Drought Conservation Planning for Whidbey Island

Whidbey Island Conservation District

Coupeville, Washington

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Contents

1.0 Introduction

Island County is located in Puget Sound on the coast of Washington State and includes Whidbey and Camano Islands. The coastal northwest area typically experiences a long rainy season from fall through early summer, followed by a drier summer season when little to no rain falls, usually from July through early September. The summer dry periods have been occurring with increasing regularity and intensity, during which significantly less or no precipitation occurs and temperatures are higher than normal for an extended period of time. These warmer and drier periods are beginning as early as March or April and lasting as late as end of October or so.

The State of Washington defines drought conditions as:

> **“**Water supply conditions where a geographical area or a significant part of a geographical area is receiving, or is projected to receive, less than seventy-five percent of normal water supply as the result of natural conditions and the deficiency causes, or is expected to cause, undue hardship to water users within that area.” (**WAC 173–166–030)**

During drier than normal spring and summer months, residential water use is beginning to outpace water resource availability, agricultural yields are decreasing, and concerns about forest health due to drought stress are increasing. Water conservation activities and strategies to adapt to and alleviate drought are becoming essential for residential and agricultural water users, as well as other natural resource managers. This drought planning report provides an overview of water management within the county, resource conditions and concerns, and conservation, mitigation, and adaptation strategies to address seasonal drought. As annual and seasonal climate patterns continue to change in the future, and especially if drought periods become more common, it is anticipated that water management strategies will be updated.

In Island County, 65 – 70% of the residents rely on a single source for all their freshwater resources, precipitation. The rain that falls on each island is the only way our lakes and ponds are refreshed, and our groundwater is recharged.   Water supplies are not sourced from the rivers that flow from distant lands, or snow melting on mainland peaks; the fresh water on each island is isolated by the surrounding seawater. On the north end of Whidbey Island, the City of Oak Harbor and the Whidbey Naval Air Station (NAS) obtain most of their potable water from the Skagit River (piped), which is purchased from the City of Anacortes. By 2025, over 100,000 people will reside in Island County with 28,000 of 40,000 households relying solely on ground water. (Island County, 2005)

The climate in Island County is highlighted by dry summer seasons and overcast winters with frequent precipitation. Historically, winter rains have fully recharged the lakes and aquifers every year, including drought years.   Climate changes in the Pacific Northwest are likely to impact Island County’s water resources in a number of ways. Climate change is just one of a variety of water resource challenges that exist for Island County. More people on the islands can lead to more competition for a finite water supply while increases in impervious surfaces have the potential to reduce groundwater recharge.

Given the critical importance water plays in our health, our lifestyle, our economy and our environment, water resource planning and management is vital to our future. Understanding the effects of drought and developing strategies to mitigate and adapt to drought conditions is becoming an increasingly important element of water resource management. To that end, The Washington State Conservation Commission (WSCC) partnered with the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) offering an opportunity for the Whidbey Island Conservation District (WICD) to complete a pilot drought plan for Whidbey Island. WICD has initiated drought conservation planning for long term sustainability of natural resource lands on Whidbey Island, including cropland, grazing lands, forestland, and developed or developing lands. The main focus of this document is on Whidbey Island, although much of this information is applicable to Camano Island as well.

Goals and Objectives of this Plan

The overall goal of drought conservation planning is to achieve improvements in natural resource conditions during drought and provide for the long-term sustainability of resource lands. In order to do so, the drought planning process aims to assess natural resource conditions and needs, set goals, identify programs and other resources to solve those needs, develop proposals and recommendations to do so, implement solutions, and measure their success during drought years.

This includes developing and implementing water conservation and drought management strategies to assist in maintaining an adequate supply of water today and in the future, and to adapt to changing environmental conditions. Objectives include identification of strategies that increase water use efficiency, reduce consumption of water, reduce loss of water, increase re-use of water, and implement agricultural and forestry best management practices.

This initial planning document begins this process with an assessment of resource conditions and needs, identification of existing water resource management programs related to drought, and compilation and development of strategies to address identified and expected resource needs.

2.0 Drought Management Partners, Plans, & Programs

2.1 State & Federal Drought Management Partners

Federal, state, and local partner agencies work collaboratively during drought situations to provide educational resources as well as technical and financial assistance to natural resource landowners and residents.

USDA is empowered to declare specific counties as primary natural disaster areas due to drought conditions (http://www.ecy.wa.gov/drought/). Farmers and ranchers within federal drought designated areas are eligible for certain federal assistance programs. These assistance programs are generally delivered through NRCS, the Farm Service Agency (FSA), and the Risk Management Agency (RMA). (http://www.usda.gov/wps/portal/usda/usdahome?contentid=usda_drought_programs.html) In some situations, loans may be available through the U.S Small Business Administration (SBA) (https://www.sba.gov/loans-grants/see-what-sba-offers/sba-loan-programs/disaster-loans/drought-disaster-assistance).

The USDA declares a drought emergency based on several considerations, including:

- Rain and snow measurements and other events
- Reports of how climate conditions are affecting crops, wildlife, and other indicators
- Recommendations from water experts

The Washington State Department of Agriculture (WSDA) does not have independent funding for drought relief but shares information about agricultural-related problems with decision makers. WSDA defers to the Washington Department of Ecology (Ecology) for detailed drought information. In situations where a federal drought has been declared, WSDA will coordinate federal funding with farmers and ranchers needing assistance.

In order for the state to declare a drought emergency in a region, two criteria must be met including:

1. The region is receiving, or is projected to receive, less than 75% of its normal water supply.
2. Water users in the region will likely incur undue hardships as a result of the shortage.

The Washington Department of Natural Resources (DNR) responds to conditions that result from the changing climate. DNR provides resources and strategies for wildfire prevention in the wildland urban interface (WUI), which is the area where homes are built near or within lands prone to wildland fire (http://www.dnr.wa.gov/programs-and-services/wildfire/wildfire-preparedness/community-wildfire-protection).

The Office of the Washington State Climatologist collects, disseminates, and interprets climate data. Their website provides links to sources of climate data and seasonal forecasts for the state of Washington (http://www.climate.washington.edu/).

Washington State University's (WSU) College of Agricultural, Human, and Natural Resource Sciences provides new information regarding drought through their website (http://drought.wsu.edu/drought-relief/).

The WSU AgWeatherNet provides access to current and historical weather data from WSU's automated weather station network, along with a range of models and decision aids. The weather data, advisories, weather data products, and decision support systems provided by AgWeatherNet and WSU can help improve production and product quality, optimize resource use, and reduce environmental impacts (http://weather.wsu.edu/index.php).

The National Drought Resilience Partnership (NDRP) comprises seven federal agencies which work collaboratively to support state, tribal, local, and private sector approaches to managing drought risks and impacts (https://www.drought.gov/drought/washington).

2.2 Local Drought Management Partners, Plans, & Programs

Island County Water Resources Management Plan

Island County updated its Water Resources Management Plan in June of 2005 with funding from Ecology. The update included several topic papers that were developed by the Island County Water Resources Advisory Committee (WRAC). The WRAC is a ten-member volunteer committee representing all of the county's distinct geographical areas and resource interests including groundwater, stormwater, watershed management, and salmon recovery. Members are appointed by the Board of Island County Commissioners. The mission of the WRAC is to ensure that the water resources of Island County are managed and protected in such a way as to ensure sustainable use, while protecting habitat and environmental and human health (https://www.islandcountywa.gov/Health/DNR/WRAC/Pages/Water-Mgmt-Plan.aspx). The Water Resource Management plan includes several topic papers that are relevant to drought conservation planning including sea water intrusion, groundwater recharge, water rights, exempt wells, streamflow and aquatic habitat, water system coordination, water supply alternatives, rainwater catchment, water conservation, data collection and management, and education and outreach. A Water Resource Detailed Implementation Plan was adopted in 2006. (https://www.islandcountywa.gov/Health/DNR/Documents/Final%20Implementation%20Plan.pdf).

Island County Groundwater Management Program

Seventy-two percent of Island County residents rely on groundwater for domestic water supplies. In response to the results of water resource investigations indicating the potential for ground water shortages and quality, Ecology declared Island County to be a Ground Water Management Area (GWMA) under the authority of WAC 173-100. The designation of Island County as a GWMA initiated the development of a Ground Water Management Program (GWMP). This document can be found at the following links:
https://www.islandcountywa.gov/Health/EH/Documents/1992%20IC_GWMP%20Sections%201-4.pdf

https://www.islandcountywa.gov/Health/EH/Documents/1992%20IC_GWMP%20Section%205.pdf

https://www.islandcountywa.gov/Health/EH/Documents/1992%20IC_GWMP%20Sections%206-7.pdf

A GWMP, as defined by WAC 173-100, is a comprehensive program designed to protect ground water quality, to assure ground water quantity, and to provide for efficient management of water resources while recognizing existing ground water rights and meeting future needs consistent with local and state objectives, policies, and authorities within a designated ground water management area.

The Island County GWMP began with the formation of a Ground Water Advisory Committee (GWAC), which later became the Water Resources Advisory Committee. This group, with the help of Island County staff, developed the Island County Ground Water Management Program (GWMP). On October 7, 1991, the Island County Board of Commissioners adopted the GWMP as an element of the Island County Comprehensive Plan. On February 19, 1992, Ecology certified the Island County Ground Water

Management Program. The Island County Planning Department was established as the lead agency with the responsibility for coordinating activities necessary for the development of the GWMP.

The stated goal of the Island County GWMP is to "protect and enhance the quality, quantity, and recharge of ground water supplies in Island County. "The GWMP encourages water conservation measures as a way to ensure the long term viability of groundwater as a source of potable supply for the majority of Whidbey Island residents." The stated goal is to "Establish a water use efficiency program, coordinated with the Island County Coordinated Water System Plan and the Comprehensive Plan, to help:

1. Reduce existing usage,
2. Maintain current ground water levels,
3. Alleviate salt water intrusion problems,
4. Ensure sustained supplies of ground water are available for Island County residents, and
5. Optimize the efficiency of future ground water usage."

The GWMP also encourages conservation efforts, stating "potential ground water quantity and quality problems are to be avoided, usage of the existing ground water resources must be carefully managed, and conservation programs that employ effective demand reduction techniques must be established."

The GWMP also states that "Any proposed action which involves or leads to withdrawals of ground water should not be granted final approval until reasonable assurances are made that such withdrawals will not adversely impact existing ground water uses." This policy is supported by state water rights statutes (WAC 173.166), but can apply to uses that are exempt under state laws.

Island County Department of Emergency Management (DEM) (http://www.islandcountydem.org/) is responsible for emergency management within Island County to include planning and coordinating actions for the preparedness, mitigation, response, and recovery from natural and man-made emergencies and disasters. In 2015, the DEM updated the Island County Multi-Jurisdiction Hazard Mitigation Plan (http://www.islandcountydem.org/hazard-mitigation-plan.html). Chapter 7 of the Plan focuses on drought and other potential hazards under six main topics including:

1. General Background – general drought information.
2. Hazard Profile - the National Drought Mitigation Center uses three categories to describe drought impacts including Agriculture, Water Supply, and Fire Hazard.
3. Vulnerability Assessment – effects of drought on economic, environmental, and social activities. Noted in this section were significant concerns by partners due to dense vegetation, natural ecosystems and natural resources, wildfire, fire services, and potential impacts from climate change enhancing a drought situation. Also noted was that drought is not a sudden-onset hazard, allowing time for advanced planning.
4. Future Development Trends – planning policies are addressing land use, water supply, and protection of water resources.

5. Climate Change Impacts – stresses including increasing populations, competition for water, water quality, environmental claims, uncertain reserved water rights, groundwater overdraw, aging urban infrastructure, and impact on habitat.
6. Issues – highlighted issues of concern include the need for alternative water sources during prolonged drought, importance of groundwater recharge, climate change increasing drought frequencies, promotion of active water conservation even during times of non-drought, impacts to businesses, and potential impacts on livelihood of those employed in industries most impacted by drought, such as agriculture, fishing, forestry, and tourism.

The Island County Multi-Jurisdiction Hazard Mitigation Plan included the Town of Coupeville, the City of Oak Harbor, the City of Langley, and others in their partner annexes in Volume 2, Planning Partner Annexes.

Each jurisdiction in Island County is required under WAC 246-290-100 to have a Water System Management Plan. The plans generally include water conservation measures. Following is a link to the plan for the City of Oak Harbor:
https://www.oakharbor.org/uploads/documents/7640water_system_plan_091214_smaller.pdf.

3.0 Resource Conditions & Concerns

Resource conditions and concerns related to drought include current and anticipated climate conditions, surface water and groundwater resources, forest health, and habitats and wildlife.

3.1 Existing Conditions, Current Concerns, and Impacts

3.1.1 Climate

The climate of Whidbey Island has relatively cool, dry summers with temperatures in the low 70's, with moderately wet mild winters from mid-October through April in a typical year. The mean annual temperature is 50^{o}F, with an average winter and summer temperature of 38^{o}F and 61^{o}F, respectively. The Island is typically cooler in the summer and warmer in the winter than surrounding mainland areas.

The mild climate is influenced by the Island's proximity to the Pacific Ocean and surrounding water mass of Puget Sound. Predominant winds move from the ocean inland from the southwest; the presence of the Olympic Mountains to the southwest blocks the majority of the low pressure storms, which drop precipitation on the Olympics, but deposit much less rain on most of Island County because the air is descending and warming as it moves across the landscape. This is the 'rain shadow' effect that characterizes the mild climate of Whidbey Island. (Based on Russell, 1975). Whidbey Island is generally protected from cold air masses from the mainland by the Cascade Mountain range.

Precipitation

Precipitation is important to Whidbey Island because most of the county's drinking water comes from aquifers that are recharged only by rainfall. Average annual rainfall on Whidbey Island varies from approximately 36 inches on the southern end of the island to just under 21 inches in the Coupeville area and up to 30 inches on the north end (Figure 1). This is due to the center of the island being in the direct line of the 'rain shadow' effect of the Olympic Mountains, which intercept much of the rain coming from the southwest on prevailing winds. This effect is most pronounced in the area around Ebey's Landing, Coupeville, and Penn Cove. To the south and north of this area on Whidbey Island, and to the east on Camano Island, the rain shadow effect is less pronounced, with annual precipitation levels ranging from 25 to 30 inches for most areas of the county.

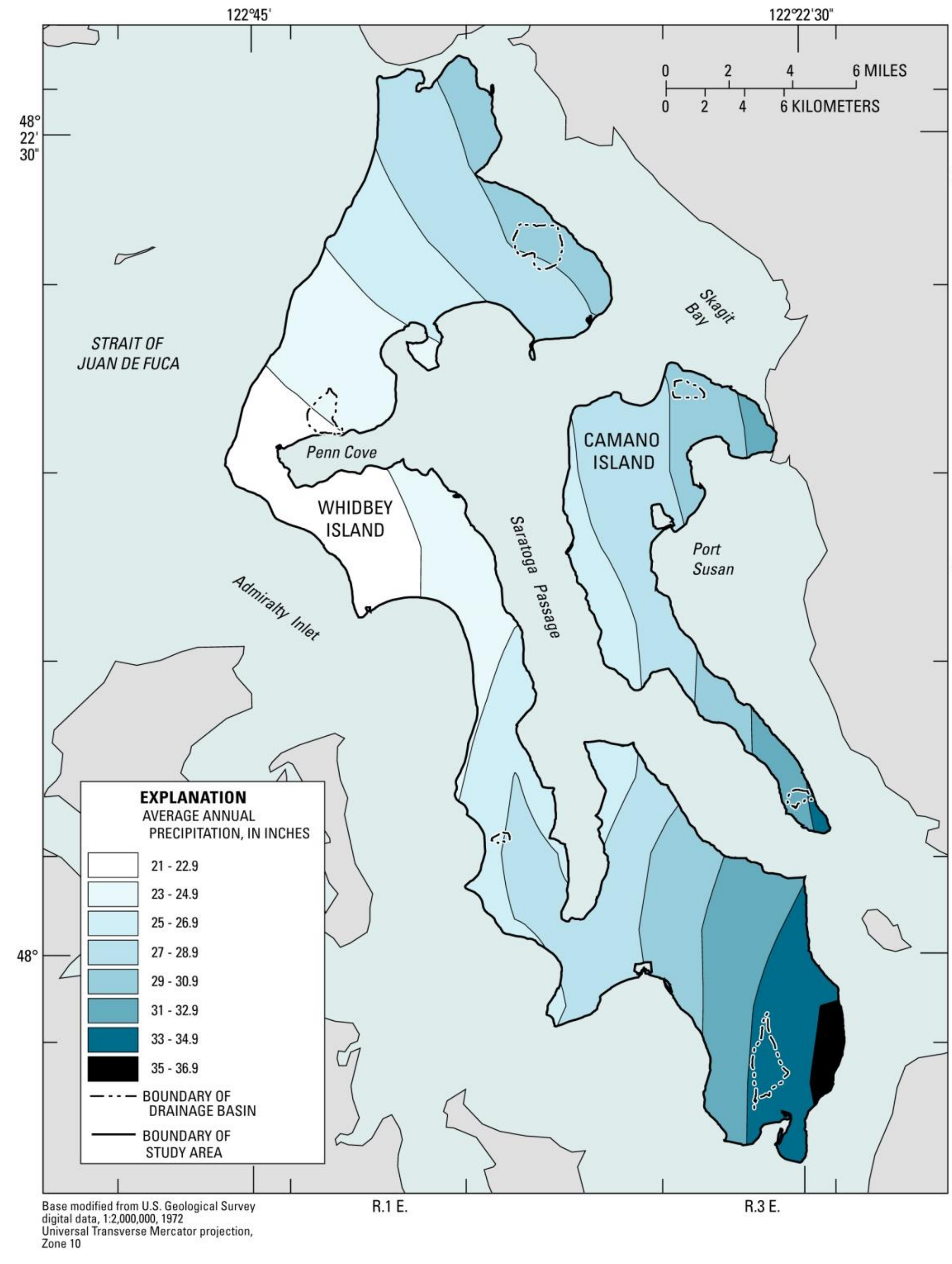

Figure 1. Average Annual Precipitation on Whidbey and Camano Islands

Rainfall in the Whidbey region is typically of low intensity. The typical rainfall rate is usually less than 0.5 inches per day. The majority of precipitation events are less than one inch. While heavy rains can result in more water being lost to runoff, light intensity rains are more prone to evaporative losses. Light rains with low volumes don't penetrate the soil deeply, and are therefore more susceptible to loss via evaporation. Light rains also result in a higher percentage of rainfall being intercepted by plant foliage without ever reaching the soil. These factors can be mitigated on a small scale by utilizing stormwater systems that collect drainage from rooftops and other surfaces and convey it to areas where it can be infiltrated into the soil. Rain gardens, bioswales, and other similar methods can greatly increase infiltration of rainfall by concentrating flows into areas where there is excess water holding capacity in the soil, and by allowing time for the water to infiltrate into the soil.

Precipitation also varies seasonally to a significant degree on Whidbey Island. Most precipitation occurs between October and May, while summers are generally dry. This presents a challenge for crop and timber production. Just as temperatures and sunlight intensity and duration are most favorable for plant production, available soil moisture often becomes limiting.

Wind is a significant factor in the local climate, as it affects evapotranspiration rates. From October through March, the air flow is predominantly from the south-southwest. Through the spring, air flow gradually reverses direction until it is predominantly from the north.

Geographic variability in precipitation influences watershed processes associated with delivery of water to surface water features (lakes, streams, and wetlands) as well as recharge into groundwater aquifers.

Warmer, drier summer conditions increase the demand for irrigation water, for both farms and residential landscaping, and thus increase the demands already placed on groundwater aquifers for potable water supply.

3.1.2 Surface Water Resources

Whidbey Island is different than most other Western Washington localities in that there are no rivers and most of the streams are small coastal streams, only a few of which have perennial flow. The lack of rivers and prevalence of seasonal, shallow-channeled streams are the results of relatively steep and rolling topography, lack of snow pack, low rainfall rates, porous soils, and the long, narrow geography of the island. The numerous coastal basins often contain multiple drainage pathways to Puget Sound, while only a few form true watersheds where all surface water flows into Puget Sound via a single stream. Several basins deliver no surface water via streams to Puget Sound. Maxwelton Creek, the largest stream on the island with a main stem approximately four miles long, is located in the largest watershed of Island County, the Maxwelton watershed, encompassing 11.6 square miles.

There are several lakes on Whidbey Island. The smaller ones are generally positioned in upper basin areas, while the larger ones are generally closer to the coast, often associated with coastal lagoons. Most are natural lakes, but in a few locations like Useless Bay and Cranberry Lake, freshwater sources have been impounded to create freshwater lakes where there had earlier been tide flats or coastal lagoons.

Surface waters also include wetland areas. The majority of wetlands on Whidbey Island are freshwater palustrine wetlands not associated with streams or lakes. Although a few are connected to streams directly, many likely are connected to aquifers, streams, or estuaries by subsurface flow. Most freshwater wetlands are on slopes at discharge sites for shallow, subsurface flow or in depressions surrounded by sloping land, making them susceptible to the quality of runoff from their contributing area.

Many of Whidbey Island's small lakes, associated wetlands, and depressional wetlands are located in areas of poorly drained soils. The island's lakes and depressional wetlands regulate the flow of water within a watershed by storing water during precipitation events, slowing the conveyance of water from the upland to the shoreline, and increasing infiltration. Development has altered the area of wetlands and small lakes across the island, however these freshwater areas still provide significant flow attenuation, infiltration, and base flow maintenance functions.

Along with these hydrologic functions, the numerous lake and wetland areas naturally provide physical, chemical, and biological filtration and treatment functions supporting maintenance of surface water quality. Lakes and wetlands are also generally a sink for sediments suspended in inflow surface waters.

3.1.3 Groundwater Resources

As noted earlier, most the population on Whidbey Island utilizes private wells for their water supply. Private wells rely on groundwater recharge to replenish their supply.

In 2004, the United States Geological Survey (USGS) conducted a series of studies in which they modeled recharge values for Whidbey and Camano islands in Island County, the four main islands in San Juan County, and the Dungeness/Sequim basin. Recharge estimates were developed after collecting rainfall and stream data and analyzing soil conditions, vegetation cover, solar, and wind effects on a daily basis compared to rainfall and runoff patterns. Recharge estimates include a comparison between the three study areas all of which are in the rain shadow of the Olympics. The following table shows that a significant portion of the total rainfall on Whidbey contributes to groundwater recharge.

Table 1. USGS Groundwater Recharge Estimates

	Recharge in inches	Percent of total rainfall
San Juan	1.99	6%
Orcas	1.46	5%
Shaw	1.44	5%
Lopez	2.49	9%
Whidbey	7.36	28%
Camano	7.24	25%
Sequim/Dungeness	8.00	28%

(USGS, 2004)

The USGS also created maps of the underlying geology for Island County (Figure 2). Understanding the capacity of the underlying geology to absorb and hold water is a key component in understanding how groundwater resources function on Whidbey.

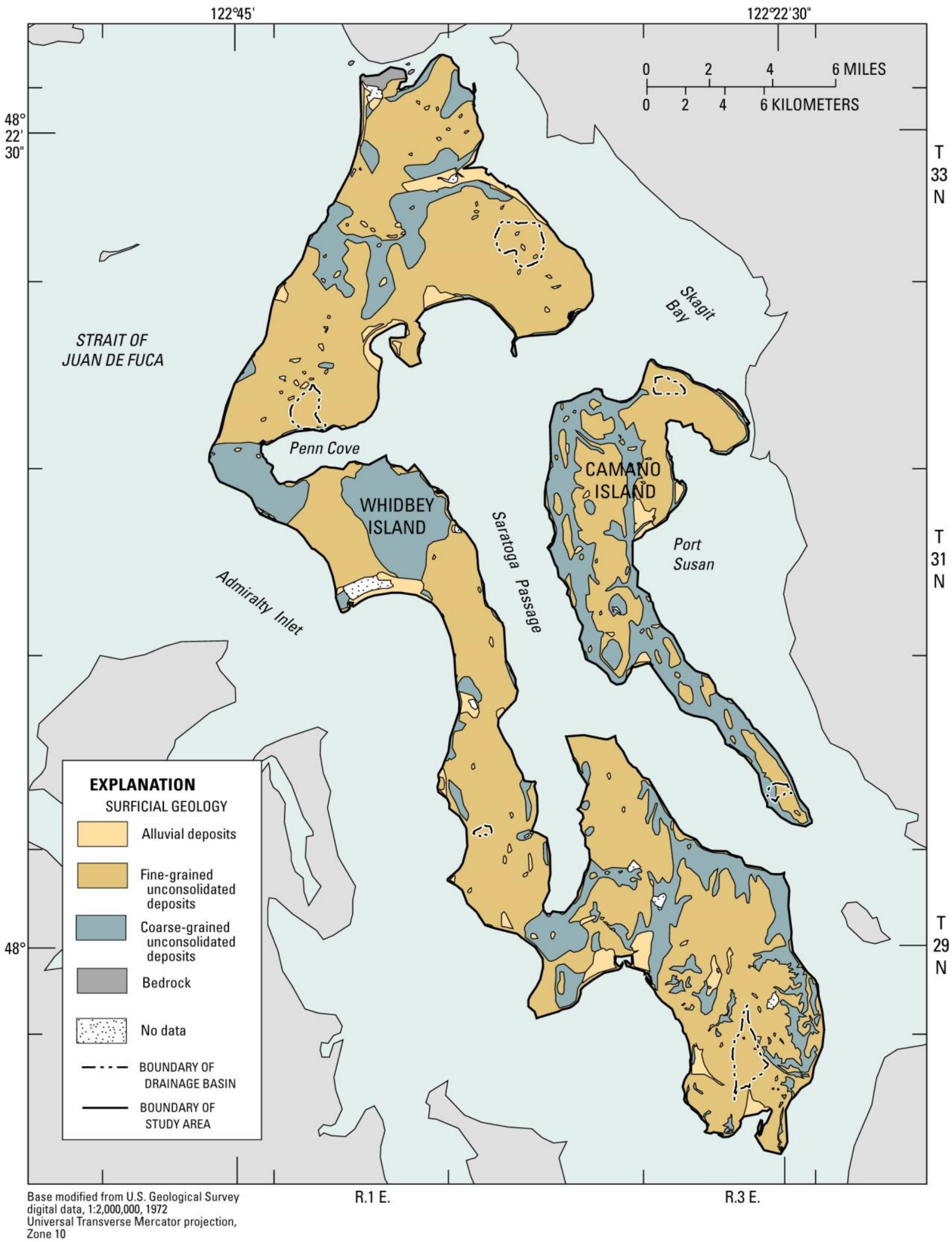

Figure 2. Generalized surficial geology of Whidbey and Camano Islands, Island County, Washington.

3.1.3.1 Private Wells

Most wells on Whidbey are 200 to 300 feet deep, and the aquifers that supply them have very slow recharge rates, measured in decades. So, the response to variations in rainfall is very slow. Even in a year of very low precipitation, deep wells are unlikely to have decreased yields, and the owners' water supply may not be affected. The more significant issue during drought is the increased withdrawals that result from low rainfall, as people increase their use of irrigation water. As withdrawals increase, these wells can become subject to lowering of water levels and yield rates, or for some wells near the shoreline, seawater intrusion. Wells that experience these conditions tend to be worse during summer months. Overall, the groundwater supply is adequate for existing rates of withdrawal, but problems can be severe in some shoreline areas. Future population growth on the island can be expected to increase groundwater withdrawal rates.

Irrigation use for agriculture varies across the island and seasonally, depending on soil water holding capacity and rainfall rates during the growing season. Based on crop surveys conducted every two years for the Washington Department of Agriculture (WSDA), approximately 1,300 acres of crop, hay, and pasture lands are irrigated for some part of the growing season.

3.1.3.2 Seawater Intrusion

Saltwater intrusion is the movement of saline water into a freshwater aquifer. Where the source of this saline water is marine water, this process is known as seawater intrusion. The marine / saline waters of the Puget Sound surround Island County and as a result, all of the aquifers in the county that extend below sea level are at risk for seawater intrusion (Figure 3). The high mineral content (primarily salts) of marine waters causes these waters to be unsuitable for many uses, including human consumption. If intrusion problems become extreme, they can cause an aquifer and its wells to be unusable for most purposes.

Seawater intrusion is a widely recognized problem in localized areas of Whidbey Island, concentrated along the shoreline. Seawater intrusion is due to the movement of the freshwater-seawater boundary, or the zone of diffusion, in response to fluctuations in the water table. Water table fluctuations are caused by changes in recharge, pumping of wells, discharge into springs and streams, and tidal fluctuations. Possible mechanisms of seawater intrusion can be either lateral migration of the zone of diffusion or upconing of the zone of diffusion toward the well.

In 1989, the Island County Health Department (ICPH), in conjunction with the Washington State Department of Health (DOH), adopted the Island County Saltwater Intrusion Policy. The primary function of the policy is to trigger additional review of potential for seawater intrusion of new or expanding public water systems in areas where seawater intrusion appears to be occurring. The goal of this policy is to protect public water supplies from seawater intrusion.

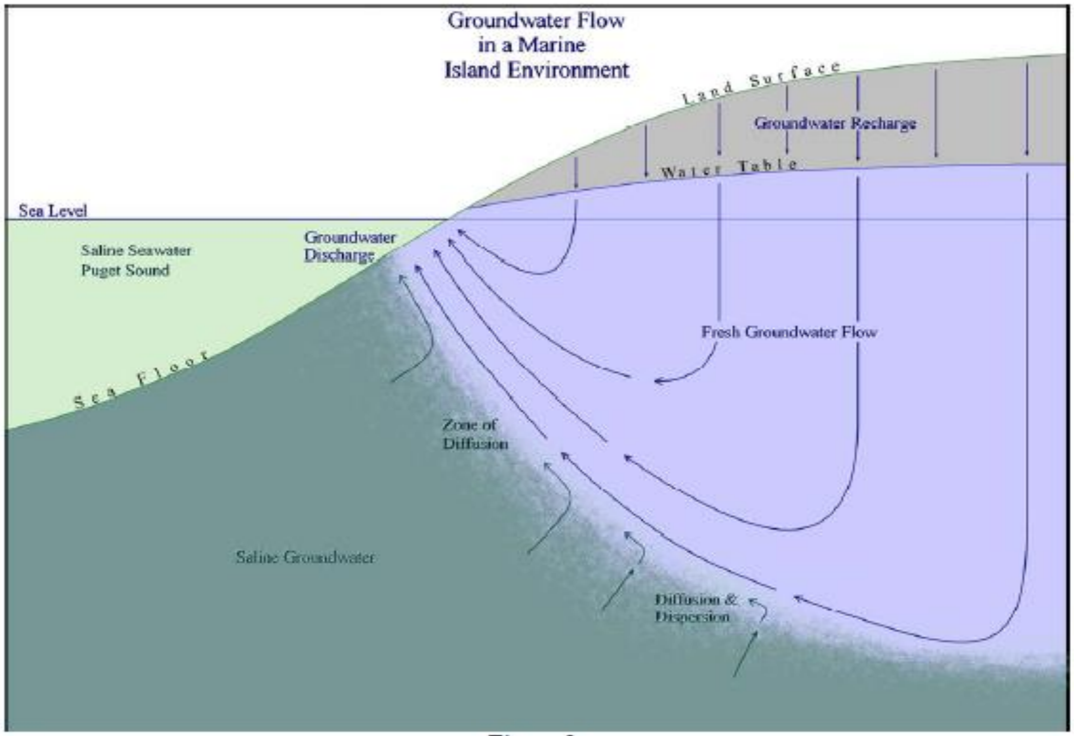

Figure 3. Groundwater Flow Adjacent to Marine Water Interface

Island County Water Resource Management Plan, 2005

The policy utilizes chloride concentrations in wells as its indicator of seawater intrusion and defines 'risk zones, drawing ½ mile circles around wells with elevated chloride concentrations. Areas are classified as being at either 'low', 'medium', 'high', or 'very high' risk of seawater intrusion based on water level elevation and chloride concentration data from all wells located within ½ mile. An area where all wells within ½ mile have chloride concentrations less than 100 milligrams per liter (mg/l) is considered 'low risk'. An area where one or more wells have chlorides between 100 and 200 mg/l is considered 'medium risk', and an area with one or more wells with chloride concentrations greater than 200 mg/l is considered 'high risk'. An aquifer that has water level elevations significantly above sea level is not at risk for seawater intrusion, while an aquifer that has near sea level water levels is at risk. Public water system sources (3 or more connections) that are classified as having elevated seawater intrusion risk (medium, high, or very-high) are required to monitor water quality in their wells and report the results to the County. Most of the seawater intruded wells on Whidbey are near the shoreline, as freshwater aquifers are at maximum thickness near the center of the island, and become thinner near the shorelines.

An aquifer that has water level elevations (pressure) significantly above sea level is not at risk for seawater intrusion, while an aquifer that has near sea level water levels is at risk. Aquifers and aquitards in Island County vary spatially in both thickness and elevation. In any given area of the county, there may be several aquifers present, and each aquifer will have different hydraulic characteristics (recharge, pressure, capacity, etc.) and susceptibility to seawater intrusion. Even within a single aquifer, the hydraulic characteristics can vary significantly from one location to another. This is why site specific data are needed to properly assess the risk of a particular well causing seawater intrusion.

3.1.4 Forest Health

Water availability and the capacity of the soil to retain water have a direct impact on tree health. Trees need large amounts of water for photosynthesis, evapotranspiration, and overall growth. Seasonal drought conditions resulting in heat stress and decreased water availability can make trees less resilient, which increases insect success and incidence of disease.

Insects and Disease

Known insect infestations and disease in the islands include tent caterpillars and oak pit scale. Caterpillars do not typically cause mortality to host trees, but it can occur when trees are already stressed. Oak Pit Scale (OPS), on the other hand, has caused dieback and occasional mortality of Oregon white oak in recent years. Crown symptoms include branch tip dieback paired with foliage that appears clumped due to suppressed shoot growth and delayed leaf expansion. Overall, the Department of Natural Resources anticipates an overall increase in insect and disease activity in 2016.

Forest Management

Resilience to drought can be increased by implementing forest restoration and stand improvement practices that reduce density and increase diversity. Many of the forests on Whidbey Island are second growth stands that have had very little management since initial logging 80-100 years ago. These forests are often very dense second growth stands with low productivity and diversity. Many stands are overstocked with too many fir and not enough drought tolerant species.

Drought Stress

In 2015, Department of Natural Resources reported increased mortality in young Douglas-fir, shore pine and western red cedar due to the summer drought in western Washington. http://file.dnr.wa.gov/publications/rp_fh_2015_forest_health_highlights.pdf Delayed drought symptoms in Hemlocks include numerous reports of trees suddenly dropping needles. Rapid needle loss is a common symptom of drought damage in conifers, as well dried out buds and wilted shoots. Many trees in the islands are experiencing stress.

Fire Risk

Fire risk is also an increased concern. Forest fires are increasing in severity and frequency in the Western United States, increasing the need for forest restoration to reduce fuels and support forest biodiversity and reduce the risk of wildfires. As more people build within the wildland/urban interface, the risk of fire increases. Often homes are built without consideration for Firewise type of landscaping. Improper home and landscape design and maintenance increase the risk of damage or loss to property, natural resources, and, potentially, loss of lives.

Having well managed forests helps to mitigate climate change. Healthy, growing forests sequester carbon while diseased, dying and/or dead trees release carbon. In addition, carbon emissions from wildfires can contribute greatly to the total carbon load.

3.1.5 Water Rights

The waters of Washington State collectively belong to the public and cannot be owned by any one individual or group. Instead, individuals or groups may be granted rights to use them. A water right is a legal authorization to use a predefined quantity of public water for a designated purpose. This purpose must qualify as a beneficial use. Beneficial use involves the application of a reasonable quantity of water to a non-wasteful use. The right to use water is primarily based on the western water law concept of “first in time, first in right.” That is, the first individuals to put water to use have a senior right to that water and junior users may only use water after the senior users’ rights are satisfied. Water rights can be wholly or partially lost after five or more years of non-use, unless there is sufficient cause for the non-use such as a drought.

State law requires certain users of public waters to receive approval from the state prior to using water - in the form of a water right permit or certificate. Any use of surface water (lakes, ponds, rivers, streams, or springs) which began after the state water code was enacted in 1917 requires a water-right permit or certificate. Ecology is the permitting authority for water rights in Washington. When considering applications for groundwater withdrawals, Ecology considers four factors: 1) is there water available; 2) is the application for a beneficial use; 3) will granting the permit adversely affect existing water rights; and 4) will granting the permit be detrimental to the public interest.

Likewise, withdrawals of groundwater from 1945 onward, when the state groundwater code was enacted, require a water right permit or certificate – unless the use is specifically exempt from state permitting requirements. While “exempt” groundwater uses are excused from needing a state permit, they still are considered to be water rights. Exempt uses include withdrawals of less than 5,000 gallons per day and irrigation of ½ acre or less.

WAC 173–166–070 Emergency drought permits

Ecology may allow water users to obtain water from alternate sources during drought conditions. To accomplish this, they may issue emergency drought permits authorizing withdrawals of ground water and surface water, including dead storage in reservoirs. Applicants must be conducting a previously established activity within a geographical area declared to be suffering from drought conditions. An Emergency Drought Permit application will be processed only if the water user is receiving, or is projected to receive, less than seventy-five percent of normal water supply as the result of natural drought conditions, and is experiencing, or is expected to experience, undue hardship as a result. “Previously established activities” may include irrigation using reasonably efficient practices, under a valid water right permit or certificate, or a supported registered water right claim.

3.2 Anticipated Climate Trend Impacts

3.2.1 Precipitation

In 2015, the University of Washington published a report entitled: "State of Knowledge, Climate Change in Puget Sound". While the trends are generalized for the region, the report notes that precipitation is likely to slightly decrease over time, with warmer, drier summers, although periods of heavy rains may intensify during the spring months (March, April, and May). March-May precipitation has increased 27% for the region from 1895 – 2014.

3.2.2 Temperature

The UW State of Knowledge report summarizes results from a wide variety of models, and summarizes existing data. According to the report, average temperatures in lowland Puget Sound have increased 1.3 degrees Fahrenheit between 1895 and 2014, with statistically significant increases in all seasons except spring. All models predict an increase in air temperature in the region throughout the 21st century. While models vary in the amount of projected temperature increase, average air temperatures may rise between 4.2 to 5.5^{o}F by mid-century. Summer air temperature increases are expected to be higher than for other seasons. This warming trend is consistent across the region and across all models.

3.2.3 Groundwater Resources

Groundwater resources are finite. Increased demand on finite resources is likely to occur in the event of increasing summer temperatures, particularly for maintaining landscapes and irrigating gardens and agriculture lands.

Groundwater resources may also be affected by sea level rise, which has the potential to increase seawater intrusion into freshwater wells. This is particularly a problem for wells along the shoreline in some areas on Whidbey Island. Sea level rise in the Strait of Juan de Fuca is projected to be 7+ inches by 2050, but the possible range is 1-14 inches (UW State of Knowledge on Climate Impacts in the Puget Sound). Such an increase would create a greater risk of seawater intrusion into freshwater wells in this area, especially those closer to the shoreline.

3.2.4 Surface Water

Changing global climate conditions will likely result in changes to Island County's precipitation patterns. Shifts in the timing and volume of precipitation will impact surface water resources, especially where these resources are already degraded due to landscape modifications associated with human development and land uses. Higher precipitation could improve surface water supply, but higher intensity storms could also increase runoff rates, resulting in altered hydrology in surface water systems, and increased erosion within stream channels. Drier summer conditions could also adversely impact stream base flows and lake levels during summer months. This could mean that streams that once ran year round may become ephemeral, and ephemeral streams will go dry earlier in the summer.

3.2.4 Forest Health

Forest health is anticipated to be adversely affected by climate change. As noted by the UW Climate Impacts group, increased temperatures and decreased snowpack (or in the case of Whidbey Island, drier summers) are likely to lead to "*a continued shift in the geographic distribution of species, changes in forest growth and productivity, increased risk of fire, and changing risks from insects, diseases, and invasive species. These changes have significant implications for ecosystem composition and species interactions*".

With respect to wildfire risk, Ecology's study notes:

> "*Warmer temperatures and reductions in summer precipitation will likely increase the areas burned by wildfire. Wildfires disrupt the watershed processes through erosion, warmer water temperatures, increased stormwater runoff, and loss of forest canopy. These changes will likely alter the soil's capacity to retain water and recharge aquifers."*

Climate Adaptation Partners (http://Adaptationpartners.org) lists the following as likely sensitivities in forest health due to climate change:

- Increased opportunity for exotic species establishment
- Potential for mortality events and regeneration failures, particularly after large disturbances
- Increased forest drought stress and decreased forest productivity at lower elevations
- Increased warming, drought and wildfire will reduce tree vigor and increase susceptibility to insects and pathogens with increased potential for large and extensive insect and pathogen outbreaks, particularly of non-native insects and pathogens
- More fire (larger aerial extent and more high-severity patches) and more area in recently burned or early-successional stages
- Higher temperatures and increasing drought will stress some species in moist mixed conifer forests, especially western larch
- Increased hazard trees that threaten people and infrastructure
- Increased tree establishment at the tree line (shift in habitat)
- Change in species composition, relative abundance, and species distribution patterns
- The distribution of subalpine forests is likely to shift as a result of increasing temperatures with climate change
- Increased tree mortality and loss of site conditions that support vulnerable species
- Possible loss of relict or disjunct populations and rare species
- The frequency and scale of disturbance will likely increase with climate change
- Areas with limited species and genetic diversity will likely be more susceptible to climate change stressors

3.2.5 Agriculture

Climate change will bring both positive and negative impacts to agriculture in the Puget Sound region. Puget Sound's agricultural systems are expected to adapt to these changes.

Positive impacts may include:

- Lengthening of the growing season due to increased temperatures, allowing opportunities to diversify into crops requiring more heat units for optimum growth.
- Where adequate irrigation water is available, increasing temperatures may result in higher yields of many crops.

Negative impacts may include:

- Declines in production where summer precipitation decreases and supplemental irrigation water is not available.
- Decreased availability of irrigation water for land that has been historically been irrigated, resulting in reduced crop yields.
- Increased flooding on low lying agricultural ground delaying and, in some cases, preventing planting.
- Changing risks from pests and plant diseases.
- Damage to agricultural infrastructure due to flooding affecting crops and livestock.
- Heat stress to meat and milk producing livestock.

The impact of climate change to agriculture will vary, leaving some locations, crops and livestock more influenced than others.

3.2.6 Wildlife & Habitats

According to Washington State's Integrated Climate Response Strategy (Ecology, 2012),

> *"Fish, wildlife, and natural systems will face increased stress. Climate change will more likely damage and destroy certain types of habitats, increase threats to certain species such as cold-water fish, alter natural patterns such as animal migrations or flower blooms, and alter the presence of pests and invasive species."*

Effects of climate change, as noted above, are expected to include increased peak flows in the winter, contributing to increased flooding, and decreased summer low flows, contributing to stressful conditions for aquatic species, including all salmon species, but in particular, these effects are likely to affect those species that spend a significant portion of their lifecycle rearing in freshwater (e.g. steelhead, stream-type Chinook, Sockeye and Coho salmon – as cited in UW State of Knowledge report). Increased peak flows during winter are likely to result in lower salmonid escapement rates, as flood scouring will eliminate redds, while lower base flows can contribute to a decrease in water quality, and an increase in water temperatures, also adversely affecting salmonid habitat and species.

For all habitats and species, water is a limiting factor. Increased competition during drought is projected to adversely affect a wide variety of habitats and species.

Ecology's study states that climate change is expected to affect ecosystems, species, and habitats in at least six key ways:

- Degradation and loss of habitat
- Increase in major ecosystem disturbances
- Shifts in geographical ranges of some native plants and animals
- Change in timing of life history events for plants and animals
- Declines in species populations and loss of biodiversity
- Spread of invasive species and disease

The potential effects of warming trends to a wide variety of habitats and species are the subject of ongoing studies by the Pacific Northwest Climate Change Vulnerability Assessment. See http://climatevulnerability.org for more information. See also http://Adaptationpartners.org.

4.0 Priorities

Based on climate model predictions for the Pacific Northwest, we can expect to continue to experience more extreme weather conditions in the future. Such conditions are likely to include more frequent drought periods of longer duration during the growing season and heavier rainfalls during the winter and spring. These changing conditions may affect a variety of resources and activities that are important to Whidbey Island's communities.

Priority drought issues for Whidbey Island include:

- Groundwater resources
- Surface waters
- Residential and commercial water needs
- Agriculture production
- Forest production and health
- Habitat and wildlife

Existing plans and programs seek to increase efficiencies of water use to minimize impacts of future drought episodes and to ensure adequate water supplies into the future.

Groundwater Resources

Our groundwater resources are dependent solely upon precipitation. As discussed in section 3.1.3 of this report, the USGS estimates that 28% or of the annual precipitation infiltrates to sufficient depths to recharge Whidbey's groundwater aquifers. During an average precipitation year, that is equivalent to 7.4 inches on average for the island. As water demands increase, it is increasingly important to carefully manage groundwater, including both maximizing groundwater infiltration rates and minimizing withdrawal rates.

Fortunately, climate change models predict that there will be only moderate changes to the average annual precipitation amounts for Whidbey. Additionally, our aquifers have about a 10-year delay between one year's precipitation and actual recharge. This allows some time for our communities to plan ahead and adjust to changing climate conditions. Ideally, communities will plan ahead and manage groundwater usage to be prepared for the effects of upcoming drought events.

Surface Waters

Some Whidbey surface waters tend to be affected in the shorter term by changes in precipitation levels and patterns as compared to groundwater. These include smaller seasonal drainages within smaller watersheds. Heavier rains in the winter will likely increase flow rates during the rainy season, while longer dry periods that start earlier in the year may result in a shorter flow season. Managing storm flows and land uses adjacent to these drainages will be important to maintaining their integrity.

Larger systems, including many lakes and wetlands on the island, are often directly connected to shallower aquifers with discharge points at ground surface. Surface waters in enclosed basins may experience higher water levels during the rainy season and for some time after depending on outflows and evaporation rates. These systems may experience less dramatic effects than the more seasonal systems. Longer term management of local hydrology will be the key to maintaining the functions of these surface waters.

Residential and Commercial Water Needs

Water use variations in the urban and rural residential setting related to drought are primarily associated with irrigation of lawns, landscapes, and gardens. Groundwater withdrawals for these uses are expected to increase during drought periods and as the island population grows. Education and outreach tools as well as steep increases in water cost beyond base amounts could be expanded to help manage usage consumption rates.

Agriculture Production

The use of irrigation for agriculture production is varied and sporadic across Whidbey Island. The usually wet springs often supply soils with water sufficient for plant production for the spring and, depending on soil types, into the first half of the summer. Many crops, hayfields, and pastures are managed without supplemental irrigation, although approximately 1,300 acres are known to be irrigated at some point of the year (WSDA Crop Survey Data, 2013).

Livestock production is also quite varied on Whidbey Island. In general, livestock operations are relatively small, with few farms running more than 50 large animals.

Water for irrigation and livestock is primarily sourced from groundwater, although there is some use of water captured in constructed ponds. Managing soil health and irrigation efficiencies are two of many important tools for agriculture producers to mitigate drought conditions and minimize impacts to groundwater aquifers.

Forest Production & Health

Forests rely on precipitation and shallow subsurface flows for the most part for water supply. Drought stress can reduce tree health, increasing susceptibility to pests and disease. Lack of active management of the forest community exacerbates drought stress, reduces production, and greatly increases the potential for a destructive fire. Many forestlands on Whidbey are excessively dense, resulting in high levels of competition between trees for water and nutrients and significant quantities of dead woody material that provides fuel to a fire, should one occur.

Tools for minimizing the effects of drought on forestlands focus on managing trees at both the individual and landscape scale.

Habitat and Wildlife

Like forests, other habitats and wildlife are dependent on natural climate conditions over which humans have less immediate influence. Minimizing disturbances to natural habitats is one of the most effective measures to protect their long-term viability. Activities on adjacent lands can take into consideration the needs of wildlife and their habitats when considering management activities. Maintaining a diversity of habitats across the landscape allows for more ‘options’ for plants and animals to survive under drought conditions.

5.0 Adaptation Strategies that Address Drought

Adaptation strategies and tools are available to help adapt to the potential impacts of drought conditions. As these conditions become more common, more effective and innovative strategies and tools are expected to become available.

5.1 Agriculture Conservation Practices

Droughts have many economic and environmental effects on crop and pasture lands, depending on their severity, whether they are seasonal versus year long, their duration, and the conditions of the lands on which they occur. Lands on which conservation practices have been thoughtfully applied are more resilient to the effects of drought than lands on which they have not. However, even lands not so prepared prior to the onset of drought can be made more resilient through proper application of the appropriate conservation practices.

There can be little doubt, on careful reflection, that the two most important soil characteristics for resisting the negative effects of drought are the ability to rapidly take in water when it is available, and the ability to retain water once it has been taken in. More than anything else, these abilities are determined by soil texture, soil depth, soil organic matter content, and soil structure.

Soil texture, the relative mixture in the soil of sand, silt, and clay, greatly affects both water intake and water retention. Sand dominated soils tend to have very high intake rates and very low water holding capacities. Clay dominated soils tend to have very low intake rates and very high water holding capacities. Silty and loamy soils tend to be in between. It is not generally economically practical to modify our soil textures.

Soil depth, the distance from the soil surface to a root restricting layer such as bedrock or hardpan, is important for water retention. Other things being equal, a deep soil can hold much more water than a shallow one. Soil depth is something we are generally unable increase. However, it can readily be decreased by soil erosion.

Soil organic matter is the decomposed remains of plants, animals, fungi, and other living things, and the substances they produce. It is generally beneficial for both water intake and water retention. Sand dominated soils that are high in organic matter can retain more water than those with little to no organic matter. Likewise, clay dominated soils that are high in organic matter have higher water intake rates than those with little to none. Soil organic matter content can be decreased or increased by farming practices.

Soil structure is the natural aggregation of soil particles. Good soil structure tends to promote both water intake and water retention. The spaces between the aggregates provide channels to increase the rate of water intake. The aggregates themselves tend to be better at retaining water than the un-aggregated soil particles. As with soil organic matter content, soil structure can be decreased or increased by farming practices.

Based on the above discussion farming practices that allow soil erosion, loss of soil organic matter, and loss of soil structure reduce drought resiliency. Practices that protect the soil from erosion, and that increase organic matter content and soil structure promote drought resiliency. The remainder of this subsection consists of discussions of how NRCS conservation practices can be applied to directly, or indirectly, reduce soil erosion, increase soil organic matter content, and increase soil structure. See Appendix – Table of NRCS Conservation Practices & Example Drought Applications for brief descriptions and example drought applications of the practices. While proper application of these practices cannot eliminate the negative economic and ecologic effects of drought, it can increase the resiliency of our crop and pasture lands to resist these effects and to recover more quickly once the drought runs its course.

5.1.1 Soil Health Practices to Counter Drought

The seasonal precipitation pattern common to Whidbey Island typically includes an annual dry season, usually July through mid-September. During recent drought periods, the spring seasons have had reduced rainfall and higher temperatures and the dry season has begun a month or two earlier in the year. These factors can result in reduced quantities of available soil water for plants, paired with higher water demand during a significant part of the growing season. Inadequate or irregular availability of water can reduce plant productivity and crop yields.

Soil characteristics, including texture, affect the availability of water for plant growth. Sandy or gravelly soils hold significantly less water available for extraction by plants than medium and fine textured soils. Plants growing on more coarsely textured soils are more susceptible to drought effects.

Some crop management activities can exacerbate drought conditions and plant stress. Examples include tillage, soil compaction through use of large equipment on wet soils or livestock on wet soils, and leaving soil surfaces bare for extended periods of time. Such practices may result in increased surface water runoff, higher rates of evaporation, lower soil organic matter content, and lower soil biological activity.

Excessive tillage when soils are either dry or excessively wet tends to destroy structure and pores. Loss of structure and pores tends to reduce infiltration and permeability rates of a soil. Additionally, each tillage operation exposes the soil to air, further drying out the tilled layer.

The weight of machinery or livestock can compact and compress soils, especially when activities occur when soils are wet. Compaction reduces porosity and, therefore, infiltration rates, permeability, and aeration. It also reduces the water storage capacity of the soil and may increase surface water runoff rates, which can accentuate drought effects. Compaction can reduce both root growth and soil biota. Reduced root growth results in a reduction in the plant's ability to extract moisture and nutrients. The reduction in plant vigor and ability to obtain moisture can reduce yields beyond the effects of drought alone.

During warm, sunny weather, lack of cover over the soil allows the surface layer to get excessively hot, increasing evaporative moisture loss. A lack of cover also allows impacts from rain drops to damage the structure of the soils' surface, reducing infiltration rates and potentially increasing runoff and erosion rates.

While we cannot effectively change soil texture by agronomic practices, we can use a variety of practices to optimize soil moisture that can help counter the effects drought.

Any soil-related strategies for drought management should include the following:

- High rate of capture of precipitation or irrigation into the soil (infiltration)
- Adequate movement of water within the soil (permeability)
- Maximum storage of water within the soil
- Efficient recovery of soil water by plant roots

Improving Infiltration Rates

Several conservation practices help maintain or improve water infiltration into soil by maintaining or increasing soil cover and increasing soil organic matter. Generally, these practices minimize soil disturbance and compaction, protect soil from erosion, reduce evaporation, and encourage the development of good soil structure and continuous pore space. Where slopes are present, implementing practices that slow runoff improves infiltration and reduces erosion.

Short-term solutions to poor infiltration include disrupting surface crusts with a rotary hoe or row cultivator and breaking up plow pans or other compacted layers by using deep tillage. Long-term solutions for maintaining or improving infiltration include practices that reduce soil disturbance and compaction and increase soil organic matter and soil particle aggregation. High residue crops, such as corn and small grains, perennial sod, and cover crops protect the soil surface from crust development and erosion. In addition, soil organic matter is increased when reduced tillage methods that maintain surface cover are used to plant the following crop. Application of animal manure also helps to increase soil organic matter. Increased organic matter results in increased aggregation and improved soil structure leading to improved infiltration rates. Conservation tillage, reduced soil disturbance, and reducing the number of trips across a field necessary to produce a crop help leave continuous pore spaces intact and minimize soil compaction.

Improving soil permeability

Many practices that improve infiltration rates also improve soil permeability by creating good soil structure or aggregation. Aggregation refers to the combining of various soil particles into larger granules that do not easily disintegrate in the presence of water. These granules are formed by activity of soil organisms in the presence of organic matter. Larger soil organisms and decomposing plant roots create large channels that improve the movement of water and air within the soil profile. Minimizing compaction helps to keep the soil pores intact.

Maximizing water storage capacity and availability within the soil

The water holding capacity of a soil depends on soil texture, depth of the soil, the size and total volume of pore spaces, and organic matter. Course soil texture allows water to drain through freely, resulting in water being available to plants for only a short time, while soil with very small particles holds water tightly in place, possibly at a level of tension that plants are not able to access it. Not all water contained in any given soil is available for plant uptake. The amount of water that can be held by soil against the pull of gravity and is still available for plant uptake is called “plant-available water”.

Water storage capacity can be enhanced by increasing soil organic matter, improving soil structure, and increasing the volume of soil into which plant roots can grow well. The greater the rooting volume of soil, the greater the moisture reserves plants have access to, which in turn improves the plants ability to withstand drought. Additionally, decomposing organic matter releases nutrients and improves soil fertility, thereby maximizing the overall health of the plant.

Reducing evaporation rates helps offset the effects of drought. Maintaining soil cover with cover crops, mulches, or plant residue, moderates temperatures, reducing evaporation rates. Because fine textured soils have an abundance of small pores, evaporative losses are likely to be greater for these soils because of greater capillary movement of water to the surface. Reducing wind speeds, such as through the use of windbreaks, or providing shade to plants also reduces evaporation rates.

Enhancing recovery of stored water by plants

Healthy plants growing in healthy soils are better able to withstand drought conditions. Maintaining healthy populations of soil organisms that help plants obtain water and nutrients can be achieved by maintaining soil organic matter and soil structure. Managing weeds reduces competition for water, as well as nutrients.

The following are management practices that can be used to improve soil health:

- Access Control
- Alley Cropping
- Conservation Cover
- Conservation Crop Rotation
- Contour Buffer Strips; Contour Orchard and Other Perennial Crops
- Cover Crop
- Critical Area Planting
- Cross Wind Ridges, Cross Wind Trap Strips
- Field Border
- Filter Strip
- Hedgerow Planting
- Herbaceous Weed Control
- Mulching
- Nutrient Management
- Prescribed Grazing
- Residue and Tillage Management, No Till, Reduced Till
- Strip Cropping
- Tree/Shrub Establishment
- Windbreak/Shelterbelt Establishment
- Windbreak/Shelterbelt Renovation

5.1.2 Irrigation Efficiencies to Counter Drought

Irrigation use on Whidbey Island includes residential and commercial landscapes, some crop fields and a few pastures, and golf courses and some sports fields. Use of water for irrigation tends to be lower on the island than is typical for other areas

To deal with reduced irrigation water availability for plants during drought, a number of cultural strategies can be utilized. Planting native, drought tolerant plants for landscaping, which have little need for supplemental water, reduces or eliminates the need for irrigation once plants have become established. Planting fruit trees with vigorous rootstocks reduces the need for irrigation. In cropland growing fall/winter seeded annual crops versus spring seeded is another strategy to better utilize available moisture. Planting rapidly maturing and drought tolerant crops increases the probability for a suitable yield in a dry year. Utilizing good nutrient and pest management practices helps to maintain crop vigor and promote deep root systems to more effectively use available moisture. Maintaining or adding surface mulch helps to moderate soil temperatures and reduce evaporation and runoff. Minimizing soil disturbing tillage helps to conserve soil moisture. The specific practice of direct seeding into high residue is very effective at conserving moisture. Planting and thereafter managing perennial crops which have deep root systems and inherent drought tolerance like tall fescue grass, and sainfoin and alfalfa legumes can reduce effects of drought on yields.

Another way to deal with reduced water availability is to find additional water resources for irrigation through rain water or surface and groundwater catchment into ponds, barrels, or tanks. Also, an additional well could be drilled. These may not be viable options in many circumstances. More information on rain water collection and storage is provided in Section 5.1.3.

Reducing losses and utilizing available water as effectively as possible for maximum benefit is especially prudent during drought.

Irrigation Water Conveyance

Conveyance pipelines or ditches from the well, diversion or storage location to the field for application can be a source of water loss if pipes or valves are leaky and soils in ditches are permeable. Proper maintenance or replacement of leaky pipes and sealing of ditches or replacement with pipe will be necessary to eliminate this source of loss.

Irrigation System Application Efficiency

No irrigation system is 100% efficient at delivering the desired amount of water to the plant without some variance of application. This variation is a system inefficiency, which can be accentuated with poor maintenance. Table 2 below shows some "typical" efficiencies for some common types of irrigation systems.

Level basin and graded border irrigation listed in the table in are not common in Washington State; the other listed methods are common. Obviously, if water is limited, a system of application with a high efficiency is desired, because there is less potential waste. Micro-irrigation with up to 95% efficiency of application is recommended for most landscaping in yards, nursery and vegetable crops due to high efficiency and high value of the "crop". Drip is not usually feasible in large fields with lower value crops like small grains or forage though, and where tillage occurs and large equipment is operated. In these fields sprinkler irrigation is common. Travelling or stationary big guns are often used in these fields due to ease of operation, but guns have an accentuated system deficiency if conditions are windy. Due to high pressure of operation, many water droplets are fine and vulnerable to drift and inefficient application if conditions are windy. Sprinkler lines and center pivots would be somewhat more efficient than guns overall. The irrigation system used should be properly designed and maintained to achieve the most uniform application patterns possible.

Table 2. Irrigation System Design (NRCS see web link in References)

Table WA6-2 Application efficiency range for various irrigation systems[1]

Type	Range	Avg (%)
Surface Irrigation		
Level Basin	80-95	85
Graded Border	50-80	65
Furrow or Corrugations	50-80	65
Surge	60-90	75
Micro Irrigation		
Point Source Emitter	70-95	88
Line Source Emitter	75-95	90
Spray Emitter	70-95	85
Sprinkler Irrigation		
Handline/Wheeline	60-85	75
Traveling Big Gun	55-75	65
Solid Set (Above Canopy)	60-75	60
Solid Set (Below Canopy)	70-85	75
Center Pivot		
Impact Sprinkler w/end gun	75-90	80
Drops, spray heads w/o end gun	75-95	85
Lateral Move		
Spray heads		
w/ hose feed	75-95	90
w/ canal feed	75-95	85

Wind and temperature can affect efficiency. For example – a 5/32" nozzle will loose 9% in winds of 5 mph and 80^0 F.
A 5/32" nozzle will loose about 20% if wind is 15 mph. The losses will reach 26% with 15 mph wind and temperatures of 100^0 F.[2]

[1] IRRIGATION SYSTEM EFFICIENCIES,2002, Terry A. Howell, ARS, Bushland, TX
[2] Montana State Univ, Extension Service – Wind Effects on Irrigation Efficiency – Management Harder than it Sounds! Jim Bauder,

Irrigation Water Management

Regardless of the system, proper timing and correct application amounts of irrigation water are important to meet consumptive use requirements of crops without waste to minimize drought stress to achieve desired yields. If adequate water is available, it is possible to fully meet water needs of growing plants by practicing careful irrigation water management. This practice is described below.

Evaluating crop water use and applying the correct amount to replenish root zone moisture use in a timely manner can be accomplished using the following methods. (1) *Checkbook method* – If soil moisture depletion by evapotranspiration were tracked by using evaporative data, irrigation could be scheduled whenever plant available soil moisture within the rooting zone is depleted to a targeted point (Management Allowable Depletion – MAD, usually 30-40% for most vegetable crops, and 50% for most forage crops) to maintain crop growth rates. Each irrigation should occur whenever evaporative data corrected for crop growth stage (-) precipitation = targeted soil moisture depletion = irrigation application amount / system efficiency. The website http://weather.wsu.edu/awn.php can be utilized to obtain evaporative data and crop growth stage correction. Another method is to install an atmometer on-site. (2) *Real-time soil moisture monitoring* – Another option would be to use soil moisture monitors and data loggers to track water use from soil by plants. Once calibrated they could monitor soil moisture and be used as a tool to help schedule irrigation. With either method, soils should be field checked for moisture content periodically using the USDA NRCS 1998 publication "Estimating Soil Moisture by Feel and Appearance" and adjustments made based on observations.

The following is a general example of irrigation water management on a vegetable farm near Coupeville, Washington, during peak consumptive use period. The rooting depth for lettuce, chard, spinach, and onions is usually 1.5 feet. Soils within this rooting zone in two planting beds based on "Physical Soil Properties Table" from Web Soil Survey for this example farm hold approximately 2.7 and 3.6 inches of plant available water. At 30% soil moisture depletion, an application of 0.8 and 1.1 inches of irrigation water would be needed. Slightly more water will need to be applied, depending on system efficiency. Peak consumptive use is 4.41 inches in July for onions in a "typical" year (NRCS Washington Irrigation Guide – Appendix A). Hence, with an average water usage rate of 0.14 inches/day, irrigation should be scheduled every 5-6 and 7-8 days on the respective beds of onions during peak water use periods. The "Pacific Northwest Irrigator's Pocket Guide", and the "NRCS Washington Irrigation Guide – Tables 2-1, 3-3, 3-4 and Appendix A" can be valuable resources for irrigation information.

Deficit Irrigation

It is not always possible to fully meet water consumptive use requirements of a crop, especially in a drought or if water is otherwise limited. Under these circumstances supplemental or deficit irrigation could be practiced to the highest benefit possible from available water.

The strategy for deficit irrigation is optimizing the timing and application of a limited supply of irrigation water to have the most desired impact on crops. This may be necessary if irrigation water supply is diminished on a short-term basis by drought and on a longer-term basis by increased demand from other users or by climatic change with increased evaporation reducing groundwater recharge and surface storage.

Of course, an efficient delivery and application system for irrigation water to reduce waste is also especially important when water supply is limited.

Numerous crops are grown world-wide utilizing deficit irrigation. This is especially the case in arid areas with limited water supply. Crops such as cotton, corn, wheat, sunflower, sugar beet and fresh market potato are well suited to deficit irrigation practices, and achieve adequate yields even with reduced soil moisture supply throughout the growing season. Other crops such as common bean, peanut, soybean, and sugar cane can produce adequate yields with reduced soil moisture during certain non-critical growth stages.

An example of growth stage moisture deficit effect on soybean yields follows. It has been reported that soil moisture limitations during vegetative growth have less of an effect on yield of soy beans than limitations during flowering and pod formation. Hence, irrigation could be more limited during the vegetative stage with less impact on yields.

A local example of a large benefit from a timely application of a small amount of irrigation water could be improved yield on a second cutting of alfalfa hay in a dry spring. Even an inch or two of supplemental irrigation water could have a significant impact. Also, spring grains, peas, corn, seed crops, etc. could have a significant yield increase in a dry year from a timely application(s) with an inch or two of irrigation water. Quality and yield of fruit crops also could benefit from a small amount of timely supplemental irrigation most years.

Some basic considerations follow regarding site specific deficit irrigation (Marshall English, Professor and Irrigation Extension Specialist (Emeritus), Oregon State University pers. comm.):

- Under deficit irrigation there typically is an increase in water use efficiency – i.e. more yield/unit of water used.
- A reduction of 10% or in irrigation below crop consumptive use requirements has negligible effect on yields
- Usually it is better to irrigate most crops at a uniform percentage of crop needs throughout the growing season than only at certain growth stages.
- A drought response plan for deficit irrigation consists of the following steps:
    - Determine growing season crop water needs – (Table A, WA NRCS Irrigation Guide)
    - Figure out quantity of water available for irrigation.
    - If adequate water, irrigate to meet at least 90% of crop needs (potential evapo-transpiration-PET) utilizing evaporative data from WSU AgWeatherNet climate station and irrigation water management parameters.
    - If less water than 90% of crop seasonal needs, irrigate at a lesser uniform base percentage. For example, if a crop needs 20 inches of water and there is only 15 inches available, irrigate at 75% of PET during the growing season.

- If severe deficiency of water, (1) irrigate only "best" crops as described above, and/or (2) irrigate certain crops only at critical stages of growth.

Under deficit irrigation, agronomic practices such as lowering plant density, using less fertilizer, and planting shorter season and more drought tolerant crop varieties may need to be considered. Also, controlling weeds, reducing tillage, and mulching become more important.

5.1.3 Water Storage Options & Re-Use Options

Rainwater Catchment and Storage

The capture, storage, and reuse of rainwater are in many cases practical options for augmenting water supplies. Drought conditions place greatly increased demands on potable supplies for irrigation and landscape watering. These increased demands can be mitigated through the use of non-potable sources such as collected rainwater. While rainwater can be treated to be potable, it is more feasible and affordable to use it for non-potable uses, such as for irrigation or stock water. Rainwater harvesting can utilize tanks or ponds to store collected water. Collection from rooftops is most common, but stormwater flows can be collected from roadways, parking lots, or any area that experiences runoff during rainfall events. Man-made landscape features such as swales and berms can be used to channel and concentrate stormwater into lined basins or buried tanks.

Rainfall patterns on Whidbey Island vary seasonally, with wet winters and dry summers. So, irrigation demands are highest when there is the least precipitation to collect. This condition places a premium on storage capacity, as recharge is not reliable during the summer months.

Ponds

Large rooftop areas, such as barns or storage buildings present opportunities for effective rainwater collection, if storage tanks or a pond can be located nearby and downslope. In 2009, Ecology clarified its policy on rooftop collection systems, stating that they are exempt from water rights permit requirements, as long as they don't affect in-stream flows or existing water rights. Conveyance of stored water to crop fields can be expensive, depending on the distance to be covered and whether the pipes are buried or can be installed above ground.

Construction of ponds for storage of water can be challenging due to regulatory issues. Due to the dry summers on Whidbey, most upland areas simply cannot hold water through the summer, even with a lined pond. The landforms that are most suitable for collecting and storing water are low-lying bottomlands, swales, and ravines. The majority of these areas are either classified as wetlands, seasonal streams, or their buffers. Any wetland "modification for use as a retention/detention facility" is defined as a "Critical Areas Alteration", and is subject to stringent permitting requirements. Per Island County Code 17.02.050, an alteration of a wetland can only be permitted if the applicant can prove that "substantial public benefit will accrue through the alteration", or that the alteration will "preserve, improve, or protect the functions" of the wetland.

Similarly, impounding surface waters behind a dam or berm would also require approval from Island County. If the flow is classified as a seasonal stream, any such impoundment would need an alteration permit, and the burden would be on the applicant to demonstrate that the activity would "preserve, improve, or protect the functions" of the stream. As most Whidbey Island receives less than 30 inches of precipitation annually, upland areas typically do not collect enough surface water to function as year-round ponds, even with liners. Construction of ponds in these areas can often result in very large groundwater withdrawals during summer, as landowners try to maintain the hydrology and aesthetics of their ponds by filling them from their domestic wells.

In addition to providing irrigation water, ponds can also have the added benefit of increasing groundwater recharge, either to deep aquifers or to shallow, perched water tables, depending on underlying soil characteristics. When water is collected, conveyed, and stored in an unlined pond or swale, saturated conditions are created in the soils below and surrounding the collected water. Under constant pressure and saturation, the soils and sediments can be expected to recharge the groundwater aquifer at the maximum rates that the underlying sediments will allow. In comparison, if the same volume of stormwater was dispersed or was lost as runoff, rather than collected and stored, lower rates of groundwater recharge would be expected. Dispersion of stormwater is effective in reducing runoff and erosion, but generally relies on low rates of application over large areas. This results in unsaturated conditions in the soil, where most of the water is held against the force of gravity by adhesion to soil particles. A large portion of this water is eventually lost to evapotranspiration, and is unavailable for groundwater recharge.

Care must be taken to ensure that ponds and other sources of aquifer recharge are free of persistent pollutants that would contaminate groundwater, particularly in shallow aquifer areas. This might be accomplished by eliminating pollutant sources, or by pre-filtering the collected water with forebays, grass-lined swales, or other means.

Tanks

Depending on the storage volumes desired, tanks can be a viable and affordable option for storing water. Polyethylene tanks are commonly used on farms and in other settings, and have become less expensive in recent years. 500 gallon tanks cost approximately $1 per gallon, with the price per gallon decreasing with larger volume tanks. Buried polyethylene tanks are more costly, due to the greater strength required. Concrete tanks that are manufactured for septic systems are often more affordable than polyethylene, and are available almost everywhere. Excavation costs must be considered, but buried tanks can be a good option, especially in cases where a pump is already needed for distribution of the water. Above ground tanks have the advantage of allowing for gravity distribution of the water if low pressure and flows are acceptable, but are limited in requiring a high input elevation, such as a rooftop.

5.1.4 Other AG Practices

Soil Erosion by Water

Water erosion occurs when soil particles are detached and transported away by water. Two common categories are sheet and rill erosion and concentrated flow erosion. Sheet erosion is loss of particles from the soil surface with little to no apparent channelization. Rill erosion is loss of particles from the soil surface that creates a number of narrow, usually parallel channels, each not more than a few inches deep. Concentrated flow erosion includes gullies and ephemeral gullies. Much concentrated flow erosion begins as a result of worsening sheet and rill erosion within a natural or artificial flow channel, so controlling sheet and rill erosion can often prevent the formation of concentrated flow erosion. Control of gullies already in existence often requires structural practices that are beyond the scope of this discussion. Most water erosion on Whidbey Island is sheet and rill erosion.

Vegetative cover, crop residue, and other forms of litter resist particle detachment and sealing of the soil surface by breaking the force of rain drop impact. They resist particle transport by slowing and filtering runoff water, and by reducing the volume of runoff water (by their effects to increase soil infiltration).

Slope length, the length of slope that water can run down before encountering a more erosion resistant surface or an established concentrated flow channel, also affects the amount of sheet and rill erosion. Several practices reduce sheet and rill erosion by shortening the effective slope length.

Some of the best management practices that can reduce sheet and rill erosion by increasing or preserving vegetative cover, crop residue, and litter and/or by shortening the effective slope length are:

- Access Control
- Alley Cropping
- Conservation Cover
- Conservation Crop Rotation
- Contour Buffer Strips
- Contour Orchard and Other Perennial Crops
- Cover Crop
- Critical Area Planting
- Field Border
- Filter Strip
- Forage and Biomass Planting
- Hedgerow Planting
- Mulching
- Prescribed Grazing
- Residue and Tillage Management, No Till
- Residue and Tillage Management, Reduced Till
- Riparian Forest Buffer

- Riparian Herbaceous Cover
- Strip-cropping

Soil Erosion by Wind

Wind erosion occurs when soil particles are detached and transported away by wind. Larger soil particles often bounce along the ground in a process called saltation. Saltation causes further particle detachment, and physical damage to plants. Smaller particles usually blow up into the air and are transported much farther before settling to the ground, often resulting in air quality issues.

Low growing vegetation, crop residue, and litter resist particle detachment by reducing the amount of soil surface that is directly contacted by wind and saltation. They can resist particle transport by reducing the wind speed somewhat within the vegetated layer. Taller vegetation, when grown in a continuous line across the direction of prevailing erosive winds, can resist both particle detachment and transport by effectively slowing the wind both within the vegetation and for a distance downwind of it.

Some of the practices that can reduce wind erosion by increasing or preserving low growing vegetation, crop residue, and litter and/or by creating fairly continuous rows of taller vegetation in lines across the wind direction are:

- Access Control
- Alley Cropping
- Conservation Cover
- Conservation Crop Rotation
- Cover Crop
- Critical Area Planting
- Cross Wind Ridges
- Cross Wind Trap Strips
- Field Border
- Filter Strip
- Forage and Biomass Planting
- Hedgerow Planting
- Mulching
- Prescribed Grazing
- Residue and Tillage Management, No Till
- Residue and Tillage Management, Reduced Till
- Riparian Forest Buffer
- Riparian Herbaceous Cover
- Sprinkler System (or other irrigation)
- Tree/Shrub Establishment
- Windbreak/Shelterbelt Establishment
- Windbreak/Shelterbelt Renovation

Soil Subsidence

Soil subsidence can occur when organic soils, usually formed under wetland conditions, oxidize on exposure to air. This generally occurs when these soils dry out for appreciable periods of time due to artificial drainage and/or drought. Soils that have experienced subsidence may be more susceptible to flooding by freshwater or sea water, and may gradually lose their value for crop and pasture production. Soil subsidence can be reduced by application of the practice Drainage Water Management, which enables retention of drainage water in the soil during times of year the soil does not need to be drained. Application of this practice generally requires installation of one or more Structure for Water Control.

Insufficient Water – Inefficient Moisture Management

Though this important drought related resource concern is addressed more fully in the subsections on Irrigation Practices, Water Storage/Re-use Practices, and Ground Water Practices, one aspect is addressed here. Some operators with fields on which artificial drainage has been installed in the past, find that in drought conditions the need for drainage is less than usual, and the need for extra moisture for crop or pasture growth is greater than usual. In these situations, installation of one or more Structure for Water Control may enable them to implement Drainage Water Management to hold some of the moisture in the soil until it can be better used for crop and pasture production.

Water Quality Degradation – Excessive Sediment in Surface Water

For the most part, excess sediment in surface water is a byproduct of soil erosion by water. The excess sediment is carried into surface waters by runoff. For this reason, practices that address water erosion also address excess sediment in surface water. (See the list of practices under Soil Erosion by Water above.) In areas where concentrated flow erosion (such as gullies) is a problem, additional practices such as Grade Stabilization Structure, Diversion, and Water and Sediment Control Basin may also be needed.

Air Quality Impacts – Emissions of Particulate Matter (PM) and PM Precursors

Drought conditions often result in increased particulate matter emissions. Large amounts are released by wildfires. (Conservation practices to address wildfire hazard are addressed in section 5.2 Forest Conservation Practices.)

Wind erosion can also add huge quantities of particulate matter to the air. (See Soil Erosion by Wind above for practices to address this issue.)

In addition, droughts often result in increased pumping of groundwater for irrigation. The older, diesel engines frequently used for irrigation water pumping tend to produce a lot of particulates and particulate precursors. Replacement of older diesel pump power units with electric motors or new, high efficiency diesel power units can help improve air quality, and may reduce fuel costs. This also applies to diesel engines of older tractors and other farm equipment. Practices to address this issue include:

- Pumping Plant
- Combustion System Improvement

Air Quality Impacts – Emissions of Greenhouse Gasses

Greenhouse gas emissions tend to increase greatly in times of drought. Large amounts of carbon dioxide and other greenhouse gasses are released by wildfires. (Conservation practices to address wildfire hazard are addressed in the Forest Conservation Practices subsection.)

As mentioned above, pumping of groundwater for irrigation commonly increases during drought. Older diesel engines frequently used for irrigation water pumping may produce more greenhouse gasses than their newer counterparts. Replacement of older diesel power units with electric motors or new, high efficiency diesel power units may help improve air quality, and may reduce operation costs.

- Combustion System Improvement
- Pumping Plant

Degraded Plant Condition – Undesirable Plant Productivity and Health

In the absence of adequate irrigation water application, drought conditions increase moisture stress on crop and pasture plant species. Moisture stress weakens plants by interfering with their abilities to carry out natural processes such as root growth, nutrient absorption and translocation, and photosynthesis. This reduces plant vigor, with the ultimate result of mortality from severe moisture stress. Plant productivity decreases, and may altogether cease. A number of practices can be applied to reduce declines in plant health and productivity in times of drought. Many of these work by improving soil health, which generally improves soil water intake and storage. (See the subsection on Soil Health Practices for more details.) Practices that can preserve plant productivity and health in drought include:

- Access Control
- Access Road
- Alley Cropping
- Brush Management
- Conservation Cover
- Conservation Crop Rotation
- Cover Crop
- Critical Area Planting
- Cross Wind Ridges and Trap Strips
- Drainage Water Management
- Fence
- Field Border
- Filter Strip
- Forage and Biomass Planting
- Forage Harvest Management
- Grassed Waterway
- Hedgerow Planting
- Irrigation Practices (See the Irrigation Practices subsection above.)
- Mulching

- Nutrient Management
- Prescribed Grazing
- Residue and Tillage Management, No Till
- Residue and Tillage Management, Reduced Till
- Strip-cropping
- Tree/Shrub Establishment
- Windbreak/Shelterbelt Establishment
- Windbreak/Shelterbelt Renovation

Degraded Plant Condition – Excessive Plant Pest Pressure

Other effects of moisture stress on crop and pasture plant species are weakened abilities to compete with weedy species and to defend themselves from insects, fungi, and disease organisms. In consequence, moisture stress is often compounded by stress from these plant pests. As moisture stress increases susceptibility to plant pests, the practices listed above for Undesirable Plant Productivity and Health also address this concern. Other practices that can address this concern include:

- Contour Buffer Strips
- Contour Orchard and other Perennial Crops
- Herbaceous Weed Control
- Integrated Pest Management
- Prescribed Burning
- Tree/Shrub Site Preparation

Livestock Production Limitation – Inadequate Feed and Forage

Most of the limitations in livestock feed availability during drought events stem from reduced plant productivity. Reduced plant productivity on-farm means less farm-grown feed available. Reduced plant productivity off-farm means shortages of market supply of hay, silage, and other feeds, and the resulting increased costs to buy them. A sensible management response to lack of feed and forage is to reduce livestock numbers by selling off animals. Failure to do so early enough often results in over-grazing, which reduces plant productivity and health even further. The problem with selling livestock during drought, however, is that many other producers are doing the same, which drives down livestock prices.

Most of the practices listed above under Degraded Plant Condition – Undesirable Plant Condition and Health, and Degraded Plant Condition – Excessive Plant Pest Pressure also generally address Livestock Production Limitation – Inadequate Feed and Forage. Other practices include:

- Feed Management
- Riparian Herbaceous Cover

Livestock Production Limitation – Inadequate Water

As supplies of water decline during drought, lack of drinking water for livestock often becomes a livestock production limitation. Practices that can help to address this concern include:

- Diversion
- Irrigation Pipeline
- Livestock Pipeline
- Pond
- Pumping Plant
- Roof Runoff Structure
- Spring Development
- Structure for Water Control
- Water Harvesting Catchment
- Water Well
- Watering Facility

Inefficient Energy Use – Equipment and Facilities

As stated under the Air Quality resource concerns above, droughts often result in increased pumping of groundwater for irrigation. The older, diesel engines frequently used for irrigation water pumping frequently are not fuel efficient. Replacement of older diesel pump power units with electric motors or new, high efficiency diesel power units can help reduce fuel consumption. This also applies to diesel engines of older tractors and other farm equipment.

A number of cultural practices that are implemented to improve soil health, reduce soil erosion, and improve plant productivity and health have the additional benefit of reducing the needed number of farm equipment on the fields. This also reduces fuel use.

Many agricultural structures require heating, ventilation, and cooling in order to maintain productivity. Examples include greenhouses and poultry houses. Increased temperatures often accompanying drought can increase energy use equipment such as fans and air conditioning.

Practices that can be used to reduce on-farm energy use include:

- Alley Cropping
- Building Envelope Improvement
- Combustion System Improvement
- Composting Facility
- Farmstead Energy Improvement
- Irrigation Practices that reduce pressure requirements (See the Irrigation Practices section above)
- Lighting System Improvement
- Pumping Plant
- Residue and Tillage Management, No Till
- Residue and Tillage Management, Reduced Till
- Tree/Shrub Establishment
- Windbreak/Shelterbelt Establishment
- Windbreak/Shelterbelt Renovation

5.2 Forest Conservation Practices

There are forest practices that can be implemented to help alleviate drought related stress.

Selective forest thinning, for example, would increase structural complexity, productivity, and biodiversity by reducing competition for light and nutrients. It would also reduce wildfire risk by removing surface and ladder fuels. Adapting the species composition of a region to a variety of water conditions and improving the ability of soil and substrates to retain soil moisture could greatly increase forest resiliency.

Districts became leaders in this arena in Washington State in the last ten years. With devastating fires in eastern Washington, some Conservation Districts (CDs) on the east side have played a key role in rehabilitation and emergency measures to private landowners. As a result, there is expertise that Puget Sound Conservation Districts (PSCDs) can utilize in the event of fires on the west side. Helping landowners and communities plan and mitigate for the threat of wildfire in a self-sustaining way protects not only natural resources, but also property and lives. PSCDs perform a variety of services including completing home and community wildfire risks assessments, preparing plans of action, providing cost-share and coordination for fuels reduction projects, and participating at the planning level to ensure policies and funding that support more resilient communities.

Conservation Districts utilize a variety of financial incentives to assist land and homeowners in caring for their forested areas. Cost-share funding can be utilized to implement NRCS forest practices. Some funding sources include Firewise funding, Department of Natural Resources (DNR), and the NRCS Environmental Quality Incentives Program (EQIP). CDs and WSU Extension also provide technical information, outreach, and forest planning services to landowners.

Selected forest health components of NRCS Forestry Practices that could be utilized to increase forest resiliency to drought stress and wildfire risk include the following:

- Brush Management
- Firebreak
- Fuel break
- Forest Stand Improvement
- Woody Residue Treatment
- Tree Pruning

See the Table of Conservation Practices in the Appendix for brief descriptions and example drought applications of these practices.

5.3 Residential Water Conservation Practices

One of the best ways to ensure that reliable supplies of groundwater are available is to implement water-saving conservation measures. As most water use on Whidbey is for domestic potable supply, residential conservation measures hold great potential for reduction in demands on our aquifers. The

Island County Groundwater Management Program states that *"In Island County, the biggest threats to water supply are salt-water intrusion and overdrawing of groundwater."* Both threats can be effectively mitigated through residential water conservation measures.

Water systems that take a proactive approach to water conservation have had success. Since 1992, Coupeville's water usage has decreased by nearly 30 percent due to a new tiered rate structure/summer surcharge, educating customers and offering rebates on low-flow toilets. Smaller water systems, however, generally lack the funding and staffing to implement conservation education and incentives. Significant water waste also results from aging and poorly maintained infrastructure. Most smaller systems also lack individual house metering and use-based or tiered rate structures. Group B Water Systems (3-14 connections) are required to submit water systems plans that, among other things, address potential conservation measures. Yet, the rules are vague on how conservation measures should be implemented. Many small systems are managed by volunteers, and record keeping varies greatly. Billing systems also vary, with many charging a nominal flat yearly rate for any amount of water used. Individual and two-party well systems have virtually no conservation requirements. Most do not have meters, and for those that do have them the meters are rarely monitored. This means that owners of individual wells have little or no economic incentive to conserve water.

Outside of infrastructure management, economic incentives such as tiered rate structures, and passive measures such as low-flow toilets, the effectiveness of conservation lies with individual willingness to conserve. As noted above, some of the larger water systems provide education and incentive programs for conservation. Island County does not maintain any ongoing conservation programs. The State does not provide on-going conservation education programs to the general public. Private and non-profit groups such as WICD, WSU Extension, and Island County Public Health are providing some degree of public education. For example, water conservation is a component of WICD's conservation planning efforts. There is certainly the potential to achieve greater savings through conservation, if more resources are devoted to educating the public. The Island County Water Resources Management Plan recommends implementing a public education program for water system managers and homeowners, focusing on efficiency, rate structures, water resource information, behavior modification, and point of use leak detection.

The Island County Coordinated Water System Plan (CWSP) requires the following water conservation measures for new and expanding water systems:

1. Installation of individual and source meters.
2. Implementation of rate structures that encourage water conservation.
3. Development and implementation of a leak detection and repair program.
4. Outlining water use restrictions for drought periods in Operation and Maintenance Agreement.

Water conservation must not be limited as a strategy employed only during severe water shortages or drought years. Even in those areas not currently experiencing quantity problems, the efficient use of water is a sensible approach to avoid future problems. This is especially true in Island County given its finite ground water supply dependent on long term recharge, and its designations as a Critical Water Supply Service Area and a Sole Source Aquifer.

Reducing domestic water use during drought conditions helps to alleviate demands on water sources. If adopted by a significant percentage of households, these measures can have a measurable cumulative effect. As irrigation use rises during drought conditions, potable supplies are subject to peak demands, making water conservation measures a crucial component of drought response strategies.

The following are residential water conservation practices that can be implemented to conserve water resources.

Toilets

- Replace toilets installed before 1994 with a Low Flow Toilet (LFT)
  - Replacing an older toilet that uses 3.5 gallons per flush (gpf) with a LFT that uses 1.28 gpf will save 2.22 gpf. The EPA WaterSense program labels efficient toilets that use a maximum 1.28 gpf.
  - If the toilet is flushed an average of six times each day it will save about 13 gallons per day or 4,745 gallons per year. Some older toilets use as much as 7 gallons per flush.
- Check toilets to verify they are working properly
  - Make sure the water level is not too high, the fill valve is working properly, and the flapper is not leaking. A running toilet can waste hundreds of gallons of water per day.

Laundry

- When it's time to replace the clothes washer, choose a high-efficiency washer with a low water factor
  - The smaller the water factor the more efficient the clothes washer.
  - Energy Star models currently have a maximum of 6.0, although many well-performing machines are available with lower water factors. Look for the lowest water factor available to achieve the highest water savings.
- When doing laundry, always wash full loads
  - Conventional washers built before 2011 typically use about 40 gallons per load; resource-efficient washers may use as little as 15 gallons per load.
  - Adjust the water level in the washer to the amount needed for the load. Some of the new efficient washers will do this automatically.

Faucets

- Install efficient faucets and/or faucet aerators
  - The U.S. EPA's WaterSense Program labels efficient faucets and aerators that use a maximum of 1.5 gallons per minute.

    - Look for the WaterSense label when selecting new faucets or aerators.

- Find and fix any leaky faucets and hose spigots
    - A faucet leaking 60 drops per minute will waste 192 gallons per month. That's 2,304 gallons per year.
- Turn off the faucet
    - When lathering hands, shaving, or brushing teeth.

Shower

- Replace showerheads that have a flow rate greater than 2.5 gallons per minute--the current National Energy Policy Act standard
    - If the showerhead is not labeled, the flow rate can be checked by catching the water in a 1-gallon bucket. If it takes less than 24 seconds to fill up, the showerhead flow rate is more than 2.5 gallons per minute. The EPA WaterSense program labels efficient showerheads that use a maximum 2.0 gallons per minute.
- Take shorter showers
    - Reducing a 10-minute shower to 5 minutes saves 12.5 gallons of water if the showerhead has a flow rate of 2.5 gallons per minute--even more if the showerhead has a higher flow rate.
- If it takes a long time for the hot water to reach the shower, use it as an opportunity to collect water for other uses, e.g. watering houseplants

Kitchen

- Install an efficient dishwasher
    - Technological advances in dishwashers make it possible to use less water to achieve the same goal. A new dishwasher that uses less water per cycle will reduce household water use.
        - Dishwashers use less water than handwashing, particularly if you limit pre-rinsing.
- Only wash full loads of dishes in the dishwasher
- If washing dishes by hand, fill the sink with water rather than continually running the tap
- Avoid using running water to thaw frozen foods

Leaks

- Check water bills for any instances of high water use -this may be an indication of a leak.

- Leaking faucets, leaking toilets, and leaking pipes all have something in common, they waste a lot of water! Your water bill will often show abnormal water consumption if there is a leak. Many water utilities have information on how to read your water bill online.

Landscape

- Landscape with water-wise landscaping principles:
    - Use native plants or other plants that require little water to thrive in your region.
    - Plant turf grass only in areas where people will use it actively for recreation.
    - Keep soil healthy and add mulch to prevent water loss through evaporation.
    - If watering with a hose, make sure it has a shut-off nozzle.
    - Water early in the morning to prevent water loss due to evaporation. Avoid watering when it is windy.
    - Use a rain barrel and cisterns to collect water for use in the landscape.
- If a sprinkler system is used, make sure it is properly set-up and maintained
    - Install and maintain a rain sensor, either wireless or wired, on the irrigation controller if it does not have one built-in.
    - Regularly inspect the sprinkler heads to make sure they are not damaged or malfunctioning.
    - Adjust sprinklers so they are not spraying water on paved surfaces such as the sidewalk or driveway.

Outside

- Sweep outdoor surfaces with a broom instead of using a hose
- Wash vehicles at a carwash that recycles its water
- If washing at home, make sure the hose has a shut-off nozzle

5.4 Wildlife & Habitat Conservation Practices

5.4.1 Streams & Salmon

The primary adaptation strategy for both streams and salmon habitat is to create greater resilience in the system to create a buffer during drought conditions such that streams, and the species they support, can withstand the impacts of drought (low flows, higher temperatures, decrease in water quantity and quality) while still providing functioning habitat to aquatic species, including salmon.

Ecology identifies a number of specific adaptation strategies. Several these are relevant in the context of adaptation strategies for both streams and salmon. See Ecology 2012 for a full list of adaptation strategies and actions. Those most relevant to this Drought Conservation Plan are reproduced below:

- Conserve sufficient habitat to support healthy fish, wildlife, and plant populations

- Promote habitat connectivity to allow for shifts in migratory patterns
- Restore floodplain connectivity
- Reduce pollution and contaminants
- Manage habitats and species to protect ecosystem functions

Several existing plans address adaptation strategies due to changing climate conditions, including drought. The following documents are listed in Mauger et al., 2015:

- The North Cascadia Adaptation Partnership (NCAP) is a science-management collaboration focused on climate change adaptation strategies in U.S. Forests and National Parks, including the Mount Baker-Snoqualmie National Forest, Okanogan- Wenatchee National Forest, Mount Rainer National Park, and North Cascades Complex National Park. Fish and fish habitat are one of the four focus sectors of NCAP for which adaptation strategies and tactics were developed based on three impact pathways. These impact pathways include increasing stream peak flows, decreasing low flows, and decreasing warming stream temperatures. For instance, adaptation strategies for mitigating the effects of increasing peak flows include restoring spawning habitat and removing migration barriers to enhance habitat resilience. (http://www.northcascadia.org/)
- The Swinomish Climate Change Initiative was a two-year project to identify vulnerability of the Swinomish Indian Tribal Community to climate change effects and prioritize planning areas to create an action plan. The Initiative was based on the 2007 Proclamation of the Swinomish Indian Senate to respond to climate change challenges. An Impact Assessment Technical Report and a Climate Adaptation Action Plan were published from the Initiative. The decline and degradation of upland wetland habitat, water quality, and streamflow were identified as medium-high freshwater risks. Adaptation strategies included in- stream and riparian enhancement. (http://www.swinomish-nsn.gov/climate_change/climate_main.html)
- The Washington State Integrative Climate Change Response Strategy (Ecology, 2012) developed a framework to aid decision-makers in state, tribal, and local governments; public and private organizations; and businesses to prepare for climate-related effects on natural resources and the economy. Climate change effects on freshwater streams included warming temperatures and lower summer stream flows. Adaptation strategies included managing freshwater withdrawals to maintain and restore stream flows and lake levels, restoring riparian zones, reconnecting rivers and floodplains, and taking early action to control non-native invasive species.
- The University of Washington's Climate Impact Group, in cooperation with the US Forest Service (USFS), is also working on a report entitled: Aquatic Ecosystem Management Under a Changing Climate in the Pacific Northwest: A Handbook for Managers. This guidebook builds on existing approaches to adaptation planning, and surveys of USFS aquatic habitat managers and scientists in the PNW, to develop a resource-specific guide for: 1) synthesizing information about climate effects to assess the sensitivity of aquatic habitats to climate change, 2) evaluating the resource's climate change-related adaptive capacity, 3) identifying priority planning areas, goals and actions related to preparing for climate change, and 4) developing measures of resilience to track progress and update plans over time.

In addition to these plans, in 2011, the USFS published "Responding to Climate Change in National Forests: A Guidebook for Developing Adaptation Options." This book provides a science-based approach to understanding the effects of climate change on national forest management practices. Sensitivity ranking of resources is recommended, followed by development and implementation of adaptation strategies. Adaptive management is used as a tool to adjust adaptation strategies as needed based on monitoring results.

Island County's nearshore habitats, including the freshwater streams that flow into this habitat, are utilized by juvenile salmonids for rearing and refuge. Protecting existing high quality habitat is a priority within the County. Streams are protected under both the County's Critical Areas Ordinance as well as under its Shoreline Master Program. Neither of these regulatory programs addresses drought adaptation strategies.

Island County's Water Resource Management Plan notes that "Surface water supplies can be significantly impacted by short term droughts" (Island County Water Resource Management Plan, 2005). In addition, the plan notes: "Island County's aquifers are susceptible to seasonal impacts of drought."

Policy recommendations for groundwater recharge, and water rights process improvements, were identified as high priorities within the County Water Resource Management Plan, along with protecting aquifers from seawater intrusion. While instream flow recommendations were also included, those recommendations are identified as low priority, as compared to other recommendations of the plan.

With respect to streams and stream flow, it is anticipated that drought conditions will lead to a shift in the hydrologic regime, including changes in flow magnitude and duration. Anticipated changes include lower summer flows and higher, more intense, and more frequent winter flows.

Adaptation strategies include planning and preparing for more frequent and severe flood events, managing increased upland water storage through a variety of means (catchment basins, beaver introduction where practicable), and maintaining or restoring flow regimes as a buffer against future changes.

Salmonid habitat protection in Island County occurs under both regulatory and non-regulatory arenas. The focus of both efforts is to inventory and prioritize nearshore and freshwater habitats, protect existing high quality nearshore and freshwater habitats, and restore critical rearing habitats for forage fish and for salmon.

Increased winter flows and decreased summer low flows are likely to adversely affect salmonid species by flushing out redds and juveniles rearing in freshwater. Adaptation strategies include creating spawning habitat resilience by restoring floodplain processes, structure, and function, and restoring habitat resilience by reducing threats from increased impervious surfaces and infrastructure within contributing watersheds.

Salmon habitat and species can also be adversely affected by summer low flows. Adaptation strategies to address summer low flows include increasing habitat resilience to summer low flows by restoring wetlands, improving floodplain connectivity, and restoring off-channel rearing and refuge habitat, as well as a variety of strategies aimed at understanding and restoring baseflow where it has been impaired.

5.4.2 Other Habitats

There is extensive research underway on the effects of drought due to climate change to a wide variety of habitats and species. The Climate Change Sensitivity Database, produced by the University of Washington and partners, summarizes the results of an assessment of the inherent climate-change sensitivities of species and habitats of concern throughout the Pacific Northwest. (http://www.climatevulnerability.org)

Those habitats and species that are most closely tied to aquatic environments, as well as those that are unable to shift in response to the effects of drought (e.g. wetland habitats and amphibian species, such as the western toad) are likely to be the most susceptible to the effects of climate change. In the face of these threats to habitat the USFS recommends ranking habitat and species sensitivity to threats, and managing those sensitive species, and their habitats, through restoration and protection to promote resilience in the face of change (USFS 2011). As the USFS document notes: “All effective approaches lead to the same end: understanding the influence of climate change on our natural resources and effective development of adaptation actions to address them.” (USFS 2011)

5.5 Groundwater Conservation Practices

Seventy-two percent of Island County residents rely on groundwater for domestic water supplies. As the only source of recharge for the island’s aquifers is rainfall, much of which runs off into Puget Sound, the groundwater resource is considered finite. The travel time for precipitation to reach the island’s aquifers is generally measured in decades, so drought conditions do not necessarily result in immediate water shortages for those who rely on groundwater. However, significant reductions in rainfall will eventually result in lowered water levels in aquifers. Even more significant will be the increased withdrawals associated with drought conditions, as people irrigate more to compensate for reduced rainfall.

The following are water conservation practices that can be implemented to conserve groundwater resources.

Reduce water usage

The primary impact to groundwater supplies during drought is the effect of increased withdrawals, so reducing water usage will be a crucial component of drought response efforts.

The Washington State Department of Health (DOH) regulates all public water systems having greater than 15 residential connections, known as Group A systems. As part of the approval process for these systems, DOH requires that the system operators prepare an ‘Annual Water Use Efficiency Report’. This report is intended to encourage system operators to maximize the efficiency of their water use, in part by proactively detecting leaking pipes and implementing fixes. DOH requires all Group A systems to install flow meters at all connections, as well as at the well head, to allow for effective leak detection.

While the annual report does not always specifically address leaks in the system, and the submission of the report is not always strictly enforced, these measures are meant to encourage water system operators to minimize water losses through leakage.

Island County also requires that individual wells have flow meters before approving them as potable water sources. This policy enables users to track their water use and aids in leak detection efforts.

In the future, it may be prudent to require more specific leak detection measures by water system operators. The annual reporting could be more strictly enforced, implementation of leak fixes could be made mandatory, and these measures could be expanded to include smaller, Group B water systems.

Water conservation efforts should include the following elements:

1. Installation of individual and source water meters, so that water system managers can monitor usage and detect leaks.
2. Implement rate structures that encourage water conservation. Many water systems either don't have metering, or charge flat rates regardless of usage.
3. Implement a leak detection and repair program. Proactive leak detection programs have been proven to be effective at reducing water demands.
4. Planning water use restrictions for drought periods in the water system's Operation and Maintenance Agreement. Every system should have a plan in place for response to supply limitations.
5. Undertake a concerted public education campaign to inform residents about the importance of conserving our groundwater resources, and how to reduce water consumption.

Water conservation should not be limited to a strategy employed only during severe water shortages or drought years. Even in those areas not currently experiencing quantity problems, the efficient use of water is a sensible approach to avoid future problems. This is especially true in Island County, given its finite ground water supply, and its designations as a Critical Water Supply Service Area and a Sole Source Aquifer.

Increase recharge rates

The potential for groundwater recharge varies significantly among different geographic areas on Whidbey. The Island County Critical Aquifer Recharge Area Map identifies area where high recharge rates can be expected, based on consideration of depths to groundwater, groundwater recharge rates, soil permeability, and permeability of geologic materials above the water table. Aquifers and aquitards in Island County vary spatially in both thickness and elevation. In any given area of the county, there may be several aquifers present, and each aquifer will have different hydraulic characteristics (recharge, pressure, capacity, etc.) and susceptibility to contamination from pollutants. Even within a single aquifer, the hydraulic characteristics can vary significantly from one location to another.

Low Impact Development involves designing developed landscapes that mimic the hydrologic properties of undeveloped landscapes. This means retaining more of the original soil and vegetation, and encouraging infiltration of stormwater, instead of conveying it off site. These methods result in lower stormwater flow rates downstream, and more stormwater recharging groundwater aquifers, as compared to more conventional “vault and pipe” stormwater systems, which are designed primarily for flood control. Detention ponds, grassy swales, rain gardens, and infiltration trenches are a few of the methods that can be used to maximize infiltration of stormwater.

More focused efforts to increase infiltration of stormwater might include collecting runoff in infiltration ponds. This would allow more time for water to soak into the soil, as well as creating saturated conditions, which maintain a constant head pressure on the water, which increases downward movement through the soil profile. Under unsaturated conditions, much of the water in the soil column is held too strongly to soil particles by the force of adhesion to move downward under the force of gravity.

Agricultural practices that maximize infiltration rates and soil water holding capacity are also important tools for increasing recharge rates. These practices are covered more thoroughly in Section 5.1.1, Soil Health Practices.

6.0 Technical Assistance and Potential Funding Sources

Local, regional and state resources are available to help provide education, planning and in certain situations, provide financial cost incentives to implement best management practices to mitigate and reduce impacts of drought.

6.1 Conservation Districts

CDs provide technical assistance (TA) through site visits as well as through extensive conservation planning. Resource concerns are determined through the TA and planning process where conservation practices are recommended to address the identified resource concerns. The district provides engineering and design specifications for the recommended conservation practices.

WICD offers a variety of additional resources to assist landowners to off-set costs to implement Best Management Practices (BMP’s) for water conservation and drought mitigation. One of these is to provide cost-share funds for BMP implementation, using funds from the Washington State Conservation Commission (WSCC). The cost-shared BMPs must be on the NRCS conservation practice list.

The cost-share rate is generally up to 75% of practice cost. The landowner is expected to cover 100% of the costs of implementing the practice up-front, and WICD will reimburse the cost-share amount when the practice is fully implemented, inspected, and certified to meet NRCS standards and specifications. Eligibility for District cost-share is limited by County, State and Federal regulations which are evaluated upon application. Projects are ranked through the WICD screening matrix to prioritize local projects. Funding requests for the WICD’s list of prioritized projects are sent to WSCC and projects are funded by WSCC as money becomes available. (This funding is made available by the WA State Legislature through capital funds appropriation to WSCC.) The landowner and WICD must sign a contract to set forth the cost-share and project implementation terms. One of these is that the implemented BMPs will be maintained by the landowner throughout their NRCS designated lifespans.

6.2 Municipal & County Programs

While Whidbey Island municipalities and Island County do not offer financial incentives to property owners to improve infrastructure for water conservation, they do provide outreach and education on water conservation. To incentivize water conservation, water districts and some municipalities use tiered rates.

For example, the Town of Coupeville changes their rate structure in the peak use months in the summer. As stated on the Town of Coupeville website as of June 2016, "For the average in-town residential customer, the base rate is $13.33 per month. There is an additional charge per cubic foot of water used. The rate October through May is $.0275 and June through September is $.0412. For the average out of town residential customer, the base rate is $20.00 per month. There is an additional charge per cubic foot of water used. The rate October through May is $.0412 and June through September is $.0618." http://www.town.coupeville.wa.us/department_files/water.htm

The City of Langley also applies tiered water rates based upon usage. As of June of 2016 for single family residential inside the city they use a base rate of $0.012 per gallon for the first 7,000 gallons on a two-month usage schedule, the rate decreases to $0.0056 per gallon from 7,001 to 30,000 gallons, but for uses over 30,000 gallons the rate increases above the base rate to $0.013 per gallon. Their rates are also higher for single family residential outside the city.
http://langleywa.org/City_of_Langley_2015_Utility_Rates.pdf

The City of Oak Harbor's also uses a tiered water rate schedule under which rates per unit increase at set usage levels as shown in the rate chart on their website:
https://www.oakharbor.org/uploads/documents/7854ord1587.pdf

Puget Sound Energy offers several rebate programs to encourage conservation of electricity. While many of these rebates are for reduction in hot water usage for electricity, at the same time, the rebates also encourage water conservation. http://energy.gov/savings/puget-sound-energy-residential-energy-efficiency-rebate-programs

6.3 NRCS programs

NRCS offers a number of voluntary conservation programs, as authorized by the federal Agricultural Act of 2014 (the 2014 Farm Bill). These programs provide benefits to both the environment and to agricultural producers. NRCS categorizes them as financial assistance programs, easement programs, a partnership program, and other programs. Many of the NRCS programs may be of particular benefit in times of drought. Each program, by category, is summarized below, together with interpretations on its potential benefits in times of drought on Whidbey Island. The reader is referred to the "USDA NRCS 2014 Farm Bill: All Farm Bill 2014 Programs" web link in the Bibliography for more detailed information.

6.3.1 Financial Assistance Programs

These programs provide financial and technical assistance to agricultural producers to help them implement and maintain conservation practices on their lands.

Agricultural Management Assistance Program (AMA)

This program helps agricultural producers to use natural resource conservation to manage risks and address resource conservation issues. NRCS administers the conservation provisions of this program, while other provisions are administered by the USDA Agricultural Marketing service and the USDA Risk Management Agency. AMA provides conservation technical and financial assistance to agricultural producers to mitigate risks by improving water management, constructing irrigation structures, establishing windbreaks, controlling soil erosion, and improving water quality. AMA is currently available only in 16 states where participation in the Federal Crop Insurance Program has been historically low. Washington is not among these states as of June 2016.

If AMA becomes available in Washington in the future, this program could be effective at helping to reduce the negative economic and environmental effects of drought on Whidbey Island. However, many of the technical and financial assistance benefits of AMA are currently available in Washington through the Environmental Quality Incentives Program.

Environmental Quality Incentives Program (EQIP)

This program helps agricultural producers by providing them with financial and technical assistance to implement practices to address natural resource concerns and secure environmental benefits. Benefits include improved water and air quality, conserved surface water, reduced soil erosion, improvement of wildlife habitat, and many others. EQIP financial assistance typically covers about 50 percent of the costs for implementation of conservation practices, and may under some circumstances be used for activities like conservation planning. EQIP assistance is provided to eligible agricultural producers on a competitive basis through multi-year contracts.

EQIP can be very effective at providing agricultural producers with financial and technical assistance for implementing conservation practices to help reduce the negative economic and environmental effects of drought on Whidbey Island. There has been little use of EQIP funding for conservation planning on individual agricultural operations in Washington, but funding of individual operation conservation plans that are focused on drought resiliency could potentially be very helpful here. Conservation planning by NRCS is often associated with specific EQIP contracts.

Conservation Stewardship Program (CSP)

This program helps agricultural producers to maintain and improve their existing conservation practices, and to adopt additional conservation activities to address NRCS identified priority resource concerns. CSP participants enter into five year contracts, and receive two kinds of payments:

- They receive annual payments for implementing new conservation practices and maintaining existing practices.

- They receive supplemental payments for adopting resource-conserving crop rotations.

Program applicants complete a self-screening checklist. Applications are evaluated relative to others addressing similar priority resource concerns, and are competitively ranked within the state for program participation.

CSP could offer effective financial assistance for implementing and maintaining conservation practices to reduce the negative economic and environmental effects of drought on Whidbey Island if NRCS identifies drought related priority resource concerns on which to rank the applications.

Easement Programs

These programs are designed to use easements or contracts to assist eligible partners and participants to conserve working agricultural lands, wetlands, grasslands, and forestlands.

Agricultural Conservation Easement Program (ACEP)

This program uses easements or contracts, and financial and technical assistance, to help conserve working agricultural lands and wetlands. This program has two components:

- The Agricultural Land Easements component NRCS provides tribes, state and local governments, and non-governmental organizations with up to 50 percent of the funding for purchasing easements to prevent conversion of working agricultural lands to non-agricultural uses.
- The Wetlands Reserve Easements component provides NRCS funding directly to private landowners and tribes to purchase wetland easements (or in the case of tribal lands to enter into contracts) and to restore, protect, and enhance wetlands. Depending on the type of easement or contract, NRCS pays between 50 and 100 percent of the restoration costs.

ACEP cannot directly help with the implementation or maintenance of conservation practices to reduce the negative economic and environmental effects of drought on working agricultural lands on Whidbey Island. However, at the discretion of the participants, the easement or contract payments could be used for these purposes, or for other purposes that help them to resist the consequences of drought.

Healthy Forests Reserve Program (HFRP)

This program uses easements, contracts, and cost-share agreements to help landowners to restore, enhance, and protect their private or tribal forest lands. HFRP is designed to promote the recovery of threatened and endangered species, improve biodiversity, and enhance carbon sequestration.

HFRP easement payments do not directly help with the implementation or maintenance of conservation practices to reduce the negative economic and environmental effects of drought on working agricultural lands on Whidbey Island. However, participants may at their discretion use easement payments to help fund these practices. In addition, contracted cost-share payments through this program can be applied directly to forest practices, such Forest Stand Improvement, that can help to reduce the negative economic and environmental effects of drought.

Partnership Program

The Regional Conservation Partnership Program (RCPP) allows NRCS to leverage or magnify the benefits of its conservation assistance to agricultural producers and landowners in priority conservation areas by working with partners who provide additional conservation assistance. However, eligibility for funding under this program is restricted to three funding categories. These are nationally designated critical conservation areas (CCAs); nationwide and multi-state projects; and state projects that meet state designated priorities. The Precision Conservation for Salmon and Water Quality in the Puget Sound project was funded for nine million dollars over a five-year period under a National Funding Pool in 2015. The priority purpose is to improve water quality and habitat for species, including Chinook salmon, bull trout, and steelhead.

There is potential that this project could be used to effectively on a specific watershed basis to reduce the negative economic and environmental effects of drought on working agricultural lands on Whidbey Island.

6.3.2 Other Programs and Resources (Farm Bill and non-Farm Bill)

Agriculture Conservation Experienced Services (ACES)

This program allows nonprofit organizations that have specific agreements with NRCS to hire experienced workers, age 55 and older to help NRCS to provide technical services in support of conservation.

ACES cannot directly help with the implementation or maintenance of conservation practices to reduce the negative economic and environmental effects of drought on working agricultural lands on Whidbey Island. However, it may be able to assist NRCS to deliver other programs that could help to reduce these drought effects.

Conservation Innovation Grants (CIG)

NRCS awards Conservation Innovation Grants on a competitive basis to stimulate the development and adoption of innovative approaches and technologies for conservation on agricultural lands. NRCS uses funding from EQIP to pay for these grants. These grants can be awarded to individuals, tribes, nongovernmental organizations, and non-federal government organizations. Agricultural producers who participate in projects funded from the CIG grants must be EQIP eligible.

Properly designed conservation innovation grant projects funded by NRCS could be very effective at providing agricultural producers with innovative approaches and technologies to help reduce the negative economic and environmental effects of drought on Whidbey Island. In areas where there are municipal waste water systems that discharge into Puget Sound that are near production agricultural lands, there are opportunities for re-using treated waste water for supplemental agricultural irrigation. (https://fortress.wa.gov/ecy/publications/documents/0510013.pdf)

Emergency Watershed Protection Program (EWP)

This program is used by NRCS to address emergencies caused by natural disasters, including drought. To be eligible for EWP the disaster must be an imminent hazard to life and property, and be declared an emergency by the President, Secretary of Agriculture, or State Governor. In addition, there must be a project sponsor that is a unit of state or local government or a tribe. For selected projects NRCS pays a share of the construction cost of emergency measures and/or purchases flood plain easements on eligible lands.

For drought circumstances directly causing, or indirectly resulting in, an emergency of imminent hazard to life and property, and meeting the other criteria in the above paragraph, EWP could potentially help to reduce the negative economic and environmental effects of drought on Whidbey Island.

Watershed Rehabilitation Program (Rehab)

This program addresses critical public health and safety concerns by helping project sponsors to rehabilitate aging dams that are reaching the end of their 50-year design lives. Under some circumstances involving drought, the program may allow sponsors to create new, or add to, existing water supplies. When a potential rehabilitation project is identified, local sponsors request NRCS Rehab funding. NRCS selects projects to fund under the program based on risks to lives and property should a dam failure occur, and other factors.

Rehab could potentially be used on Whidbey Island if the above criteria are met. In particular, it could help to address the negative economic and environmental effects of drought if it can indeed be used to create new, or add to existing water supplies.

Technical Service Providers (TSP)

TSPs are individuals, private businesses, nonprofit organizations, and public agencies that are certified by NRCS to be able to provide technical assistance to agricultural producers to plan and apply conservation practices.

While TSP assistance does not help to pay actual construction costs, the provided technical assistance could be helpful to reduce the negative economic and environmental effects of drought on Whidbey Island especially where this technical assistance could facilitate implementation of practices under a financial assistance program such as EQIP.

Voluntary Public Access and Habitat Incentive Program (VPA-HIP)

This is a competitive grants program that helps state and tribal governments to increase public access to private land for fishing, hiking, nature watching, and similar wildlife related recreation activities. Private farm and forest land owners are eligible to enter into access and funding agreements under the state or tribal grants.

It is unclear how this program could directly be helpful to reduce the negative economic and environmental effects of drought on Whidbey Island. However, payments received by land owners under this program could be used to indirectly reduce some of these negative effects.

6.4 Washington Department of Ecology

Ecology works closely with Washington communities to provide effective water management and to ensure future water availability for people, fish, and the natural environment. In 1992, Ecology developed the Drought Contingency Plan that provides a process for monitoring water supply conditions, anticipating potential drought problems, mobilizing local, state and federal resources and responses to drought conditions, and providing relief and assistance to those seriously affected by drought to minimize the overall impacts.

The goals of the Drought Contingency Plan are to aid agriculture producers, protect public water supplies, safeguard fish and stream flows, and maintain critical energy supplies. This is accomplished through funding drought relief projects, issuing emergency drought water right permits, curtailing junior water users, and boosting stream flows.

Ecology issued a 2015 Drought Response Summary Report that stated the following:

- Drought conditions have abated, but due to current strong El Niño conditions, Ecology is closely monitoring water supply conditions to be prepared to respond if needed.
- It has been a decade since our state's last drought. To be better prepared for the next drought, the state is updating our drought contingency plan.
- Although we did not measure a specific impact from the drought to groundwater levels, more extensive monitoring has identified significant groundwater level declines in several areas of the state, primarily in the Columbia River basin.
- Planning for climate change should use the lessons learned from this year's drought to identify potential impacts, needs and uncertainties. Successfully adapting to changes may be required to protect our state's farms, communities, and natural environment. https://fortress.wa.gov/ecy/publications/documents/1611001.pdf

Governor's Climate Change Action Plan

Washington State's Integrated Climate Change Response Strategy, "Preparing for a Changing Climate" lays out a framework and discusses policies that build capacity to respond and adapt to climate change. It also provides recommendations for state agencies to increase efforts and partner with local and tribal governments, private and public organizations, and individuals to reduce vulnerability to climate change impacts. The plan addresses improved water management for agriculture, fish, and residential needs and reducing forest and agriculture vulnerability.

Strategies identified in the plan include:

- Protection and preservation of groundwater through stronger regulation of homestead (permit-exempt) wells
- Encouragement and support for the reclamation and reuse of wastewater
- Encouragement of water conservation
- Development of new water supplies

7.0 Outreach & Education

Much of the efforts to plan for and mitigate effects of drought rely on the involvement and participation of members of each community. Whether people are urban residents, business owners, farmers, or owners of forest land, effective drought management begins at the scale of individual land units. By understanding potential impacts and strategies, each of us can make choices and take actions that help ensure adequate water supplies for all of Whidbey Island's needs.

7.1 Agriculture Community

WICD and Island County Washington State University (WSU) Extension are two organizations that provide information and education to Whidbey farmers and gardeners. These organizations provide education through a variety of venues including classes, workshops, and conferences, as well as one-on-one site visits and on-line information.

Topics for educational programs related to drought include irrigation design, soil and plant health, plant selection, crop rotation, use of low-drill and no-drill techniques, and others (see Appendix). Farm tours can be used to demo strategies that are working on local farms.

On a larger scale, the farm community and local organizations have initiated discussions about possible programs to reuse treated wastewater and to collect, store, and reuse excess stormwater that floods agriculture fields during winters with heavier than normal rainfall.

7.2 Forest Community

Forest stewardship courses have been educating local forest land owners for several years about managing forests for health and production. The Firewise program is another tool for educating landowners about strategies to keep their forests healthy and reducing fire risk for both forests and structures. Continuing these types of educational opportunities along with assisting landowners with the development of forest management plans will provide opportunities to educate more landowners about drought effects and management tools.

Whidbey Island has many absentee landowners of forest lands. Outreach efforts could be expanded to better engage these owners to the risks of drought, including wildfire, to their properties.

7.3 Residential & Urban Communities Outreach

There are many avenues to provide outreach about drought issues to residential and urban communities. Local jurisdictions provide information at public events, through utility billings, and through local media outlets. Many partners collaborate to provide information and education through events and informational materials. Additional collaborations could build on information currently available to increase awareness and engage communities through effective social marketing.

Topics of high priority include encouraging water conservation inside and outside the home using practices such as those outlined in Section 5.3. Programs can be targeted to families, school children, and social organizations.

7.4 Outreach Tools

Modern technology provides for multiple types of tools to reach diverse audiences. As mentioned earlier, classes, workshops, and tours are common ways to raise awareness and provide information. Social media, including webpages, online videos, webinars, and social internet programs are becoming increasingly effective tools for communicating ideas and information.

WICD is developing a webpage dedicated to hosting information about drought conditions, planning efforts, management strategies, and resources. As part of future phases of developing a comprehensive drought plan for Whidbey Island and Island County, additional outreach tools and collaborative programs will be developed.

8.0 Conclusions & Next Steps

Drought conditions affect a wide range of resources in both urban and rural settings, including ground water and surface water resources, residential and urban landscapes, agriculture production, forest health and production, and risk of wildfire.

Whidbey's sole source aquifer status for approximately 70% of the island's population requires that protection and management of groundwater resources be a very high priority. Uses of groundwater on the island include household use, commercial businesses, and irrigation in urban, rural and agriculture settings.

While regional climate models project that the total annual precipitation will likely remain near normal under future conditions, the seasonal distribution and intensity may change such that even less precipitation occurs during our typical low rainfall summer season, while winter season rainfalls become more intense. This could generate increased runoff rates which in turn results in reduced infiltration to soils and groundwater aquifers.

Meanwhile, potentially warmer and drier summers typically result in increased use of irrigation to maintain landscapes, gardens, and agriculture. The island's growing population will increase demands for groundwater.

For many resources, there are no options to use groundwater to offset drought conditions. These include most of the Island's agriculture lands, forest lands, and natural areas, including wetlands and streams. These resources are important to the Island's economy and health in support the vitality of our communities now and into the future.

Fortunately, many strategies are available to both manage groundwater resources and mitigate impacts of drought on other resources. This preliminary drought plan identifies many such strategies included under the following categories:

- Agriculture Conservation Practices
- Forest Conservation Practices
- Residential Water Conservation Practices
- Wildlife Habitat Conservation Practices
- Groundwater Conservation Practices

An essential part of implementing drought management planning and measures is to engage the community, both rural and urban, to participate. To engage different segments of the population, collaboration between partner organizations and landowners will be an important tool.

Next steps

The overall goal of drought management is to protect and achieve improvements as needed in natural resource conditions during drought and to provide for the long-term sustainability of resource lands. To move the Whidbey Island Drought Conservation Plan forward, future efforts will include the following steps:

- Identify and set goals for Whidbey Island resource conditions
- Identify programs and resources needed to achieve the identified goals,
- Develop proposals and recommendations to achieve the identified goals
- Implement solutions
- Measure their success during drought years.

These steps will be accomplished collaboratively engaging Whidbey Island landowners and residents; WICD, and our local, state and federal partners.

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6.0 Technical Assistance and Potential Funding Sources

USDA NRCS. 2014. Farm Bill: All Farm Bill 2014 Programs. Available from: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/farmbill/?cid=stelprdb1244022

Appendix – Table of NRCS Conservation Practices & Example Drought Applications

Table of NRCS Conservation Practice Names and Example Drought Applications

This table presents the names, numbers, general benefit categories, brief descriptions, and example drought applications for some NRCS conservation practices selected for their potential to address drought related resource concerns. Some practices not included here may also be of benefit in times of drought. The full list of NRCS conservation practices, along with much more comprehensive information about each practice is presented in Section IV of the NRCS Field Office Technical Guide for Island County.
https://efotg.sc.egov.usda.gov/efotg_locator.aspx?map

Conservation Practice Name & Number	Soil Health	Irrigation	Water Storage & Re-Use	Other Crop & Pasture	Forest	Residential & Urban	Wildlife & Fish Habitat	Ground-water
Access Control (472)	X	X	X	X	X		X	
Temporarily or permanently excluding animals, people, vehicles, and/or equipment from an area. The exclusion is designed to achieve and maintain desired resource conditions for a wide variety of purposes. Example drought applications: • It could address soil sheet and rill or wind erosion by keeping livestock or equipment off of a sensitive slope to maintain or improve protective vegetative cover. • It could address wildfire hazard by keeping people out of an area of forest with large amounts of very dry fine fuels when temperatures are high, to reduce chances of ignition.								
Access Road (560)	X	X	X	X	X		X	
Establishing a route for equipment and/or vehicles. It provides a permanent seasonal or all-weather route for vehicular travel needed for management of crops, timber, livestock, wildlife habitat, and other conservation enterprises. Example drought applications: • It can reduce wildfire hazard by providing needed access to a forest stand for tree thinning or fire break maintenance. • It can provide access to a facility or structure needed for irrigation in order to prevent or reduce drought-caused crop loss.								
Alley Cropping (311)	X			X	X		X	
Planting of rows of trees or shrubs in alternation with agronomic, horticultural crops, or forages produced in the alleys between the rows of woody plants. Example drought applications: • It can reduce sheet and rill erosion when aligned across the slope, or wind erosion when aligned across the predominant wind direction. • It can improve soil health by increasing utilization and cycling of nutrients.								

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<tr><th>Conservation Practice Name & Number</th><th>Soil Health</th><th>Irrigation</th><th>Water Storage & Re-Use</th><th>Other Crop & Pasture</th><th>Forest</th><th>Residential & Urban</th><th>Wildlife & Fish Habitat</th><th>Ground-water</th></tr>
<tr><td>Brush Management (314)</td><td>X</td><td></td><td></td><td>X</td><td>X</td><td></td><td>X</td><td>X</td></tr>
<tr><td colspan="9">Removing or managing woody plants, including those that are invasive and noxious. Example drought applications:
• It can remove or reduce competition from brush to crops or other desired vegetation in order to increase plant productivity, increase herbaceous cover to protect soils and control erosion.
• It can reduce wildfire hazard by reducing woody biomass accumulation.</td></tr>
<tr><td>Conservation Cover (327)</td><td>X</td><td></td><td></td><td>X</td><td></td><td></td><td>X</td><td></td></tr>
<tr><td colspan="9">Establishing and maintaining permanent vegetative cover. It does not apply to plantings for forage production or for critical area plantings, both of which are separate practices. It can be applied to a portion of a field. Example drought applications:
• It can reduce sheet, rill, and wind erosion by providing more consistent erosion resistant cover on the soil through the year.
• It can address wildlife habitat by providing a variety of food and cover.</td></tr>
<tr><td>Conservation Crop Rotation (328)</td><td>X</td><td></td><td></td><td>X</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="9">Planting a planned sequence of crops on the same ground over a period of time. Example drought applications:
• Corn (which is highly productive but tends to deplete soil organic matter over time) might be grown in rotation with a mixture of alfalfa and grass (which add to soil organic matter and soil nitrogen, and improves water holding capacity).
• Alternating the crop grown from year to year can reduce plant pest pressure by breaking the life cycles of crop specific pests.</td></tr>
<tr><td>Contour Buffer Strips (332)</td><td>X</td><td></td><td></td><td>X</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="9">Planting narrow strips of permanent, herbaceous vegetative cover on the slope contour, and alternated with wider strips of crops that are also farmed on the contour. Example drought applications:
• They can reduce sheet and rill erosion by reducing the effective erodible slope length.
• They can reduce plant pest pressure by interrupting the spacial continuity of a pest susceptible crop on the landscape.</td></tr>
<tr><td>Contour Orchard and Other Perennial Crops (331)</td><td>X</td><td>X</td><td></td><td>X</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="9">Planting orchards, vineyards, or other perennial crops so that all cultural operations are don on or near the slope contour. Example drought applications:
• It can reduce sheet and rill erosion by increasing the effective slope length between rows of trees or vines.
• It can improve water use efficiency by slowing the flow of surface water and increasing opportunity time for its infiltration into the soil.</td></tr>
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<tr><td>Cover Crop (340)</td><td>X</td><td>X</td><td></td><td>X</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="9">Planting grasses and/or legumes for seasonal vegetative cover during periods when the soil surface would otherwise be largely bare. Example drought applications:
• It can reduce sheet and rill erosion by providing protective vegetative cover on fields that would otherwise be bare during the rainy season.
• It can maintain or improve soil health, organic matter content, and fertility, and improve water holding capacity.</td></tr>
<tr><td>Critical Area Planting (342)</td><td>X</td><td></td><td></td><td>X</td><td>X</td><td>X</td><td>X</td><td></td></tr>
<tr><td colspan="9">Establishing permanent vegetative cover in areas that have particularly high erosion rates, and/or in areas where physical, chemical or biological conditions prevent vegetative establishment through less intensive practices. Example drought applications:
• It can reduce sheet, rill, and wind erosion by providing protective soil cover.
• It can improve water quality by reducing sediment and turbidity.</td></tr>
<tr><td>Cross Wind Ridges (588)</td><td>X</td><td>X</td><td></td><td>X</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="9">Creating ridges by tilling, planting, or other means, that are aligned across the prevailing wind direction during periods when the threat of wind erosion is high. Example drought applications:
• They can reduce wind erosion during these periods by increasing soil roughness.
• They can help to preserve soil organic matter, which is subject to loss from wind erosion, and thereby preserve soil water holding capacity.</td></tr>
<tr><td>Cross Wind Trap Strips (589C)</td><td>X</td><td>X</td><td></td><td>X</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="9">Establishing strips of perennial or annual herbaceous cover that is resistant to the effects of wing erosion across the direction of most erosive winds. These strips typically alternate with strips of crops less resistant to wind erosion, or that are bare ground during periods of wind erosion. Example drought applications:
• They can reduce wind erosion by reducing the unsheltered distance between the relatively wind erosion resistant strips.
• They can improve plant productivity and health by protecting plants from damaging saltation (wind induced sand blasting at or near the soil surface).</td></tr>
</table>

Conservation Practice Name & Number	Soil Health	Irrigation	Water Storage & Re-Use	Other Crop & Pasture	Forest	Residential & Urban	Wildlife & Fish Habitat	Ground-water
Drainage Water Management (554)	X	X	X	X			X	
Managing water discharges from surface and/or subsurface agricultural drainage systems. This practice essentially allows farmers to control when their drainage systems are functioning. Example drought applications: • This practice can enable retention of some of the drainage water in the soil for a period of time so it can be used to relieve drought stress on crop and pasture species, thereby improving plant productivity and health. • It can also reduce soil organic matter losses due to oxidation, reduce discharges of nutrients and other pollutants to receiving surface waters, and provide seasonal wildlife habitat.								
Farmstead Energy Improvement (374)		X	X	X	X	X	X	
Developing and implementing improvements to energy efficiency or otherwise reducing on-farm energy use. Example drought applications: • This practice allows operators to retain the drainage water within the soil for a period of time, to relieve drought stress on crop or pasture species and thereby improve their productivity and health. • It can also help to maintain soil organic matter, reduce nutrient and pathogen discharge to receiving surface waters, and provide seasonal wildlife habitat.								
Fence (382)	X	X	X	X	X	X	X	X
Constructing a barrier of posts, wire, and/or other materials to control movement of animals or people, including vehicles. Fences generally do not address resource concerns by themselves, but rather as they facilitate the implementation of other conservation practices. Example drought applications: • They can control grazing animal movement to support implementation of practices such as Access Control, Critical Area Planting, or Prescribed Grazing to reduce soil erosion and increase vegetative productivity. • They can facilitate improvement of fish and wildlife habitat by keeping animals and people out of areas where a variety of habitat improvement practices are being implemented.								

Conservation Practice Name & Number	Soil Health	Irrigation	Water Storage & Re-Use	Other Crop & Pasture	Forest	Residential & Urban	Wildlife & Fish Habitat	Ground-water
Field Border (386)	X	X		X			X	
Establishing a strip of permanent vegetation around the perimeter of or along the edge of a field. Example drought applications: • They can reduce sheet, rill, or wind erosion by reducing the unprotected slope length or unsheltered distance over which water or wind can cause erosion. • They can add to soil organic matter by the process of deposition, and reduce organic matter losses resulting from erosion, thereby helping to improve or maintain soil water holding capacity.								
Filter Strip (393)	X	X		X		X	X	
Establishing a strip of herbaceous vegetation that is intended to remove suspended solids and other contaminants from flowing surface water. Example drought applications: • They can add to soil organic matter by the process of deposition, and reduce organic matter losses resulting from erosion, thereby helping to improve or maintain soil water holding capacity. • They can help to reduce excessive sediment in surface waters by filtering out sediment.								
Firebreak (394)					X			
Install a permanent or temporary strip of bare ground or relatively fire resistant vegetation designed to resist the spread of wildfires or contain prescribed burns. Example drought applications: • The hazard of wildfires is often much greater during times of drought. Firebreaks reduce losses to forest productivity and health by retarding the spread of wildfires and containing prescribed burns. • They can be used to reduce the air quality effects of particulate emissions and greenhouse gases resulting from wildfires.								
Forage and Biomass Planting (512)	X			X	X		X	
Establishing adapted, compatible species, varieties, or cultivars of herbaceous species for pasture, hay, or other biomass production. Example drought applications: • Successful plantings can reduce the negative effects of drought on livestock feed and forage supplies by increasing the quality and quantity of feed and forage produced. • Successful plantings can reduce sheet, rill, and wind erosion by increasing the effectiveness of soil cover.								

Conservation Practice Name & Number	Soil Health	Irrigation	Water Storage & Re-Use	Other Crop & Pasture	Forest	Residential & Urban	Wildlife & Fish Habitat	Ground-water
Forest Stand Improvement (666)					X		X	
Manipulating species composition, stand structure, and stocking by cutting or killing selected trees and understory vegetation. Example drought applications: • Drought stress reduces tree vigor and productivity, and thereby reduces the ability of trees to defend themselves against forest pest organisms. Thinning of trees and understory allows remaining trees to make better use of soil moisture and other resources to improve growth, forest health, and pest resistance, restore natural plant communities, and alter water yield. • Reduced fuel moisture and frequently hot and dry air conditions greatly increases the risk of damaging wildfires during times of drought. This practice reduces excessive biomass accumulation to reduce wildfire hazard.								
Fuel Break (383)					X			
A fuel break is similar to a firebreak with an added focus on reducing or removing debris and detritus to control or diminish the spread of fire crossing the strip or block of land.								
Grassed Waterway (412)	X			X		X		X
Establishing a channel with a broad and shallow cross section that is vegetated by grass and/or other suitable vegetation to convey surface water at a non-erosive velocity to a stable outlet. Example drought applications: • They can help to reduce soil loss due to sheet, rill, and concentrated flow erosion by slowing and spreading the flow of water over a larger area. • They can reduce excessive sediment in surface waters by slowing the rate of flow and filtering out sediment.								
Hedgerow Planting (422)	X			X			X	
Establishing single or multiple densely planted rows of shrubs or small trees to achieve a conservation purpose. Example drought applications: • Drought causes stress to crops and other plants that can make them more susceptible to damage from plant pest species. Hedgerow Plantings can interrupt the continuity of pest susceptible crop monocultures, and provide cover for birds and other animals that help to control many plant pest species. • They can provide food and cover habitat elements for a variety of wildlife and fish species.								

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<tr><td>Herbaceous Weed Control (315)</td><td>X</td><td></td><td></td><td>X</td><td>X</td><td>X</td><td>X</td><td></td></tr>
<tr><td colspan="9">Removing or controlling herbaceous weeds, including noxious species. Example drought applications:
• Drought reduces the abilities of crop and forage species to compete effectively with herbaceous weeds for water, nutrients, and light. Controlling or removing these weeds can allow the crop and forage species to better utilize available resources to increase or maintain their productivity.
• Competition from weedy species often results in greater amounts of bare ground that make the soil more susceptible to sheet, rill, and wind erosion. Control of these weeds helps to promote an increase in vegetative cover that helps to protect soils from erosion.</td></tr>
<tr><td>Irrigation Pipeline (430)</td><td></td><td>X</td><td>X</td><td>X</td><td></td><td></td><td></td><td>X</td></tr>
<tr><td colspan="9">Installing a pipeline and appurtenances to convey water for storage or field application, as part of an irrigation water system. Example drought applications:
• Replacing an irrigation ditch with a pipeline generally improves the efficiency of water use.
• Urban and rural growth is associated with increases in impermeable areas such as roofs and transportation infrastructure. Subsequent stormwater events then cause unnatural levels of seasonal ponding. This practice can be used to transport some of this excess stormwater to impoundments where it can later be used for irrigation.</td></tr>
<tr><td>Irrigation Reservoir (436)</td><td></td><td>X</td><td>X</td><td>X</td><td></td><td></td><td></td><td>X</td></tr>
<tr><td colspan="9">Installing an irrigation water storage structure by pit, embankment, pit, or tank. Example drought applications:
• Urban and rural growth is associated with increases in impermeable areas such as roofs and transportation infrastructure. Subsequent stormwater events then cause unnatural levels of seasonal ponding. This practice can be used to store some of this excess stormwater where it can later be used for irrigation.
• It can be used to provide retention time to increase breakdown of pollutants accumulated by stormwaters.</td></tr>
</table>

Conservation Practice Name & Number	Soil Health	Irrigation	Water Storage & Re-Use	Other Crop & Pasture	Forest	Residential & Urban	Wildlife & Fish Habitat	Ground-water
Irrigation System, Micro-irrigation (441)		**X**	**X**	**X**	**X**	**X**	**X**	
Installing an irrigation system on or below the soil surface for frequent application of small quantities of water as drops, tiny streams, or miniature spray through emitters or applicators placed along a water delivery line. Example drought applications: • Drip irrigation or other types of Micro-irrigation are generally more efficient than sprinkler systems, as the water is delivered to individual plants right where it is needed. This can provide maximum benefits from limited amounts of irrigation water. • It can be very helpful for establishing vegetative practices to address the effects of drought, such as providing water for establishment of a windbreak to reduce wind erosion.								
Irrigation Water Management (449)		**X**	**X**	**X**				
Determining and controlling the volume, frequency, and application rate of irrigation water to meet desired objectives, such as irrigation water use efficiency. Example drought applications: • Irrigation efficiency requires both good system efficiency and good application efficiency. This practice implements procedures to achieve good application efficiency, thereby improving the benefits from limited water supplies. • This practice should allow available irrigation water to benefit more acres, and thereby improve crop yields, including feed and forage for livestock.								
Livestock Pipeline (516)	**X**			**X**	**X**		**X**	
Installing a pipeline and appurtenances to convey water for livestock or wildlife. Example drought applications: • This practice can deliver drinking water to improve wildlife habitat in previously dry areas. • It can provide drinking water to livestock to enable them to graze areas that previously could not be grazed due to water unavailability. This can facilitate rest from grazing in other areas in order to improve plant condition and productivity.								
Mulching (484)	**X**	**X**		**X**	**X**	**X**	**X**	
Applying plant residues (or other suitable materials produced off site) to the soil surface. Example drought applications: • Mulching can protect soils from sheet, rill, and wind erosion • It can reduce emergence of weedy species and thereby reduce excessive pest pressure.								

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<tr><td>Nutrient Management (590)</td><td>X</td><td></td><td></td><td>X</td><td>X</td><td>X</td><td>X</td><td></td></tr>
<tr><td colspan="9">Managing the amount, source, placement, and timing of application of plant nutrients and soil amendments. Example drought applications:
• Nutrient Management can budget, supply, and conserve nutrients for plant production, and thereby increase crop and forage productivity and health.
• It can help to maintain or improve the physical, chemical, and biological condition of soils, both through increased growth of soil building species like grasses, and through direct addition of organic matter in the case of manure or compost application.</td></tr>
<tr><td>Pond (378)</td><td>X</td><td></td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td colspan="9">Installing a water impoundment by constructing an embankment, by excavating a dugout, or a combination of both. (Such a structure that is intended to store water for irrigation may more appropriately be considered an Irrigation Reservoir.) Example drought applications:
• Ponds can store water for livestock and wildlife, and for fire control.
• They can be used to provide retention time to increase breakdown of pollutants accumulated by stormwater.</td></tr>
<tr><td>Pond Sealing or Lining (521)</td><td>X</td><td></td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td colspan="9">Installing a treatment or lining material to reduce seepage losses from Ponds and Irrigation Reservoirs. A variety of treatments or liners can be used, including bentonite sealant, soil dispersant, compacted clay, bentonite sealant, and flexible membrane. Example drought applications:
• This practice can reduce water losses from leaking Irrigation Reservoirs to improve water storage efficiency for irrigation and related purposes.
• It can reduce water losses from leaking Ponds to improve water storage efficiency for livestock and wildlife, and for fire control.</td></tr>
<tr><td>Prescribed Grazing (528)</td><td>X</td><td>X</td><td></td><td>X</td><td>X</td><td></td><td>X</td><td></td></tr>
<tr><td colspan="9">Grazing and/or browsing according to a plan or prescription to manage plant species composition and production. Example drought applications:
• This practice can improve the supply of feed and forage for both livestock and wildlife.
• It can increase the continuity of plant cover to reduce sheet, rill, and wind erosion.</td></tr>
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Conservation Practice Name & Number	Soil Health	Irrigation	Water Storage & Re-Use	Other Crop & Pasture	Forest	Residential & Urban	Wildlife & Fish Habitat	Ground-water
Pumping Plant (533)		X	X	X	X	X	X	X
Installing a facility to deliver water at a designated pressure and flow rate. This includes pump, associated power units, plumbing and appurtenances, and possibly energy sources and protective structure. Example drought applications: • This practice can help to provide sufficient water to improve efficiency of moisture management. • It can contribute to improvement of plant health and productivity.								
Residue and Tillage Management, No Till (329)	X	X		X				
Limiting soil tillage or disturbance to manage the amount, orientation, and distribution of plant residue on the soil surface year round. Crop residues are left in place following harvest, and the following crop is seeded into the residue using special equipment such as a no till drill. Example drought applications: • Increased plant residues on the soil surface reduce sheet, rill, and wind erosion, and may improve soil organic matter and moisture relations. • Fewer equipment passes on the soil improves energy use efficiency and reduces greenhouse gas emissions.								
Residue and Tillage Management, Reduced Till (345)	X	X		X				
Reducing soil tillage or disturbance to manage the amount, orientation, and distribution of plant residue on the soil surface year round. Tillage is reduced compared to past practices, but does not meet the criterial for No Till. Example drought applications: • Increased plant residues on the soil surface reduce sheet, rill, and wind erosion, and may improve soil organic matter and moisture relations. • Fewer equipment passes on the soil improves energy use efficiency and reduces greenhouse gas emissions.								
Riparian Forest Buffer (391)	X			x	x	x	x	
Establishing a strip or area of vegetation dominated by trees and/or shrubs that is adjacent to streams or other water bodies. Example drought applications: • This practice can help to reduce excessive sediment from reaching a stream, and by shading, can reduce water temperatures. • It can improve cover and food elements of wildlife and fish habitat.								

Conservation Practice Name & Number	Soil Health	Irrigation	Water Storage & Re-Use	Other Crop & Pasture	Forest	Residential & Urban	Wildlife & Fish Habitat	Ground-water
Riparian Herbaceous Cover (390)	X			X	X	X	X	
Establishing a strip or area of grasses, sedges, rushes, ferns, legumes, and forbs that is tolerant of intermittent flooding or soil saturation, and that is adjacent to streams or other water bodies. Example drought applications: • This practice can improve the health and productivity of streamside vegetation, and can enable the plant community to better resist competition from weeds and other pest species. • It can help to maintain or increase soil organic matter, and thereby improve soil moisture relationships.								
Roof Runoff Structure (558)	X	X	X	X		X	X	X
Installing a structure or system, generally including gutters and downspouts, to collect and convey precipitation from a roof. Example drought applications: • This practice can help to provide additional water to improve moisture management for plant production. • It can sometimes help to reduce sheet and rill erosion and resulting sediment in surface waters.								
Spring Development (574)			X	X	X	X	X	X
Constructing a structure to collect water from springs or seeps for the purpose of providing water for livestock and/or wildlife. Example drought applications: • While flow from springs and seeps frequently declines in drought conditions, there are some circumstances in which they can still help to provide water for livestock. • It can help to provide water to improve wildlife habitat.								
Sprinkler System (442)	X	X	X	X		X	X	
Installing a system to spray pressurized water through nozzles for irrigation and related purposes. Example drought applications: • This practice can help to address water insufficiency by improving the efficiency of water application, especially if designed as a high efficiency sprinkler system. • It can help to improve the quantity and quality of livestock feed and forage, especially during periods of drought.								

Conservation Practice Name & Number	Soil Health	Irrigation	Water Storage & Re-Use	Other Crop & Pasture	Forest	Residential & Urban	Wildlife & Fish Habitat	Ground-water
Stormwater Runoff Control (570)		X	X	X	X	X	X	X
Controlling the quantity and quality of stormwater runoff, generally through implementing structures and/or plantings. Example drought applications: • This practice can reduce sheet and rill erosion, and thereby reduce sediment in surface waters by reducing the amount of stormwater runoff. • Structures that impound or slow the flow of stormwater can contribute to the recharge of ground waters.								
Stripcropping (585)	X			X				
Growing planned rotations of erosion-resistant and erosion-susceptible crops in alternating strips across a field. Example drought applications: • This practice can reduce sheet and rill erosion when strips are aligned across the slope, and can reduce wind erosion when strips are aligned across the direction of erosion causing winds. • It can sometimes increase soil moisture content crop production by increasing infiltration of runoff waters.								
Structure for Water Control (587)		X	X	X	X	X	X	X
Installing a structure in a water system that controls the direction or rate of flow, maintains desired water surface elevations, or measures water. Example drought applications: • This practice can help to address insufficient water for irrigation by performing as a component if a higher efficiency irrigation system. • It can help to route excess stormwater for ground water recharge or water storage for re-use.								
Subsurface Drain (606)		X	X	X		X		X
Installing a conduit beneath the ground surface to collect and/or convey excess water. Example drought applications: • This practice can help to accumulate and transfer seasonal excess soil moisture to sites for ground water recharge or water storage and re-use, especially in situations of increased stormwater accumulation due to runoff from urban and transportation infrastructure. • It can help to reduce sheet and rill erosion, and at times concentrated flow erosion, by reducing erosion causing flows across the soil surface and in concentrated flow channels, and can thereby reduce sediment in surface waters.								

Conservation Practice Name & Number	Soil Health	Irrigation	Water Storage & Re-Use	Other Crop & Pasture	Forest	Residential & Urban	Wildlife & Fish Habitat	Ground-water
Surface Drainage, Field Ditch (607)		X	X	X				X
Installing a graded channel on the field surface for collecting excess water. Example drought applications: • This practice can help to accumulate and transfer seasonal excess soil moisture to sites for ground water recharge or water storage and re-use, especially in situations of increased stormwater accumulation due to runoff from urban and transportation infrastructure. • It can help to reduce sheet and rill erosion, by reducing erosion causing flows across the soil surface, and can thereby reduce sediment in surface waters.								
Surface Drain, Main or Lateral (608)		X	X	X				X
Installing an open drainage ditch for transporting water collected by a subsurface drain or field ditch to a safe outlet. Example drought applications: • This practice can help to transport seasonal excess soil moisture to sites for ground water recharge or water storage and re-use, especially in situations of increased stormwater accumulation due to runoff from urban and transportation infrastructure. • Where it provides water for re-use, this practice can provide water for irrigation to improve plant productivity and health.								
Tree/Shrub Establishment (612)	X			X	X	X	X	
Establishing trees and/or shrubs by planting seedlings or cuttings, direct seeding, or natural regeneration. Example drought applications: • This practice can help to reduce sheet, rill, and especially wind erosion, and can help to maintain and increase soil organic matter. • It can contribute to a plant community with greater health and productivity, and can sequester carbon to reduce greenhouse gas emissions.								
Tree/Shrub Pruning (660)	X			X	X	X	X	
Removing all or part of selected branches, leaders, or roots from trees and/or shrubs to reduce fire and/or safety hazards and improve health and vigor of woody plants. Example drought applications: • This practice can improve tree or shrub health and productivity to make more efficient use of drought-reduced soil moisture levels. • It can reduce wildfire hazard by reducing the amount and continuity of fuels.								

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<tr><td>Tree/Shrub Site Preparation (490)</td><td></td><td></td><td></td><td>X</td><td>X</td><td>X</td><td>X</td><td></td></tr>
<tr><td colspan="9">Treating areas where trees and/or shrubs are to be planted to improve site conditions for successful establishment. Example drought applications:
• This practice can improve efficiency of water use by reducing use of water by species other than the planted trees and/or shrubs.
• It can improve health and productivity of planted trees and/or shrubs by removing or otherwise suppressing plant pest pressure.</td></tr>
<tr><td>Upland Wildlife habitat Management (645)</td><td></td><td></td><td></td><td>X</td><td>X</td><td>X</td><td>X</td><td></td></tr>
<tr><td colspan="9">Provide and manage upland habitats for wildlife, including steps to provide habitat connectivity. (A broad range of activities beneficial to upland habitats can be included.) Example drought applications:
• In Tree/Shrub Pruning, brush piles can be left to provide cover and shelter for small animals and birds.
• Bird and small mammal access ramps can be installed in drinking troughs for livestock to provide them with safe access to water.</td></tr>
<tr><td>Water Harvesting Catchment (636)</td><td></td><td></td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td></td></tr>
<tr><td colspan="9">Installing a facility for collecting and storing runoff from precipitation. This typically includes a sealed apron on the ground surface or elevated above the ground surface, and some kind of water storage facility such as a tank or (generally sealed) pond. Example drought applications:
• This practice can provide drinking water for livestock in situations where no other water is available.
• It can provide water for wildlife habitat.</td></tr>
<tr><td>Watering Facility (614)</td><td></td><td></td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td></td></tr>
<tr><td colspan="9">Installing a facility (generally a drinking trough or storage tank) to provide drinking water to livestock and/or wildlife. Example drought applications:
• A trough could be installed (possibly in association with a livestock pipeline) to provide water for an otherwise dry area in order to provide more uniform forage utilization or rest an area with special needs.
• A steel storage tank could be installed to make water available in an area or at a time when it was not available in the past.</td></tr>
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<tr><th>Conservation Practice Name & Number</th><th>Soil Health</th><th>Irrigation</th><th>Water Storage & Re-Use</th><th>Other Crop & Pasture</th><th>Forest</th><th>Residential & Urban</th><th>Wildlife & Fish Habitat</th><th>Ground-water</th></tr>
<tr><td>Wetland Wildlife Habitat Management (644)</td><td></td><td></td><td></td><td>X</td><td>X</td><td>X</td><td>X</td><td></td></tr>
<tr><td colspan="9">Retaining, developing, or managing wetland habitat for wetland wildlife. (A broad range of activities beneficial to wetland habitats can be included.) Example drought applications:
• Excess stormwater could be transported or diverted into a pond to enable it to hold water longer for the benefit of waterfowl.
• Grazing or other used of a riparian area could be deferred until completion of the reproductive cycle of a target wildlife species.</td></tr>
<tr><td>Windbreak/Shelterbelt Establishment (380)</td><td>X</td><td>X</td><td></td><td>X</td><td></td><td>X</td><td>X</td><td></td></tr>
<tr><td colspan="9">Establishing single or multiple rows of trees or shrubs in a linear configuration. Example drought applications:
• Windbreaks can be established across the direction of the prevailing erosion causing wind to reduce soil loss from wind erosion and protect crops from wind related damage.
• They can be established at intervals within a large field, thereby reducing effective wind speeds, in order to improve sprinkler irrigation efficiency.</td></tr>
<tr><td>Windbreak/Shelterbelt Renovation (650)</td><td>X</td><td>X</td><td></td><td>X</td><td></td><td>X</td><td>X</td><td></td></tr>
<tr><td colspan="9">Replacing, releasing and/or removing selected trees and shrubs in an existing windbreak/shelterbelt, or adding rows to the windbreak/shelterbelt, in order to extend or improve the effectiveness of the planting for its intended purposes. Example drought applications:
• Trees or shrubs making up the planting may die or lose their needed form over time or due to drought, affecting the ability of the planting to perform its intended tasks. Removal and replacement of dead or damaged plants will enable the windbreak/shelterbelt to continue to protect soils and plants from wind damage, and provide wildlife habitat benefits over an extended period of time.</td></tr>
<tr><td>Woody Residue Treatment (384)</td><td>X</td><td></td><td></td><td></td><td></td><td>X</td><td></td><td></td></tr>
<tr><td colspan="9">The treatment of residual woody material to reduce hazardous fuels and the risk of harmful insects and disease, and improve the soil organic matter. Example drought applications:
• Chipping slash from pruning or harvesting will reduce the fire risk, can be used to form a mulch layer over the soil, and chips will break down over time to add organic material back into the soil.</td></tr>
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