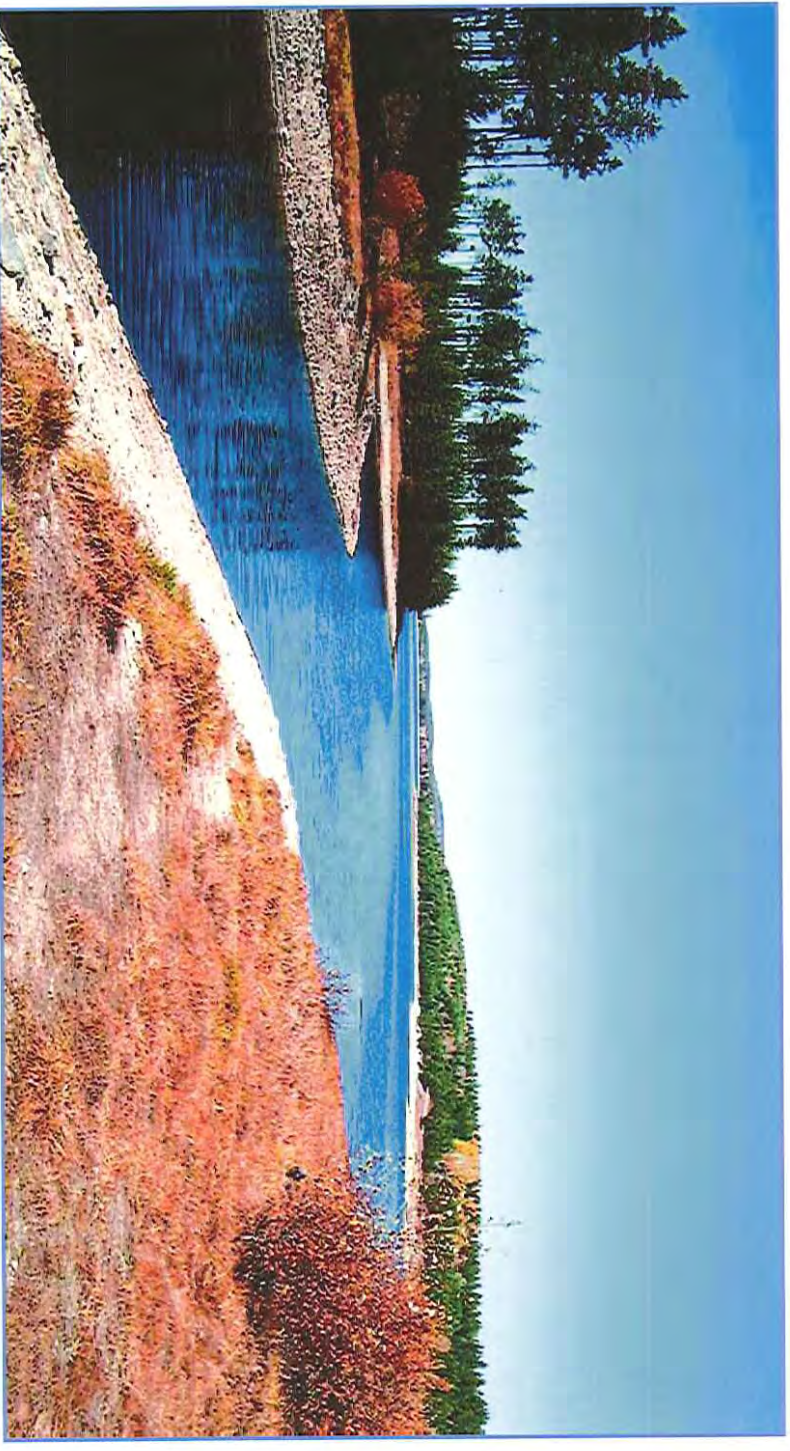


Dealing with Drought

A Handbook for Water Suppliers in British Columbia

Updated July 2009

June 2004



Ministry of
Environment

Cover Photo: Toby Pike, General Manager
SEKID - South East Kelowna Irrigation District

Message from the Minister



For years, British Columbia has had a reputation for having a plentiful amount of clean water to support our quality of life and keep our ecosystems healthy and vibrant. But water is a finite resource. It is paramount that we learn to carefully manage it so we can keep it healthy and secure for the future.

The hot, dry summers of recent years, and 2003 in particular, brought home the message that we shouldn't take our water supply for granted. We need to change our way of thinking about our valuable water resource to ensure we are protecting water for communities, for economic development and for the sustainability of fish and aquatic ecosystems.

That is why I am pleased to offer this update to *Dealing with Drought: A Handbook for Water Suppliers in British Columbia*. Prepared with the support and assistance of the Union of British Columbia Municipalities, this document is designed to assist local water suppliers in dealing with drought management and water conservation planning.

Local governments and water suppliers are responsible for managing community water supplies, so I encourage you to take advantage of the information in this handbook.

By working together, we can better plan for the conservation of our water resource.

A large, stylized handwritten signature in black ink that reads "Barry Penner".

Barry Penner
Minister of Environment



Ministry of
Environment

Acknowledgements

This handbook was initially prepared in 2004 under the direction of the Deputy Ministers' Committee on Drought. Technical content and review was provided by the Inter-ministry Task Force on Drought, including: Ministry of Agriculture, Food and Fisheries; Ministry of Community, Aboriginal and Women's Services; Ministry of Forests, Intergovernmental Relations Secretariat; Ministry of Health Services; Land and Water British Columbia, Inc., Ministry of Public Safety and Solicitor General; Ministry of Sustainable Resource Management; and Ministry of Water, Land and Air Protection. The advice and support of the Union of British Columbia Municipalities is gratefully acknowledged.

Legal Disclaimer

The information provided in this handbook is offered as a public service. Many factors may influence water supply availability. Without being limited to the following, several examples might be geography, the existence of microclimates, storage capacity, and population demands. As a result, the information in this handbook is of necessity general in nature and should not be relied upon as specific advice for responding to particular circumstances. You will have to review your particular circumstances and then determine whether the suggestions in this handbook are appropriate to those circumstances.

Water suppliers, such as local governments, improvement districts, and other authorities, should consider the appropriateness of the suggestions in this handbook and adapt them to suit their specific local conditions and requirements. Plans and bylaws should not be put in place by water suppliers without first receiving appropriate professional and legal advice.

While information provided within this handbook is believed to be accurate at the time of publication, we cannot confirm its currency, accuracy, or completeness or its applicability to or suitability for individual circumstances. Therefore, persons using this handbook should take steps to independently verify the information.

Also, the handbook also contains links to web sites of other organizations. As we do not control those websites, we cannot confirm the information provided by them.

British Columbia. Deputy Ministers' Committee on Drought.

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Dealing with Drought

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Introduction

The impacts of climate change coupled with the severe drought of 2003 in British Columbia demonstrated that the historical approach of supply management for our water resource is not sufficient. The Deputy Ministers' Committee on Drought was formed in August 2003 to address this issue, followed by the creation of a Drought Management Action Plan. Many of the Plan's long term actions are strategic, and largely focus on examining water management policy and practices for the purpose of recommending revisions. However, the majority of actions concentrate on helping water suppliers to better manage supplies at an operational level. The Action Plan activities also include continual communication efforts to sensitize the people of BC to the ongoing need for water conservation and demand management.

One important component of the Action Plan is the development of the document, *Dealing with Drought: A Handbook for Water Suppliers in British Columbia*. The handbook was prepared for the province and its communities with a two-part vision: 1) to provide proactive drought management goals to help prevent the onset of drought conditions, and 2) to assist and support water suppliers with assessing, planning, and responding to drought conditions and coordinating internal and external communications. The goals and responses outlined in the handbook are based on existing legislation.

The province has taken a lead role in drought management, providing water supply monitoring and forecasting, effective communication, and tools and templates. Water suppliers may use the tools provided by the provincial government and customize their responses and actions to accommodate the major water demands in their area. The handbook is just one part of a comprehensive water management strategy. Additional steps towards protecting drinking water and aquatic ecosystems, and ensuring sustainable community growth are also critical.

While some communities have been making concerted efforts to improve water use efficiency in their areas, a survey conducted by the provincial government in September 2003 found that approximately 25% of the province's water supply systems were stressed last fall, with two-thirds of those systems imposing water restrictions. Unusual or increased expenditures resulting from the drought conditions were experienced by 20% of those surveyed. In terms of drought management planning, the survey findings showed that less than a quarter of the province's water suppliers were well prepared to deal with a long term reduced supply of water (Figure 1). The results of the research have demonstrated the need to improve water supply planning. The *Dealing with Drought* handbook provides a framework and tools for local governments and water suppliers to meet this need.

The July 2009 update to the *Dealing with Drought* Handbook provides current web links and other references in the document. The primary information and planning templates are otherwise unchanged.

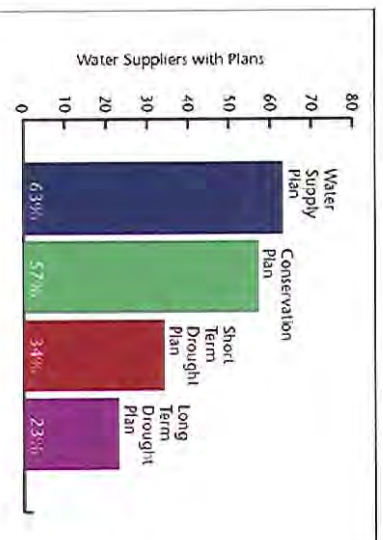


Figure 1.
Summary of water and drought management planning by water suppliers in British Columbia, September, 2003.

Why Prepare for Drought?

Managing community water supplies is a local government and local supplier responsibility. Planning will help your community to:

- protect community supplies for drinking water, sanitation, and fire protection,
- protect fish and aquatic ecosystems, and
- sustain industrial development and economic activity.

What is Drought?

Drought is the result of natural variability of climatic conditions. Dry areas of the Province like the Okanagan and Nicola valleys have challenges supplying sufficient water to meet demand even during normal years. Depending on the severity of the drought conditions these and other areas of the Province may experience significant adverse effects from drought. Drought can occur when there is a combination of sustained low precipitation and high rates of evaporation, resulting in:

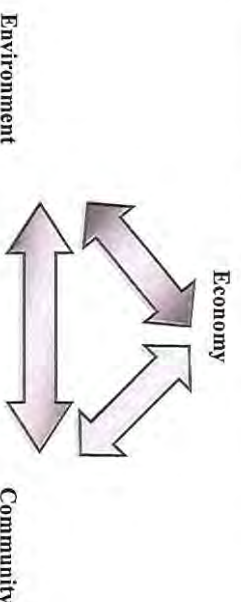
- low water flows in streams, and/or
- low water storage levels, e.g. wells, reservoirs.

In BC, drought may be caused by natural or climate change impacts resulting in insufficient snow accumulation, hot and dry weather, a delay in fall rain, or by a combination of these factors. In addition to climate, our water supplies are affected by how much we use. With a growing population, increased demands are placed on water supplies, causing greater stress on water resources and intensifying the effects of drought conditions.



What are the Effects of Drought?

Drought affects communities, the environment, and the economy through a reduction of water for communities, agriculture, industry, and forestry. It also affects the sustainability of aquatic ecosystems.



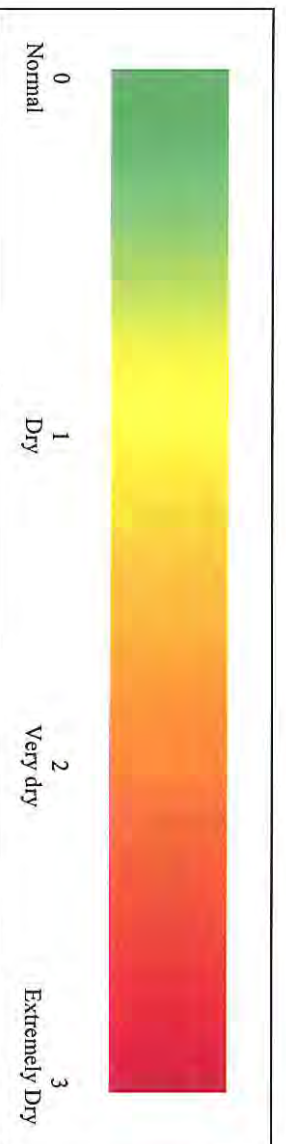
- Lower water levels may increase concentrations of nutrients or contaminants, leading to poor water quality.
- With less available potable surface water, people may make heavier draws on ground water supplies, wells, and springs.
- Water that is necessary for biological or industrial production processes may be reduced, and agriculture and industry users may lose the ability to produce crops or provide goods and services to communities of the province, impacting the health and economy of an area.
- Coping with the effects of reduced supplies may cause chronic stress for some individuals and negatively affect the social fabric of a community.
- Drought conditions will also increase the risk of forest fires and limit water supplies for firefighting.
- Lower stream flows and the corresponding increased water temperatures threaten the survival of many fish and aquatic species.

How is Drought Measured?

By being familiar with local climate and water supplies, a community can anticipate and prepare for drought and “stressed” systems. To determine if your water supplies are “stressed” by drought, examine your supplies for one or more of the following conditions:

- streamflows are significantly lower than the recorded average,
- water quality does not meet water quality standards,
- key habitat factors, such as temperature, quality, cover, substrate, and accessibility – all necessary to sustain a biologically diverse community – are degraded,
- typical seasonal demands cannot be fully met,
- restrictions are currently in place, and anticipation of increasing severity of restrictions exists, or
- water use conflicts have arisen.

To assist suppliers, the provincial government monitors precipitation and streamflows across the province and posts regular updates to the River Forecast centre website at <http://www.env.gov.bc.ca/rfc/index.htm>. General responses applicable to each stage have been provided in the Drought Stages and Responses Matrix (Appendix 2-1).



How to Prepare for Drought

In order to assess risk and respond to drought, a water supplier may wish to establish a **local drought management team**. Recommendations for the team building process are provided in Appendix 1. Be sure to include people from all the relevant local water user groups on the team. A team may:

- gather all the available drought information for your community.
- identify information gaps,
- target water management needs,
- implement water conservation strategies,
- provide support to local government in managing community water supplies, and
- communicate with the public.

Many steps may need to be taken to accomplish these goals, and suggestions for actions and responses are described below and in Appendices 2 to 5.

How to Minimize the Impacts of Drought

One of the most important ways to maximize the effects of drought is to prepare a **Drought Management Plan** (Appendix 2). In order to plan for and respond to drought, a local drought management team needs to focus on three main goals:

- 1) get to know your water supplies,
- 2) improve water use efficiency, and
- 3) communicate, educate, and participate.

Achieving these goals will require assessment, response, and coordinated communication and conservation education efforts. To assist local governments with reaching these goals, the handbook provides planning templates and example bylaws. These are available in Appendices 2 to 4. Some communities have conducted these studies already, and reviewing their plans may assist your community with deciding upon the most useful approach. For more information, refer to the resources provided in the “Drought Management Planning Resources” (Appendix 5).

Drought Management Goals

1. **Get to Know the Water Supplies – Assess and Plan**
 - Assess your local water supply and demand by preparing a **Water Supply and Demand Analysis Plan**, a **Drought Management Plan** and an **Emergency Drought Consequence Plan** (Appendices 2,3).
 - Establish a monitoring system including location, frequency of data collection, and reporting tools.
 - Establish a communication plan to reach all people in your community.
2. **Improve Water Use Efficiency... Conserve! Conserve! Conserve!**
 - In addition to the environmental benefits, reductions in water use translate into lower costs for water supply and sewage infrastructure. It makes economic, environmental, and social sense to conserve water 365 days a year.
 - Create a **Water Conservation Plan** (Appendix 2).
 - Establish bylaws for water restrictions (Appendix 4).
 - Communicate and educate – share water conservation and drought management ideas with your community.
 - Stop the leaks! Develop leak detection and repair programs for supply systems in every sector (e.g. irrigation pipelines, municipal distribution systems, residences).
 - Plant drought-tolerant species.
 - Encourage (or regulate through bylaws) the use of water efficient appliances, including washing machines, dishwashers, and ice machines, and water efficient livestock watering systems.
 - Encourage proper design and installation of irrigation systems to increase system efficiency.
 - Schedule irrigation water using soil moisture monitoring devices or evapotranspiration data. Climate data can be found at www.farmwest.com and www.agr.gc.ca/pfa/drought/index_e.htm.
 - Install water meters and implement appropriate water rates and pricing. To read about one successful experience, see the City of Kelowna's website www.getwatersmart.com.
 - Monitor water use to ensure water conservation goals are being achieved.
 - Evaluate impacts of drought on the economy of the region to highlight vulnerable sectors.
 - Develop reclaimed water initiatives for non-potable water supplies.
3. **Communicate, Educate, and Participate**
 - A local drought management team can communicate directly with the community about drought management goals, actions, water supply status, and forecasts.
 - Check that the goals of the **Drought Management Plan** correspond to goals of the **Water Conservation Strategy** (1998), the *Drinking Water Protection Act*, and any other applicable legislation or other local water management plans and bylaws, and communicate the benefits of these plans to the public.
 - Teams can conduct one-on-one meetings with major water users in the community to discuss the goals of your Drought Management Plan and Water Conservation Plan, and their role in implementing these plans.
 - Create water conservation stewardship awards to recognize water saving efforts in your community.

For More Information

Visit BC's Provincial Drought Information website at: http://www.env.gov.bc.ca/wsd/public_safety/drought_info/.

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Overview of Appendices

The resources and templates included in the appendices are intended to assist water suppliers with increasing their knowledge and understanding of local water supplies, implementing conservation measures, and making decisions about appropriate responses to specific stages of drought.

Appendix 1: Local Drought Management Teams – context and guidelines for the establishment of local drought management teams.

Appendix 2:

- **Drought Stages and Response Matrix** – an overview of the stages of drought and appropriate response at each stage, as well as in the event of emergency loss of community water supplies.
- **Drought Management Plan Template** – steps for building an effective drought management plan.
- **Water Supply and Demand Analysis Template** – a framework for the development of a comprehensive water supply and demand analysis.
- **Water Conservation Plan Template** – strategies and tools for reducing water demands on a long term basis.

Appendix 3: Emergency Drought Consequence Plan Template – a general emergency plan template, provided by the Provincial Emergency Program (PEP), that identifies the steps that are necessary when a pending loss of water source exists, and once that water supply is lost. The priorities of potable water, fire protection, and agricultural supplies are a reflection of PEP's mandate, and are not necessarily consistent with the purpose of the handbook.

Appendix 4: Example Bylaws – may serve as a guide for local jurisdictions considering creation of regulatory controls to reduce water demands on the local supply system.

Appendix 5: Drought Management Planning Resources for Water Suppliers – general water management, drought management, and water conservation resources available online.

Appendix 1

Local Drought Management Teams

Introduction

Effective implementation of the drought management practices recommended in the *Dealing with Drought* handbook largely relies on the formation of a local drought management team. The responsibilities of a local drought management team may include:

- acting as an advisory committee to local politicians and staff regarding water conservation and drought management recommendations,
- compiling data on water supplies and users in their own watershed,
- coordinating efforts with various stakeholders (including fisheries, agriculture, industry, and neighbouring communities),
- providing timely information to the public about water supplies, and
- continually encouraging water conservation and appropriate responses to drought conditions.

The team should include representatives from each of the major and relevant user groups served by the supply system. Some communities may choose to develop drought management teams in a combined effort with neighbouring areas if water is drawn from a common watershed. Some watersheds in British Columbia may already have committees to address local water supply issues and in this case may adopt drought management goals as one part of their mandate. Overlap with any existing or proposed drinking water quality, water conservation, and emergency planning activities should be encouraged as a step towards integrating the goals and actions of these related groups.

Guidelines

General guidelines for a **Local Drought Management Team Action Plan** include:

- Establish membership. In addition to the water supplier, involve members from all user groups in the area, including but not limited to: at least one representative from each type of agriculture, one from each type of major industry, as well as fisheries, tourism, and public services.
- Obtain public input and promote public involvement.
- Improve understanding and awareness regarding local government responsibilities for water management.
- Develop mandate, specify roles for members, determine meeting frequency, and identify team needs.
- To reduce potential conflicts among user groups and improve coordinated management efforts, clearly establish water use priorities in the supply system. Consider the following priorities:
 - uses imperative to the protection of public health and basic aquatic ecology,
 - uses important to the social and economic well-being of the area, and
 - uses that may be disrupted or restricted for a short term without considerable impact.
- Identify goals outlined in the handbook (see page 6), and create a timeline to meet those goals, along with a plan outlining members' responsibilities.
- Gather all available relevant drought information and identify gaps and target needs.
- Complete water supply plans based on the recommendations and templates provided by this handbook.

Appendix 2

Planning Templates

Introduction

The templates included in this appendix are intended to assist with water supply planning with the purpose of protecting community supplies for drinking water, sanitation, and fire prevention. They are also intended to assist in protecting water supplies for protecting fish and aquatic ecosystems, and sustaining industrial development and economic activity. The templates highlight the information needs for water supply planning recommended by the Dealing with Drought handbook.

- **Drought Stage and Responses Matrix** – provides an overview of appropriate responses during the different stages of drought (Normal, Dry, Very Dry, and Extremely Dry). An assessment of regional drought stages will be provided online and will inform water suppliers of the surrounding conditions as well as the responses and management actions that are appropriate for those conditions. Updates of regional drought stages will be provided online at: http://www.env.gov.bc.ca/rfc/river_forecast/water-supply.htm
- **Drought Management Plan Template** – the plan includes establishing a local drought management team, identifying drought stages and corresponding responses, and clearly assigning responsibilities, to ensure that the party responsible and the expected actions have been planned and agreed upon among the major users of the watershed.
- **Water Supply and Demand Analysis Template** – provides a framework for conducting a hydrology study to characterize the present supply of water to a local system. The study also assesses current demands and evaluates future growth in demands, examines the adequacy of the supply to meet those demands, and suggests alternative management strategies.
- **Water Conservation Plan Template** – encompasses strategies and tools for reducing water demands on a long term basis.

2-1 Drought Stages and Response Matrix

Stage	Goal/Targets	Action/Response	Communication
Normal	Prevent entrance to Dry Stage	Encourage conservation, stewardship, and education; complete water supply, conservation, drought management, and emergency drought consequence plans	Promote conservation programs through local media
Dry	Prevent and prepare for Very Dry stage, target water use reduction of 10-20%	Voluntary conservation among all users, as well as an increase in monitoring efforts and watering restrictions	Use local media releases to advise of watering restrictions, encourage conservation, update current supply status and share forecasts of future conditions
Very Dry	Prevent and prepare for Extremely Dry, target water use reduction 20-40%	Use sector-specific restrictions based on priority water licence rights; eliminate filling of public fountains and watering of public parks, gardens, medians, and other similar areas; limit new connections or uses. Province may limit the number of, and impose restrictions on, new licences, regulate storage, or invoke conditions on existing licences	Directly contact users, explain priority licensed uses and conservation needs; have local media explain restrictions and enforcement; increase communication between province and local jurisdictions (seek contact information at http://www.env.gov.bc.ca/wscd/)
Extremely Dry	Prevent and prepare for possible loss of supplies, maximum possible reductions for all sectors	Regulatory control rather than voluntary – monitor and enforce restrictions and allocations through bylaws; no outdoor or summer usage. Province may restrict use by lower priority licensees or those with conditional clauses, may assist communities seeking alternative sources	Increase frequency of communication with all users, continue reporting to province, forecast future scenarios, and explain the expected responses in the case of a loss of community supplies
Loss of Community Supplies	Ensure health and safety, aim to re-enter lower drought classification	Follow the steps of your Emergency Drought Consequence Plan. Allocate water on a per capita basis, no outdoor or summer usage, no potable water used on landscapes, monitor compliance, seek and use alternative supplies	Declare a state of emergency, provide frequent updates through all forms of media on necessary actions

Appendix 2 2-2 Drought Management Plan Template	
<input type="checkbox"/>	1. Build a local drought management team <ul style="list-style-type: none"> • Include representatives from all major users in water supply area. • Follow the guidelines outlined in Appendix 1.
<input type="checkbox"/>	2. Document your water system profile <ul style="list-style-type: none"> • Base it on information from Water Supply and Demand Analysis study, Appendix 2-3.
<input type="checkbox"/>	3. Evaluate the impacts of drought on the region's economy <ul style="list-style-type: none"> • Consider drought impacts on the public as well as the local economy and on the potential for economic growth, especially in industrial and agricultural sectors.
<input type="checkbox"/>	4. Monitor water supplies and climate <ul style="list-style-type: none"> • Establish data requirements, location, frequency of data collection, and reporting.
<input type="checkbox"/>	5. Define Drought Stages <ul style="list-style-type: none"> • Consider your water supply, all demands on that supply, and climate factors to define the drought stages of Normal, Dry, Very Dry, and Extremely Dry. The provincial Forecast Centre will rank your region according to these stages, but the rank of your local supplies may differ according to storage and regulated flows.
<input type="checkbox"/>	6. Establish Drought Responses <ul style="list-style-type: none"> • Identify the actions required by each user group and water supplier for each drought stage, including activities recommended in your Water Conservation Plan or relevant bylaws. • Examples of user groups may include, but are not limited to, industry, agriculture, public utilities, and local fisheries. • Responses may be based on those outlined in the Drought Stages and Response Matrix (Appendix 2-1) but will need to be customized to local needs.
<input type="checkbox"/>	7. Develop Communications <ul style="list-style-type: none"> • Identify the local drought management team representative responsible for documenting necessary communications for each drought stage. • Communicate with provincial government and the public about water management goals, actions, water supply status, and forecasts. As well, review the province's online Drought Information website: http://www.env.gov.bc.ca/wsd/public_safety/drought_info/index.html. • Communicate the benefits of water management plans to the public. • Conduct one-on-one meetings with water users in the community to discuss the goals and responsibilities of your Drought Management Plan and water conservation strategies.
<input type="checkbox"/>	8. Evaluate your Drought Management Plan <ul style="list-style-type: none"> • Confirm that your Drought Management Plan corresponds to the goals of the provincial Water Conservation Strategy (1998), Drinking Water Protection Act, and other local water management plans.

2-3 Water Supply and Demand Analysis Template

(Based on the Nanaimo River Water Management Plan, BC Ministry of Environment, Land and Parks, 1993.)

This template highlights the information needs of a water supply and demand analysis, especially for the purpose of creating a Drought Management Plan. Note that it may not be necessary or possible to complete each section. To access an example online, visit www.crd.bc.ca/water/reports/strategic/.

Note: Real-time data from local climate monitoring stations are available through Environment Canada, Water Survey of Canada at: <http://science.pvt.gc.ca/waterweb/formnav.asp>

<p>1.0 Introduction</p> <p>Study Area: area served by the supply</p> <p>Background:</p> <ul style="list-style-type: none"> • Location of supply (<i>name of supply</i>) • Historical water use (<i>indicate average annual, monthly, and daily use in cubic metres for each sector connected to supply and indicate methodology of measurement, e.g. metres, pump log</i>) • Fisheries (<i>describe historical trends with population counts, economic value to region, instream flow requirements in cubic metres and metres per second</i>) <p>Water Management Issues and Concerns:</p> <ul style="list-style-type: none"> • Population growth trends (<i>use individual counts and total percent change</i>) • Fisheries (<i>identify potential conflicts, impacts of population growth, water quality and quantity, changes to fish populations</i>) • Ground water management (<i>describe management strategies, including monitoring, total use in cubic metres, location and quality of wells and pumps; also describe conflicts or contamination concerns</i>) • Surface water supply (<i>describe management strategies, including monitoring, total use in cubic metres, location of wells and pumps; also describe conflicts or contamination concerns</i>) <p>Purpose and Objectives of Study:</p> <ul style="list-style-type: none"> • Address instream uses • Consider management alternatives • Resolve potential conflicts 	
<p>2.0 Basin Description</p> <p>Location and size:</p> <ul style="list-style-type: none"> • Map of basin areas including size of basin (km^2), origin of water source, elevation range <p>Population:</p> <ul style="list-style-type: none"> • Population served (<i>individual counts</i>) • Service connections (<i>number</i>) • Growth trends (<i>consider past 50 years or maximum time period of data records, in individual counts and total % change</i>) <p>Land Use (Agriculture, Forestry, Urban, Future Land Use):</p> <ul style="list-style-type: none"> • Discuss effect of each of the following on water resource: <ul style="list-style-type: none"> - Growth trends for each sector (% change) - Water supply use - Effects of land-use changes on water quality and quantity (e.g. erosion, release of organic effluent) <p>Basin Features:</p> <ul style="list-style-type: none"> • Geologic (% composition, spatial distribution, special features) • Vegetation (<i>instream and riparian, % cover and composition</i>) • Climate (<i>annual, monthly, and daily precipitation in mm, annual, monthly, and daily temperature in °C, and annual, monthly, and daily evapotranspiration using temperature for past 50 years or maximum time period of data records</i>) • Soils (<i>instream and riparian, total % composition, average moisture content</i>) 	

3.0	Water Resources
3.1	Surface Waters
	<ul style="list-style-type: none"> • Streamflow Records: <ul style="list-style-type: none"> - Drainage area of recorded station (km^2) - Daily, monthly, annual summaries (<i>cubic metres/s</i>) - Graphical summaries (<i>consider maximum time period of data records</i>) - Map showing climate monitoring stations in relation to study area • Reservoir and Lake Levels: <ul style="list-style-type: none"> - Daily, monthly, annual storage summaries (<i>water levels in metres, volumes in cubic metres, and calculation of cubic metres per day of supply based on average population use</i>) - Stage storage curves and rule curves (<i>water levels in metres</i>) • Effects of Storage and Diversion: <ul style="list-style-type: none"> - Size of storage (<i>cubic metres, minimum and maximum reservoir storage volume</i>) - Use of reservoirs (<i>rules and regulations of use, diversion rates in cubic metres/second, comparison of regulated and natural flows if available in % change</i>) • Low Flows: <ul style="list-style-type: none"> - Critical low flows and probabilities (<i>"chance" that flows will be below a certain period based on a 7 day period, total percent change from mean discharge rates, and flow rates in cubic metres/second</i>) - Historical low flows recorded - Potential conflicts among user demands • Quantification of system leaks (<i>location in system, water loss in cubic metres/day, total % of extracted use</i>) <ul style="list-style-type: none"> - Drainage area of recorded station (km^2) - Daily, monthly, annual summaries (<i>cubic metres/s</i>) - Graphical summaries (<i>consider maximum time period of data records</i>) - Map showing climate monitoring stations in relation to study area
3.2	Ground water
	<ul style="list-style-type: none"> • Description of Ground Water Resource: <ul style="list-style-type: none"> - Map of existing wells (<i>from section 1.0 of the template, or from the Ministry of Environment: http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/wells/gwsmaps.html</i>) • Description of Ground Water Resource: <ul style="list-style-type: none"> - Summary of water level measurements over time (mm) and average volume (<i>cubic metres</i>) - Ground water withdrawals (<i>litres/second or cubic metres/second, identify use</i>) - Capacity tests, pumping tests, the aquifer mapping resource, observation well data • Ground Water Potential: <ul style="list-style-type: none"> - Bedrock (<i>extent of exposure</i>) - Summary of yields over time (<i>include maximum time period of data records</i>) - Ground water/Surface water relationship

4.0	Water Quality
4.1	Surface Water Quality <ul style="list-style-type: none"> • Data Collection: <ul style="list-style-type: none"> - Bacteria (<i>daily total and fecal coliform per 100 mL</i>) - Chlorine residuals (<i>daily total and free chlorine mg/L or ppm</i>) - Daily temperature (<i>°C</i>) - Daily pH - Daily turbidity (<i>ppm</i>) - Disinfection by-products (e.g. <i>Trihalomethanes and Haloacetic acids in ppm measured quarterly</i>) - Heavy metals (<i>mg/L or ppm</i>) - Nutrient loading (<i>average concentrations of nitrogen and phosphorus recorded weekly compared to maximum time period of data records</i>) - Heavy metal concentrations (<i>recorded weekly</i>) - Turbidity (<i>average annual, monthly, and daily in mm if using a Secchi Disk or NTUs if using turbidity sensors</i>) - E. coli counts (<i>per 100 mL</i>) - Fecal coliform counts (<i>frequency as prescribed by the Drinking Water Protection Act per 100 mL</i>) • Water Quality Assessment: <ul style="list-style-type: none"> - By use (e.g. <i>impact from and upon industrial use, irrigation/stock watering, aquatic life, recreation</i>) - Maximum draw down level of storage (<i>before water quality is compromised</i>) • Trend Assessment: <ul style="list-style-type: none"> - Summary of changes in water quality parameters over time (<i>maximum time period of data records</i>)
4.2	Ground Water Quality <ul style="list-style-type: none"> • Available Data for all Parameters in 4.1 • Ground Water Quality Assessment: <ul style="list-style-type: none"> - By use (e.g. <i>drinking water, industrial compared to BC Approved Water Quality Guidelines</i>) • Aquifer Contamination Potential: <ul style="list-style-type: none"> - Identify upstream and downstream uses, permeability of sediments - References to more data: BC Aquifer Classification System, Vancouver Island Vulnerability Mapping Project
5.0	Fisheries
5.1	Fisheries Management (Federal) <ul style="list-style-type: none"> - Resource description (e.g. <i>spawning and rearing habitat for salmon</i>) - Summary of returns (<i>catch in kilograms and economic value, if applicable</i>) - Instream water requirements (<i>cubic metres/second needed to maintain specific water levels, water temperature requirements for each species</i>)
5.2	Recreational Fisheries Management (Provincial) <ul style="list-style-type: none"> - Resource description (as above) - Summary of returns (as above) - Instream water requirements (as above)
5.3	First Nations Fisheries Management <ul style="list-style-type: none"> - Resource description (as above) - Summary of returns (as above) - Instream water requirements (as above)

- 6.0 Water Resource Uses**
- 6.1 Surface Water Rights**
- Details of licensed use (information available on the Ministry of Environment website: http://www.env.gov.bc.ca/wsd/water_rights/index.html).
 - Maximum and minimum withdrawals (convert to cubic metres), and
 - Average annual, monthly, and daily withdrawals (cubic metres/second, % extraction out of total use) for:
 - municipal
 - industrial
 - agricultural
 - domestic
 - storage
 - conservation
- 6.2 Instream Water Requirements**
- First Nations
 - Fisheries (minimum and maximum flows in cubic metres/second)
 - Wildlife (minimum and maximum flows in cubic metres/second, or life cycle characteristics dependent on water supply)
 - Wetlands preservation
 - Recreation uses (e.g. tourism operator requirements, average annual economic value of recreational services to region)
 - Flow dilution
 - Power projects
- 6.3 Identification of Species at risk by COSEWIC**
- http://www.sararegistry.gc.ca/default_e.cfm
- 6.4 Identification of designated sensitive streams**
- http://www.bclaws.ca/Recon/document/freeside/-%20F%20-%20Fish%20Protection%20Act%20%20SBC%201997%20%20c.%2021/05_Regulations/11_89_2000.xml
- 6.5 Ground water uses (from section 3.2 of template)**
- municipal
 - industrial
 - agricultural
 - domestic
 - average annual, monthly, daily withdrawals
- 6.6 Downstream uses (ensure priority water rights and instream requirements are being met)**
- 6.7 Future Water Resource Requirements**
- Future water demands (based on population growth trends from section 2.0 of template in cubic metres per person per day, month, and year)
 - Future instream requirements (based on fisheries and wildlife growth trends, and necessity of contaminant dilution)

7.0	Water Management Analysis
7.1	Natural Flows: <ul style="list-style-type: none"> - Estimate inflow in cubic metres/second (may need to "naturalize" flows from Section 3; that is, assess quantity of water that would flow through the basin if storage structures were not present)
7.2	Demands: from section 6 of template
7.3	Supply/Demand Comparison <ul style="list-style-type: none"> - Balance natural flows versus demands (daily, monthly, and annual totals) including future demands such as population growth. Assess if demands can be met in all years, or if a risk exists of not meeting demands in 1:5 years, 1:10 years, 1:25 years. (Note: local jurisdictions generally need to look at the 1:25 year risk of not meeting demands.)
7.4	Analysis Results
7.5	Interpretation of Results <ul style="list-style-type: none"> - Consider adequacy and reliability of supply to meet existing and future demands based on water rights, previous supply deficiencies if applicable, and restrictions on water use.
7.6	Supplementary Storage Requirements <ul style="list-style-type: none"> - Evaluate need for additional storage with respect to present and future demands.
8.0	Conclusions and Recommendations
	Summarize findings from the study and report on the following: <ul style="list-style-type: none"> • Water resource • Water quality • Fisheries resource • Water resource uses • Reservoir operations (evaluate if changes to rule curves for minimum, maximum, and average storage are required) • Future storage (assess need for infrastructure upgrades or new storage sites)

2-4 Water Conservation Plan Template

For an example of more detailed planning strategies, please visit:
<http://www.epa.gov/watersense/pubs/guide.htm>

<input type="checkbox"/>	1. Existing Conservation Strategies
	<ul style="list-style-type: none"> Review and report on the conservation measures previously and/or currently in place for each sector in area.
<input type="checkbox"/>	2. Annual Audit of Water Supply
<input type="checkbox"/>	3. Future Projections
	<ul style="list-style-type: none"> Consider future population projections and potential drought scenarios and implement appropriate conservation measures, restrictions, and supply source identification.
<input type="checkbox"/>	4. Meters
	<ul style="list-style-type: none"> If not yet metered, install water meters on all or major service connections and create informative water bills (compare past usage, information on cost and value of water, basic conservation tips).
<input type="checkbox"/>	5. Testing and Maintenance
	<ul style="list-style-type: none"> Initiate a regularly scheduled meter testing and maintenance program. Conduct a system-wide leak detection program and repair any problems.
<input type="checkbox"/>	6. Conservation Measures Implemented (examples below)
	<ul style="list-style-type: none"> Retrofitting of water efficient appliances and plumbing fixtures for residential and commercial sectors, possibly through rebate programs Leak detection program for homeowners, industry, agriculture Drip irrigation systems and voluntary irrigation start times (reduce peak hour) Examine water reuse, recycling, and non-potable water opportunities Xeriscaping Lawn watering restrictions Industrial power-washing restrictions Incentive-based water rates
<input type="checkbox"/>	7. Conservation Measure Implementation Schedule
<input type="checkbox"/>	8. Conservation Measure Evaluation
	<ul style="list-style-type: none"> Evaluate each measure before, during, and after implementation for: <ul style="list-style-type: none"> simple payback period reliability of water savings political and legal constraints in implementation, enforcement, or effectiveness compatibility with municipal, provincial, and federal goals reduction goals or achievements useful lifetime life cycle cost (initial purchase prices and maintenance costs) impact on level of service reduction of wastewater and energy savings environmental impact and success in other jurisdictions
<input type="checkbox"/>	9. Public Education Program
	<ul style="list-style-type: none"> Encourage efficient water use through: <ul style="list-style-type: none"> workshops for plumbers, landscapers, irrigation service providers, farmers, schools, and First Nations Drought Information website: http://www.env.gov.bc.ca/wsd/public_safety/drought_info/ press releases for newspapers and radio posters, brochures, flyers, special events booths, and volunteer stewardship programs
<input type="checkbox"/>	10. Technical and Financial Assistance Programs
	<ul style="list-style-type: none"> Rebates for installation of drip irrigation systems, or low volume plumbing fixtures Demonstrate cost savings (e.g. average annual expenses on infrastructure maintenance)

Appendix 3

Emergency Drought Consequence Plan Template

Provided by the Provincial Emergency Program

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