Resilience in a Time of Drought:
A Transferable Model for Collective Action in North Coast Watersheds

Salmon Keeper, ©2001 Valery McKee

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Sanctuary Forest is a non-profit land trust whose mission is to conserve the Mattole River watershed and surrounding areas for wildlife habitat and aesthetic, spiritual and intrinsic values, in cooperation with our diverse community.

The Bella Vista Foundation's Ecosystem Restoration program focuses on protecting, restoring, and revitalizing high priority watershed ecosystems in California and Oregon.

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Section One: Introduction

> *"You enter* Whitethorn *valley, and see signs about the river. And in every driveway there is a symbol, showing this family is part of the conservation effort. There is restored groundwater hydrology in the entire headwaters, so even in drought years the tributaries are flowing. The water is clear. The forests are thinned to a healthy level. There is a stewardship balance, in the way native peoples experienced it. And the humans are a part of that, instead of cast out of the garden."* -Vision for the Mattole Headwaters, Tasha McKee, January 2012

Overview

Resilience in a Time of Drought: A Transferable Model for Collective Action in North Coast Watersheds is a practical 'how-to' guide for community members, restoration practitioners, non-profits, and other stakeholders wishing to establish a voluntary water conservation program in their watershed. This guide was developed based on the methods and findings of a collaborative technology transfer project that was initiated in Humboldt County, California in 2013 by Sanctuary Forest and Salmonid Restoration Federation in collaboration with Sara Schremmer, a graduate student in the sociology program at Humboldt State University.

While this guide was being developed, California was experiencing its worst drought since recordkeeping began in the 1840s, with one paleoclimatologist suggesting that 2013 "could potentially be the driest water year in 500 years"[1]. While climatologists predict that changes in global climate will continue to manifest in unexpected ways in the Pacific Northwest, longer dry seasons (i.e. months without rainfall) are an impact already being felt in Northern California, which can result in reduced water quality and quantity for increased periods of time.

The challenge of low water flows galvanized many concerned residents and stakeholders in Southern Humboldt to raise a challenging question: How can we become more resilient in a time of drought, and what can we do to keep more water in the rivers, tributaries, and streams so that people and fish have enough to survive?

The steps outlined in this guide have been designed for use in watersheds where a rural population is dependent on a local watercourse for their agricultural and household needs, and where changing human use has the potential to increase streamflows. Our recommendations should be considered and applied as appropriate, based on the social and ecological context of the watershed where implementation is to take place.

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[1] Quote by UC Berkeley paleoclimatologist B. Lynn Ingram, author of The West Without Water: What Past Floods, Droughts, and Other Climatic Clues Tell Us About Tomorrow (2013): http://newscenter.berkeley.edu/2014/01/21/states-water-woes/

Background

In instances where policy prescriptions and state control of resource systems have been unsuccessful in accomplishing specific resource management or restoration goals, a move toward self-governed collective action by local stakeholders may be a viable alternative. This section describes the voluntary model that Sanctuary Forest developed in order to collectively manage streamflows in their rural watershed[2].

From 2005-2013, a water conservation pilot project was implemented by Sanctuary Forest in the Mattole headwaters for the purposes of addressing low summertime water flows that impact rural residents and sensitive aquatic species. Following a "water storage and forbearance" concept, they recruited eighteen landowners to voluntarily sign a legal agreement with Sanctuary Forest to store water from the Mattole River during the high flows of the winter season, and to forbear from pumping during the dry season by using the stored winter water from their tanks during low flows. In exchange for the legally binding water forbearance agreement, Sanctuary Forest coordinated the purchasing and installation of government subsidized 50,000-gallon Pioneer water storage tanks on the private properties of the participating landowners. After placing the large storage tanks in critical fish habitat reaches that overlapped with private property, the landowners were able to store plentiful winter water for their domestic and agricultural needs—often more than enough to last them through 105 days of low summer flows. Sanctuary Forest maintained regular communication with the participating landowners throughout the year, and would notify each household when it was time to turn off their pumps for the season. Sanctuary Forest's water storage and forbearance efforts resulted in measurable improvements in streamflows. In low flow years prior to program implementation (2004 & 2006), flows dropped to 0-3 gallons per minute (gpm) at MS6, the measure point at the downstream end of the program area. Post-implementation in low flow years (2011, 2012 & 2013), flows were measured at 49-206 gpm. The threshold flow when pools become disconnected is 90 gpm and therefore the increase in flows from turning off the pumps was significant for fish and wildlife.

Early in 2013, Sanctuary Forest and Salmonid Restoration Federation initiated a study to determine the feasibility of conducting a "technology transfer" of Sanctuary Forest's Mattole headwaters water storage and forbearance program to Redwood Creek on the South Fork Eel River in Northern California. Redwood Creek is a 26 square-mile watershed that flows into the South Fork of the Eel River near Redway, California; it also happens to be located adjacent to the Mattole watershed, and suffers from many of the same cumulative impacts that have led to serious concerns about low summertime flows. To address these concerns, the Redwood Creek Water Conservation Project was designed in order to gather data about human water use and low

[2] Sara Schremmer's (2014) thesis, Resilience in a Time of Drought: Building a Transferable Model for Collective Action in North Coast Watersheds, examines Elinor Ostrom's (1990) theory of collective action as a useful framework for understanding how individuals can be organized to act collectively for the continued enjoyment of a shared resource.

flows in the watershed, to gauge community interest in establishing a voluntary water conservation program similar to the one in the Mattole, and to understand the type of water conservation program that might be appropriate for the Redwood Creek watershed and its rural residents. The feasibility study that was conducted at the onset of the Redwood Creek Water Conservation Project has been translated into this step-by-step manual, in the hopes that what we have learned can be taken and applied in other watersheds in Northern California and elsewhere.

What is "technology transfer"?

The definition of "technology transfer" varies by discipline, but can be generally understood as **the movement of know-how, technical knowledge, or technology from one setting to another**[3]. In the case of a collaborative water conservation model, transferability can be thought of as **the replication, scaling-out, or adoption of water conservation technologies or practices that were successful in one place to another place, based on the unique social and environmental context of the watershed.**

The significance and challenge of addressing water scarcity through technology transfer was addressed in the opening statement of the Symposium on Water Issues in 2006:

> *The transfer of technology, when it deals with water (an essential element of life, economic development, social communities, and national politics), is one of the most complex areas facing the world today… the desperate need for water and our dependence on it make it one of the most contentious substances on earth—and thereby vastly complicates the challenge of diffusing the technical capacity to provide better methods for water supply and use for the citizens of the world*[4].

Applying technological solutions to freshwater problems is not a new practice. There are any number of techniques, programs, and point source fixes—informed by hydrology, biology, geography, and ecology—which can help mediate human impacts on freshwater resources. However, only recently has the transfer of technology been recognized as a beneficial tool in collaborative place-based efforts to restore watersheds.

The Center for Collaborative Conservation Research produced a report in 2011 that provides a useful framework for understanding the feasibility of technology transfer in the context of collaborative water conservation[5]. In the social-ecological-temporal (SET) model, the social dimensions require that the restoration process "needs to be landowner driven, there needs to be sense of community, and the right 'type of' leaders need to be willing to lead." From an ecological standpoint, accurate and appropriately translated scientific data should be shared with community members that they can use as they are formulating their objectives. Lastly, the SET

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[3] Roessner, J.D., in press. Technology transfer. In: Hill, C. Ed., Science and Technology Policy in the US, A Time of Change. Longman, London.

[4] Huber, T. P. 2006. In This Issue: Symposium on Water Issues. *Comparative Technology Transfer and Society*, *4*(3), viii–xi. doi:10.1353/ctt.2007.0007

[5] Bixler, Patrick R. 2011. *Navigating Waters Beyond the Blackfoot: Transferability of the Collaborative Conservation Model*. Report produced for the Center for Collaborative Conservation Research, Colorado State University.

model notes, "even with the right social and ecological conditions, ultimately it also 'has to be the right time'" and there needs to be capacity—from both scientific, professional, and citizen stakeholders—to invest the resources that are available to them in order to make the program or project successful.

Place-based Collaborative Watershed Restoration

In response to inefficient environmental policies that have historically failed to address the interrelationship between human beings and the ecosystems in which they live, multi-stakeholder collaboration has emerged as a popular archetype in watershed restoration. Collaborative methods of addressing environmental degradation developed in the 1990s in tandem with the rise of citizen-based groups that were forming in order to address the failing health of their local environments. One result of this new paragon of grassroots environmental organizing was the emergence of collaborative watershed management, which can be defined as follows:

> a primarily self-directed and locally focused collection of parties, usually featuring both private and intergovernmental representatives, organized to jointly address water-related issues at the watershed level… and typically reliant on collaborative mechanisms of group interaction characterized by open debate, creativity in problem and solution definition, consensus decision-making, and voluntary action[6].

While there are many benefits to collaborative watershed restoration, it is helpful to understand some of the difficulties that might arise prior to initiating your project. Collaborative restoration efforts can be challenging, requiring not only a sound understanding of the hydrological, geological, and ecological characteristics of the watershed, but also effective multi-stakeholder cooperation across different social sectors. Complications or intractability can arise during collaborative watershed management efforts when the social ecosystem (i.e. human geographic boundaries) conflicts with traditional administrative-political boundaries (i.e. counties, states, or national forests) or the actual geo-physical boundaries that define the watershed itself. Furthermore, collaborative restoration has been described as inherently political because its success relies upon the incorporation of complex relationships involving authority and power between individuals and groups in a social setting, and because it relies upon the active participation of private and public stakeholders across disciplines, levels of authority and sometimes varying scales of land ownership, resulting in social terrain that can be challenging to navigate.

It has been argued that collaborative restoration efforts in rural settings can be more challenging than those located in smaller-scale urban neighborhoods. Working at a landscape scale in a rural area involves "higher degrees of personal stake in outcomes, higher sensitivities to planners as 'outsiders,' more pronounced power dynamics, challenges to implementation due to diverse land ownerships, more diffuse social and community structure, and greater opportunities for

[6] Kenney, D.S., et al., (2000). *The new watershed source book*. Boulder, CO: Natural Resources Law Center. Page 2.

incorporating technology"[7]. The problem of large-scale projects complicating social participation among stakeholders can be remedied by breaking "the larger region into smaller subregions with which stakeholders more readily identify"[8].

Successful collaborative watershed restoration requires more than active citizen participation. It is also vital that your efforts be conducted within the ecological context of the watershed where you are attempting to work. A project is likely to fail when it lacks: "1) the inclusion of a solid conceptual model of river ecosystems; 2) a clearly articulated understanding of ecosystem processes, 3) recognition of the multiple, interacting temporal and spatial scales of river response, and 4) long-term monitoring of success or failure in meeting project objectives following completion"[9]. In order to circumvent these challenges, it is often recommended that practitioners of collaborative watershed restoration include representatives from a broad range of stakeholder groups early in the analytical and decision-making phases of the project, including local residents, scientists with expert knowledge of the resource systems under investigation, and representatives from appropriate governing agencies.

Place-based collective action strategies will look different depending on the social and ecological context of the watershed setting, but Schremmer (2014:95) suggests that in most cases, a few conditions will need to be met if stakeholders hope to achieve a paradigm shift toward responsible water use and stewardship in their watershed. "Collective efforts to transfer or scale-out voluntary water conservation strategies will increase their chances for success if: a) local residents have an emotional and physical attachment to the watershed as their place; b) if the project is driven by the stakeholders and residents who stand to benefit from increased streamflows; c) if stakeholders and residents have sufficient access to ecological data; and d) if, as the SET model suggests, it's 'the right time' and 'the right type of' leaders are willing and able to lead the collective endeavor."

For stakeholders on the North Coast, and particularly in Southern Humboldt, Schremmer (2014:97) advocates for a place-based emphasis when developing a collaborative streamflow improvement strategy. She suggests that such a strategy would: "a) put a high value on local and inter-generational knowledge-sharing and participation; b) emphasize the intrinsic value of non-human creatures indigenous to the watershed (particularly of native salmon); and c) be motivated by a desire to improve the landscape for the benefit and enjoyment of future generations."

Under the right circumstances, place-based collaborative restoration can provide an effective framework for encouraging local citizens to become active participants and caretakers of the places that they call home.

[7] Cheng, A. S. and S. E. D. 2003. Examining the Interaction Between Geographic Scale and Ways of Knowing in Ecosystem Management: Collaborative Planning. *Forest Science*, *49*(6), 841–854.
[8] Moote, M. A., M. P. McClaran, and D. K. Chickering. 1997. Theory in practice: Applying participatory democracy theory to public planning. *Journal of Environmental Management*. 21(6):877–889.
[9] Wohl, E. 2005. River restoration. *Water Resources Research*, *41*(10), 1–12. doi:10.1029/2005WR003985

Section Two: Conduct a Feasibility Study

Step One: Determine the Scope of Your Study Area

Conservation efforts focused on freshwater resources need to be conducted at a scale that appropriately and sufficiently addresses the impacts that contribute to low streamflows. Choosing a specific area within your watershed where a program can be implemented and evaluated will enable you to more easily show a demonstrable increase in flows as a result of your efforts. After your water conservation program has been implemented and its progress has been evaluated, you can take lessons learned and apply them at a larger scale and/or replicate your efforts elsewhere.

Recommended Actions:

Select a main steam reach or tributary system that is an area of concern. The study area that you choose will need to reflect the problem that you are hoping to address. Consult any existing recovery or species plans that might exist for the location(s) that you have in mind, and speak with agency personnel for ideas about priority areas.

- If your primary concern is protecting aquatic species and your goal is to improve habitat conditions, select a study area that has high habitat value and where you have reason to believe that changing human use will have a demonstrable impact on increasing flows and water quality. Consider whether the lack of flow is a threat to species in that area.

- If your primary concern is water scarcity and your goal is to increase flows for both people and wildlife, select a study area where the residents are highly dependent on the water source for subsistence purposes, and where you have reason to believe that changing human use will have a demonstrable impact on increasing flows and water quality.

Step Two: Identify and Contact Stakeholders

Collaborative restoration movements have been flourishing in rural communities since the 1990s as a direct result of pressures on the natural resource bases upon which those communities depend. In situations where riparian landowners are an important stakeholder group in the restoration of a specific water body, the "localness" of those landowner groups, coupled with a reliance on the degraded water resource for economic and/or subsistence purposes, is understood to be an asset in fostering broad support for watershed restoration efforts.

Recommended Actions:

1. Make a list of the individuals and groups whom you think should be directly involved with the project. Include representatives from a broad range of stakeholder groups early in the analytical and decision-making phase of your project, including citizens and landowners, scientists with expert knowledge of the resource systems under investigation, and appropriate governing agencies.

2. Contact the people on your list to inform them about your interest in initiating a feasibility study for a water conservation program. This outreach can be conducted individually, on a conference call, at group meeting, or all of the above, and will provide you with an opportunity to share your ideas, to gather feedback from stakeholders, and to find out what type(s) of resources those stakeholders might be able to offer as the project progresses.

Step Three: Collect and Analyze Preliminary Data

Every watershed is comprised of unique land use histories, climactic conditions, and human water use patterns. These factors interact in complex ways and need to be examined in order to understand the historic context and current conditions of flows in a watershed, as well as which causes of low flows can be controlled.

Extensive data collection and research will be necessary in order to understand what type of water conservation program will be feasible and have the greatest impact in your study area. The good news is that many of the big questions can be answered without the cost of hiring an expert.

Sending out survey questionnaires to all of the households in your study area is an ideal way to collect preliminary data from residents in the community. The surveys will provide important information on human water use in your watershed, which you will need in order to later compare an estimate of the percent of water being used (i.e. agricultural and residential) to available flows. Survey questionnaires can double as an excellent opportunity to gauge the interest of local residents in participating in a voluntary water conservation program, and to collect anecdotal information on historic precipitation patterns and flows from long-term residents (i.e. Have flows changed over time or have they always been low seasonally? Are the low flows are more severe than they used to be?).

Data on land use histories, changes in climate over time, and historic and current flow patterns in your watershed are likely available in public reports and records.

Recommended Actions for the Surveys:

1. Obtain a mailing list for the survey questionnaire. This can present a challenge in rural areas, but typically there will be at least one or two entities that should be able to assist you. For example, for the Redwood Creek Water Conservation Project, a mailing list of parcel owners was obtained from the Humboldt County Planning and Building Department. Volunteer fire departments may also be able to help.

2. Write a survey questionnaire that will help answer specific questions about water use and long-term observations in your watershed. In Appendix I, we provide a sample based on the questionnaires that Sanctuary Forest and Salmonid Restoration Federation mailed to residents in their respective watersheds. Here are some recommendations for conducting your survey mailing:

- Include a cover letter that explains the purpose of the survey and how the information will be used. A sample cover letter can be found in Appendix I.
- Make the survey anonymous. Since you are looking for general information about water usage in your watershed, there is no need to ask for identifying information like name, address, and so on.
- If possible, send a pre-notice to residents one week prior to the mailing in the form of a letter or a postcard. Pre-notices informing recipients of an upcoming survey have been shown to significantly improve response rates.
- If possible, include a stamped return envelope with the survey mailing. The stamped envelope serves as an incentive to respond, and has been shown to increase response rates in survey mailings.
- Make the survey questionnaire available online for respondents who may have missed the survey mailing.

3. Mail the surveys, collect the responses and compile the data into a spreadsheet for analysis. In all likelihood you will not receive a 100% response rate, especially if the survey recipients live in remote areas. Aim to collect survey questionnaires from 20-25% of your mailing list. Consider enlisting the help of local volunteers to spread the word about the survey using phone trees (i.e. one resident makes five phone calls to neighbors and asks those neighbors to each make five calls, etc.).

Additional Recommended Actions for Collecting Preliminary Data:

1. Analyze existing data from river gauges in your study area, annual precipitation reports, and seasonal precipitation patterns. For example, in the Mattole, Sanctuary Forest looked up US Geological Survey (USGS) gauge records in 2008 and found that in Petrolia, 6 out of the past 8 years showed the lowest flows in the 59-year record for that gauge. Residents were galvanized by this information, since it demonstrated a growing trend toward extreme low flows in the summertime.

While conducting your analysis, attempt to answer the following questions:

- Have low flows become more severe?
- Is there a trend toward more frequent low flows?
- Is annual precipitation a factor in influencing low flows?
- Are there apparent long-term trends in annual rainfall?
- Is seasonal precipitation a factor in influencing low flows?
- What sorts of changes in seasonal precipitation have been observed over the years?
- Does existing data indicate whether rainfall during one season (e.g. summer or early fall) might have more of an impact on flows than another season (e.g. late winter and spring)?

- Could changes in summer temperatures be a factor?

2. Outline the land use history of your watershed and the potential impacts that may be contributing to low flows. For example, in the Mattole watershed, the historic effects of the timber industry resulted in significant and cumulative impacts that are still being felt to this day. Sedimentation from logging roads has impacted streamflows in multiple ways, including the filling in of channels, the loss of large pools, and the loss riparian shade. The loss of groundwater storage in the region is thought to be an even larger contributor to the low flow crisis. An understanding of these and other land use impacts has helped inform the solutions that have been developed for that region.

3. Try to answer the following questions about human water use patterns in your watershed:

- What does the most current US Census data show the population of your watershed to be? Compare this information to data from 10 years ago. How much has the population increased during this time?
- In what ways has water use per person increased over time in your watershed? Answering this question may require looking at the cultural history of populations in your watershed in order to assess how changing lifestyles may be contributing to increased water use.
- Look at aerial photographs to get an idea of how different types of water use are scattered throughout the watershed.

Step Four: Work with a Hydrologist to Assess the Flow Regime in Your Watershed

A 'flow regime' refers to the changes in water flow in a river that occur over the course of a year. A quantitative hydrologic assessment of your river's flow regime can help answer the following critical questions:

- What types of fluctuations in flow take place throughout the course of the year?
- Is there a distinct low flow season or are the flows low year round?
- Are current flow patterns outside the predicted natural variation?
- For how many years does the data show that flows have been lower than average?
- What is the minimum amount of flow in cubic feet per second (cfs) or gallons per minute (gpm) required in order to maintain adequate water quality?
- Could changing human use have an impact on improving streamflows?

In addition, for all fish bearing streams, you would need to investigate the following question: What are minimum flows required for spawning, juvenile rearing, and juvenile migration?

Recommended Actions:

1. Recruit the assistance of a hydrologist to analyze any historic or current hydrologic assessments and/or flow data in your watershed for fish bearing streams. For example, Sanctuary Forest worked with a hydrologist to analyze flow data from the North Coast Watershed Assessment Program (NCWAP) and from the USGS.

2. If there are locations of interest in your watershed where no quantitative data exists, begin a monitoring project to measure streamflow, water quality, and if possible dissolved oxygen. Obtain permission from the landowners of the properties where you would like to conduct the monitoring. Map the locations of the monitoring sites using GPS. Reach out to stakeholders to see if they have resources (in the form of time, funding, expertise, or equipment) that they can contribute. Streamflow monitoring can be conducted at relatively little cost using alternative monitoring methods, such as the bucket-and-stopwatch technique (see Appendix III for resources on alternative monitoring methods).

3. At the peak of the dry season, conduct a walking survey to observe and evaluate flow conditions, water diversions and fish passage barriers. This information will provide a qualitative assessment of flow conditions and a quantitative assessment of water pump density. Streamflow monitoring should be done at the same time as the walking survey so that you can correlate the flows to what the on-the-ground conditions are. For example, Sanctuary Forest staff walked the river right as pools on the main stem were beginning to disconnect and conducted steamflow monitoring the same day. By conducting the walking survey and streamflow monitoring at the same time, Sanctuary Forest was able to establish a *threshold* for connectivity at 0.2 cfs.

Step Five: Assess the Type of Actions Required to Reduce Water Diversion Impacts

If human water use in your program area is more than 10% of available flows, then water conservation efforts should be implemented. Sanctuary Forest suggests 10% as defining percentile because it represents the limit of measurement accuracy.

Recommended Actions:

1. Prepare human water use estimates. Obtain an estimated population total for your program area, including number of individuals and households. You may already have this information on hand from the survey mailing. Daily use estimates can be calculated using the following guidelines (based on average water usage data from the State Water Resources Control Board):

- 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: 2,500 gallons

Sample storage calculation for a 3-person household with a 1,600 sq-ft. garden:

- Household water need (August 1 – November 15): 17,325 gallons
- Garden water need (August 1 – October 15): 22,496 gallons

*Note that these water use estimates can be significantly reduced using water conservation techniques. See Section Three for additional information.

3. Compare the percentage of human water use estimates to streamflow measurements. Multiply the estimated human use per household times the number of households to obtain the total residential water use per day for the watershed area. In addition, interview farmers, businesses and institutions to estimate their daily water use. Sum all water use categories for the watershed area. Then convert the total daily use into gallons/minute or cfs such that the water use can be compared with streamflow.

In the Mattole headwaters in 2004, total human use was estimated at 130,000 gallons/day with 90,000 for residential, 25,000 for small farms and schools, businesses, public agencies, and 15,000 for non-profits. To convert this daily use to streamflow in cfs:

130,000 gallons/day x day/86,400 seconds x 1 cubic foot/7.48 gallons = 0.2 cfs. The measured flow on Aug 28th at the downstream end of the program area was 0.1 cfs. Therefore, with sufficient water storage and conservation the flow could be increased by 0.2 cfs or 200%.

Make recommendations for reducing cumulative water use impacts using the following criteria:

- If cumulative water use is <10% of available flows, changing human use through a voluntary water conservation program will probably not have a measurable impact on improving streamflows.
- If cumulative water use is between 10-20% of available flows, coordinated water conservation measures should be explored to address human impacts.
- If cumulative water use is at 20% or higher of available flows, water storage and forbearance will likely need to be incorporated into your water conservation strategy.

If you find that changing human use will likely not have a measurable impact on improving streamflows, you may need to explore projects that could help restore the groundwater hydrology and vegetation balance in your study area. You may also need to combine changes in human use along with stewardship and restoration to address land use impacts in order to adequately restore flows. For example, in the extreme drought year of 2008, 13 out of 16 fish bearing tributaries in the Mattole headwaters dried up, and 5 of these have no human use. The results of analysis showed that the shallow groundwater resources were not adequate to sustain flows during dry seasons longer than 3.5 months, but 2008 had a 4.5 month dry season. Further research suggests that both restoration of groundwater hydrology and thinning of overstocked forests will be needed to provide resilience in drought years and adequate water for fish, wildlife and people.

See Section Three for information on coordinated water conservation measures and storage options.

Step Six: Community Outreach and Engagement

If a goal of your restoration efforts is to cultivate a paradigm shift in your watershed that emphasizes stewardship and responsible management of freshwater resources, then the engagement and participation of local residents is absolutely vital. This will require that you provide avenues for public engagement, capacity building, and solutions-oriented dialogue as frequently as possible.

Recommended Actions:

1. Utilize local media for public outreach. Radio stations, local online forums and message boards, and local newspapers are excellent venues for spreading the word about your water conservation program. If you don't already have existing relationships with a few local reporters, consider reaching out to them about the program. They may be interested in writing an article about your efforts, and/or be willing to publish press releases or event announcements for you.

2. Provide multiple opportunities for public engagement. For example, during the feasibility study for the Redwood Creek Water Conservation Project, the project team organized two house parties and a free water conservation workshop and field tour for local residents. The house parties took place at the homes of well-known local residents on two different tributaries in the watershed, and provided opportunities for residents to ask questions and share concerns and ideas regarding the scope and trajectory of a potential water conservation program for the watershed. The purpose of the water conservation workshop was to bring residents and restoration practitioners together in order to share skills and knowledge about water conservation techniques, including water storage options, water loss prevention mechanisms, and the importance of storing enough water during the wet season so as to avoid pumping during the critical dry season. The workshop was followed by a four-hour field tour of permaculture and water storage sites on a local resident's property.

3. Maintain an ongoing list of local residents who attend public meetings, workshops, or contact you with questions. Try to collect their mailing address, phone number and e-mail and keep notes on when/how they have participated.

4. Identify obstacles and potential solutions. During your public engagement efforts, ask local residents what they perceive some of the barriers to participating in voluntary water conservation efforts are. Their responses may range from financial barriers to lack of technical skill to permitting or regulatory hurdles. When you understand what the perceived barriers are, you will more easily be able to develop solutions that can reduce or remove the barriers entirely, which will ultimately result in increased participation by local residents in your program.

5. Keep local residents informed about your progress. For example, after data and anecdotal information was compiled and analyzed from the surveys, house meetings and water conservation workshop, the Redwood Creek Water Conservation Project team produced a brief report that summarized the findings and next steps of the project. The report was distributed to project participants and stakeholders, and was made available online in a printable format.

Step Seven: Implement a Voluntary Water Conservation Program

Conducting a feasibility study and implementing a voluntary water conservation program can take several years. For example, Sanctuary Forest's program in the Mattole began in the summer of 2004 with their streamflow monitoring and community outreach efforts and was implemented between 2005-2013 with the installation of the water storage tanks and the signing of the landowner forbearance agreements. The time that it takes to conduct the feasibility study and implement a program will depend on how much hydrologic data is currently available, as well as what kind of stakeholder and citizen relationships already exist in your region.

Recommended Actions:

After you have conducted your feasibility study:

1. Propose projects to improve streamflows. The projects should reflect your findings from the flow studies and public outreach efforts, and be based on the recommendations that you have already developed (see Step Six) to help reduce water diversion impacts in your watershed. Depending on the amount of water being consumed in your watershed and the type and timing of water use, appropriate water conservation options might include coordinated changes in pumping rates during the dry season and/or the installation of mechanisms on water storage tanks to prevent water loss. In watersheds with higher rates of water use, water storage and forbearance via tanks and/or ponds may be necessary. See Section Three for additional information.

2. Determine permitting requirements for implementation. It is important to note that funders will require full compliance with local and state permit requirements. Landowners need to know their permitting liability prior and costs to committing to a project.

3. Secure necessary funding to implement water conservation measures. It goes without saying that some water conservation techniques are more costly than others, in terms of both staff and volunteer time and the cost of equipment and materials. For example, shut-off valves for water tanks and water efficiency measures for households can be installed or implemented at little cost. On the other hand, water storage tanks can cost thousands of dollars to purchase, site and install. Develop a budget that accurately reflects the costs of the project(s) that you wish to implement, and start the process of securing funding. Private foundations, state agencies and local fundraising events are all potential resources that should be explored.

4. Establish how you plan to evaluate the effectiveness of your program. In most cases, your funders will require that you have an evaluation plan and follow specific reporting guidelines. Even if they do not, take time to develop a plan that will enable you to evaluate the progress of your program at important milestones, and based on deliverables that you intend to complete.

Section Three: Water Conservation, Efficiency, and Storage Information

Water Conservation and Efficiency

Tank-filling systems and piping are thought to be significant contributors to water loss, but the good news is that they can be easily remedied. For example, many tank-filling systems do not have automatic shut-off valves, resulting in unnecessary overflows. By installing float valves, automatic shut-off valves and/or overflow piping back to the source river, tributary, or stream, countless gallons of water can be saved at relatively little cost. System leaks resulting from damage from animals, joint leaks from frost, or a dripping faucet (inside or outside a house) can also result in water waste. Conducting annual system maintenance and installing water efficient fixtures (like low flow shower heads, toilets and faucet aerators) can reduce these impacts significantly.

Water-efficient gardening and permaculture techniques can also greatly reduce water use. The average standard water use for an 800 sq. ft. garden is 150 gallons per day (gpd), 15,500 gallons total for 3.5 months (based on the State Water Resources Control Board suggested water use). These water use estimates can be reduced by 50% or more by applying different techniques that can be easy to implement at little cost. Examples include:

- Permaculture
- Drip irrigation
- Deep Mulching
- Soil preparation*
- Timing of watering and methods to avoid overwatering
- Plant selection and timing of planting
- Rainwater harvesting in the garden (build berms)
- Dry farming

*Increasing organic content of soil from 1% to 2% organic matter can reduce irrigation by 75%[10].

See Appendix III for a list of resources related to water conservation and permaculture techniques.

The potential water savings from water conservation are roughly estimated based on an overall comparison between water-efficient households and gardens versus standard usage. Total water use (for household and garden combined) is estimated at 195 gpd for the water-efficient model and at 500 gpd for the standard usage model. Both models are calculated for a two person household and an 800 sq. ft. garden. Water conservation savings are estimated at 305 gpd (61% of standard use) and 32,000 gallons per household over a 3.5 month period. While storage along

[10] Hemenway, Toby. 2009. *Gaia's Garden: A Guide to Home-Scale Permaculture*. Chelsea Green Publishing Company.

with complete cessation water withdrawals offers the greatest potential benefit to streamflows, storage may not be feasible for every household. Water conservation measures are economical and within the means of most households.

Coordinated Water Conservation Measures

In some instances, just two households pumping at the same time can completely de-water a stream, stranding sensitive aquatic species in disconnected pools and reducing the availability of fresh water for downstream neighbors. Sanctuary Forest recommends the following two coordinated water conservation measures to address these concerns:

Stream Reach Coordination: Reduce the impacts of pumping from a source river, tributary or stream by asking households on a specific watercourse to follow a pre-determined pumping rotation. This can ensure that during dry the season, when flows are lowest, multiple households are not pumping at the same time.

Reduced Pumping Rates: Instruct residents to slow their daily pumping rates during the dry season. To protect fish and wildlife habitat, individual pumping rates should never exceed 5% of streamflow at the point of diversion. If there are several pumps in one tributary or main stem reach, the cumulative effects of all of the pumps also needs to be considered. Cumulative impacts should not exceed 10%. In the Mattole River headwaters program, main stem diversion pumps are limited to 11 gpm and tributary pumps are limited to 6 gpm. In normal years these pumping rates meet the requirements during winter, spring, and early summer. However, in drought years when flows are lower, lower rates of diversion are needed. If possible, water should be diverted at a low rate by gravity into a collection tank and then a higher capacity pump can be used to move the water from the collection tank to the storage tank. The following example illustrates the difference in impact:

Household (3 people and 2600 sq ft irrigated area) using 900 gpd: If collecting water at the rate of use, then the diversion rate is 0.6 gpm (900 gallons/1440 min). At the rate of 0.6 gpm, 5 households could divert water from a tributary with a cumulative impact of 3 gpm equivalent to 10% if a tributary is flowing at 30 gpm. Alternatively, if the same 5 households all are diverting with pumps at a rate of 10gpm with a cumulative impact of 50 gpm, then the stream would need to be flowing at 500 gpm to meet the 10% requirement.

Water Storage and Forbearance

Ideally, the goal of water storage and forbearance is to prepare a household for not pumping at all during the driest months of the year, whether during a one month dry season or a six month dry season.

Sanctuary Forest and concerned residents of the Mattole researched the amount of water an average household would need to store during the wet winter season in order to forbear from pumping during the dry, low flow season. Based on their findings, water storage for 3.5 months, assuming a water-efficient, two-person household and an 800 sq. ft. garden, was calculated at

23,000 gallons. This includes 10,500 gallons for household use (based on 50 gpd per person), 10,000 gallons for a water-efficient garden and 2,500 gallons of fire safety water.

The two main options for storage are tanks and ponds. Ponds may be a viable option for small farmers with large irrigation needs. If more than 50,000 gallons of storage is required for irrigation, a pond will likely be more economical than tank storage. However, ponds raise other potential concerns, including erosion, leaks, evaporative losses, and the introduction of non-native species habitat. They also have rigorous permitting requirements. Household use cannot be supplied by pond water because of water quality issues.

Options for tank storage include large steel tanks (15,000 to 75,000 gallons) and smaller Poly tanks (500 to 5,000 gallons). If cost, permitting, or siting are limiting factors for installing winter water storage, Poly "tank farms", or multiple 2,500-5,000 gallon tanks, may offer a more accessible solution for rural residents. They are easier to install than the large steel tanks, have more flexible permitting requirements, and can be installed incrementally to help diffuse the cost.

Bladder tanks are another option that can be easily transported to very remote areas and can offer large storage capacity at a low upfront cost, but they are susceptible to damage from outside elements such as rodents, bears, and falling tree branches, which means that they may only last for one or two seasons before needing to be replaced. Bladder tanks are not typically recommended for winter water storage, simply because they are not a cost-effective or long-term investment for a property.

Before purchasing storage tanks or suggesting that others do so, be sure to review the following recommendations:

- **Obtain a technical consultation.** It is important to speak with a professional before purchasing water tanks, to make sure that your water storage will be sited and installed properly based on the unique geological properties of your land.
- **Find out about permitting.** Permitting needs vary depending on the tank style, capacity, and the county that you live in. We recommend that you contact your county building department to determine permit requirements for your location, and there may be organizations in your area that can assist you with the permitting process.
- **Calculate your water storage needs.** It is recommended that every household store enough water to last for a dry season lasting 3 ½ months, or 105 days.

See Appendix II for tank storage option comparisons and for system design prototypes using Poly tanks prepared by Sanctuary Forest.

Section Four: A Note About Water Rights[11]

In order for a collective action strategy to be successful in managing human water use, people diverting water from rivers, springs, and tributaries need to acknowledge that they are beneficiaries of a *public trust resource*; in other words, that they are reaping the benefits of a public resource that is imbued with significant aesthetic, economic, cultural, and ecological value. The *public trust doctrine* "holds that certain natural resources belong to all and cannot be privately owned or controlled because of their inherent importance to each individual and society as a whole"[12]. It applies to rivers and their tributaries, and to private water rights as well, where "individual water rights that affect public trust resources are rights of use that a state can revoke if the private right harms those resources"[13].

State water rights law requires all people diverting surface waters (from springs, streams, and rivers), including diversion of water from subterranean streams flowing in known and definite channels, to file a basic statement of use. Additionally, if a resident is interested in conserving water through the storage and forbearance method, they are required by law to file for an appropriative water right.

Established as a legal means for protecting rivers as a shared resource and public trust value, water diversion permitting requirements have existed in California for many years, but have not been enforced in Humboldt County until recently. Prior to an enforcement sweep that began in the summer of 2013[14], many landowners were not aware they had to report their water diversions and register their water storage to comply with state water law and avoid potentially onerous fines. According to Matt McCarthy, of the State Water Resources Control Board (SWRCB) Division of Water Rights, Southern Humboldt residents are not alone. Roughly 75% of all water diverters in California are in need of some form of action in order to come into compliance with state water law[15].

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[11] This section is drawn from Schremmer's (2014) thesis: Resilience in a Time of Drought: Building a Transferable Model for Collective Action in North Coast Watersheds.

[12],[14] Klass, Alexandra B. and Ling-Yee Huang. 2009. Restoring the Trust: Water Resources and the Public Trust Doctrine, A Manual for Advocates. Center for Progressive Reform. Accessed April 2014: http://www.progressivereform.org/articles/CPR_Public_Trust_Doctrine_Manual.pdf

[14] Brooksher, Dave. 2013. "DWR enforcement sweep coming to a neighborhood near you." Redwood Times Online. Accessed April 14, 2014: http://tinyurl.com/qdnfq2p

[15] Schremmer, Sara. 2013. Water Diversion Enforcement Spawns Community Education. The Eel River Reporter: Volume XV, Fall 2013. http://eelriver.org/water_diversion/

Permits for Water Diversion and Storage[16]

The SWRCB and CDFW both have a vested interest in ensuring that rural residents comply with state water law and register their water diversions and storage. When a household files their Statement of Diversion and Use, they are informing the SWRCB about their diversion amount(s), location(s), method(s), and basis of water right.

State Water Board permits[17]: 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 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 CDFW 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: CDFW 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 CDFW 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 a water diversion could have a "substantial" impact on the resource, a Lake or Streambed Alteration Agreement (also known as a "1600 Agreement") may be required. CDFW 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.

[16] Information in this section is drawn from Sanctuary Forest's (2008) Water Storage Guide.
[17] Institutions will require a different permitting process than the one described in this section.

Streamlined Permitting in Response to Drought

While California's unprecedented drought continued to wreak havoc on local water supplies, watershed stakeholders and state agency personnel conversed on how to streamline the registration process so that residents could begin storing winter water quickly, without fear of legal or regulatory repercussion. In March of 2014, CDFW made a welcome announcement[18]:

> With today's action, CDFW has essentially "pre-approved" the installation of storage tanks that meet the general criteria. The State Water Board has agreed to incorporate these criteria as conditions of approval, and to expedite the issuance of the registrations.
>
> "We have been working in these coastal communities for many years, and have good reason to believe that these emergency changes are going to be welcomed," said Charlton H. Bonham, Director of CDFW. "Many landowners who have wanted to take these steps can do so now more quickly with greater regulatory certainty from our department."
>
> Today's action was the direct result of suggestions made by local communities and fish conservation organizations such as Trout Unlimited, Mattole River Sanctuary Forest and the Salmonid Restoration Federation.

While California's Drought Emergency declaration is in effect, the Emergency Tank Storage Registration program will enable landowners to register their storage without a 1600 Agreement or a site inspection from CDFW as long as they meet the general criteria. Interested parties should complete a Statement of Diversion and Use through the SWRCB (see Appendix III for additional information). Though far from an all-encompassing solution, CDFW's pre-approval of storage tanks under the SDU registration program represents a victory for collaborative watershed restoration efforts on the North Coast.

Appendix I: Sample Materials

Sample Streamflow Monitoring Methods

Sanctuary Forest: Streamflow Monitoring Guidelines 2013

For Standard cross-section measurements and velocities:

Definition: LEW is defined as the left edge of water when facing downstream. Always start at this edge for cross section measurements and try to duplicate prior method.

- Set up cross-section the same way at the same exact spot unless flows require modification of site or moving to another location. (Start at the same side at the marked location and use the same cell widths).
- Do a minimum of 10 cells per site unless site is narrower than 2 feet. Make all cell widths the same unless the channel bottom is irregular- then adjust cells as needed to describe channel shape. Cells on the edges make narrower than the others. (If site is less than 0.5 feet wide than get at least 4 cells) If less than 4 cells find another site.
- Minimum cell size of .1 feet wide.
- Review last monitoring for this site prior to leaving site. Make sure width is the same (or slightly less if flows have decreased). Make sure all of the new data makes sense. (If flows have decreased than the velocity and depth for each cell should be less than the prior monitoring).
- If velocities are less than 0.05 cfs, the velocity meter will not be accurate. Either modify the channel cross-section to increase the velocity, move to another location nearby with higher velocities, or use bucket and stopwatch method.
- If staff gauge and/or data logger are upstream as at MS1, avoid modification of the channel. Doing so will change the height of the water and cause error to the staff and data logger readings. If necessary to modify the channel, put in notes time of modification and describe what was done. Avoid modification more than 2 times during the season.
- Use tape measure divided into tenths of feet.
- Wading rod: depth should be the average of the depth on the upstream and downstream sides of the wading rod
- Time: Set watch and data loggers on standard time and leave that way all season.
- Check for errors on the data sheet while still on site.

Staff Gauge:

- Have two people read staff gauge every time to double check reading.
- Read staff gauge before and after measuring stream flow.
- Review last monitoring of staff gauge for this site prior to leaving site. Make sure the new measurement makes sense. (If the flows have decreased the staff gauge should have gone down.)
- Check alignment marks on post to make sure gauge has not moved.

Bucket method:

- Do at least 4 trials even if the numbers for the first 3 are close. Calculate flows in milliliters/second prior to leaving to make sure 3 of the trials are within 10% of each other.
- Write notes at bottom of page estimating amount of water bypassing bucket: ie catching everything; at least 10% getting by, etc

For all methods:
If any changes are made from prior time note them on sheet
Take photos of each monitoring site and at least one photo of river conditions at that site. Note river conditions-leaves falling, stagnant water, etc. REQUIRED PHOTOS: MS6 waterfall view; Shadowbrook Bridge downstream and upstream views.

Draft Outline of Quality Assurance Project Plan

Mattole Flow Program: Streamflow Monitoring

Title and Approval Sheet

- Quality Assurance and Quality Control Plan for Mattole Flow Program: Streamflow Trend Monitoring
- Approvals: California Department of Fish and Game, Bureau of Land Management, Mendocino Fish and Game Commission, Other Partners

A3 Distribution List

- Barry Collins, California Dept. of Fish and Game; David Fuller, Bureau of Land Management; Tom Campbell, Mattole Salmon Group; Craig Bell, Mendocino Fish and Game Commission; Randy Klein; Project Scientific Consultant
- Other Partners as necessary

A4 Project/Task Organization

- Sanctuary Forest is administering Streamflow Trend and Effectiveness Monitoring program with funding from various agencies
- This monitoring is an element of Sanctuary Forest's Mattole Flow Program
- Responsible individuals for QA/QC:
    - Project & Contract Management:
        - Tasha McKee, Sanctuary Forest, Project Director
    - Project Implementation:
        - Tony Fair, Sanctuary Forest, Project Coordinator & Staff Monitor
    - Community Volunteers, Field Assistants
    - Project Design & QA/QC
        - Randy Klein, Consulting Hydrologist

A5 Problem Definition/Background

- A pattern of dry season low flows is impacting viability of endangered salmonids in critical habitat of the Mattole River headwaters
- Sanctuary Forest is implementing the Mattole Flow Program restoring in-stream flows to benefit salmonid habitat.
- The Mattole Flow Program consists of a) Storage and Forbearance to limit seasonal withdraws b) Community Outreach and Education c) Streamflow Trend Monitoring
- Streamflow Trend and Effectiveness Monitoring has occurred in dry seasons of 2004 - 2011

- The goals of Streamflow Trend and Effectiveness Monitoring are a) determine water quantity and related water quality trends b) support implementation of the Mattole Flow Program and c) determine effectiveness of the Mattole Flow Program.
    - Streamflow Trend and Effectiveness Monitoring Objectives are:
        - Build on existing data to determine seasonal flow, water quantity and water quality trends in support of solutions to low flow problem.
        - Build a predictive model for seasonal water management purposes by correlating flow trends with rainfall data to test the hypothesis that good summer flows are correlated with high late spring and early fall rains
        - Collect baseline data upstream and downstream of critical reaches in preparation to measure effectiveness of Storage and Forbearance limits to water withdraws
        - Collect data needed for development of forbearance flow thresholds in tributaries
        - Collect and report flow data to support Community Outreach Campaign encouraging water conservation and enforcement of Storage and Forbearance Program

A6 Project/Task Description

- Project Tasks
    - Mainstem Streamflow Monitoring – Measure streamflow at 5 established monitoring points weekly during dry season (July 1 – Dec 1) or until first winter rain using: Marsh McBirney meter, bucket and stopwatch (extreme low flows) and calibrated pressure transducers.
    - Tributary Contribution Monitoring – Measure streamflow at 15 established monitoring points at the initiation of the dry season and at maximum anticipated low flows using the methods described above.
- Project Timetable
    - Project tasks occur from July 1 to Dec 1 or until the cessation of the dry season by the first winter rain.

A8 Training Requirements

- Volunteer receive two days of field training on use of data collection methods
- Training is provided by consulting hydrologist Randy Klein
- Program Coordinator oversees all field data collected and reviews data in office.
- Consulting Hydrologist reviews all collected data

A9 Documents and Records

- Field results - will be recorded at the time of completion, using the field data sheets
- Data transcription - routine consistency checks are performed to check for transcription errors from paper to electronic form
- Data storage – data files backed-up on network weekly after collection and stored off-site.
- Annual datasets burned to cd and stored in Sacramento archive.
- Instrument maintenance logs - will also be kept at the headquarters location
- All data available for inspection upon written request

B Data Generation and Acquisition

B1 Sampling Process Design (Experimental Design)

- Design in consultation with consulting hydrologist.
- Five mainstem monitoring points chosen to create baseline data for effectiveness monitoring in Storage and Forbearance critical reaches.
- Tributary sites chosen to best determine tributary contribution to overall flows
- Dissolved oxygen measurements will be taken from pools likely to endure dry season and from within critical reaches.

B2 Sampling Methods

- Choice of flow measurement method – choice of measurement method will be determined by flows at which method is most valid and accurate.
- Flow measurements taken in a minimum of teams of two with supervision of Project Coordinator
- Twice/monthly measurements will be taken as close to the same time of day as possible. Precise timing of semi-seasonal measurements (tributaries) will be determined by consulting hydrologist.

B3 Sample Handling and Custody

- Volunteer submit data collection sheets to Project Coordinator after each measurement session
- No samples are collected

B4 Analytical Methods

- DFG trainer Ruth Goodfield established stream cross section procedure with Project Coordinator used to convert velocity to volume measurements.
- Consulting Hydrologist will help establish conversion methods for pressure transducer continuous depth measurements.

B5 Quality Control

- Data sheets are inspected in the field by Project Coordinator
- After conversion to flow volumes, any measurements outside of expected variability will be reported to Consulting Hydrologist by Project Coordinator for further review
- Consulting Hydrologist will have final judgment of data validity.

B6 Instrument/Equipment Testing, Inspection, and Maintenance

- Project Coordinator is responsible for maintenance and inspection of equipment prior to each field session

B7 Instrument/Equipment Calibration and Frequency

- All equipment will be calibrated in the field under natural conditions prior to monitoring season by Project Coordinator and Consulting Hydrologist

B8 Inspection/Acceptance of Supplies and Consumables

- All instruments will be inspected prior to use by Project Coordinator

B10 Data Management

- All data entry will be undertaken by a single individual to reduce transcription errors.
- Data sheets will be in excel spreadsheets
- Data is back-up weekly and stored off-site.

C Assessment and Oversight

C1 Assessments and Response Actions

- Each volunteer will be retrained on an annual basis
- If an individual volunteer consistently produces unusual measurements, they may be retrained.

C2 Reports to Management

- If Project Coordinator and Consulting Hydrologist concur that data quality has been compromised they will submit a report to the Project Director with suggestions on how to improve data quality or alter sample design to remeasure.

D Data Validation and Usability

D1 Data Review, Verification, and Validation

- All data to be reviewed by Consulting Hydrologist on annual basis

Sample Survey Cover Letter

December 27, 2012

Dear Redwood Creek Area Resident,

I am a graduate student at Humboldt State University, and in collaboration with Sanctuary Forest and Salmonid Restoration Federation, we are writing to ask for your help in understanding residential water use patterns in the Redwood Creek area. Your voluntary response will help us determine the feasibility of transferring the Mattole headwaters voluntary water storage and forbearance program to Redwood Creek.

Redwood Creek provides important habitat for coho salmon and supplies many Southern Humboldt residents with fresh water for drinking and irrigation. In recent years, there has been a notable decrease in water flows during the low flow season in several Redwood Creek drainages, jeopardizing the water supply for both people and fish. Understanding residential water use patterns is the first step in determining if voluntary water storage and forbearance is an appropriate and desirable solution to the low flow problem on Redwood Creek. This study will also examine the length of the dry season, land use patterns and forest cover conditions as they relate to water flows on Redwood Creek.

You will receive one survey questionnaire in the mail for every parcel of land that you own in the Redwood Creek area. Please complete and return one survey for each parcel that you own that has a residence or business located on the property. The survey can be completed by the landowner, a tenant, or any other adult (18 years or older) with knowledge of how water is used and stored on your parcel. For each survey that you complete, please use the postage-paid envelope that we have provided and mail it back to the Salmonid Restoration Federation office: PO Box 784, Redway, CA 95560.

The questionnaire should only take 5-10 minutes to complete. Your responses are voluntary and will be kept confidential. Your names are not on our mailing list, and your answers will never be associated with your mailing address. If you have any questions about this survey of Redwood Creek area residents, please call the researcher, Sara Camp Schremmer, at (xxx) xxx - xxxx or e-mail xxx@humboldt.edu.

By taking a few minutes to share how your household uses water, you will be directly contributing to important restoration work in the Redwood Creek area and your participation is greatly appreciated by the local organizations that are leading those efforts.
I hope you enjoy completing the survey and I look forward to receiving your response.

Many thanks,

Sara Camp Schremmer, Sociology Graduate Student, Humboldt State University

Sample Survey Questionnaire

Redwood Creek Community Perceptions & Residential Water Use Survey

Please complete this anonymous survey and mail it to the Salmonid Restoration Federation office: PO Box 784, Redway, CA 95560.

1. Please tell us what you value about Redwood Creek by marking each scale provided below. If there is something that you value about Redwood Creek that is not included in this list, please write in your response on the line provided.

I value Redwood Creek for its…

Fresh drinking water:
Strongly Agree [ ] [ ] [ ] [ ] [ ] Strongly Disagree

Water for irrigation:
Strongly Agree [ ] [ ] [ ] [ ] [ ] Strongly Disagree

Habitat for salmon:
Strongly Agree [ ] [ ] [ ] [ ] [ ] Strongly Disagree

Aesthetic beauty:
Strongly Agree [ ] [ ] [ ] [ ] [ ] Strongly Disagree

Other: _____

2. Please tell us about any changes you have observed over the years in Redwood Creek and the surrounding area that you think may be contributing to low summertime flows. Mark each scale provided below, and please use the additional space to write in any other observations or comments.

In Redwood Creek or the surrounding areas, I have noticed…

Fewer pools and/or pools that are less deep in the creek:
Strongly Agree [ ] [ ] [ ] [ ] [ ] Strongly Disagree

Changes in the amount or type of forest cover (for example: less meadow/grassland or increases in certain species of trees):
Strongly Agree [ ] [ ] [ ] [ ] [ ] Strongly Disagree

Changes in the length of the dry season (or changes in the timing of the first rains of the year:
Strongly Agree [ ] [ ] [ ] [ ] [ ] Strongly Disagree

Fewer logs in the creek:
Strongly Agree [ ] [ ] [ ] [ ] [ ] Strongly Disagree

More gullies, landslides or roads that could be draining the groundwater:
Strongly Agree [ ] [ ] [ ] [ ] [ ] Strongly Disagree

Other Observations or Comments:
_____
_____
_____
_____

3. How frequently or infrequently do you talk to other people in your community about the health of Redwood Creek?

[ ] Very Frequently
[ ] Frequently
[ ] Occasionally
[ ] Infrequently
[ ] Very Infrequently

4. How interested or uninterested are you in participating in voluntary water flow restoration efforts in Redwood Creek?

[ ] Very Interested
[ ] Interested
[ ] Neither Interested or Uninterested
[ ] Uninterested
[ ] Very Uninterested

5. How many years have you been a resident in the Redwood Creek area? _____

6. How many people live in your household? _____

7. What is the total estimated square footage of the irrigated lawn(s), shrubbery, orchard(s), and/or garden(s) on your parcel of land? Please only include irrigated areas in your estimate.

[ ] 10 ft x 10 ft (100 sq. feet)
[ ] 16 ft x 24 ft (384 sq. feet = the size of a one car garage)
[ ] 22 ft x 26 ft (572 sq. feet = the size of a two car garage)
[ ] 30 ft x 50 ft (1500 sq. feet = the size of a two bedroom house)
[ ] 60 ft x 60 ft (3,600 sq. feet = the size of a little league baseball diamond)
[ ] 160 ft x 360 ft (57,600 sq. feet = the size of a football field)
[ ] I don't have any irrigated areas on my parcel of land.

[ ] Other: _____

8. What is the approximate length of your irrigation season?

[ ] May – October (6 months)
[ ] June – September (4 months)
[ ] Not Applicable
[ ] Other: _____

9. What is your water source for household use?

[ ] Redwood Creek tributary
[ ] Spring
[ ] Well
[ ] Other: _____

10. What is your water source for irrigation?

[ ] Redwood Creek tributary
[ ] Spring
[ ] Well
[ ] Other: _____

11. Does your household use one or more water storage tanks?

[ ] Yes

If yes, please tell us how much total storage capacity you have in your water tank(s): _____ gallons

[ ] No

If no, please describe your household water system and then skip to Question 13:

_____
_____

12. If your household does use one or more water storage tanks, do you have any mechanisms in place to prevent tank overflows?

[ ] Yes

If yes, please tell us how your household prevents tank overflows (example: tank shut off valves):

_____

[ ] No

If no, please tell us why your household does not use mechanisms to prevent tank overflows (example: concern about economic costs):

_____
_____

13. How often does your household perform maintenance to fix all water leaks in your water system and household plumbing?

[ ] More than once per year
[ ] Once per year
[ ] Less than once per year
[ ] Never
[ ] Not sure

14. Please let us know if you would be interested in joining us for any upcoming water conservation and restoration gatherings in the Redwood Creek area.

As part of this study, two voluntary house meetings and one free conservation workshop will be hosted by SRF and Sanctuary Forest in your area to provide a forum where neighbors can discuss potential solutions to the low flow problem on Redwood Creek and learn more about this project.

If you are interested in attending a voluntary house meeting and/or the free water conservation workshop, please check one (or more) of the boxes below. This information will be used for planning purposes only.

[ ] House meeting #1: Thursday, January 10, 2013 at the [redacted] residence at [redacted] Miller Creek Road in Briceland from 5-7pm.

[ ] House meeting #2: Thursday, January 31, 2013 at the home of [redacted], at [redacted] Briceland Thorn Road in Redway from 5-7pm.

[ ] Workshop: Saturday, February 2, 2013 at Beginnings Octagon in Briceland.

If you would like to know more about the upcoming house meetings or have any other questions or concerns related water flow restoration efforts in Redwood Creek, please call the Salmonid Restoration Federation office at (707) 923-7501 or e-mail water@calsalmon.org.

Sample Community Meeting Agenda

Time	Agenda Item	Who/How	Desired Outcomes
5pm	Introductions: Name, tributary, reason for attending	Roundtable: Give each person a turn to speak without cross-talk	Get acquainted, Learn what is of concern to rural landowners
5:20pm	Introduce the project	Sara Schremmer explains need for data	Emphasize the need for landowner participation
5:30pm	Explain SRF's role in the project	Dana Stolzman, SRF ED	Explain the trajectory of the project
5:40pm	Background on Sanctuary Forest's program	Tony Fair, Sanctuary Forest	Answer questions about the program for landowners
5:50pm	Introduce value of community engagement	Hezekiah Allen, ED Mattole Restoration Council	Create constructive environment for discussing options
6pm	Discussion of potential solutions	Group brainstorm	Learn about community ideas
6:45pm	Next steps	Dana / Sara	Identify volunteers

Helpful Definitions

Water Rights: A water right is a granted permission to withdraw water from a river, stream, or groundwater source for a "reasonable" and "beneficial" use. Water rights vary from very small domestic use water rights to very large state and federal projects to provide water for irrigation districts, hydropower, and cities. Generally speaking, the diversion of surface water, including diversion of water from subterranean streams flowing in known and definite channels, requires a valid basis of right. California recognizes many types of water rights, including riparian (streamside) and appropriative water rights.

Riparian Rights: Land that touches a stream—or a parcel that kept water rights when it was split from a larger parcel that touches a stream—has the right to divert and use the natural flow of surface water for domestic, agricultural, and other beneficial uses as long as other riparian diverters and public trust resources like fisheries are not impaired. A riparian right can only be used to divert the natural flow of surface water. Water may not be diverted during wetter years or months and stored for use during drier years or months.

Appropriative Rights: Someone who takes water for use on non-riparian land or who uses water that would not be there under natural conditions on riparian land appropriates water. Water right certificates, permits and licenses issued by the State Water Board and its predecessors are examples of appropriative water rights.

Beneficial Uses: The beneficial uses of water, pertaining to water rights, are defined in the California Code of Regulations (CCR), title 23, §659-672 and include, but are not necessarily limited to: domestic; irrigation; power; municipal; mining; industrial; fish and wildlife preservation and enhancement; aquaculture; recreational; stockwatering; water quality; frost protection; and heat control.

Public Trust Resources: The State Water Board is responsible for the protection of resources, such as fisheries, wildlife, aesthetics, and navigation, which are held in trust for the public. The State Water Board must consider these responsibilities when planning and allocating water resources, and protect public trust uses whenever feasible. The State Water Board must consider these public trust values in the balancing of all beneficial uses of water in accordance with the Water Rights Mission Statement and Water Code §1253.

Water Rights Resources

For more information about water rights and other requirements related to the diversion and use of water, the following public agencies and organizations can help:

For information on **Water Rights**:

- Mark Matranga, State Water Resources Control Board, Division of Water Rights, (916) 327-3112, *mark.matranga@waterboards.ca.gov*
- Matt McCarthy, State Water Resources Control Board, Division of Water Rights, (916) 341-5310; *Matthew.McCarthy@waterboards.ca.gov*
- Visit: *www.waterboards.ca.gov/waterrights*

For information on **Water Quality**:

- Bryan McFadin, North Coast Regional Water Quality Control Board, (707) 576-2751, *bryan.mcfadin@waterboards.ca.gov*

For questions about permits to install diversion facilities or other structures in the stream:

California Department of Fish & Wildlife

- Jane Arnold, Staff Environmental Scientist (Eureka), (707) 441-5671; *jane.arnold@wildlife.ca.gov*
- For information about filing a Lake or Streambed Alteration Agreement with the Department of Fish & Wildlife, visit: *www.dfg.ca.gov/habcon/1600*

To view a map of all claimed or authorized water diversions in California, go to the **New California Water Atlas:** www.*ca.statewater.org*

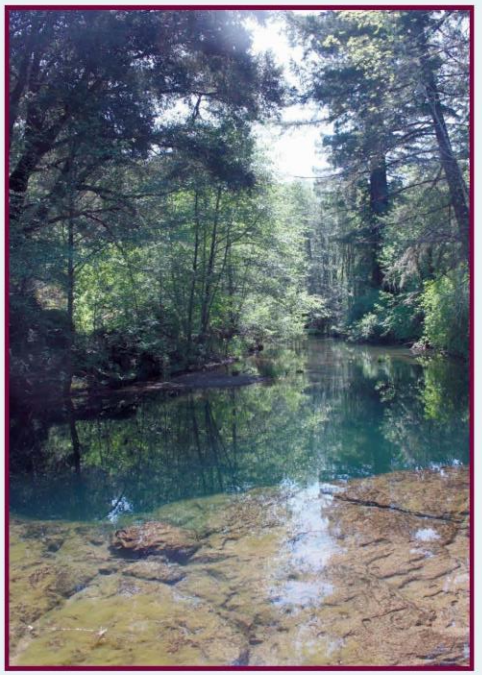
State Water Board Electronic Water Rights Information Management System (eWRIMS) Database: *www.waterboards.ca.gov/ewrims*

Water Rights and Storage Frequently Asked Questions: *www.waterboards.ca.gov/waterrights/board_info/faqs.shtml#toc178761088*

This brochure was prepared by:

- Salmonid Restoration Federation: (707) 923-7501; *srf@calsalmon.org; www.calsalmon.org*
- Friends of the Eel River: (707) 822-3342; *foer@eelriver.org; www.eelriver.org*

Know Your Water Rights



Water is a Shared Resource and Public Trust Value

If you're diverting water from a spring or stream, you need to be informed about your water rights and responsibilities.

The State Water Resources Control Board, Division of Water Rights has notified landowners that diverting water without complying with State water rights law could lead to enforcement action and fines of up to $1,000 plus $500 a day.

Compliance with State water law requires filing forms and acquiring permits when needed. The benefits are ensuring your homestead's water security and your land's value, while protecting our region's vital fisheries and wildlife.

Step 1: File a Statement of Diversion & Use

State water rights law requires all people diverting surface waters (springs, streams, and rivers), including diversion of water from subterranean streams flowing in known and definite channels, to file a basic statement that includes the following information related to the diversion: amount, location, method, and basis of water right.

How to File:

Download the Statement of Water Diversion and Use form, available here: *www.waterboards.ca.gov/waterrights/water_issues/programs/diversion_use/docs/intl_stmnt_form_2013.pdf*

The form is an initial filing. You will be notified every three years to file a supplemental Statement. There is **no fee** to file.

Helpful Tips:

If you can't determine the latitude and longitude, you may indicate on a topographic map the location of your diversion and include this as an attachment. When indicating the rate of your diversion, a rough calculation will suffice, but don't be afraid to get to know your water meter!

What if I Don't File a Statement?

If you received a legal notice and you fail to respond after 30 days, you may be subject to fines of up to $1,000, plus $500 for every additional day of diversion where a Statement of Diversion has not been filed. If you do not have a valid basis of water right, your diversion could be subject to removal, particularly if your diversion is likely to contribute to significant and/or cumulative harms to public trust resources like fisheries.

Who is Exempt From Filing a Statement of Diversion & Use?

A Statement is not necessary if your diversion (1) has a valid basis of ***appropriative*** right, such as a certificate, permit, or license, (2) if a Watermaster files a report that includes the diversion, or (3) if you are diverting from a spring that does not otherwise flow off your property and your combined diversions do not exceed 25 acre-feet per year.

Step 2: Determine If You Need an Appropriative Right:

If you cannot divert water under a riparian right, you will need to establish an appropriative water right through the State Water Resources Control Board's Registrations Program.

Register Your Water Storage

Riparian water users have the right to divert water for beneficial use (i.e. domestic or agricultural) on their parcel as long as it doesn't impair other riparian users and other beneficial uses of water including fish and wildlife. If you store winter water for use in the summer, you will need to establish a storage right.

How to Register

To learn more about appropriative rights &/or to download the appropriate form go to: *www.waterboards.ca.gov/waterrights/water_issues/programs/registrations/index.shtml*

Domestic Water Storage Rights

A relatively simple way to secure an appropriative right is to file a Registration of Small Domestic Use, which allows storage of three million gallons. Whether or not you need an appropriative right, it is important for all of us to do our part to protect fish and wildlife. Developing water storage minimizes taking water out of our creeks in the summer. Winter water storage ensures both landowners and fish have enough water in the dry season. The cost is $250 for a five year registration. The Department of Fish and Wildlife may conduct a site visit to provide protective terms for fish and wildlife resources based on site conditions. Here is the link to the small domestic use registration form and instructions. *www.waterboards.ca.gov/waterrights/publications_forms/forms/docs/sdu_registration.pdf*

What if I Don't Register My Water Storage?

You may be asked to remove your water storage system and subsequently draw unwanted attention from state agencies to your neighborhood.

A lake or streambed alteration agreement may also be required by CDFW, this is determined by on the environmental conditions and the project itself. The information and form are here: *www.dfg.ca.gov/habcon/1600/*

Step 3: Fish and Wildlife Protection

Your diversion of water or other alteration of streams (construction or modification of culverts, etc.) may require special notification to the California Department of Fish and Wildlife, which has the job of managing California's fish and wildlife resources and their habitats for their ecological value and enjoyment by the public. DFW issues Lake and Streambed Alteration permits ('1600 agreements') that may put limits on your diversion to ensure that public trust resources, including fish, are protected. From the DFW website:

Notification is required by any person, business, state, or local government agency, or public utility that proposes an activity that will:

- substantially divert or obstruct the natural flow of any river, stream or lake;
- substantially change or use any material from the bed, channel, or bank of, any river, stream, or lake; or
- deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it may pass into any river, stream, or lake.

If your diversion matches any of these criteria, you may need a 1600 agreement. Contact DFW for information on fees (which vary depending on the project) and how to get started:

CA Dept. of Fish & Wildlife
Eureka Office, 619 Second Street, Eureka, CA 95501,
(707) 445-6493

Additional information about filing for a 1600 permit can be found here: *www.dfg.ca.gov/habcon/1600/Forms.html*

What if I Don't File for a 1600 Agreement?

If you don't file for a 1600 agreement and your diversion or other alteration is found to substantially modify a river, stream or lake, you may be subject to a financial penalty and/or the removal of any diversion facilities that are not covered. Additionally, you run the risk of substantial liability for harms to public trust resources, especially fish listed under the state and federal Endangered Species Act.

Appendix II: Table of Water Storage Options

2014 Comparison of Steel 50,000 gallon tanks, water bags, poly tanks, and underground poly tanks:

	Steel 50,000 gallon tanks	**Water Bags 15,000 gallon (Aqua Dam)**	**Poly 5,000 gallon tanks**	**Underground poly**
Sources				
	Whitethorn Construction 986 7416	Aquadam, ATL	Multiple local Whitethorn Construction, Dazey's Wycoff's	Contech Duramax system: Contech Engineered Solutions LLC 415-897-8587 tel ckruger@conteches.com
	Mark Hilosky 986 7241		National tank	
			American Tank	
	National tank			
	American tank			
Durability and longevity				
Warranty	10 years	N/A	3 years	
Life expectancy	30 years	New product hasn't been around long enough to determine lifespan, but after four years bags have held up fine, so far.	10-15 years if shaded	10-15 +
Fireproof	Medium resistance	Low-no resistance	Low-no resistance	High resistance
Earthquake	Medium strength	Hi strength	Hi strength	Hi strength
Snow loading	Low strength	Hi strength	Hi strength	Hi strength
Sun- UV	Hi resistance because liner is enclosed and protected	Low resistance- tanks will eventually break down if exposed directly to sun. But does contain UV inhibitors that should delay this process.	Low resistance- tanks will break down if exposed directly to sun	Hi resistance
Damage from falling trees	Medium -low strength	Not stronger but unlikely that multiple tanks would be damaged if several were installed in series	Not stronger but unlikely that multiple tanks would be damaged if several were installed in series.	Unlikely due to earth cover
Vermin resistance	Medium (sand and geo tech fabric help protect the liner;	Medium (Hard for vermin to chew through if full, and	High (It would be more difficult for vermin to chew	High

	however it is possible that vermin could chew their way through- so far no instances reported in Humboldt and Mendocino Counties)	very easy to patch)	their way through the tank wall or bottom)	
Water quality				
Drinking water safe	Yes -AS/NZS 4020-2002 approved	Yes -NSF approved, but patching process compromises approval rating	Yes -NSF approved	Nsf 61 material
Water temperature	Colder because of large volume =better water quality	Warmer because of smaller volumes= lower water quality	Warmer still because of small volumes= lower water quality	Colder=better
Volume to surface ratio	Higher volume to surface ratio- could result in lower pick up (leaching) from surface materials	Lower volume to surface ratio - could result in higher pick-up (leaching) from surface material	Lower volume to surface ratio - could result in higher pick- up (leaching) from surface material	Higher volume to surface ratio-depending on design
Water Security	Medium high security with a goof ladder and proper operation of valves. Significant water loss would only occur if: 1) the goof ladder was destroyed; 2) a leak occurred between the goof ladder and the tank; 3) the tank itself developed a leak	Low security with one unit, but security increases if there are multiple bags installed with only one open at any time, thus limiting potential loss to the capacity of one unit.	High security with proper operation of valves: If there were several tanks, and only one tank was open at any time, the maximum loss would be the capacity of the one tank.	High security with proper operation of valves: If there were several tanks, and only one tank was open at any time, the maximum loss would be the capacity of the one tank.
Permit Requirements				
Building permit	Required for greater than 5,000 gals; approved for AOB application only	Not required	Not required	Not required but untested with county
Grading permit	Required for excavation greater than 50 yards	Required for excavation greater than 50 yards	Required for excavation greater than 50 yards	Required for excavation greater than 50 yards
SWRCB permit	Required for storage longer than 30 days	Required for storage longer than 30 days	Required for storage longer than 30 days	Required for storage longer than 30 days

Appendix III: Recommended Resources

Funding Resources

- The Natural Resource Conservation Service: http://tinyurl.com/l54loyw
- California State Water Resources Control Board Division of Financial Assistance: http://www.swrcb.ca.gov/water_issues/programs/grants_loans/
- California Department of Water Resources Integrated Regional Water Management (IRWM) Grants: http://www.water.ca.gov/irwm/grants/index.cfm
- EPA Watershed Funding: http://water.epa.gov/grants_funding/shedfund/watershedfunding.cfm
  EPA Catalog of Federal Funding Sources for Watershed Protection: https://ofmpub.epa.gov/apex/watershedfunding/f?p=fedfund:1

Government Data on Streamflow, Rainfall, and Water Temperature

- USGS Water Data for the Nation: http://waterdata.usgs.gov/nwis
- USGS Water Data Discovery: http://water.usgs.gov/data/
- NOAA's National Weather Service Precipitation Data Frequency Server: http://dipper.nws.noaa.gov/hdsc/pfds/

Flow Monitoring Methods

- State Water Resources Control Board Alternative Monitoring Methods: http://www.waterboards.ca.gov/waterrights/water_issues/programs/diversion_use/wm_alt_mthds.shtml
- Sanctuary Forest Quality Assurance Project Plan. Download at: http://sanctuaryforest.org/water-stewardship/
- Railsback, Steven F., John Kadvany and William J. Trush. *Demonstration Flow Assessment Procedures*: http://205.225.207.106/waterrights/water_issues/programs/hearings/cachuma/comments_rdeir/williams/h_railsback_undated.pdf
- Sanctuary Forest Quality Assurance Project Plan (QAPP): http://www.sanctuaryforest.org

Survey Methodology

- Dillman, Don A., Jolene D. Smyth and Leah Christian. 2009. *Internet, Mail, and Mixed-Mode Surveys: The Tailored Design Method*. Hoboken, NJ: John Wiley & Sons, Inc.

Water Rights Information

- Sawyers, Gary W. 2010. *A Primer on California Water Rights*: http://aic.ucdavis.edu/events/outlook05/Sawyer_primer.pdf
- New California Water Atlas: http://ca.statewater.org/
- Sanctuary Forest. 2004. *Options and Obstacles: Living with Low Water Flows in the Mattole River Headwaters*.

Water Conservation, Efficiency, Permaculture and Storage Information and More

- Sanctuary Forest. 2008. *Water Storage Guide: Storing water to benefit streamflows and fish in North Coast Creeks and Rivers*. Produced with support from the California Department of Fish and Wildlife's Fisheries Restoration Grant Program.
- Hemenway, Toby. 2009. *Gaia's Garden: A Guide to Home-Scale Permaculture*. Chelsea Green Publishing Company.
- Lancaster, Brad. *Rainwater Harvesting for Dry Lands and Beyond*. Volumes One, Two and Three: http://www.harvestingrainwater.com/
- Water efficiency educational materials and literature for residential and commercial properties from the California Department of Water Resources: http://www.water.ca.gov/wateruseefficiency/landscapeordinance/technical.cfm
- High Tide Permaculture Design. 2014. Water Through a Permaculture Lens (Brochure): http://tinyurl.com/mar-water

Emergency Tank Storage Registration Information

- SWRCB Registration for Small Domestic Use Appropriation (FORM): http://www.waterboards.ca.gov/waterrights/publications_forms/forms/docs/sdu_registration.pdf
- SWRCB Water Rights Registration Program Flow Chart: http://www.waterboards.ca.gov/waterrights/board_info/docs/regprocess_sdulsu_overview.pdf
- Emergency Tank Storage Registration Process Guide: http://eelriver.org/wpcms/wp-content/uploads/2014/03/Process-Guide-for-Registration-for-SDU-Appropriation.pdf