possible temperature schedule for the compliance point at Watt Avenue Bridge. The draft plan will be shared with the ARG before finalization and may be updated monthly based on system conditions.

Reclamation proposes to manage the Folsom/Nimbus Dam complex and the water temperature control shutters at Folsom Dam to maintain a daily average water temperature of 65°F (or other temperature as determined by the temperature modeling) or lower at Watt Avenue Bridge from May 15 through October 31, to provide suitable conditions for juvenile Steelhead rearing in the lower American River. If the temperature is exceeded for 3 consecutive days, Reclamation will notify NMFS and outline steps being taken to bring the water temperature back into compliance. During the May 15 to October 31 period, if the Temperature Plan defined temperature requirement cannot be met because of limited cold water availability in Folsom Reservoir, then the target daily average water temperature at Watt Avenue may be increased incrementally (i.e., no more than 1°F every 12 hours) to as high as 68°F. The priority for use of the lowest water temperature control shutters at Folsom Dam shall be to achieve the water temperature requirement for listed species (i.e., Steelhead), and thereafter may also be used to provide cold water for Fall-Run Chinook Salmon spawning.

CONSERVATION MEASURES

Reclamation and DWR are proposing conservation measures to avoid and minimize, or compensate for CVP and SWP project effects, including take, on species as well as contribute to the recovery and enhancement of species and their habitats. These conservation measures include non-flow actions that benefit listed species without impacting water supply or other beneficial uses. Actions could be implemented in part or fully through agreements and cost share with the State of California and potentially under the Voluntary Agreement alternative under the State Water Resources Control Board update to the Bay-Delta Water Quality Control Plan.

➤ **Spawning and Rearing Habitat Restoration**

Project activities include primarily side channel and floodplain creation, expansion, and grading, spawning gravel and large cobble additions, and woody material additions. Pursuant to CVPIA 3406(b) (13), Reclamation proposes to implement the following projects: Paradise Beach, Howe Avenue to Watt Avenue rearing habitat, William Pond Outlet, Upper River Bend, Ancil Hoffman, El Manto, Sacramento Bar North, Sacramento Bar South, Lower Sunrise, Sunrise, Upper Sunrise, Lower Sailor Bar, Upper Sailor Bar, Nimbus main channel and side channel, Discovery Park, Cordova Creek Phase II, Carmichael Creek Restoration and Sunrise Stranding Reduction. Reclamation proposes to continue maintenance activities at Nimbus Basin, Upper Sailor Bar, Lower Sailor Bar, Upper Sunrise, Lower Sunrise and River Bend restoration sites.

➤ **Nimbus Hatchery Genetic Management Plans**

Reclamation will complete Hatchery Genetics Management Plans (HGMPs) for Central Valley Steelhead and Fall-run Chinook Salmon for use in Nimbus Fish Hatchery management. Reclamation intends to improve the status of CV steelhead and Fall-run Chinook salmon in the American River by developing these plans. The steelhead HGMP will describe hatchery operations and associated monitoring to reduce genetic introgression from the out-of-basin Nimbus Hatchery broodstock, implement practices to reduce straying and eliminate inter-basin transfers from Nimbus hatchery, and promote a CV steelhead DPS population in the American River. The fall-run Chinook Salmon HGMP will describe hatchery operations and associated monitoring to reduce impacts on hatchery Chinook salmon on natural fall-run Chinook salmon and minimize effects on the genetic diversity and run-timing of American River fall-run Chinook salmon. Within six months of completion of the consultation, Reclamation will work with CDFW and NMFS to establish a clear understanding on this conservation measure's goals, appropriate time horizons, and reasonable cost estimates for this effort.

➤ **Drought Temperature Management**

Reclamation proposes to evaluate and implement alternative shutter configurations at Folsom Dam to allow temperature flexibility during drought conditions.

➤ **Yellow-billed Cuckoo Surveys**

Reclamation will coordinate with the USFWS to develop a baseline survey for the Yellow-billed cuckoo. The survey for this action would focus on the critical habitat areas, associated project sites, and occupied habitat within the action area. In addition, the baseline survey would incorporate the efforts from the Yolo Restoration Project and other related projects when conducting protocol-level surveys for Yellow-billed Cuckoo in the over-lapping project areas. Results from Yellow-billed Cuckoo surveys conducted by other agencies and organizations within the Action Area will be analyzed by Reclamation when determining baseline conditions for the species and effects resulting from project activities. By reducing redundant survey efforts, Reclamation would be able to leverage their resources to cover areas not recently surveyed and develop a more comprehensive baseline survey. Reclamation would coordinate and discuss with USFWS on the potential need for additional surveys for specific project areas and surveys to monitor the effects of project activities over the project timeline. Information collected in the baseline surveys could be used to inform ecological surrogate models in the future, potentially replacing

the need for follow-up presence/absence surveys. In addition, Reclamation will follow the nesting bird protocols during construction activities and consider the needs of Yellow-billed cuckoo when designing and implementing salmonid habitat restoration projects. Results of Yellow-billed cuckoo surveys and findings from ecological surrogate models shall be shared with the U.S. Fish and Wildlife Service Bay-Delta Fish and Wildlife Office no later than 120 days after completion.

Feather River

On December 15, 2010, the SWRCB adopted, as Order WQ 2010-0016, a water quality certification for the Oroville Facilities, FERC # 2100, for the relicensing of the Oroville project by DWR. The water quality certification contains instream-flow and temperature-control requirements for the Feather River's reaches downstream of DWR's Oroville Dam.

In general, the streamflow requirements adopted by the SWRCB in the certification are as follows.

For the **Low Flow Channel** – which is the reach between DWR's Fish Barrier Dam and the outlet of the Thermalito Afterbay – the certification requires that DWR release into that Channel 800 cfs from September 9 to March 31 of each water year to accommodate spawning anadromous fish and 700 cfs the remainder of the time, with both standards subject to possible revision as recommended by resource agencies under a settlement agreement signed by parties to DWR's relicensing proceeding. The SWRCB's Deputy Director for Water Rights would have to approve changes from the indicated streamflows for the Low Flow Channel.

For the **High Flow Channel** – which is the reach between the Thermalito Afterbay's outlet and the Feather River's confluence with the Sacramento River – the certification applies the following instream-flow requirements, provided that they, along with project operations, are not projected to cause Oroville Reservoir to be drawn below elevation 733 feet (approximately 1,500,000 acre-feet of storage):

Preceding April through July unimpaired runoff	Minimum Flow in HFC October-February	Minimum Flow in HFC March	Minimum Flow in HFC April-September
Percent of Normal			
55% or greater	1,700 cfs	1,700 cfs	1,000 cfs
Less than 55%	1,200 cfs	1,000 cfs	1,000 cfs

Under the certification, if applying these requirements would be projected to cause Oroville Reservoir to be drawn below elevation 733 feet, then the minimum streamflows in the High Flow Channel could be reduced by the same percentage as State Water Project deliveries for agricultural use, provided that streamflows would not ever be reduced more than 25 percent below the requirements. In addition, if the

highest one-hour streamflow between October 15 and November 30 were to exceed 2,500 cfs because of project operations and not a flood flow, then DWR is required to maintain a minimum flow within 500 cfs of the peak flow.

The certification also contains complex terms that require DWR to operate the Oroville project to meet temperature standards in the Low Flow Channel and the High Flow Channel.

For the **Low Flow Channel** at the Robinson Riffle, the certification sets the following temperature standards: (1) October 1-April 30, 56 degrees F; (2) May 1-15, 56-63 degrees F (as a transition); (3) May 16-August 31, 63 degrees F; (4) September 1-8, 63-58 degrees F (as a transition); and (5) September 9-30, 58 degrees F. If DWR were to demonstrate that it cannot meet these requirements with its current facilities, then the certification would require DWR to submit an interim operations plan to the SWRCB and, within three years of the renewed FERC license's issuance, submit a long-term facility-modification and operations plan to the SWRCB. If after implementing the facility modifications, DWR were to demonstrate that it still cannot meet the above temperature standards, then DWR would be required to propose alternate temperature standards that would provide "reasonable protection of the COLD beneficial use." Upon the approval of the SWRCB's Deputy Director for Water Rights, DWR would be required to operate to the alternate standards.

For the **High Flow Channel**, DWR is required to operate the project "to protect the COLD beneficial use in [that Channel], as measured in the Feather River at the downstream Project Boundary, to the extent reasonably achievable." Within one year of the renewed FERC license's issuance, DWR would be required to submit an operations plan for the period before facility modifications, which plan would be required to include proposed interim temperature standards and interim measures to reduce temperatures. Within three years of the renewed FERC license's issuance, DWR would be required to submit a long-term facility modification and operations plan, which plan would have to include proposed temperature standards to take effect within 10 years of the renewed license's issuance.

Sacramento River

1. 1960 MOA BETWEEN RECLAMATION AND CDFW

An April 5, 1960, Memorandum of Agreement (MOA) between Reclamation and the California Department of Fish and Game (now CDFW) originally established flow objectives in the Sacramento River for the protection and preservation of fish and wildlife resources. The agreement provided for minimum releases into the natural channel of the Sacramento River at Keswick Dam for normal and critically dry years (Table 1, below). Since October 1981, Keswick Dam has operated based on a minimum release of 3,250 cfs for normal years from September 1 through the end of February, in accordance with a modification of the flow schedule in the MOA. This modified release schedule was included in Order 90-05 (described below), which maintains a minimum release of 3,250 cfs at Keswick Dam and Red Bluff Diversion Dam (RBDD) from September through the end of February in all water years, except critically dry years.

The 1960 MOA provides that releases from Keswick Dam (from September 1 through December 31) are made with minimum water level fluctuation or change to protect salmon to the extent compatible with other operations requirements. Releases from Shasta and Keswick Dams are gradually reduced in September and early October during the transition from meeting Delta export and water quality demands to operating the system for flood control and fishery concerns from October through December.

2. SWRCB WATER RIGHTS ORDER 90-05 AND WATER RIGHTS ORDER 91-01

In 1990 and 1991, the SWRCB issued Water Rights Orders 90-05 and 91-01 modifying Reclamation's water rights for the Sacramento River. The orders stated Reclamation shall operate Keswick and Shasta Dams and the Spring Creek Powerplant to meet a daily average water temperature of 56°F as far downstream in the Sacramento River as practicable during periods when higher temperature would be harmful to fisheries. The optimal control point is the RBDD.

Under the orders, the water temperature compliance point may be modified when the objective cannot be met at RBDD. In addition, Order 90-05 modified the minimum flow requirements initially established in the 1960 MOA for the Sacramento River below Keswick Dam as reflected in Table 1.

Table 1: Minimum Flow Requirements and Objectives (cfs) on the Sacramento River below Keswick Dam

Water year type	MOA	WR 90-5	MOA and WR 90-5
Period	Normal	Normal	Critically dry
January 1 - February 28 (29)	2600	3250	2000
March 1 - March 31	2300	2300	2300
April 1 - April 30	2300	2300	2300
May 1 - August 31	2300	2300	2300
September 1 - September 30	3900	3250	2800
October 1 - November 30	3900	3250	2800
December 1 - December 31	2600	3250	2000

The water right orders also recommended the construction of a Shasta Temperature Control Device (TCD) to improve the management of the limited cold-water resources.

Pursuant to SWRCB Orders 90-05 and 91-01, Reclamation configured and implemented the Sacramento-Trinity Water Quality Monitoring Network to monitor temperature and other parameters at key locations in the Sacramento and Trinity Rivers. The SWRCB orders also required Reclamation to establish the Sacramento River Temperature Task Group (SRTTG) to formulate, monitor, and coordinate temperature

control plans for the upper Sacramento and Trinity Rivers. This group consists of representatives from Reclamation, SWRCB, NMFS, the Service, CDFW, Western, DWR, and the Hoopa Valley Indian Tribe.

Each year, with finite cold-water resources and competing demands usually an issue, the SRTTG devises operation plans with the flexibility to provide the best protection consistent with the CVP's temperature control capabilities and considering the annual needs and seasonal spawning distribution monitoring information for winter-run and fall-run Chinook salmon. In every year since the SWRCB issued the orders, those plans have included modifying the RBDD compliance point to make best use of the cold-water resources based on the location of spawning Chinook salmon. Reports are submitted periodically to the SWRCB over the temperature control season defining the temperature operation plans. The SWRCB has overall authority to determine if the plan is sufficient to meet water right permit requirements.

3. OCTOBER 21, 2019 NMFS BIOLOGICAL OPINION

The National Marine Fisheries Service's (NMFS) October 21, 2019, Biological Opinion on the Long-Term Operation of the Central Valley Project and State Water Project (2019 NMFS BiOp) contains numerous terms and conditions addressing instream flows on the Upper Sacramento River.

The 2019 NMFS BiOp adds to the 3,250 cfs minimum flow by considering flows at specified levels based on storage volume. Specifically, Reclamation will set target base flows from Keswick based on Shasta Reservoir end-of-September storage. From October until the end of February, Reclamation will target these flows in the table below, taking into account building cold water pool and storage for the following year and the risk of dewatering redds and juvenile stranding.

Table 2: Keswick Dam Release Schedule for End-of-September Storage (Table 18 in NMFS 2019 BiOp and Table 4-10 in Reclamation's Biological Assessment)

Keswick Release (cfs)	Shasta End of September Storage (million acre feet)
3,250	≤2.2
4,000	≤2.8
4,500	≤3.2
5,000	>3.2

Reclamation expects to refine this framework through future modeling efforts as part of seasonal operations planning. In addition, in years with sufficient cold water pool (likely more than 4 million acre-feet in storage in Shasta Reservoir on May 1), Reclamation proposes to release one or more spring pulses of up to a total of 150,000 acre-feet if the pulse does not interfere with the ability to meet performance objectives or other anticipated operations of the reservoir.

The 2019 NMFS BiOp replaces the Reasonable and Prudent Alternative (RPA) set forth in the 2009 NMFS BiOp and includes operations on Clear Creek; release requirements from Whiskeytown Dam for temperature management; cold water pool management of Shasta Reservoir; spring pulse flows; restoration projects and ongoing scientific review. A selection of the more specific flow-related requirements is described below.

CLEAR CREEK OPERATIONS

Reclamation will release Clear Creek flows in accordance with the 1960 MOA with CDFW, and the April 15, 2002 State Water Resource Control Board permit, which established minimum flows to be released to Clear Creek at Whiskeytown Dam. Reclamation proposes a minimum base flow in Clear Creek of 200 cfs from October through May and 150 cfs from June to September in all year types except Critical year types. In critical years, Reclamation must coordinate with NMFS through the Clear Creek Technical Team and/or the SRTTG on the timing, frequency, duration and magnitude of flows below 150cfs.

Reclamation will create pulse flows for both channel maintenance and spring attraction flows. For spring attraction flows, Reclamation would release 10,000 acre-feet from Whiskeytown Dam in all year-types except for Critical year-types. For channel maintenance flows, Reclamation would release 10,000 acre-feet from Whiskeytown Dam, in all year-types except for Dry and Critical year-types.

Reclamation will manage Whiskeytown Dam releases to meet a daily average water temperature of: (1) 60°F at the Igo gauge from June 1 through September 15; and (2) 56°F or less at the Igo gauge from September 15 to October 31.

In addition, Reclamation must undertake a study to collect and analyze temperature data in Whiskeytown Reservoir and Clear Creek to determine the magnitude and potential impact on temperatures from power peaking and flat loading of hydropower production. The data collected shall be analyzed and shared with NMFS and considered for implementation in the temperature model.

SHASTA OPERATIONS

Reclamation will operate Shasta Dam utilizing a tiered approach to temperature management. This approach will allow Reclamation to better manage the limited cold-water resource to improve winter-run Chinook salmon egg survival. The tiered approach recognizes the substantial influence of hydrology on available cold water, and targets a temperature of 53.5°F in the upper Sacramento River above Clear Creek from May 15 to October 31. Reclamation would manage water temperatures based on the following tiers of year-types (with Tier 1 years having wetter hydrology, and Tier 4 years being the driest of the year types):

- Tier 1 – Targets 53.5°F or lower starting May 15
- Tier 2 – Targets 53.5°F during critical egg incubation period
- Tier 3 – Targets 53.5-56°F during critical egg incubation period; consider intervention measures in lower Tier 3 years
- Tier 4 – Targets 56°F or higher; consider intervention measures

In coordination with NMFS and the SRTTG, Reclamation shall consider technical assistance from NMFS regarding the development of annual temperature management plans, regardless of Shasta storage or tiered temperature management stratum. Reclamation shall submit the final temperature management plan to NMFS by May 20 of each year, as reporting under the opinion. NMFS does not expect Reclamation to seek NMFS concurrence on the plan.

Temperature management includes performance metrics to ensure that the conditions that manifest as a result of operations within a tier reflect the modeled range. The 2019 NMFS BiOp also includes a process for chartering independent review, including established timelines, triggers, and focus topics.

4. WILKINS SLOUGH NAVIGATION FLOW REQUIREMENTS UNDER FEDERAL LAW

Congress initially authorized the construction of certain facilities for the Central Valley Project (“CVP”) under the Rivers and Harbors Act of 1935 (the “1935 Act”). (49 Stat. 1028, 1038). The 1935 Act mandated in relevant part that “the following works of improvement of rivers . . . are hereby adopted and authorized . . . in accordance with the plans recommended in the respective reports hereinafter designated and subject to the conditions set forth in such documents . . . Sacramento River, California; Rivers and Harbors Committee Document Numbered 35, Seventy-third Congress . . .” (50 Stat. 1028, 1038.) As such, the 1935 Act incorporates by reference, and expressly requires the implementation of, the recommendations of the Rivers and Harbors Committee Document Number 35. This document is a 1934 report from the Corps’ Chief Engineer recommending to Congress that Kennett Dam (predecessor to Shasta Dam) “shall be operated so as to provide a minimum flow of 5,000 cubic feet per second between Chico Landing and Sacramento.” (See Central Valley Project Documents, Part I, 544, 548 [Committee Doc. 35, 73rd Cong.])

Congress re-authorized the CVP under the Rivers and Harbors Act of 1937 (the “1937 Act”). (50 Stat. 844, 850.)¹ This re-authorization mandated in relevant part that “the \$12,000,000 recommended for expenditure for a part of the Central Valley project, California, in accordance with the plans set forth in Rivers and Harbors Committee Document Numbered 35, Seventy-third Congress, and adopted and authorized by the provisions of section 1 of the Act of August 30, 1935 (49 Stat. 1028, at 1038) . . . shall, when appropriated, be available for expenditure in accordance with the said plans of the Secretary of Interior instead of the Secretary of War.” (50 Stat. 844, 850.) As such, the 1937 Act also incorporates by reference, and expressly requires the implementation of, the recommended minimum flow of 5,000 cfs between Chico Landing and Sacramento. There has been no subsequent action by Congress that has “discontinued” or otherwise changed this minimum navigation flow requirement.

The 1937 Act also mandates that CVP “dams and reservoirs *shall* be used, *first*, for river regulation, improvement of navigation, and flood control; second, for irrigation and domestic uses; and, third, for power.” (50 Stat. 844, 850, emphasis added; *see also United States v. SWRCB* (1986) 182 Cal.App.3d 82, 135.) In 1992, Congress explicitly amended this hierarchy of use by enacting sections 3406(a) and (b)

1. *See also Stockton East Water District, et al. v. United States*, 583 F.3d 1344, 1349 (Fed. Cir. 2009) [citing to the 1935 and 1937 Acts as Congress’ initial authorization and reauthorization of the CVP].

of the Central Valley Project Improvement Act (Pub. L. No. 102-575 (1992)), which make protection of non-ESA listed fish and wildlife co-equal priorities with irrigation. Even with this amendment, however, Reclamation's first priority remains river regulation, navigation and flood control.

On the Sacramento River, all major diversions have positive barrier flat-plate fish screens installed that provide protection to listed fishery species. These screens have been designed with an approach velocity of 0.33 ft/s as required by NMFS and CDFW. During design, the screens, velocities, and diversion rates were based upon the Wilkins Slough Navigational Flow requirement of 5,000 cfs since this requirement under federal law was controlling.

The 2019 NMFS BiOp contemplates that Keswick releases could be reduced to 3,250 cfs, which is lower than the Wilkins Slough flow requirement. If the Bureau of Reclamation reduced flows below the Wilkins Slough control point requirement and depending on the diversion rate, some screens may not meet the velocity criteria as designed. Reclamation has proposed to provide grants to water users near Wilkins Slough to install new diversions and screens that would operate at lower flows.

Sacramento River Tributaries

1. ANTELOPE CREEK

New State-of-the-Art Fish Screen to Accompany Additional Year-Round Flows

Through grants from the State Water Resources Control Board and the United States Fish and Wildlife Service Anadromous Fish Restoration Program and the Anadromous Fish Screen Program, which grants are being administered by the Tehama County Resource Conservation District, Jim Edwards and Los Molinos Mutual Water Company are assisting that District with the installation of a new state-of-the-art fish screen to be installed at their existing joint point of diversion on Antelope Creek. The new chevron-style screen will replace two existing screens and will include a new bypass pipe that will return fish protected by the screen directly back into Antelope Creek. In addition to the new screen, additional flows will be provided by Mr. Edwards and Los Molinos throughout the year to improve fish migration and habitat.

2. BATTLE CREEK

1998, 2003 and 2006 Agreements with PG&E and the Bureau of Reclamation

For winter-run and spring-run Chinook salmon, the instream flow objective for the North Fork of Battle Creek is 30 cubic feet per second (± 5 cfs). The South Fork of Battle Creek instream flow objective would vary from the Federal Energy Regulatory Commission license condition minimum flow of 5 cfs, to 30 cfs (± 5 cfs). All flows reaching Wildcat Diversion Dam will be released, and no diversion will occur at the main spring collectors at Eagle Canyon. PG&E will block the downstream entrances to fish ladders at the Eagle Canyon and Coleman Diversion Dams unless California Department of Fish and Game, NOAA Fisheries,

and US Fish and Wildlife jointly provide PG&E 48 hours advance written notice to open either or both of such downstream entrances.

3. BUTTE CREEK

M&T Ranch and Llano Seco Ranch

In 1997, M&T Ranch and Llano Seco Ranch agreed to dedicate approximately 40 cfs in instream flows from October through June in Butte Creek from Parrott-Phelan diversion to confluence with Sacramento River, for spring-run Chinook and steelhead migration and rearing.

Resource Renewal Institute Court Order

In 1998, the Butte County Superior Court issued an order to change the authorized place of use and point of diversion of 5 cfs of pre-1914 appropriative water rights the Resource Renewal Institute had acquired on Butte Creek, which included the following provisions:

- a. The authorized purpose of use in these water rights is now protection of fish and wildlife dependent on instream flows in the portions of Butte Creek that is specified as the place of use;
- b. The authorized place of use in these water rights now is Butte Creek between diversion number 54 and the confluence of Butte Creek and Butte Slough (Butte Slough outfall); and,
- c. The present authorized point of diversion of these water rights has been eliminated.

DeSabra-Centerville Hydroelectric Project Water Quality Certification

On April 8, 2015, the SWRCB adopted a water quality certification for the DeSabra-Centerville Hydroelectric Project, FERC # 803, for FERC's relicensing of the project. The certification was modified on August 2, 2016 by Order WQ 2016-0084. To date, FERC has not issued the license to Pacific Gas & Electric (PG&E), the licensee.

The water quality certification contains instream-flow requirements for Butte Creek. During normal years, the certification sets a minimum instream flow requirement at the Butte Creek Diversion Dam of 30 cfs from March 1 – May 31 and 16 cfs from June 1 – February 28/29. During dry years, the minimum instream flow requirement at the same location is 20 cfs from March 1 – May 31 and 10 cfs from June 1 – February 28/29.

The certification also provides minimum instream requirements for the Lower Centerville Diversion Dam. During normal years, 75 cfs is required from September 1 – 30, 80 cfs from October 1 – 31, 95 cfs from November 1 – March 14, 80 cfs from March 15 – May 31, and 40 cfs from June 1 – August 31. There are no minimum instream requirements for the Lower Centerville Diversion Dam in dry years.

4. DEER CREEK

2014 and 2015 Voluntary Agreements with Deer Creek Irrigation District, Grant Leininger, National Marine Fisheries Service (NMFS) and California Department of Fish and Wildlife (CDFW)

For adult spring-run Chinook and juvenile spring-run chinook: From May 30 until June 14, 2014, 50 cubic feet per second (cfs), as measured at the Department of Water Resources (DWR) Gage below Stanford-Vina Ranch Irrigation Company (SVRIC) Diversion Dam, as long as 100 cfs is coming out of the canyon. There will be a proportional reduction in base flow obligation of 1 cfs for each 1 cfs reduction in natural flow below 100 cfs.

June 15 to June 30: 25 cfs, as measured at the DWR Gage below SVRIC Diversion Dam, with Deer Creek Irrigation District (DCID) providing 8.3 cfs during the 25 cfs period.

October 15 to December 31: 50 cfs, as measured at the DWR Gage below the SVIC Diversion Dam, is required for out-migrating yearling juvenile spring-run Chinook and coincidentally Central Valley juvenile and adult steelhead (*Oncorhynchus mykiss*), which are federally listed as Threatened. In the event of a rain freshet, base flows could start on October 1, 2014 if mutually agreed to by NMFS, CDFW and DCID.

Pulse Flows: A minimum of 50 cfs over base flow or full natural flows as recorded at the U.S. Geological Survey (USGS) Stream Gage at the mouth of the canyon above DCID Dam. The duration of the pulse flow in terms of time at which peak flow is maintained will be a minimum of 24 hours but not more than 72 hours. A pulse flow event occurred on May 18-20, 2014 and DCID shall create one more pulse flow event before June 15, 2014. Another pulse flow event may be necessary in June 2014 if monitoring detects fish holding below the SVRIC Diversion Dam.

5. HAT CREEK

2002 Federal Energy Regulatory Commission License for the Hat Creek Project

On November 4, 2002, the Federal Energy Regulatory Commission (FERC) issued a new license for the Hat Creek Project. As stipulated in the new license, minimum instream flows in the Hat 1 Bypass Reach were increased from 2 cfs to 8 cfs. In addition, the flow release at the Baum Lake Dam (a minimum of 8 cfs) and accretion flow from the Hat 2 Springs must provide a minimum flow in the lower portion of the Hat 2 Bypass Reach of 43 cfs (measured at the Joerger Diversion Dam).

6. MILL CREEK

2014 and 2015 Voluntary Agreements with Water Users, National Marine Fisheries Service (NMFS) and California Department of Fish and Wildlife (CDFW)

For adult spring-run Chinook and juvenile spring-run Chinook: 50 cubic feet per second (cfs) between April 1 and June 14, 2014, and 25 cfs between June 15 and 30, 2014 for fish passage through the 2.8 miles of stream between the confluence with the Sacramento River and Ward Dam.

If monitoring and evaluations conducted by CDFW determine that fish are not present in lower Mill Creek or water temperatures are not conducive to fish survival during the period of June 15 to 30, 2014, and it is mutually agreed to by CDFW and Los Molinos Mutual Water Company (LMMWC), base flows may be reduced below 25 cfs.

For juvenile spring-run Chinook: For the fall period, 50 cfs is required for out-migrating yearling juvenile spring-run Chinook and coincidentally Central Valley juvenile and adult steelhead (*Oncorhynchus mykiss*), which are federally listed as Threatened. In the event of a rain freshet, base flows could start on October 1, 2014 if mutually agreed to by NMFS, CDFW and LMMWC.

Pulse Flows: A minimum of 50 cfs over base flow or full natural flows as recorded at the U.S. Geological Survey (USGS) Stream Gage at the mouth of the canyon above Upper Dam. The duration of the pulse flow in terms of time at which peak flow is maintained will be a minimum of 24 hours but not more than 72 hours. The pulse flows will occur from April 1 through June 30 at a minimum of once every two weeks. If monitoring and evaluations conducted by CDFW determine that fish are not present in lower Mill Creek or water temperatures are not conducive to fish survival during June, and it is mutually agreed to by NMFS, CDFW and LMMWC, pulse flows may cease prior to June 30, 2014.

These were voluntary agreements covering substantially all of the water diverted on Mill Creek, thus the State Water Resources Control Board emergency regulations did not go into effect.

1990, 1996 and 2007 Flow Agreements with Water Users, Department of Water Resources and Department of Fish and Game

The 1990 Agreement: The Department of Water Resources and Fish and Game paid for the construction, operation and maintenance of wells with a capacity of 25 cubic feet per second (the actual well capacity is closer to 10 cfs) for the purpose of increasing flows in Mill Creek for fisheries transportation in the late spring of some years, during the upstream migration of adult spring-run salmon and downstream migration of juvenile salmon and steelhead.

The 1996 Agreement: Los Molinos Mutual Water Company shall provide a minimum of 10 cubic feet per second in addition to the state's instantaneous capacity (of 10 cfs) for fall-run Chinook immigration and spawning and spring-run Chinook juvenile migration. Los Molinos Mutual Water Company shall release such water upon Fish and Game's request on or after October 15 and allow such water to continue to flow uninterrupted for the remainder of the calendar year. The 1996 Agreement expired on May 31, 2007.

The 2007 Agreement: Reaffirms and expands and refines the intent of the earlier agreements to provide spring flows (May 1 through June 15) and fall flows (October 15 through November 30) for spring and fall run Chinook salmon.

The 2015 Agreement: This Agreement with the Nature Conservancy replaces the expired 1996 Agreement. A new water right was added to the 10 cfs required by the 1996 Agreement. Los Molinos Mutual Water Company shall provide 24 cfs of instream flows from the beginning of the irrigation season until July 1, and from October 15 through the end of the irrigation season. This water is available for use by Los Molinos Mutual Water Company throughout its system from July 1 through October 14.

Yuba River

In 2008, the State Water Resources Control Board (the SWRCB) adopted minimum streamflow requirements and related measures proposed by Yuba Water Agency (YWA) that implemented the Yuba River Accord Fisheries Agreement, which YWA developed with the Department of Fish and Game (CDFW), the National Marine Fisheries Service (NMFS), the U.S. Fish and Wildlife Service (USFWS) and several conservation groups. The Accord and the SWRCB's related order – Corrected Order WR 2008-14 – resolved 20 years of disputes concerning the Yuba River's minimum streamflows. The Accord streamflow requirements, as implemented by the SWRCB, are depicted in Exhibit A. The SWRCB adopted Corrected Order WR 2008-14, after considering a \$6 million environmental impact report that YWA certified and that was not challenged in court. The Yuba River Accord is summarized below and additional information is available on YWA's website at <http://www.ycwa.com/projects/detail/8>.

Disputes concerning the Yuba River's streamflows began in 1988 and continued through a 14-day SWRCB hearing in 1992, a 13-day SWRCB hearing in 2000 and a three-day SWRCB hearing in 2003. In 2003, the SWRCB adopted Revised Water Right Decision 1644 (RD-1644). Many lawsuits, including one by YWA, were filed to challenge RD-1644.

As an alternative to litigating these disputes to a conclusion, YWA, CDFW, NMFS, USFWS and environmental groups engaged in a collaborative, science-based process to identify and prioritize the key stressors on salmon and steelhead in the lower Yuba River and then to develop streamflow requirements that would address these stressors. River temperatures were one of the key stressors addressed by the Accord through additional minimum flow requirements. The resulting Yuba Accord Fisheries Agreement sets new, substantially-higher streamflow requirements that allocate more water to fishery benefits than RD-1644 would have required. Specifically, the Fisheries Agreement's streamflow schedules include up to more than 174,000 acre-feet of water annually, and more than 100,000 acre-feet in the springtime of about 60% of all years, to fishery benefits than RD-1644 would have required. The Fisheries Agreement allocates these fishery streamflows in a manner that enables YWA to deliver approximately 350,000 acre-feet of water per year for consumptive use in Yuba County and to transfer water to downstream water users, including Delta-export agencies, for irrigation, municipal and environmental uses.

The Fisheries Agreement is one of four agreements that make up the Yuba River Accord. The other agreements are: (1) Conjunctive Use Agreements with local Yuba County water suppliers; (2) a Water Transfer Agreement with the state Department of Water Resources (DWR); and (3) an agreement with

PG&E to allow modified operations at YWA's New Bullards Bar Reservoir. Under the Conjunctive Use Agreements, Yuba County water suppliers agreed to pump up to 30,000 acre-feet of groundwater to substitute for surface water deliveries in certain dry years to provide water allocated by the Fisheries Agreement for fishery benefits. Also, under the Conjunctive Use Agreements, YWA agreed to provide funding from its Accord transfer proceeds to assist water suppliers in pumping the necessary groundwater and to monitor local groundwater conditions to ensure that pumping under the Accord does not cause overdrafts. Under the Water Transfer Agreement, YWA agreed to transfer at least 60,000 acre-feet per year of water to the Environmental Water Account (and successor programs) and potentially 140,000 acre-feet of water in drier years to DWR. In addition to assisting local Yuba County water suppliers in implementing conjunctive use, YWA has used Accord transfer proceeds to contribute to the funding of setback-levee projects and other flood risk management projects.

The Accord Fisheries Agreement contains several unique elements besides the new streamflow requirements depicted in Exhibit A. The Agreement establishes a River Management Team (RMT), which includes representatives of YWA, CDFW, NMFS, USFWS, PG&E and conservation groups. The RMT may modify flows at certain times for fishery benefits (subject to SWRCB approval). The RMT also is responsible for allocating 50% of the volume of any supplemental surface water transfer by YWA and up to 20% of the streamflows enabled by implementation of the Accord Conjunctive Use Agreements. The RMT oversees a monitoring and evaluation program that has the goal of determining the efficacy of the Fisheries Agreement's streamflows. That Agreement also establishes a cap on irrigation diversions in extremely dry (1-in-100) "conference years" at about 70% of annual irrigation demands.

Consistent with the Accord agreements, the SWRCB's Corrected Order WR 2008-14 approved water-right permit terms under which, in conference years, YWA will operate its project to maintain the minimum streamflows required by a 1965 streamflow agreement between YWA and CDFW, but without certain reductions authorized by that agreement and subject to supplemental flow release requirements developed by the RMT's Planning Group under the Fisheries Agreement and approved by the SWRCB's Deputy Director for Water Rights. Under Corrected Order WR 2008-14, if the Planning Group does not make any streamflow recommendations in a conference year by April 1 or if no streamflow requirements are in place by April 11 of such a year, then YWA must comply with streamflow requirements ordered by the SWRCB after a hearing.

When YWA operates its facilities, it must comply with the requirements of its existing license for Project No. 2246, which was issued by the Federal Energy Regulatory Commission (FERC). Those FERC license requirements, however, typically are satisfied through implementation of the Accord Fisheries Agreement's streamflow requirements.

The Yuba River Accord has been recognized as a landmark achievement in collaborative water management to achieve water supply reliability and habitat protection. For example, the Accord received the 2008 ACWA Theodore Roosevelt Environmental Award for Excellence in Conservation and Natural Resources Management, the 2009 National Hydropower Association Award for Outstanding Stewards of America's Waters and the 2009 Governor's Environmental and Economic Leadership Award.

EXHIBIT 1

Yuba Accord Streamflows, Approved by SWRCB in Corrected Order WR 2008-14

Marysville Gage (cfs)

Schedule	OCT		NOV	DEC	JAN	FEB	MAR	APR		MAY		JUN		JUL	AUG	SEP	Total Annual Volume (AF)
	1-15	16-31	1-30	1-31	1-31	1-29	1-31	1-15	16-30	1-15	16-31	1-15	16-30	1-31	1-31	1-30	
1	500	500	500	500	500	500	700	1000	1000	2000	2000	1500	1500	700	600	500	574200
2	500	500	500	500	500	500	700	700	800	1000	1000	800	500	500	500	500	429066
3	500	500	500	500	500	500	500	700	700	900	900	500	500	500	500	500	398722
4	400	400	500	500	500	500	500	600	900	900	600	400	400	400	400	400	361944
5	400	400	500	500	500	500	500	500	600	600	400	400	400	400	400	400	334818
6	350	350	350	350	350	350	350	350	500	500	400	300	150	150	150	350	232155

* Indicated flows represent average volumes for the specified time period. Actual flows may vary from the indicated flows according to established criteria.

* Indicated Schedule 6 flows do not include an additional 30 TAF available from groundwater substitution to be allocated according to established criteria.

Smartville Gage (cfs)

Schedule	OCT		NOV	DEC	JAN	FEB	MAR	APR		MAY		JUN		JUL	AUG	SEP	Total Annual Volume (AF)
	1-15	16-31	1-30	1-31	1-31	1-29	1-31	1-15	16-30	1-15	16-31	1-15	16-30	1-31	1-31	1-30	
A	700	700	700	700	700	700	700	700	-	-	-	-	-	-	-	700	-
B	600	600	600	550	550	550	550	600	-	-	-	-	-	-	-	500	-

* Schedule A used with Schedules 1, 2, 3 and 4 at Marysville.

* Schedule B used with Schedules 5 and 6 at Marysville.

Bay-Delta

The following map shows the existing Bay-Delta standards in SWRCB Decision 1641. The federal Central Valley Project (CVP) and State Water Project (SWP) manage water supplies in the Sacramento River Basin to meet these standards and the 2019 Biological Opinions.

D-1641 Bay-Delta Standards Stations

FLOW/OPERATIONAL

Fish and Wildlife

- ◆ SWP/CVP Export Limits
- ◆ Export/Inflow Ratio
- Minimum Delta Outflow
- Habitat Protection Outflow
- Salinity Starting Condition
- River Flows
- @ Rio Vista
- @ Vernalis - Base
- - Pulse
- ▲ Delta Cross Channel Gates

WATER QUALITY

Municipal & Industrial

- All Export Locations
- Contra Costa Canal

Agriculture

- Western/Interior Delta
- Southern Delta

Fish & Wildlife

- San Joaquin River Salinity
- Suisun Marsh Salinity



Vernalis ■ ●

Vernalis-Base (710-3,420 cfs Feb-Apr 14 & May 16-Jun)
Vernalis-Pulse (Apr 15-May 15 & Oct)