WATER STORAGE GUIDE

Storing water to benefit streamflows and fish in North Coast creeks and rivers

Produced by Sanctuary Forest
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INTRODUCTION

Congratulations on acquiring a large-capacity water storage tank—and thank you. By following certain "best practices" in the use of your water storage and pump system, you have the opportunity to be part of the collective solution to a growing problem affecting coastal watersheds in the North Coast of California: the extreme reduction of instream flows during the dry season of late summer and early fall, resulting in a serious threat to the survival of salmon and steelhead.

The purpose of this guide is to provide instructions and advice on how to pump, store and use water in a way that meets your household's needs while also preserving streamflows and protecting fish in your neighborhood creeks and river. Sanctuary Forest's work in developing solutions to the seasonal low-flow crisis has been based in the Mattole River watershed in Humboldt and Mendocino Counties; but we intend for this brochure to be useful to anyone in the North Coast region who acquires a large-capacity water storage tank (20,000 gallons or more) and draws their water from a river, creek or spring.

The information that follows on how to manage water and acquire permits for water diversions and storage is derived from Sanctuary Forest's efforts to increase streamflows in the upper Mattole River. If you are storing or diverting water in another watershed, you may need permits that differ from those mentioned here, and nothing in this guide should supersede the specific requirements of any permits you may already have.

An appendix is included with contact information for all suppliers and agencies mentioned in this guide.

FISH-FRIENDLY PUMPING AND STORAGE

Benefits of water storage for streamflows and fish

The most important thing you can do to help keep your creek or river flowing in the dry season is this: **Practice water conservation, and store enough water from the wetter months to provide for your use during the dry months**, so that you don't need to pump when flows are lowest and fish survival is most threatened.

In general, September and October are the most critically dry months in our North Coast region, when streamflows are at their lowest and every gallon diverted or pumped may prove harmful to fish. In drier years, August and the first half of November also have extreme low flows. During this season, many North Coast fish-bearing streams have seen flows drop below the level that fish require to

survive, sometimes drying up into a series of disconnected pools. Every household that can manage to abstain from pumping water during this time of year is helping to give these fish a chance to survive until the rains come.

There are four key elements to fish-friendly water storage:

- *Calculate your household's water storage needs for the low-flow season.*
- *Fill and top your tank(s) outside of the low-flow season.*
- *Limit pump rates and use fish screens to protect small fish.*
- *Monitor your weekly water use to meet your water budget.*

These guidelines, and other important steps you can take, are explained in the following sections. When we refer to the "low-flow season," it is important to realize that the calendar is not a perfect guide to when you should stop pumping from your creek or river. The most important guide is the actual level of streamflows at the point where you are pumping. Based on streamflow data collected for the Mattole River, Sanctuary Forest has determined that the dates discussed here correspond, on average, to the period of critically low flows in the Mattole Headwaters, when juvenile fish are most imperiled. This period corresponds generally, but not perfectly, to the period of lowest flows seen in many other North Coast creeks and rivers. To get more detailed information about streamflows and recommended no-pump periods outside the Mattole, contact your local watershed group or your nearest Department of Fish and Game office, or check the data on streamflows available through the U.S. Geological Survey website listed in the Appendix.

Calculating your water storage needs

We recommend that every household store enough water to last for a dry season stretching 3½ months, or 105 days. The following guidelines will help you calculate your total water needs for this period. (Note: These figures are based on average water usage data from the State Water Resources Control Board. Water conservation tips discussed later in this guide can help you reduce your actual use by 25-50% below these levels.)

- Household water use: 55 gallons per day (gpd) per person
- Garden water use: 18.5 gpd per 100 square feet of garden
- Fire protection water reserve: 2500 gallons

Sample storage calculation for a 3-person household with a 1600 sq ft garden:

- Household water need (Aug 1 – Nov 15): **17,325 gallons**
  (105 days × 3 people × 55 gpd)
- Garden water need (Aug 1 – Oct 15): **22,496 gallons**

(based on 76 days × 1600 sq ft x 18.5 gpd per 100 sq ft; this assumes that households will stop irrigating their gardens after October 15, which is recommended)

- Fire protection: **2500 gallons**
- **Total household storage need: 42,321 gallons (for 3½ months)**

This figure represents the household's required storage for the full 3½-month dry season from August 1 through November 15. If you are unable to store enough water for this entire period, make sure at least that you have adequate storage to last through the two lowest-flow months of September and October—that is, at least 60 days' worth of water.

Optimal pumping season for filling/topping tanks

As a general rule, **you should fill your tank no later than May 31** to ensure minimal impacts to flows and optimum water quality. Pumping in June and July should be limited to topping your tank to ensure that you have enough water stored to cease pumping by August 1.

Ideally you should stop pumping entirely from August 1 until November 15. If your storage capacity is not sufficient to last this entire period, then you should continue to top your tank through August, but stop pumping entirely during September and October—the two most critical low-flow months in most years.

Preventing water loss from overfilling

Avoid overfilling your tank and causing significant water losses. One hour of overflow at an average pump rate of 10 gallons per minute results in 600 gallons wasted; an overnight overflow would lose 4800 gallons. Two recommended methods to ensure against overflow losses are installation of an automatic shut-off valve that turns your pump off when the tank is full, and overflow piping back to the water source.

Maximum pumping rates

To protect fish habitat and prevent direct harm to juvenile fish, pumping rates should never exceed 5% of the streamflows of the water source, and in general pump rates should never go above 11 gallons per minute (gpm), which is adequate to fill tanks in an efficient manner. In the headwaters of the Mattole River mainstem (as in many other smaller rivers or creeks), it may be necessary to reduce pump rates further when flows are particularly low—even before the "no-pump season" which begins August 1 in the upper Mattole River program. A pump rate of 11 gpm represents 5% of flows when streamflows drop to 220 gpm. If you must pump when flows drop below this level, we recommend reducing your pump rate to no more than 5 gpm.

It is therefore very important to know the pump rate of your system. Pump rates can easily be reduced by installing a bypass valve or flow reducer. (Rogers Machinery, listed in the Appendix, can give specific information on how to modify your pump to adjust your rate.)

It is also critical to consider the cumulative impacts of multiple pumps drawing from one stream or river reach. If you know that others are pumping from the watercourse you draw from, the best way to reduce your impacts is to coordinate pumping schedules so you don't all take water at the same time. Either your local watershed group or the nearest DFG office may be able to help you develop a pumping schedule that protects your stream.

Installing and maintaining fish screens on pumps

All pumps need to be equipped with intake screens to prevent damage to small fish. The screen openings must be small enough so that small fish can't get sucked into the pump. Additionally, the total screened area needs to be large enough so that the suction pressure against the screen is almost non-existent. If the screened area is too small, juvenile fish will be impinged against the screen and injured. The following specifications are summarized from the 2000 Department of Fish and Game criteria for California streams with juvenile coho, steelhead, and Chinook. (Note that these criteria may change as more research is done, and currently the National Marine Fisheries Service is updating its criteria; see the Appendix for DFG contact information to get the most up-to-date guidelines.)

Specifications for pump screens (as of May 2008):

- Screen mesh openings must not exceed **3/32 of an inch** for woven wire or perforated plate screens.
- Screen mesh must have a minimum of **27% open area**.
- For an **11 gpm pump**, the total unobstructed screen area must be at least **43 square inches**. For a 22 gpm pump, the total unobstructed screen area must be 86 square inches.

Pump intake screens can be purchased ready-made from Pacific Ag Systems (see Appendix). These screens are sized to match your pump and are guaranteed to provide fisheries protection. They are made out of 20-gage stainless perforated plate and are very durable, though also relatively expensive (about $450 for a 15 gpm pump).

Pump screens can also be fabricated inexpensively using a screen support structure such as PVC and a stainless steel screen mesh covering. When making your own screen, make sure the screen mesh is securely fastened to the support structures and that no gaps greater than 3/32 inch exist in the mesh or the points of attachment.

It is very important to clean pump screens regularly to avoid clogging. When pump screens become partly blocked by debris, the suction pressure on the remaining screen will be higher, potentially injuring juvenile fish. Check and clean your screens at the beginning of the pumping season, and then as needed to keep them free of debris. If the screens are fabricated with wire mesh, replacement of the mesh will be required every year for bronze mesh and every two years for stainless steel mesh.

MAKING YOUR STORED WATER LAST

Monitoring weekly water use

A water budget is an essential way to ensure that your stored water will last through the low-flow season, along with weekly monitoring of your water usage. In its simplest form, a water budget takes your total water storage capacity (excluding fire reserve) and divides it by the number of weeks when you will stop pumping—ideally the full 15-week low-flow season. Depending on your needs for irrigation or other special uses, the allocation may be the same for each week, or may vary during the no-pump season. By measuring your weekly usage you can ensure that you're staying "within budget"—and make adjustments if you are not.

The easiest way to measure usage is to install a water meter (cost: about $200) on the outlet of your tank, and record usage on a weekly log. The water used per week is then easily calculated from the log and can be compared with the water allocation to make sure that water use is on budget. (A sample water log is shown in the Appendix.)

Alternatively, you can manually calculate your weekly water use by taking depth measurements of your tank and using these to figure the change in volume. (The Appendix provides a simple formula to use, along with a sample log for recording these measurements.)

Reducing your use through water conservation

You can reduce water use by up to fifty percent during the dry season by following these tips:

- Reduce irrigation water by water-efficient gardening and landscaping techniques: dry farming and drought-resistant plants, drip irrigation, mulching, evening watering, avoiding overwatering.
- Reduce household water use by using efficient fixtures and turning the water off except when actually rinsing dishes, showering, brushing teeth, etc.

Replacing older, standard water fixtures and appliances with newer, more water-efficient versions can make a tremendous difference in reducing your daily household water use, as the following table shows:

Fixture	Old-style (standard)	New (water-efficient)	Water savings
Toilets	5-7 gallons/flush	1.6 gal/flush	~ 5 gal/flush
Sink faucets	3 gal/minute	2 gal/minute (with aerator)	1 gal/minute
Showerheads	3-4 gal/minute	2.7 gal/minute	~ 1 gal/minute
Washing machine	40 gal/load (top loader)	20 gal/load (front loader)	20 gal/load

Leak-proofing your tanks and pipes

Leak-proofing your tank and water system is absolutely essential to ensure that your water lasts through the dry season. Two methods for leak proofing large-capacity water tanks are described below.

Option 1: Install a valve manifold on your tank to limit water loss in the event of leaks. Whitethorn Construction, listed in the Appendix, fabricates tank valve manifolds upon order. The manifold divides the tank into sections so that only one section of the tank's capacity can be drained at a time. It is best to divide your tank into a minimum of three sections so that the maximum loss will be one third of your tank. (Note: If you use an automatic pressure pump to take water *from* your tank, be sure to protect it with an automatic shut-off switch so that your pump will not run when no water is available)

Option 2: Alternatively, you can use a small tank for all of your water supply needs and manually fill the small tank from the large capacity tank as needed. If the small tank is isolated from the large tank, then the maximum water loss in the event of leaks is the volume in the small tank. However if the big tank is set up to automatically keep the small tank full, all of the water in both tanks could be lost in the event of a major leak.

Exposed pipes are a common cause for major loss of water from leaks. Raccoons bite exposed plastic pipes and can cause losses of thousands of gallons per day. Fittings can break loose from the expansion and contraction of pipes exposed to the elements, again resulting in major water losses. Burying your water pipes will protect them from animal bites and the elements. Upgrading your water system with professional advice or assistance from a plumber is recommended if you have exposed plumbing.

Optimizing quality of stored water

The quality of water from long-term storage in tanks is primarily dependent on the quality of the source water, the tank itself, and the two critical storage conditions of temperature and light. If the tank is made of food-grade materials and the guidelines below are followed, water from long-term storage should be of equal quality to water stored short-term. To obtain drinking water quality from either long- or short-term storage, it is recommended that both a drinking water filter and UV purification cartridge be installed at the drinking water faucet to remove common bacteria and other organisms.

Incoming water quality is critical for long-term water storage. It is important to fill the tank when the water source is clear. Filtering the incoming water is best; otherwise, be sure to use a pre-settling tank that allows the clear water to be pumped from the top while the sediment collects at the bottom. (Fish screens also provide a convenient first-stage filter.)

Cool storage temperature is also important for water quality, and large tanks keep water cooler than small tanks. Exposure to light is also a critical factor for water quality. All sunlight must be excluded from the tank because sunlight encourages algae growth and water quality deterioration. Site the tank away from full sun if possible, or use shade cloth to minimize sun exposure.

Depending on the type of tank you use, there may be other steps you should take to optimize the quality of your stored water. Be sure to obtain a tank owner's manual from the tank retailer or manufacturer.

OTHER THINGS YOU NEED TO KNOW

Emergency water loss

The sudden loss of a large portion of stored water in the midst of the low-flow season is a serious problem for any household. But deciding to pump from the stream or river in order to refill the tank at that point would be potentially devastating for fish survival. In that circumstance, the most responsible choice you can make is to obtain the water you need to get through the dry season from a retail water supplier. Find out who supplies potable water in your community, and where they get their water from. (See the Appendix for two suppliers in the Mattole watershed and Southern Humboldt area.)

Fire storage requirements

Fire protection storage requirements may vary by county, but generally apply to rural residents in the North Coast region. In Humboldt County, homes in State Responsibility Areas for fire are required to maintain a reserve of 2500 gallons at

all times to fight fire. If this reserve is not kept in a separate tank, your larger tank must be plumbed in such a way that the 2500 gallons will not be bled down by other usage. A 2.5-inch standard male fire hose adapter is required for access to this water.

Permits for tanks and water storage

County installation requirements: Permits or other requirements also vary for tank installation within different counties and for different zones within counties. It is recommended that you call your county building department to determine permit requirements for your location. In Humboldt County the following general requirements apply:

- **Grading permit**: Required if excavation for installation exceeds 50 cubic yards.
- **Tank permit**: Required for tanks whose capacity is more than 5,000 gallons. A standard building permit cannot be obtained for a tank unless the tank meets California building code and is approved by a California engineer. An Alternative Owner-Builder (AOB) building permit is allowed for tanks that do not meet California building code if the landowner qualifies under the AOB ordinance.
- **Setback requirements**: Riparian setbacks are 100 feet from edge of stream or river bank. Property line and county road setbacks are 30 feet.

State Water Board permits: California requires an appropriative water right (or "small domestic use appropriation") for water that will be stored longer than 30 days. The riparian water rights held by landowners who withdraw water from a stream that passes by or through their property allows only for direct diversion, and does not allow water storage for longer than 30 days. A small domestic use appropriation registration can be obtained from the State Water Resources Control Board (SWRCB) if the applicant qualifies for small domestic use as defined by the SWRCB. As of March 2008, the application process requires (1) completion of the application form; (2) submission of the application to California Department of Fish and Game (DFG) for clearance and/or terms and conditions under which water may be diverted; and (3) payment of application fees of $250.

Fish and Game Code requirements: DFG has authority under Fish and Game Code section 1602 to regulate any water withdrawal that may have an impact on fish or other aquatic life. According to the Code, anyone who undertakes an activity that might "substantially divert or obstruct the natural flow of any river, stream, or lake" is required to notify DFG of this activity. Such notifications are particularly important in fish-bearing streams and tributary streams where low flows have been identified as a problem. If the Department determines (on a case-by-case basis) that your water diversion could have a "substantial" impact on the resource, a

Lake or Streambed Alteration Agreement may be required. DFG defines fish to include amphibians and other aquatic and terrestrial life. If your stream or spring has habitat for any aquatic life or is a tributary to such a stream, then an agreement may be necessary. (See Appendix for a website providing more guidance on submitting a notification.)

APPENDIX – CONTACT INFORMATION

Contact information for suppliers and services

- Manufactured pump screen supplier:
  - Pacific Ag Systems, supplier of Pump-Rite Screens: (888) 998-1983
    Website: www.pump-rite.com

- Stainless steel screen mesh supplier for homemade pump screens:
  - Englund Marine in Eureka: (707) 444-9266

- Modifying pumps to reduce flow rate:
  - Rogers Machinery in Eureka: (707) 443-6388

- Tank valve manifold to limit water loss:
  - Whitethorn Construction in Whitethorn: (707) 986-7416

- Retail water suppliers (in Southern Humboldt region):
  - Sidonie's H2O To Go in Garberville: (707) 923-2551
  - Pura Vita Drinking Water in Shelter Cove: (707) 986-1500

Contact information for public agencies

- Humboldt County Building Department: (707) 445-7245

- Mendocino County Building Department: (707) 463-4281

- California Department of Fish and Game
  - For questions about DFG water rights, permits and pump screens, contact:
    - Jane Arnold, Staff Environmental Scientist (Eureka)
      (707) 441-5671, jarnold@dfg.ca.gov
  - For information about filing a DFG notification of diversion:
    - Visit http://www.dfg.ca.gov/habcon/1600
  - For up-to-date information about pump screen requirements:
    - Visit http://iep.water.ca.gov/cvffrt/DFGCriteria2.htm

- State Water Resources Control Board
  - The Division of Water Rights provides information on water rights and permits (including small domestic use appropriations), as well as water use standards for households, irrigation, livestock and dust control.
    - Visit http://www.waterrights.ca.gov
      Or call: (916) 341-5300

- U.S. Geological Survey – Water Resources
    - The USGS National Water Information System provides online streamflow data for thousands of locations around the country.
        - Visit http://waterdata.usgs.gov/nwis/dv
          Or call: (800) ASK-USGS

APPENDIX – TECHNICAL INFORMATION

Conversion rates for water volume calculations

- 1 cubic foot = 7.48 gallons
- 1 gallon = 0.13 cubic feet
- 1 gallon/minute (gpm) = 0.0022 cubic feet/second (cfs)

Calculating pump screen area requirements

Minimum screen area – sample calculation:

- **Step 1**: Convert your pumping rate from gallons/minute to cubic feet/second (using the conversion rate above).
- **Step 2**: Multiply your pumping rate (in cubic feet/sec) × 12.1 sec/feet to get square feet of screened area required.

Calculating minimum screen area for an 11 gpm pump:

- **Step 1**: 11 gpm × 0.0022 cfs ÷ 1 gpm = 0.024 cfs
- **Step 2**: 0.024 cfs × 12.1 sec/feet = 0.29 square feet of screened area.

Sample water use log tables

1. Sample log using water meter readings

(Storage = 50,000 gallons allocated at 450 gallons per day = 111 days or 15.9 weeks)

Weeks of restricted season (approx. 15 weeks)	**Date**	**Water meter reading (gallons)**	**Actual water used per week (gallons)**	**Water allocation per week**	**Difference (allocation minus actual use)**
Start date	Aug 1	25,000			
Week 1	Aug 8	28,000	3000	3150	150
Week 2	Aug 15	31,500	3500	3150	- 400
Continue through week 15					

2. Sample log using tank depth measurements
(For 50,000 gallon tank with diameter = 35.17 feet)
(Storage = 50,000 gallons allocated at 450 gallons per day = 111 days or 15.9 weeks)

The volume of the water in your tank can be calculated as follows:

- **Step 1**: Calculate gallons per foot of tank depth for your tank.
  a) Measure your tank's diameter (in feet), then divide this in half to get the tank radius.
  b) Multiply water depth of 1 foot × tank radius squared × 3.14 = cubic feet of water per foot of depth.
  c) Convert to gallons per foot of depth by multiplying cubic feet of water per foot of depth × 7.48 (gallons per cubic foot).

- **Step 2**: Calculate the total volume in your tank.
  a) Measure your current water depth (in feet).
  b) Multiply the water depth × gallons per foot as computed above.

Sample calculation for a tank with diameter of 35.17 feet:
- Volume per foot = 1 foot × $(35.17 \div 2)^2$ × 3.14 × 7.48 = 7259 gallons/ft
- Total volume at 6.9 feet = 6.9 feet × 7259 gallons/ft = 50,087 gallons

Make a chart to record depth and calculated volume for your tank, then track water use on this chart as shown on the sample below (based on 35.17 foot diameter tank).

Weeks of restricted season (approx. 15 weeks)	**Date**	**Water depth reading**	**Water volume calculated (gallons)**	**Actual water used per week (gallons)**	**Water allocation per week**	**Difference (allocation minus actual use)**
Start date	Aug 1	6.9 ft	50,087			
Week 1	Aug 8	6.5 ft	47,184	2903	3150	247
Week 2	Aug 15	6.0 ft	43,554	3630	3150	- 480
Continue through week 15						