

Report Number 104

**RHODE ISLAND  
Drought Management Plan**

State Guide Plan Element 724

June 2002

**Water Resources Board**

**STATEWIDE PLANNING PROGRAM**  
Rhode Island Department of Administration  
Information Services  
One Capitol Hill, Providence, RI 02908

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The objectives of the Program are: (1) to prepare strategic and systems plans for the state; (2) to coordinate activities of the public and private sectors within this framework of policies and programs; (3) to assist local governments in management, finance, and planning; and (4) to advise the Governor and others concerned on physical, social, and economic topics.

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**The Rhode Island Water Resources Board** is a state agency charged by *Chapter 46-15 of the Rhode Island General Laws* with the development, use and conservation of water resources. The main function of the board is to assure that a sufficient water supply is available to the present and future populations of the state. The board is also charged with the sole responsibility for apportioning available water when necessary and establishing water allocation for the state. The Rhode Island Water Resources Board corporate is a separate quasi-public corporation from the board. It has the power to establish public water supply facilities, lease facilities or sell water derived from those facilities. The board provides staff to the board corporate in order to fulfill the mission of both.

## ABSTRACT

**TITLE:** *Rhode Island Drought Management Plan*  
**SUBJECT:** Statewide drought management and response  
**DATE:** June 2002

**AGENCIES:** Rhode Island Water Resources Board &  
Rhode Island Statewide Planning Program

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**ABSTRACT:** This plan establishes coordinated procedures for the State of Rhode Island's response to severe drought episodes. It outlines the responsibilities of state, federal and local entities involved in water resources management, and defines the roles these key entities are to play in the state's response to a long-term drought. Duties related to data gathering, anticipation of drought conditions, and mitigation of the effects of drought are described. Policies and recommendations are established to anticipate drought conditions, respond early and coordinate resources to effectively manage the state's water resources during a drought.

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## PREFACE

This plan was developed to provide the State of Rhode Island with a policy guide and framework for coordinated responses in times of drought. The 1993 Rhode Island State Guide Plan Element #723, *The Rhode Island Water Emergency Response Plan*, recommended that the state develop a separate drought plan. In addition, during a short drought experienced in the spring and summer of 1999, the need for such a plan was reinforced. During that time, some areas of the state experienced cumulative deficits in rainfall that were 8-12 inches below normal over a 12-month period. Stream flows across much of the state were 75% of their historical flows according to the United States Geological Survey (USGS) Rhode Island Office. Several streams set record low stream flow levels during 1999, and the ground water levels measured then were also well below normal.

As a result in 1999, the RI Water Resources Board convened a Long-term Drought Management Task Force (the Task Force) to develop a Drought Management Plan for the state. Mr. M. Paul Sams, General Manager of the Water Resources Board, served as chairman. Statewide Planning Program staff participated as a Task Force member, advised the Task Force on existing water resource-related policies of the State Guide Plan, and provided other assistance as requested. The Task Force developed Interim Drought Guidelines, which were approved by the Governor in August 2000 to remain in effect until *The Drought Management Plan* was completed and adopted.

During its two year study process, the Task Force worked closely with the National Weather Service and the US Geological Survey to coordinate drought levels and indices with those used by neighboring states and by the Drought Watch/Warning Program of the National Weather Service. The Task Force reviewed historical precipitation trends and data available from the 1999 drought. The Taunton Office of the National Weather Service also analyzed meteorological data to identify past trends to be used as a basis for predicting future drought events. The Task Force's process in developing the plan was consensus-based, and Ms. Ann Morrissey of the University of R.I., Office of Professional Development, Leadership and Organizational Training, facilitated its deliberations. The individuals who served on the Task Force are listed on page vi of this plan. Staff support to the Task Force, including the initial drafting of the plan, was provided by Ms. Galen McGovern, Supervising Planner, Water Resources Board (resigned, 2001); and Ms. Kathleen Crawley, Supervising Planner, Water Resources Board.

The plan is organized into five parts. Part one provides the introduction and purpose of the plan. Part two contains background on drought in Rhode Island. Part three establishes policies for drought management, goals, objectives, and recommendations and strategies for ongoing drought planning. Part four, the heart of the plan, presents a strategic response plan to drought. Part five, the conclusion, emphasizes the need for continuing pro-active implementation of State Guide Policies to reduce vulnerability to drought. The Executive Summary includes a listing of key actions to be taken by various agencies and entities at different drought stages.

## **ADOPTION**

In recognition of the worsening drought conditions during late 2001 and early 2002, the State Planning Council adopted this plan as an element of the State Guide Plan on March 14, 2002 in accordance with its Rule 13: Emergency Procedures. Following a public hearing held on May 2, 2002, and revision of the plan to reflect input and comments received, the Council re-affirmed its adoption of the plan on June 13, 2002. Finalization of the plan for adoption as a State Guide Plan element was performed by Ms. Nancy Hess, Principal Environmental Planner, of the Statewide Planning Program, working under the supervision of Ms. Blanche Higgins, Supervising Planner, Mr. George Johnson, Assistant Chief, and Mr. John O'Brien, Chief.

## **ACKNOWLEDGEMENTS**

The Drought Management Plan represents a sum of efforts contributed by numerous individuals and groups. In addition to the Long-term Drought Management Task Force Members listed on page vi and the staff of the two agencies previously mentioned, the following individuals contributed to production of this plan:

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# Rhode Island Drought Management Plan

## EXECUTIVE SUMMARY

JUNE 2002

### Background

This plan was developed to provide the State of Rhode Island with a policy guide and framework for coordinated responses in times of long-term drought. The framework sets up a coordinated response for the state to be overseen by the Rhode Island Water Resources Board as advised by a Drought Steering Committee.

Drought is a natural hazard that evolves over months or even years, affects a specific area or an entire spatial region, and causes little structural damage. Generally, a drought can be defined as a continuous period of time in which rainfall is significantly below the norm for a particular area. This period could be as short as one summer, or as long as several years. Although the State of Rhode Island is often considered a “water-rich” state, it can experience extended periods of dry weather, from single season events to multi-year events such the long-term drought of the mid-1960s.

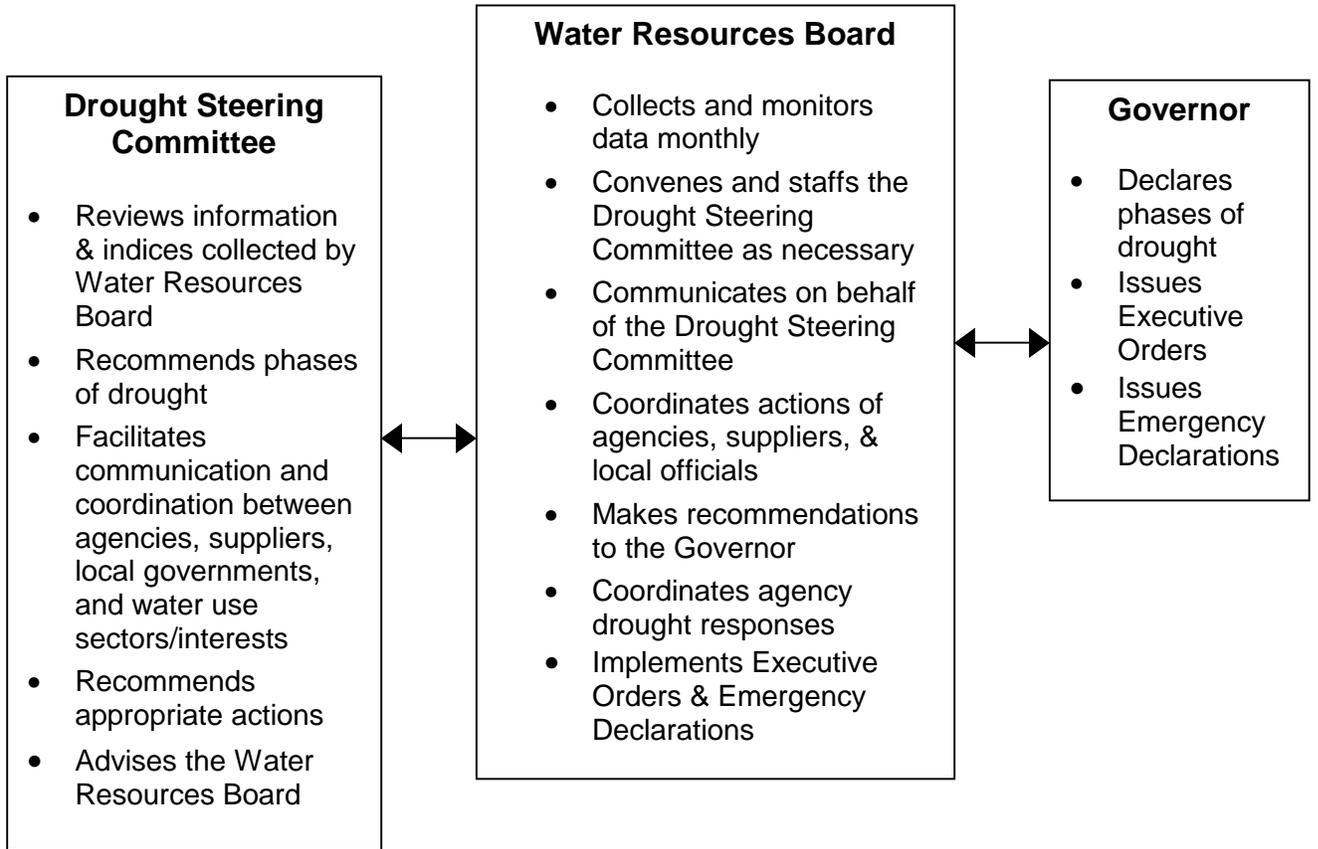
The 1993 Rhode Island State Guide Plan Element #723, *The Rhode Island Water Emergency Response Plan*, recommended that the state develop a separate drought plan. In addition, during a short drought experienced in the spring and summer of 1999, the need for such a plan was reinforced. The Water Resources Board convened a Long-term Drought Management Task Force to develop a drought management plan for the state. The State Planning Council adopted this plan as an element of the State Guide Plan on June 13, 2002.

### The Drought Management Process

The primary responsibility for coordination of the drought management process and implementation of this plan rests with the Water Resources Board, as advised by a Drought Steering Committee. The Drought Steering Committee is convened by the Water Resources Board and includes agencies which routinely collect and monitor data critical to assessing drought phases in the state, as well as federal and state agencies, local water suppliers, and community officials. The Water Resources Board is responsible for maintaining a current membership/contact list, monitoring conditions, convening the Drought Steering Committee, and recommending to the Governor to declare the appropriate phases of drought. The following chart illustrates the management process as coordinated by the Water Resources Board.

**Rhode Island Drought Management Plan  
EXECUTIVE SUMMARY**

**Rhode Island  
Drought Management Process**



# **Rhode Island Drought Management Plan**

## **EXECUTIVE SUMMARY**

### **Drought Phases**

The Plan defines five phases of drought consistent with the Drought Watch/Warning System of the National Weather Service:

1. Normal.
2. Advisory
3. Watch
4. Warning
5. Emergency

The Drought Steering Committee will recommend phases for the state based on hydrological and meteorological indices. The Water Resources Board will advise the Governor of the need to set the appropriate phase of drought. Exceeding the threshold of a particular phase establishes grounds for recommending moving to the next phase. Each phase requires increased action and coordination by the Water Resources Board as advised by the Drought Steering Committee. Table 724-(2), Rhode Island Drought Indices and Phases, shows the thresholds for each phase and the relationship of all of the drought phases.

A given drought phase can change in one of three ways. If conditions worsen and reach the criteria for the next most severe drought phase, a recommendation that the drought severity level be increased accordingly will be made by the Water Resources Board to the Governor. If conditions persist but do not reach the next level, the drought phase will be held constant. If conditions begin to improve, the Drought Steering Committee will recommend whether conditions have returned to normal. Once the precipitation index triggers a drought phase of warning or emergency, conditions must improve beyond the previous level to reduce the drought phase.

### **Drought Regions**

The plan delineates seven drought-planning regions for the state (See Figure 724-(4), page 4-16.) The normal, advisory and watch phases are issued on a statewide basis. The more severe warning and emergency phases are issued on a regional basis, taking into consideration local hydrological conditions, sources of drinking water supplies, and infrastructure considerations.

**Rhode Island Drought Management Plan  
EXECUTIVE SUMMARY**

**TABLE 724-(2) Rhode Island Drought Indices and Phases**

<b>Drought Phase</b>	<b>Palmer Drought Index +</b>	<b>Crop Moisture Index</b>	<b>Precipitation +</b>	<b>Ground Water** +</b>	<b>Stream flow +</b>	<b>Reservoirs**</b>
Normal	-1.0 to -1.99	0.0 to -1.0 Slightly Dry	1 month below normal	1 month below normal	2 consecutive months below normal	Reservoir levels at or near normal for the time of year
Advisory	-2.0 to -2.99	-1.0 to -1.9 Abnormally Dry	2 month cumulative below 65% of normal	At least 2 out of 3 months below normal	3 consecutive months below normal	Small index Reservoirs below normal
Watch	-3.0 to -3.99	-2.0 to -2.9 Excessively Dry	1 of the following criteria met: 3 month cum. < 65% or 6 month cum. < 70% or 12 month cum. < 70%	4-5 consecutive months below normal	At least 4 out of 5 consecutive months below normal	Medium index Reservoirs below normal
Warning	-4.0 and below	> -2.9 Severely Dry	2 out of 3 of the above criteria met: 3 month cum. < 65% and 6 month cum. <65% or 6 month cum. <65% and 12 month cum. <65% or 3 month cum. <65% and 12 month cum. <65%	6-7 consecutive months below normal  observation wells recording monthly record lows	At least 6 out of 7 consecutive months below normal	Large index reservoirs below normal
Emergency	-4.0 and below	> -2.9 Severely dry	Same criteria as Warning and Previous month was Warning or Emergency	>7 months below normal observation wells recording monthly record lows	>7 months below normal	Continuation of previous month's conditions

+ Major hydrologic indicators.

\*\* Local triggers from the water system supply management plans will also be considered in a assessing drought phases on a regional basis. The Water Resources Board will review local plans and work with suppliers to coordinate regarding drought phases and to collect, review and report surface reservoir and ground water data.

**Normal** is defined as the statistical average of the data for the period of record. Percentages for precipitation are relative to normal.

## Rhode Island Drought Management Plan Executive Summary

### Data Collection and Monitoring

The plan identifies the various agencies that can provide information to be used by the Water Resources Board and the Drought Steering Committee to assess the severity of drought conditions in the state. The Water Resources Board is responsible for assembling the necessary information and providing it to the Drought Steering Committee. The Board is to publish a monthly “Current Conditions Report” which summarizes current water resource conditions, and provides data on ground water levels, surface water, reservoirs, precipitation, stream flow conditions, fire danger, and agricultural conditions. A description of the data typically available from each agency is provided in Table 724-(2), Information Collection.

**TABLE 724-(2)  
INFORMATION COLLECTION**

<b>INFORMATION</b>	<b>AGENCY</b>
Ground water levels, surface water levels, and stream flow conditions Surface water flows for rivers receiving major RIPDES discharges	United States Geological Survey Water Resources Board Department of Environmental Management
Extended weather forecast (3-month intervals). Summary of historical comparisons	National Weather Service University of Rhode Island
Precipitation data	National Weather Service University of Rhode Island
Wells both static and pumping levels	Water Suppliers Water Resources Board
Suppliers with restrictions and water emergencies	Water Resources Board
Scituate Reservoir level	Providence Water Supply Board
Levels of other major reservoirs	Water Resources Board
Forest fire conditions and fire danger levels	Department of Environmental Management State Fire Marshal's Office
Crop, soil, and agriculture conditions	Department of Environmental Management United States Department of Agriculture RI Agricultural Council
Regulated utility issues	Division of Public Utilities and Carriers Public Utilities Commission
Public health and drinking water quality issues	Department of Health
Drought indices	Water Resources Board
Impacts to ecosystems, flora, and fauna	Department of Environmental Management Designated Watershed Associations

## Rhode Island Drought Management Plan Executive Summary

### Communication

The plan establishes responsibilities for coordinated communication of drought response between state and other agencies, with a goal of providing accurate, timely and consistent information to the public. The Water Resources Board is primarily responsible for recommending to the Governor the appropriate phases of drought and implementing the recommended actions of the Drought Steering Committee. Table 724-(4), Communication of Drought Steering Committee Recommendations summarizes the communication responsibilities and identifies the target audiences for each agency.

**Table 724-(4)  
Communication of Drought Steering Committee Recommendations**

Agency/Organization	Audience
Water Resources Board Governor's Office	General Public
Water Resources Board	Watershed Councils, Local Government
Water Suppliers Rhode Island Water Works Association	Customers, Water Resources Board
Water Resources Board Department of Health	Water Suppliers
Department of Environmental Management	Foresters
Department of Environmental Management RI Agricultural Council	Farmers/Agricultural Interests
Water Resources Board Department of Environmental Management	Large Water Non-Agricultural Users- e.g. Industrial, Golf Courses, etc.
Narragansett and Mashantucket Pequot Indian Tribes	Indian Tribes
Water Resources Board State Fire Marshal	Local Fire Departments
RI Economic Development Corporation Chambers of Commerce	Industries/Businesses

### Rhode Island Drought Management Plan

Part Four, Implementation: Rhode Island Drought Management Plan identifies the actions to take place during the different phases of drought. The actions start with general information collection and sharing under normal conditions and may culminate in declaration of an emergency situation for severe droughts. All response actions in the early phases of drought will be continued in the later stages of drought as needed.

**Rhode Island Drought Management Plan  
Executive Summary**

<b>RHODE ISLAND DROUGHT MANAGEMENT ACTIONS</b>	
<i>Drought Phase: Normal</i>	
1.	WRB collects basic weather and hydrological data.
2.	USGS monitors surface and groundwater levels.
3.	WRB works with municipalities on drought related contingency plans and to adopt drought related ordinances.
<i>Drought Phase: Drought Advisory</i>	
1.	WRB communicates with public, municipalities and water suppliers about dry conditions.
2.	WRB convenes Drought Steering Committee and recommends to the Governor to declare an advisory phase.
3.	WRB develops press announcements as advised by the Drought Steering Committee.
4.	WRB collects information and advises Drought Steering Committee on list of water restrictions.
5.	WRB coordinates regular meetings of the Drought Steering Committee to review information and circulate educational materials.
6.	WRB works with DEM and USGS in order to expand data collection and monitoring.
7.	WRB forwards "Current Conditions" report to the Drought Steering Committee, general public, municipalities and major water suppliers.
8.	WRB develops and recommends statewide voluntary conservation measures and begins public awareness campaign on water conservation.
9.	WRB works with the DEM and USGS to measure stream flow and groundwater levels and to relay this data to farmers, golf courses, other water users and watershed councils in the affected watershed(s).
10.	DEM-Agriculture mails listing of water conservation techniques to farmers, requests farmers to conserve, and initiates appropriate steps of the Drought Response Plan for Agriculture (See Appendix E).
11.	WRB offers technical assistance to water suppliers to enhance efficiency of their major users

**Rhode Island Drought Management Plan  
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*Drought Phase: Drought Watch*

1. WRB distributes monthly Current Conditions Report to the Governor, Drought Steering Committee, major water suppliers, and municipalities.
2. WRB and the Drought Steering Committee recommend to the Governor to declare a watch phase.
3. WRB works with the Drought Steering Committee to develop and distribute clear and consistent public information regarding current conditions and general water conservation measures.
4. WRB offers technical assistance to municipalities on managing water use during dry conditions.
5. WRB works with state agencies to intensify monitoring and appraisal of drought situation.
6. WRB, as advised by the Drought Steering Committee, reports on status of the drought to the Governor, Senate and House leadership.
7. WRB works with state agencies to initiate contact and planning efforts with federal agencies.
8. WRB develops, recommends and encourages continued water conservation and use restrictions.
9. The WRB updates and distributes the statewide map reporting the drought status by region.
10. Large water systems follow triggers and actions from WSSMPs to determine their drought level.
11. DEM-Agriculture continues to implement response plan for agriculture.
12. When rivers approach their 7Q10 low flow (a standard used to measure stream flow), DEM requests voluntary reductions in the quantity of pollutants discharged from industrial sources.
13. WRB works with DEM-Agriculture to provide a list of water suppliers and water transporters willing to supply farmers.
14. WRB develops and distributes a list of well drillers.

**Rhode Island Drought Management Plan  
Executive Summary**

*Drought Phase: **Drought Watch*** (continued)

15. DOH provides a list of private laboratories for water testing.
16. DOH expedites permitting and gives priority reviews to replace public wells that have gone dry, where practical.
17. Fire districts/departments identify alternative sources of water or call on a regional tanker force, when water bodies are low.
18. WRB, as advised by the Drought Steering Committee, encourages fire departments to distribute educational materials stating that dry conditions may cause problems for sprinkler systems.
19. DEM expedites dry hydrant permits for fire departments

*Drought Phase: **Drought Warning***

1. WRB, as advised by the Drought Steering Committee, recommends to the Governor to declare a warning phase and WRB works with all constituencies (the public, municipalities, suppliers, etc.) to implement measures to reduce water use.
2. WRB, as advised by the Drought Steering Committee, implements and promotes public information and provides technical assistance to conserve water and reduce water demand.
3. WRB, as advised by the Drought Steering Committee, intensifies media coverage and public education efforts.
4. WRB, works with local suppliers and updates statewide maps to report those regions that have entered the warning stage.
5. WRB, as advised by the Drought Steering Committee, adopts list of non-essential water uses and strongly recommends that water users cease all non-essential water uses.
6. WRB, reviews readiness and availability of emergency interconnections and sources of water.

## Rhode Island Drought Management Plan Executive Summary

### *Drought Phase: Drought Warning* (continued)

7. DOH assesses public health threats and acts as needed.
8. WRB, initiates contact and planning with northeast states regarding regional conditions and responses.
9. WRB, works with the Governor's Office to declare a warning phase and to prepare a proclamation for the Governor in case of a drought emergency and develops a communications strategy.
10. WRB, informs the House and the Senate leadership about drought conditions.
11. WRB, as advised by the Drought Steering Committee, coordinates with RIEMA to investigate potential funding and assistance.
12. Individual water systems implement drought-response actions outlined in their WSSMPs.
13. DEM-Agriculture follows steps in the Drought Response Plan for Agriculture.
14. Regulated water suppliers may petition the Public Utilities Commission for emergency rate relief.
15. DEM and WRB identify adverse environmental impacts and advise the Drought Steering Committee regarding mitigation.

### *Drought Phase: Drought Emergency*

1. WRB, as advised by the Drought Steering Committee, recommends to the Governor to declare an emergency, and recommends to the Senate and House leadership on implementing emergency responses and mitigation measures.
2. The Governor may issue a proclamation of a drought emergency. The proclamation may stipulate mandatory bans on non-essential water use as recommended by the WRB. Water use restrictions shall be in accordance with WSSMPs for large water suppliers. More restrictive measures may be required according to the Governor's Emergency Proclamation.
3. WRB, as advised by the Drought Steering Committee, continues to coordinate the responses of state, local and federal agencies.
4. WRB, as advised by the Drought Steering Committee, coordinates with RIEMA to seek disaster declarations and secure emergency funding/assistance.

## **Rhode Island Drought Management Plan Executive Summary**

### **Returning to Normal**

To determine the end of a drought, the two key drought indices, precipitation and ground water levels, should be examined. These two indices have the greatest long-term impact on drought conditions. Precipitation is a key factor because it is the overall cause of improving conditions. The drought phase can only be revised downward to a less severe phase when normal conditions for both precipitation and ground water have been reached for a sustained period of time. Complete guidelines are defined on Table 724-(7), Returning to Normal on page 4.29.

## **724-01: INTRODUCTION AND PURPOSE**

### **01-01 Purpose of the Plan**

The primary purpose of this plan is to coordinate state, federal and local agencies with responsibilities for water resource management during a drought. The plan enables the state to anticipate drought conditions, to respond early and to coordinate efforts to effectively manage water resources. The plan establishes data gathering, communication, and response actions. Primary responsibility for coordination of the drought management process and plan implementation lies with the Water Resources Board as advised by a Drought Management Steering Committee. The plan also provides a framework for coordinating the statewide response to drought with the authorities and actions of regional and local water supply systems and municipal governments.

### **01-02 Context for Drought Planning**

In July 1998, the 105<sup>th</sup> Congress enacted *United States Public Law 105-199, The National Drought Policy Act*. This act established an advisory commission charged with creating a national drought policy. The resulting report of the commission recommended preparedness over crisis management, systematic versus *ad hoc* responses, and mitigation strategies for drought management. The relevant goals of this national report for this Rhode Island plan are:

- To incorporate planning, implementation of plans and proactive mitigation measures, risk management, resource stewardship, environmental considerations, and public education as the key elements of an effective national drought policy.
- To improve collaboration among scientists and resource managers to enhance the effectiveness of monitoring, prediction, information delivery and public education as the key elements of effective national drought policy.
- To coordinate drought programs and responses effectively and efficiently.

Rhode Island's Drought Management Plan is intended to respond to the recommendations of the National Advisory Commission's report. It was modeled after the Massachusetts Drought Management Plan.

## **01-02-01 State Guide Plan Water Supply Management Policies**

At the state level, the Rhode Island State Guide Plan is developed by the Department of Administration's Statewide Planning Program pursuant to *Rhode Island General Laws (RIGL) 42-11*. It is a means for centralizing and integrating long-range goals, policies and plans with short-range project plans and implementing programs prepared on a decentralized basis by the agency or agencies responsible in each functional area. In addition to this drought management plan, there are three elements of the Guide Plan that specifically relate to water resource management in the State. These are:

- State Guide Plan Element 721, *Water Supply Policies for Rhode Island, 1997 (Revised)*
- State Guide Plan Element 722, *Water Supply Plan for Rhode Island, 1991*
- State Guide Plan Element 723, *Water Emergency Response Plan for the State of Rhode Island, 1993*

Elements 721 and 722 contain policies regarding supply management, demand management, and planning and administrative management issues of water use. State Guide Plan Element 723 sets forth a response framework for specific water supply shortages and emergency situations and recommends that a separate drought management plan be developed for the state. More details on the existing policies are outlined in Appendix A, State Guide Plan Elements Related to Water Resource Management.

## **01-02-02 Municipal Comprehensive Planning**

The *Rhode Island Comprehensive Planning and Land Use Regulation Act, RIGL 45-22.2* requires all municipal governments to adopt and maintain local comprehensive plans. The comprehensive plans are to be used to direct community land use decisions and capital improvement funding strategies. Under the Act, locally adopted comprehensive plans are reviewed for consistency with the State Guide Plan, and the goals and policies of state agencies. Following adoption of new state guide plan elements, municipalities have one year to make necessary revisions to their local comprehensive plans. Future updates of municipal comprehensive plans will be expected to address drought management in order to be consistent with this State Guide Plan element.

### **01-02-03 Water Supply System Management Planning**

The *Water Supply Systems Management Plan Act, RIGL46-15.3* requires Water Supply Systems Management Plans (WSSMP). All water suppliers that obtain, transport, purchase, or sell more than fifty million gallons of water per year are classified as large water suppliers and must, under the Act, develop a WSSMP. The Rhode Island Water Resources Board establishes the rules and procedures for preparation, review and approval of these plans. These serve as master plans for the water system, addressing adequacy of water supply, water distribution system, conservation measures, watershed protection, capital improvements, and emergency preparedness, including drought. The Water Resources Board, the Department of Health, the Department of Environmental Management, and the Statewide Planning Program review the plans. To receive approval by the Water Resources Board, WSSMPs must be found consistent with State Guide Plan elements, other state laws and regulations, and (the) applicable local comprehensive plan(s).

Water suppliers are required to address drought contingencies and appropriate responses in the emergency operations management section of their WSSMP. In addition, the Regulations of the Water Resources Board require that a WSSMP include an emergency component to assess system risks and response capabilities, and to describe a contingency plan for all foreseeable water supply emergencies. Suppliers are required to identify system risks, including droughts that exceed the water supply system's design capacity. They are also required to identify their response to specific water supply emergencies. Future updates and revisions of WSSMPs will be expected to address drought management in order to be consistent with this State Guide Plan element.

## **724-02: BACKGROUND ON DROUGHT**

### **02-01 Background on Drought**

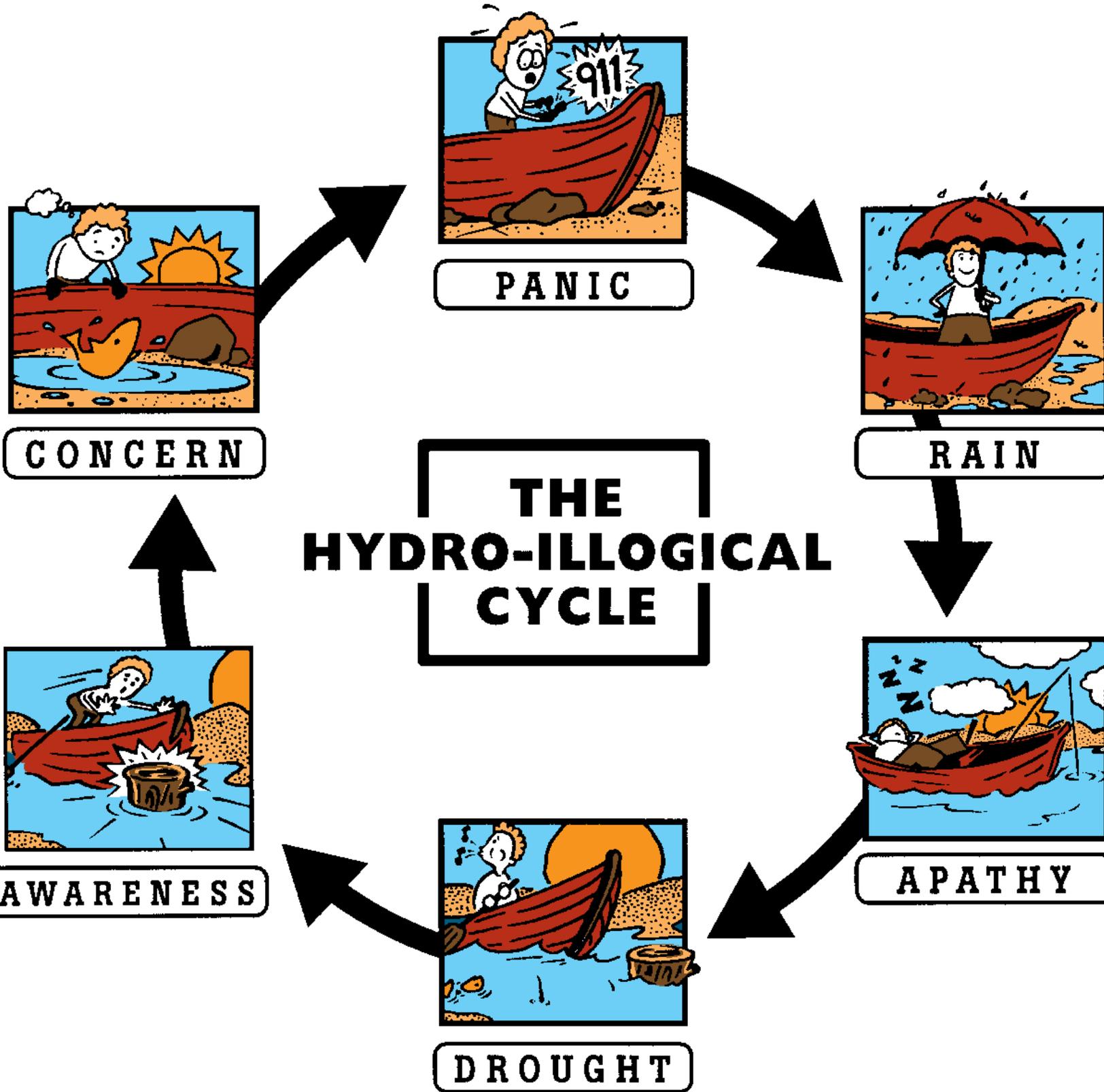
Generally, drought is characterized as a continuous period of time in which rainfall is significantly below the norm for a particular area. The American Meteorology Society defines drought as a period of abnormally dry weather sufficiently long enough to cause a serious hydrological imbalance. A drought is a natural hazard that differs from other natural hazards in that it is not something that occurs suddenly. Rather, a drought evolves over months or even years and, while causing little structural damage, can have profound economic, environmental, and social impacts.

The abilities of the state to withstand the effect of droughts are dependent upon numerous factors. The primary use of water in Rhode Island by the general population is for domestic uses, sanitation and drinking water. The vulnerability of the state to drought is increasing as water use increases. People tend to assume that plentiful water is the norm for Rhode Island, when, in fact, occasional droughts of at least moderate intensity and duration have occurred here. Drought can have wide-ranging effects but, unlike fast-moving natural disasters, such as hurricanes or blizzards, drought as a disaster lacks drama. Though droughts give plenty of warning, the perception of drought's consequences by the average person may only occur when they directly affect him or her. Figure 724-(1), the Hydro-Illogical Cycle from the National Drought Mitigation Center illustrates how little the average person thinks about drought until directly impacted by it.

The impacts of drought span economic, environmental and social sectors. According to the National Drought Mitigation Center, the impacts of drought typically cost the taxpayers of the United States at least as much as other disasters. Drought takes a heavy toll on farm families, the environment, and other areas. During severe droughts, streams and rivers can dry up, affecting wildlife habitat, recreation, and major users dependent upon adequate flow within watercourses (e.g., power generation, sewage treatment systems.) Certain shallow private or community wells could dry up or begin drawing salt water (in coastal communities) as groundwater levels drop, presenting health hazards. Ponds and streams that are used for fire fighting could dry up, increasing fire risks and response times as rural fire fighters seek alternate water sources.

In addition, droughts can raise conflicts between competing interests. For instance, while farmers may seek to increase groundwater withdrawal to maintain their crops, the increased groundwater withdrawal could adversely affect wildlife habitats or the water needs of other well users. Agriculture is often the first to be affected, with drinking water supplies for animals and irrigation sources drying up, affecting livestock, and crops.

Figure 724-(1)  
The Hydro-Illogical Cycle



Economic impacts can result from a drought itself or, more indirectly, through conservation measures implemented because of a drought. Farmers can lose livestock or crops or pay substantially more to produce a year's crop. Water suppliers may lose income if they impose restrictions or face increased costs for developing alternate water supplies. Economic impacts to industries can include loss of production due to use restrictions or increased costs for alternate water supplies (e.g., for cooling). Rhode Island relies heavily on tourism. Use restrictions on water dependent uses at beach communities, and restrictions on fishing and canoeing in rivers or on golf courses could reduce the state's appeal to visitors causing reduced revenues from tourism. Drought's impacts can be moderated through mitigation planning and preparedness. Because droughts are a normal part of any climate, it is important to have a plan in place providing for response actions.

## **02-02 Drought in Rhode Island**

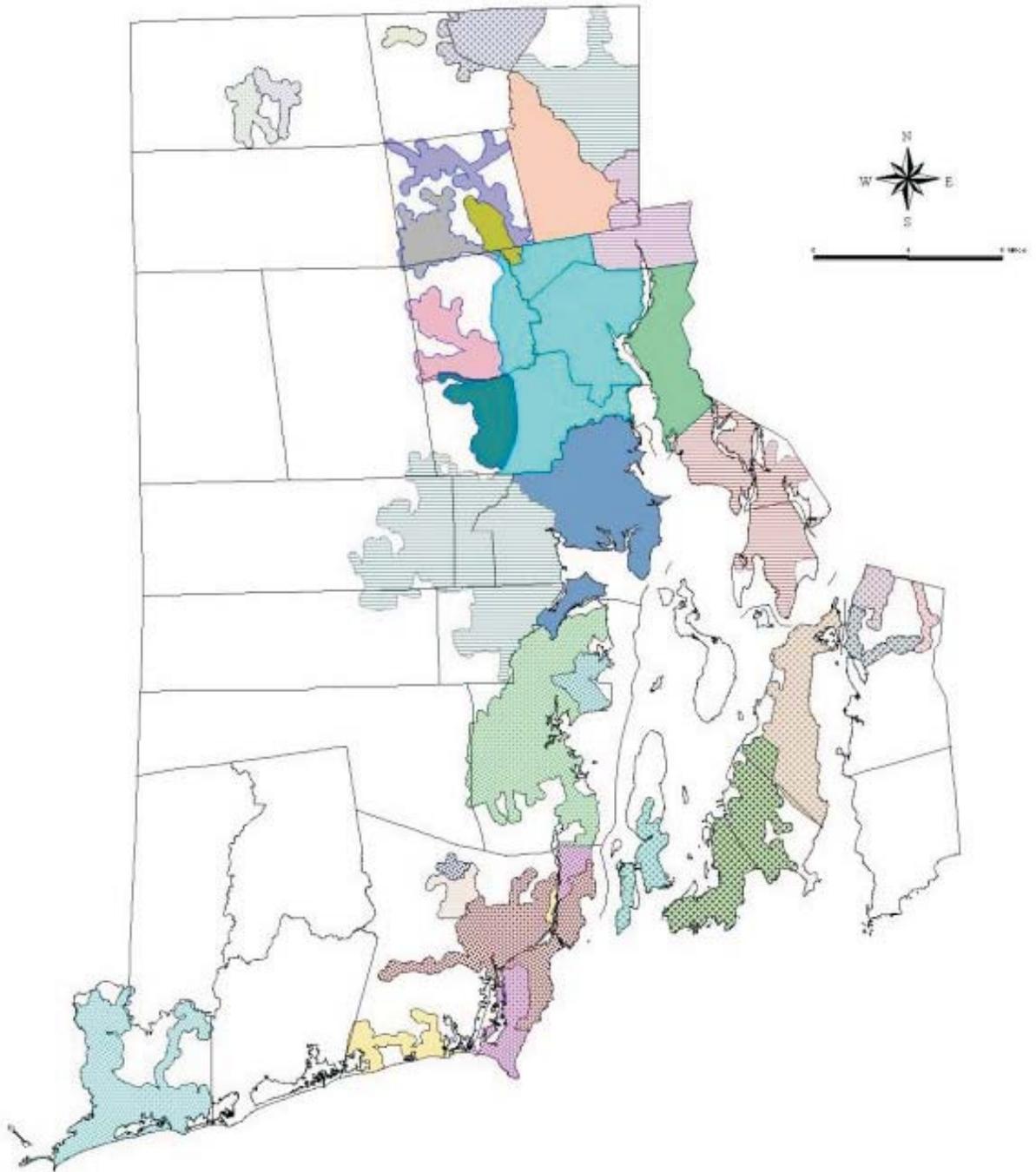
Under normal conditions, the State of Rhode Island can be considered a water-rich state. According to the Department of Environmental Management world-wide-web page, Rhode Island enjoys an abundance of water resources that support vital uses such as drinking water, recreation, habitat and commerce, among others. The state has approximately 1,383 miles of rivers, 21,800 acres of lakes and ponds, and approximately 15,500 acres of freshwater swamps, marshes, bogs and fens as well as close to 72,000 acres of forested wetlands. Estuaries, including Narragansett Bay and various coastal ponds, cover one hundred and fifty square miles. Underlying the state are twenty-two major stratified drift aquifers as well as usable quantities of groundwater in almost all other locations from bedrock aquifers.

According to the National Weather Service, the state receives, on average, between thirty-nine inches (on Block Island) to fifty-four inches of rain (in Foster) annually. In contrast, the average annual precipitation for the United States is 29.53 inches. Even though the state receives more rain annually than the average for the United States, Rhode Island does experience extended periods of dry weather. Summer dry spells, during which crops and lawns may require irrigation, are fairly common. Droughts, while less frequent, do occur.

Past planning efforts, including the two previously adopted state guide plan elements dealing with water supply policies and the water emergency response plan, did not directly address specific measures to be taken in the event of a drought. Consequently, prior to the creation of this *Drought Management Plan*, there was no mechanism for coordinating responses to drought by water suppliers throughout the state because of the decentralized nature of water suppliers and the variability of water supply sources. According to the Rhode Island Water Resources Board, there are thirty-one major municipal and private water suppliers that provide water for approximately 90% of the population of the state. Figure 724-(2), Areas Served by Major Public Water Suppliers, shows generalized areas currently served by major public water systems and their source of water.

Unlike some states, Rhode Island has not developed a systematic regulatory procedure for the allocation of water on a statewide or regional basis. Water allocation is currently based on riparian rights, traditional usage, and *ad hoc* permit approvals. Each water supplier imposes use restrictions when necessary based on the limitations of their system. Generally this has worked because water supply has traditionally exceeded demand throughout most of the state's history. However, when drought conditions occur, shortages develop which may affect water suppliers and individual wells (private or community) differently because of regional hydrology, water demand, differing water supply sources, and infrastructure. For example, southern Rhode Island relies on extensive groundwater aquifers for water supply, while much of the rest of the state relies on surface water reservoirs for water supply.

According to *the* Rhode Island Department of Environmental Management's Section 305(b) *State of the State's Waters Report*, approximately two-thirds of Rhode Island municipalities utilize groundwater from public and/or private wells for all or a portion of their water supply needs. It is estimated that twenty-six percent of Rhode Island's population (roughly 262,000 people) depends on groundwater for domestic water use. Domestic water use includes water for normal household purposes such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets and watering lawns and gardens. In 1999, there were six hundred and seventy-one public wells in Rhode Island according to the Rhode Island Department of Health, Division of Drinking Water Quality. One hundred and sixty-eight of these wells are community wells, which serve residential populations of twenty-five persons or more. The remaining five hundred and three wells are non-community wells that supply schools, places of employment, hotels, restaurants, etc. It is estimated that there are an additional 112,000 people served by an on-site water supply source.



**Notes:**  
*Major Water Suppliers as defined by Rhode Island General Law 46-15.*

**Sources of water:**  
 (c) combined sources of water  
 (gw) groundwater  
 (PWSB) Providence Water Supply Board  
 (sw) surface water

**RIGIS**  
 RI Department of Administration  
 Statewide Planning Program

**Figure 724 - (2)**  
**Areas Served by Major Public Water Suppliers**

## **02-02-01 Short-term Droughts**

Short-term droughts occur as single season events and involve a summer of less than normal rainfall. Short-term droughts may have brief periods of extremely dry and hot weather, but they do not extend from one year to the next. The amount and the timing of precipitation received are key indicators of an impending drought according to the National Weather Service. Under normal conditions, the United States Geological Survey states that late fall and winter precipitation recharges ground water and stream systems prior to the green-up period in the spring. Short-term drought episodes in Rhode Island usually commence just after the spring green-up period, reaching their greatest intensity during the mid-summer and early fall. The data of the National Weather Service indicate that the short-term droughts of the 1980's and the 1999 drought were preceded by precipitation during the spring that was not sufficient to replenish the deficit from the lack of snow and rain during the previous winter and late fall. The amount of preceding fall and winter precipitation is critical to the evolution and intensity of all drought episodes.

A classic short-term drought occurred during the spring and summer of 1999. The rainfall recorded in June of 1999 by the University of Rhode Island, Department of Plant Sciences was only 0.05 inches. This was the second driest June ever recorded in one hundred and twelve years. The rainfall shortage caused duress for agricultural water users and many other water users dependent on groundwater. Several public water systems whose supplies were dependent on groundwater responded with water use restrictions. Many shallow private wells went dry. According to the United States Geological Survey Rhode Island Office, streams in the state set record or near-record low flows. During this time, the Department of Plant Sciences, University of Rhode Island noted that the Kingston area received 4.01 inches of rain, but lost 5.57 inches to evaporation. In contrast, the largest public water supplier (Providence Water Supply Board) that relies on surface water reservoirs for water supply reported no supply problems in 1999.

## **02-02-02 Long-term Droughts**

Long-term droughts may involve several seasons and/or years of lower than normal precipitation. The National Weather Service has documented that historical long-term droughts have begun with lower than normal precipitation during the preceding fall and winters and evolved into major drought status in the summer. Extended droughts, though not common, require statewide monitoring of climactic conditions. Table 724-(1), Rhode Island Historical Droughts, is based on information from the United States Geological Survey. The table shows that some type of drought occurs about every eleven years in Rhode Island. Rhode Island has had at least six major droughts since 1929.

**Table 724-(1)  
Rhode Island Historical Droughts**

<b>Date</b>	<b>Area Affected</b>	<b>Remarks</b>
1930-31	Statewide	Estimated stream flow about 70% of normal
1941-45	Statewide Particularly severe in the Pawtuxet and Blackstone Rivers	Estimated stream flow about 70% of normal
1949-50	Statewide	Estimated stream flow about 70% of normal
1963-67	Statewide	Water restrictions and well replacements common
1980-81	Statewide Groundwater deficient in eastern part of State	Considerable crop damage in 1980
1987-88	Southern part of State	Crop damage, \$25 million

Source: United States Geological Survey

For the major historical drought events, the National Weather Service noted that the precipitation during the preceding fall and winter months was below-normal to much-below-normal which is typically defined as ninety and seventy-five percent less than normal precipitation. Precipitation continued at below normal to much-below-normal levels through the spring and led to the most severe drought episodes, including the 1965-67 long-term drought. The 1965-67 drought episode lasted for three summers and included long periods of below-normal precipitation through the winter, spring, and summer months. This drought period serves as the classic model of a long-term drought in Rhode Island. Though short-term droughts, such as 1999, may not pose a significant impact for the state's public water systems, no water system will be immune to periods of long-term drought.

Historical data for the meteorological conditions present during the 1999 short-term drought is included in Appendix B, Historic Meteorological Data for reference. Included are the monthly historical precipitation rates and yearly averages for the Providence and Kingston weather stations recorded between 1889 and 2001 by the National Weather Service. Also included are the levels of the Scituate Reservoir recorded from 1928 to March 2002 by the Providence Water Supply Board and the Rhode Island 2002 groundwater levels from the United States Geological Survey. This information should be used to calculate and set the base normal conditions for future monitoring of droughts in Rhode Island.

## **PART THREE: GOALS, OBJECTIVES AND STRATEGIES FOR DROUGHT MANAGEMENT**

### **03-01 State Guide Plan Context**

*“...there is a shared responsibility among state agencies, water suppliers, and municipal governments in responding to emergency situations...”* *Water Emergency Response Plan, 1993*

This *Drought Management Plan* is the fourth State Guide Plan element concentrating on statewide water policy and is a specialized companion to *The Water Emergency Response Plan for the State of Rhode Island*, State Guide Plan Element 723. Many of the goals and policies contained in Elements 721 and 722, *Water Supply Policies for Rhode Island* and *Water Supply Plan for Rhode Island*, two plans which cover a broader range of policy, are also relevant to drought-related issues.

The *Drought Management Plan's* goals, objectives and strategies that follow are organized into two sections, one for short-term and one for long-term recommendations. The short-term section focuses on preparedness and management for a specific drought event. The long-term recommendations focus on ways to reduce the impact of future droughts on the state's water supply.

### **03-02 Drought Management Policies**

Policies are the guiding principles that should be followed in attempting to achieve goals, objectives and strategies. The following policies are intended to guide both short and long-term drought management efforts.

1. Drought events must be managed through a coordinated and cooperative interagency response.
2. Sound water management that includes promotion of conservation, protection of natural resources and augmentation of supply should occur before the onset of a drought.
3. Ongoing public education and outreach should be a component in drought preparedness and management.
4. The Rhode Island Water Resources Board, advised by the Drought Management Steering Committee, shall lead statewide drought preparedness and drought response efforts.
5. Local water suppliers have primary responsibility for drought management within their supply districts and shall establish procedures for drought preparedness and drought emergency responses in their Water Supply Systems Management Plans.

6. Municipal governments have a key role, particularly in public education, local water conservation regulation, and enforcement and shall be assisted by state agencies and local water suppliers in developing coordinated response actions.

*Water Emergency Response Plan, State Guide Plan 723 Context*

The *Drought Management Plan* policies, goals and strategies should be viewed within the context of the four over-arching goals of *The Water Emergency Response Plan* which seeks to assure:

1. Protection of public health, safety and welfare;
2. Conservation of essential drinking water resources ;
3. The reasonable allocation of water supply; and
4. Support of essential and high priority water uses.

**03-03 Short-term Goals, Objectives and Strategies**

*Goals:*

1. Minimize the effects of drought on public health and safety, economic activity, and environmental resources.
2. Preserve the water supply of the state.

*Objectives:*

1. Ensure the reasonable allocation of supply during drought events through a coordinated and cooperative inter-agency response.
2. Conserve essential drinking water resources to maintain the continuity of water supply.
3. Provide support to essential and high priority uses, especially protection of public health, safety and welfare.
4. Manage available resources to sustain water-using industries and other economic activities to the extent practicable.
5. Manage available resources to sustain environmental values and wildlife habitats to the extent practicable.

### **03-03-01 Strategies for State Government**

1. The Water Resources Board, as advised by the Drought Management Steering Committee, will manage a coordinated and cooperative inter-agency response to drought from the normal condition through the drought emergency stage.
2. The Water Resources Board shall coordinate efforts between the state agencies, municipal governments, school systems, and local water suppliers to assess drought risks and to develop programs, plans, and policies that mitigate the potential effects of drought.
3. The Water Resources Board, advised by the Drought Management Steering Committee, shall recommend specific actions and identify the necessary implementation authority to strengthen water conservation efforts within the state and to respond to drought from normal conditions through the drought emergency stage.
4. The Water Resources Board shall prepare post-drought mitigation evaluation reports and shall recommend amendments to this Plan to further drought mitigation in the state.

### **03-03-02 Strategies for Water Supply Systems**

1. Water Supply Systems Management Plans (WSSMPs) shall be coordinated with the appropriate elements of the State Guide Plan and shall contain provisions in anticipation of drought that will direct suppliers to respond promptly and effectively.
2. WSSMPs must address how each supplier will manage its system during emergency conditions, including drought.
3. WSSMPs must address providing water under emergency circumstances and restoring water service as quickly as possible.
4. WSSMPs must address management of the system in preparation for and during drought.
5. WSSMPs must address the status of written agreements with other water systems, particularly emergency interconnection agreements.

### **03-03-02 Strategies for Municipal Government**

1. Chief Elected Officials and Town/City Managers must be fully integrated into the drought management process in order to coordinate municipal government efforts during stages of drought preparation, water conservation and water emergencies.
2. Municipalities should consider adoption of local ordinances to provide guidance and regulations to manage drought at the community level.
3. Municipalities must coordinate with water supply systems, state officials and other municipalities who share their water systems to ensure that the WSSMPs properly address drought and emergency preparedness.
4. Municipal officials shall enforce both local regulations/restrictions and state emergency orders.

### **03-04 Long-Term Goals, Objectives and Strategies**

Climate models predict increased occurrences of weather extremes in the future. Rhode Island can anticipate more frequent periods of drought. Consequently, whether or not Rhode Island is currently in a drought, the State needs to take steps to reduce vulnerability to periods of reduced precipitation. It is acknowledged that water suppliers and others are already required to implement policies and programs that address water conservation as part of their normal course of business.

The following long-term recommendations are categorized for actions relative to large consumers on public supplies, residential consumers on public systems, large consumers not on public supplies (i.e. on private wells or drawing from surface waters), and users of non-public water sources. They also target wastewater reuse, water rate changes, and policy and legislative actions. The Long-term Drought Management Task Force recommended in April 2002 that the concepts described in this plan receive immediate attention by the Water Resources Board and the General Assembly. As recognized earlier in this plan, oversight of Rhode Island's water supply is a shared responsibility that involves all levels of government and crosses lines of jurisdiction between a number of agencies.

Please note that for each major water use category the agents for strategy implementation are identified in parentheses.

*Goal:* Reduce Rhode Island's vulnerability to periods of low precipitation (or long-term drought).

*Objectives:*

1. Increase efficiency of water use.
2. Allocate high quality water first to uses that require that quality.
3. Establish programs to insure efficient use by all types of water consumers, with programs tailored to their situations.

**03-04-01 Strategies for Large Consumers on Public Supplies** (*Implementation: Major water suppliers & Water Resources Board*)

1. Implement the *Major Users Technical Assistance Program* (MUTAP) as established by current Water Resources Board regulations for WSSMPs, Section 8.05 (b) to accomplish the following:
  - a. Identify major users and their amount of use.
  - b. Request from major users descriptions of management practices that will best improve water efficiency.
2. Establish procedures to implement best management practices for the MUTAP to accomplish the following:
  - a. Regular reporting on progress toward implementation.
  - b. Assure that qualified and independent auditors conduct audits.
  - c. Stipulate a post-audit timeframe for major users to implement recommended audit provisions, consistent with their complexity and expense.
  - d. Charge excess water use at a higher rate, e.g. where actual water use is significantly higher than the water supplier's system management plan projected.
  - e. Allocate funds for excess usage to infrastructure improvements to the water systems.
3. The Water Resources Board shall report annually on the extent to which water supply systems have implemented 8.05(b) and related strategies described in items 1 and 2.
4. Evaluate the MUTAP to assess issues and constraints to effective implementation.

- 03-04-02 Strategies for Residential Consumers on Public Systems** *(Implementation: Large water suppliers & Water Resources Board)*
1. Implement provisions of the Water Resources Board regulations for WSSMPs, 8.05 (a) that include a plan for residential demand reduction.
  2. The Water Resources Board shall report annually on progress of required ten-year implementation program and how compliance can be improved.
  3. Evaluate reduction in residential water demand, especially for stressed systems.
- 03-04-03 Strategies for Large Consumers not on Public Supplies** (i.e. on private wells or drawing from surface waters) *(Implementation: Large consumers, DOH, DEM, Drought Steering Committee & Water Resources Board)*
1. Users shall demonstrate to suppliers that they have identified and are using Best Management Practices.
  2. The Water Resources Board should register large consumers and require them to meter and report their withdrawals. (Monthly withdrawals annually, and, in times of drought, monthly).
  3. Best Management Practices should be submitted to the Water Resources Board that provide for water use reduction in time of drought consistent with demand reduction targets for particular drought conditions. Reporting during a drought period should demonstrate compliance with these plans.
- 03-04-04 Strategies for Users of Non-public Water Sources** *(Implementation: Large consumers, DOH, DEM, Drought Steering Committee, Municipalities, Watershed associations & Water Resources Board)*
1. Promote water efficiency and drought mitigation strategies for those using private wells or surface waters that are not part of a public water distribution system.
- 03-04-05 Strategies for Wastewater Reuse** *(Implementation: DOH, DEM, Legislature & Water Resources Board)*
1. Establish programs for reuse (rather than discharge into receiving waters) of treated wastewater where it is of sufficient quality to be used for other purposes.
  2. Institute necessary studies to determine feasibility and identify mitigation measures for potential negative impacts of a statewide wastewater reuse program.
  3. Establish a formula to quantify the value of water that relates to the projected costs of producing, distributing and treating the water.

**03-04-06 Strategies for Water Rates** (Implementation: Large suppliers, Water Resources Board & Public Utilities Commission)

1. Public water systems should utilize water pricing as an incentive to reduce demand during periods of drought as follows:
  - a. Define drought indices and establish demand reduction actions for their systems in the WSSMPs.
  - b. Set demand reduction (percentage) goals for each stage of drought in the WSSMPs.
  - c. Implement rate changes when drought conditions appear in order to provide higher incremental rates for water usage which is in excess of demand reduction targets for each stage of drought. (Suppliers subject to PUC rate jurisdiction have authority to institute such changes on an emergency basis during a drought, subject to later PUC review.)
  - d. Notify customers when drought rates take effect and that those who reduce their usage by the required percentage **will not** have an increase in their water bill.
  - e. Notify customers that those who do not reduce usage during drought **will** pay a higher incremental rate for exceptional water usage.
2. For suppliers not under Public Utilities Commission rate jurisdiction, propose new legislation to require rate-setting policy similar to that outlined above.
3. Evaluate water rate structures used throughout the state in terms of conservation pricing and investigate other incentives to further reduce demand.

**03-04-07 Strategies for Policy and Legislative Actions** (Implementation: Water Resources Board & General Assembly)

1. Develop a water allocation policy consistent with *the Drought Management Plan* and as recommended by State Guide Plan 721, *Water Supply Policies*.
2. Explore legislation that may be needed to promote efficient water use by water users which are not using a public water supply system.
3. See Section F.2. Water Rates, above.

## 724-04: IMPLEMENTATION: RHODE ISLAND DROUGHT MANAGEMENT PLAN

### 04-01 Response Framework

Rhode Island's framework for anticipating, monitoring, and mobilizing in response to drought seeks to coordinate and organize the efforts of key agencies and organizations having management responsibilities, important data, and/or representation of important interests affected by drought. The R.I. Water Resources Board (WRB) which is charged with broad responsibilities for the management of the state's water resources, will assume a primary role in anticipating and facilitating the statewide response to drought events.

During normal conditions, the WRB is responsible for gathering and reviewing reports on conditions from the United States Geological Survey (USGS), the National Weather Service (NWS), the RI Department of Environmental Management and other experts as appropriate. When dry conditions persist and drought appears evident, the WRB shall convene a Drought Steering Committee to provide for expert advice and multi-disciplinary input to assist the Board in shaping a coordinated state response to the drought situation and advising the Governor on setting the phases of drought for the state.

The WRB will coordinate public communication and education efforts, as advised by this committee, and will assemble and coordinate the efforts of state and federal agencies, organizations, local officials and suppliers. Specific responsibilities of the Water Resources Board for the implementation of this *Drought Management Plan* are as follows:

- Maintain a list of committee members and contact information
- Convene the Drought Steering Committee when conditions warrant, and provide secretariat support (agendas, facilitation, minutes, etc)
- Collect, correlate, and disseminate data on the status of the drought
- Publish a monthly current conditions report that summarizes current water resource and weather conditions
- Communicate the Drought Steering Committee's recommendations to all audiences and coordinate communications between government agencies, water suppliers and the general public
- Appraise the Drought Steering Committee of agency, local, and public responses
- Forward recommendations to appropriate entities
- Recommend, as advised by the Drought Steering Committee, to the Governor:
  - Declaring phases of drought
  - Declaring local, regional, or statewide emergencies
  - Developing and coordinating emergency actions
- Advise all parties of gubernatorial actions and/or directives

## **04-02 Drought Steering Committee**

An advisory Drought Steering Committee shall be convened by the WRB to provide technical expertise and advice to the WRB on monitoring, coordinating, and managing the state's response to drought situations. The Drought Steering Committee will assist in facilitating coordinated actions and communications related to drought conditions. The Committee will make recommendations to the WRB concerning drought levels and mitigation measures to assist the WRB in advising the Governor, local officials and other appropriate entities on actions needed to minimize drought impacts upon public health, safety and the environmental resources of the state. The primary responsibilities of the Drought Steering Committee include:

- Reviewing information gathered by the WRB to assess the impact of dry conditions
- Recommending drought phases and appropriate responses to drought-related impacts

### *Committee Membership*

The Drought Steering Committee shall consist of representatives from agencies that have responsibility for functions related to water resources and/or interests likely to be affected by drought conditions. It shall also include agencies that manage data necessary for assessing the severity of drought conditions. The WRB shall maintain an up-to-date list of Drought Steering Committee members and contact information. The committee members will advise their respective agencies or constituencies on necessary actions. Committee membership shall consist of, but not be limited to:

- Governor's Office
- Department of Environmental Management
- Emergency Management Agency
- Civil Preparedness Advisory Committee
- Rhode Island National Guard
- Department of Administration
- Department of Health
- State Planning Council
- Public Utilities Commission,
- Providence Water Supply Board
- Rhode Island League of Cities and Towns
- National Weather Service
- Rhode Island Water Works Association
- Rhode Island Agricultural-Council
- Rhode Island Rivers Council
- Rhode Island Senate
- Rhode Island House of Representatives

- Rhode Island Economic Development Corporation
- United States Environmental Protection Agency-Region 1
- United States Department of Agriculture-Natural Resources Conservation Service
- United States Geological Survey
- Audubon Society of Rhode Island
- Representatives of large & small public water systems
- Other interested parties as designated by the WRB

The director or chief executive officer of each of these agencies/organizations will be invited to be a member and may designate appropriate staff representatives to attend Committee meetings. The Chair of the Water Resources Board shall serve as Chair of the Drought Steering Committee. When drought conditions appear imminent, the WRB will convene the Drought Steering Committee to meet on a regular basis throughout a long-term drought to review data and make recommendations.

#### **04-03 State and Local Roles**

This section summarizes the general authorities and outlines the anticipated roles of key state and local agencies and organizations in managing drought events in Rhode Island. Please note that for all the following agencies their water management responsibilities take on heightened importance and priority during extended drought. Figure 724-(3), Rhode Island Drought Management Process, page 4-11 is a flow chart illustrating the drought management process.

##### **04-03-01 Water Resources Board (WRB)**

The Water Resources Board is charged by *Rhode Island General Laws 46-15* with broad duties to regulate the proper development, protection, conservation and use of the water resources of the state. The Board is delegated a number of specific responsibilities concerning water resources management, including water supply development, promoting the planning, development, and conservation of water supplies, and reviewing requests for new water supplies by major suppliers. In addition, it is responsible for developing both an inventory of the water resources of the state and an allocation program for water users and the quantity being used. The WRB also establishes regulations governing water supply system management planning and reviews and approves all water system supply management plans (WSSMPs). Large public water suppliers are expected to address droughts by following the emergency response actions prescribed in their WSSMP.

##### *Emergency Water Systems Interconnection Program*

The WRB manages an Emergency Water Systems Interconnection Program to promote emergency connections between large public water systems throughout the state for use during the time of water shortages and supply emergencies. This program is funded through general obligation bonds. It reimburses twenty-five percent of the cost of installation of an emergency interconnection between a single system, and fifty

percent of the cost of a connection benefiting two or more systems. During a long-term drought, these interconnections will be vitally important. Depending upon the impacts of a drought on local/regional supplies, they may be instrumental in transferring water from areas that have surplus water to areas of need based upon the pre-established emergency supply agreements between the suppliers. Where such agreements do not exist, emergency declarations by the affected communities and the Governor may be necessary to activate their use. Water suppliers are expected to address droughts by maintaining updated emergency supply agreements through the WSSMP process. The status of the existing interconnections is included in Appendix C, Water Resources Board Emergency Interconnection Program.

#### **04-03-02 Office of the Governor**

*Rhode Island General Law 46-15-14* authorizes the Governor to declare a water emergency, in all or in a part of the state in situations in which “water supplies are insufficient to meet the needs of the inhabitants of the state either through a water shortage or contamination of water supplies.” In a water emergency, the Governor may take such actions and issue such orders as may be necessary to implement the plan, including the imposition of conservation measures and the allocation of water supplies. RIGL 30-15-7 assigns the Governor the responsibility to prepare a comprehensive response plan for disasters and gives emergency management power to implement the response plan. This section also gives the Governor the authority to declare a state of emergency if a disaster has occurred or is imminent. Drought is included in the definition of “disaster”.

A proclamation of a state of emergency provides the Governor with expansive power, authority and discretion to address and resolve the declared emergency. In a water emergency, the Governor may take such actions and issue orders as necessary including imposing conservation measures and the allocation of water supplies. The actions and orders may be directed to state agencies, municipalities or entities engaged in the sale of water to the public. Once declared, a state of emergency may last only thirty days unless renewed.

#### **04-03-03 Department of Environmental Management (DEM)**

The Department of Environmental Management includes several units having specific responsibilities and/or resources related to the state’s drought response:

##### *Division of Agriculture*

The responsibilities of the division include a broad range of agriculture-related functions, organized within five primary program areas: animal health, mosquito abatement, pesticides, farmland ecology, and plant industry sales. The staff of the Farmland Ecology Unit works with, and regulates, farmers to ensure that agricultural activities do not negatively impact the state’s valuable wetland and groundwater resources. The division is responsible for coordinating with the Governor to declare a disaster or take other steps necessary based on either actual or predicted drought impacts to agricultural products. This declaration is often made in anticipation of crop

failures so that the state will be eligible to receive federal disaster assistance from the United States Department of Agriculture. Federal funding sources for drought assistance to agricultural interests are included in Appendix D, Federal Funding Assistance. The Division of Agriculture will also seek state financial assistance as necessary. The division has developed an agency response plan to reduce drought impacts on the agricultural community/industry. (See Appendix E, DEM Drought Response Plan for Agriculture.) The DEM plan is considered part of this plan in its entirety and part of the state response to drought management.

### *Office of Water Resources*

The Office of Water Resources implements a variety of programs aimed at protecting and restoring the state's surface waters, groundwater and wetlands. The Office of Water Resources' programs play a pivotal role in controlling wastewater discharges, promoting non-point source abatement, preventing groundwater pollution and averting alterations to freshwater wetlands. The office is also responsible for regulating individual septic systems, underground injection control, groundwater certification, private well installation, water quality certification, the Rhode Island Pollution Discharge Elimination System and wastewater facility treatment permitting. The private well installation program regulates the location, design and installation of private drinking water wells. It also provides for registering of well drillers and pump installers and maintains a current list of companies and/or individuals who are properly registered. Rules stipulate the design and construction requirements for drilling new wells or improving old wells. Permits are not necessary but drillers are required to adhere to the standards. Records of well installations including size, location, geology, depth and yield are maintained. The office estimates that there are approximately five hundred to one thousand private drinking water wells installed annually in Rhode Island.

### *Division of Forest Environment*

The Forest Environment Division manages 40,000 acres of state-owned rural forestland. It coordinates a statewide forest fire protection plan, provides forest fire protection on state lands, assists rural volunteer fire departments, and develops forest and wildlife management plans for private landowners. The division promotes public understanding of environmental conservation, enforces Department rules and regulations on DEM lands, and assists the federal government in providing landowner assistance programs. Risk of fires in wild land, rural areas, state forests and parks are linked to dry conditions. Assessment of fire risk and management of fire control resources is an on-going activity of the Division of Forest Environment. The division is responsible for managing state fire suppression resources and coordinating with other local, state, federal agencies and other states to obtain the appropriate resources.

## *Division of Fish and Wildlife*

The Division of Fish and Wildlife protects, restores, and manages the fish and wildlife resources of the state. The division is responsible for operating and managing twenty-four wildlife management areas totaling over 46,000 acres and also operates more than one hundred boat launching ramps and shore fishing areas located through the state. The division is responsible for setting seasons, size limits, methods of taking, and daily limits for the harvest of all wildlife as well as all recreational and commercial fisheries in the state. It is divided into three separate sections: Marine Fisheries, Freshwater Fisheries, and Wildlife Management. Each section is responsible for specific program activities. These activities include fisheries and wildlife research and management, freshwater fish hatcheries and fish stocking programs, habitat restoration, public access, land acquisition, education and information, public angling and hunting programs, and commercial fisheries management. Dry conditions can lead to a range of impacts to fisheries and wildlife, from reducing food sources to fish kills or displacement of certain populations of animals. Department responsibilities include responding to incidents of wildlife entering residential or urban areas. They also include identifying impacts to specific fisheries and wildlife populations and recommending measures to reduce the impacts to these resources.

### **04-03-04 Emergency Management Agency (EMA)**

The Emergency Management Agency is charged with protecting life and property in the event of a disaster or crisis situation. The EMA provides assistance to communities to protect the health and safety of their residents. During a drought and other types of water shortages, the agency may assist communities in locating alternative water supplies and in providing water (distributing emergency supplies) to their residents. The EMA coordinates the acquisition and transport of trucked water, large amounts of bottled water, or other equipment and supplies needed for emergency response. The agency may seek assistance through the RI National Guard, Federal Emergency Management Agency, Army Corps of Engineers, or the Emergency Management Assistance Compact if the water emergency is beyond the ability of the state to alleviate. The EMA may also assist communities in declaring a state of emergency.

### **04-03-05 Department of Health (DOH)**

*Rhode Island General Law 46-13* charges the Department of Health with preventing disease and protecting and promoting the health and safety of the people of Rhode Island. The Division of Environmental Health, Office of Drinking Water Quality is responsible for ensuring the quality of the state's public drinking water supplies. The Office of Drinking Water Quality works closely with local water suppliers, other state and federal programs, and various divisions within the DOH to ensure the safety of the state's drinking water. The office regulates the construction and operation of all public water systems and sources and assures the safety of drinking water supplies through monitoring requirements.

#### **04-03-06 Public Utility Commission (PUC)**

The Public Utility Commission is a regulatory body whose mission is to ensure that safe, reliable, quality utility service is provided at a fair and reasonable cost. The Commission has the powers of a court of record, and is charged under *RIGL 39-1-27.6* with responsibility for implementing and enforcing standards of conduct and holding hearings and conducting investigations involving the rates of water utilities. The Commission consists of three members appointed by the Governor to six-year terms with the advice and consent of the Senate. There are seven PUC-regulated water utilities in the state: Providence Water Supply Board, Pawtucket Water Supply Board, Woonsocket Water Department, Newport Water Department, United Water of Rhode Island, Kent County Water Authority, and Prudence Island Utility Corporation.

The PUC has a provision for seeking drought-related rate adjustments for regulated utilities during a drought emergency. When public safety requires or when an emergency exists in the financial affairs of a public utility, which is not met immediately, or will interfere with the accommodations, convenience, and welfare of the people, the Commission may order emergency rate relief, which becomes effective immediately, on a temporary basis. Under the Rules of the Commission, it has discretion over whether to hold a public hearing on such a request; and, if it finds that delay may cause immediate or irreparable harm, may set conditions it deems reasonable for such relief.

#### *Division of Public Utilities and Carriers*

The Division of Public Utilities and Carriers is a unit of the PUC charged with the supervision and execution of all laws relating to public utilities and carriers and all regulations and orders of the commission governing the conduct and charges of public utilities. The division serves as the advocate for water customers served by the seven regulated water utilities. The division must be notified of any water restrictions within these (regulated) water systems. Regulated water suppliers must coordinate mandatory conservation regulations through the Division of Public Utilities and Carriers. The division also reviews the calculation of proposed rates to ensure they are properly designed and will enforce all directives arising from the PUC's decision on such a request. All other suppliers can impose mandatory conservation, including rate changes, without the division's or the PUC's approval.

#### **04-03-07 Statewide Planning Program and State Planning Council**

The Statewide Planning Program of the Department of Administration is charged by *Sections 42-11-10 and 12 of the General Laws* with preparing and maintaining plans for the physical, economic, and social development of the state; encouraging their implementation; and coordinating the actions of state, local and federal agencies and private individuals within the framework of the state's development goals and policies. A State Guide Plan is prepared and maintained by the program as a means for centralizing and integrating long-range goals, policies and plans with short-range project plans and implementing programs prepared on a decentralized basis by agencies responsible in each functional area. Pursuant to *RIGL Ch. 45-22.3*, Statewide Planning

is responsible for establishing guidelines and with coordinating state review and approval of community comprehensive plans which all Rhode Island municipalities are required to prepare and maintain.

The State Planning Council, a seventeen member body representing a range of interests, guides the staff in preparing plans and in coordinating planning and development activities of governmental agencies at all levels and the private sector. The Council approves all statements of goals and policies and all elements of the State Guide Plan. The Council has been designated the Metropolitan Planning Organization (MPO) for transportation planning purposes and, as such, adopts the two year program of transportation investments, the Transportation Improvement Program. As the Comprehensive Economic Development Committee for the state, the Council adopts an annual priority list of projects for consideration by the US Economic Development Administration. The State Planning Council also advises the Governor on strategic planning matters such as this drought plan, and is required to ensure that major project and program proposals are consistent with the State Guide Plan.

#### **04-03-08 Water Suppliers**

Individual water supply systems, specifically the twenty-nine major public supply systems subject to the provisions of the Water Supply Systems Management Plan Act, have primary responsibility for assuring continuity of supply to their customers and for taking actions to mitigate the effects of drought on the ability of their systems to meet essential needs. As described previously, the Act requires large public suppliers to prepare Water Supply Systems Management Plans (WSSMPs). Contingency plans for drought circumstances are a critical component of any water supply management program in order to establish what levels of dry or drought conditions are likely to cause a water supply emergency. They are also critical in defining actions that will be taken to prevent the emergency and/or respond should one occur. Major water suppliers are responsible for implementing appropriate conservation responses as necessary to conserve water and to activate the appropriate actions outlined under the emergency operations portion of their WSSMP. The Water Resources Board is responsible for overseeing the implementation of the WSSMP Act.

Because each water supplier may be affected differently by drought due to differences in sources of supplies, capacity, regional hydrology, demand, timing, and permitting requirements, it is essential that each supplier identify drought indicators or triggers, within its WSSMP in order to assess the status of water supplies. The drought indicators for a particular water supply system will depend upon the specific conditions of the system, such as the capacity of storage and treatment facilities, storage tank elevation, reservoir storage, stream flows, groundwater levels, and precipitation. They will also depend upon the location and sensitivity of environmental resources. Drought triggers in emergency operations portions of the WSSMPs act as benchmarks that will provide warnings of impending water shortages. The purpose of developing triggers is to link the triggers with specific response actions for dry conditions and to mitigate drought impacts. A key response action for suppliers will be to restrict water use. Water use restrictions should move from limited and voluntary to more extensive mandatory restrictions depending upon the phase of drought. The development of clear triggers

and responses for suppliers within the WSSMPs will provide communities and water users predictable responses to dry conditions and droughts.

It is important for all water suppliers regardless of size to have access to contingency water supplies. All suppliers should establish connections to other nearby public suppliers where possible, identify emergency sources of water, and have in place up to date contingency contracts for the purchase of emergency supplies and/or distribution processes (e.g., bottled water or water tanker truck). All suppliers should identify non-potable water sources that can be used for fire protection and/or for other non-potable purposes. By having these contingencies in place prior to the onset of drought, water suppliers can ensure that they can protect the public health and safety during droughts.

#### **04-03-09 Local Governments**

Local governments, water suppliers and Indian tribes share the primary responsibilities for the management of their local systems and for ensuring that they can provide sufficient water to meet public health and safety needs of their communities and customers. Based upon local water supply conditions, municipalities may initiate their own actions ranging from voluntary water use restrictions to declarations of local water emergencies.

Information-sharing between state and local officials is essential in assessing drought situations. The local water entities must provide the specific information about their districts for state agencies to assess the broader situation faced by a region. Similarly, state drought levels and information to water suppliers should prompt action by local communities.

Municipal governments have the lead role in preparing for and managing all stages of drought at the community level. Drought preparedness measures include assuring plans for drought in Water System Supply Management Plans and local emergency plans, as well as coordinating with adjacent municipalities and their water suppliers to ensure emergency interconnections. Local governments should establish municipal policies to promote water conservation wherever possible. Municipalities, particularly those which experience chronic water shortages, should develop local ordinances to ensure that regulations and procedures are in place to anticipate and respond to drought conditions.

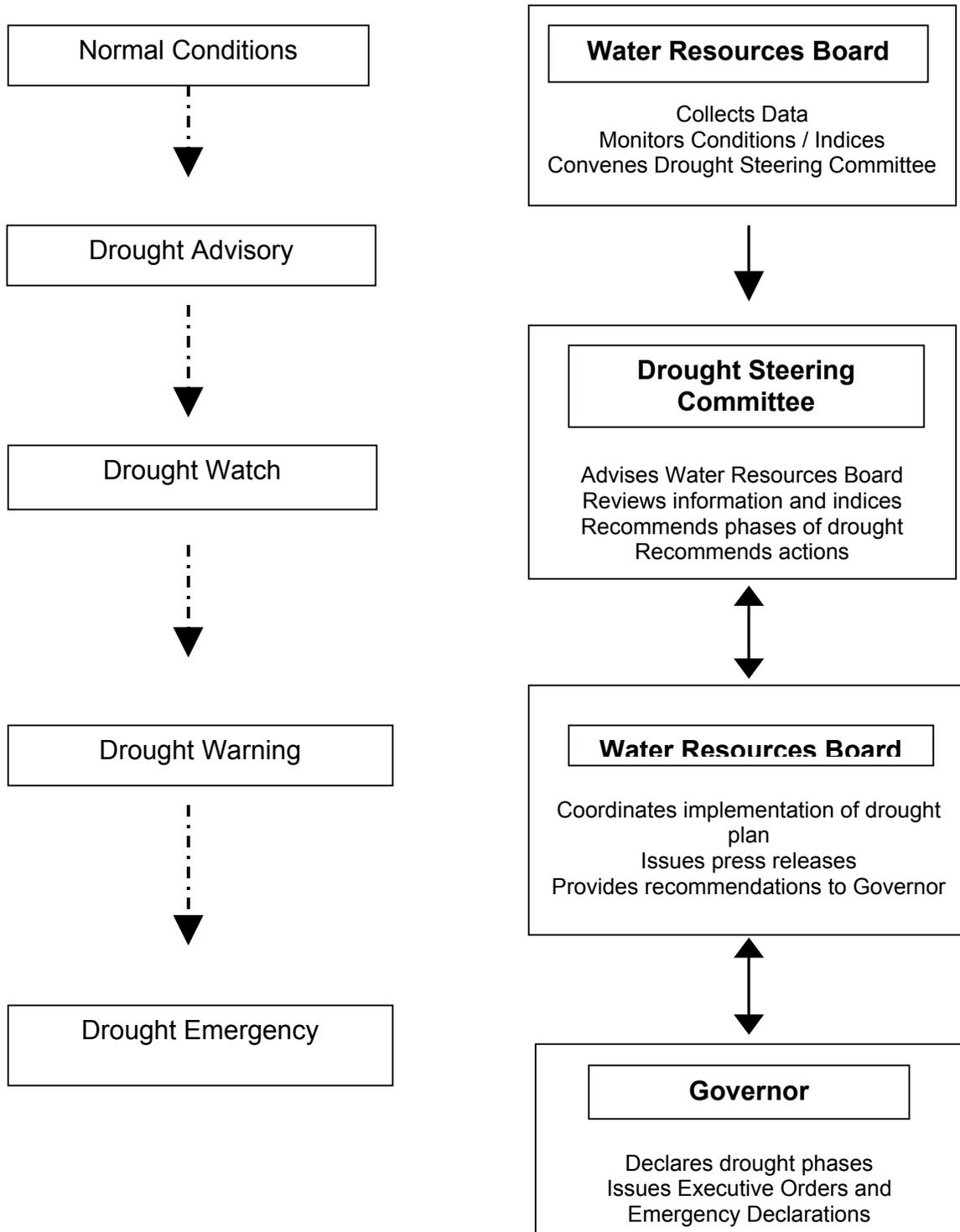
Emergency powers are conferred upon the chief elected municipal officer pursuant to *Rhode Island General Laws, 30-15-12*. This state law and individual municipal charter confer the authority to the municipality to plan for and declare an emergency on the municipal level. Municipal emergencies have a time limit of seven days, unless renewed.

The local government's most visible roles in the community may be in public education on the drought status and in the development and enforcement of local regulations as the situation worsens. However, not all restrictions may be ordered by local government. It should be noted that, in some cases, municipal governments have little control over water supply districts. However, it is local government that will be responsible for enforcing water restrictions at the community level.

#### **04-03-10 Other Local Organizations**

Local conservation groups and watershed councils can assist in efforts to encourage efficient water use in normal times and during drought conditions. They can serve as outreach agents to educate the public on the impacts of drought to natural resources and to coordinate and deliver information on water conservation. In addition, local watershed associations can work to assure that the minimum stream flows necessary for supporting healthy and naturally diverse populations of flora and fauna are maintained. They can serve as another important local source of information about water quality and quantity during drought conditions.

**Figure 724-(3)  
Rhode Island Drought Management Process**



## **04-04 Anticipating Drought**

### **04-04-01 Data Collection and Monitoring**

Monitoring meteorological trends and other climatic information is vital to making timely and accurate decisions on drought management. When persistent dry conditions occur, the WRB shall assemble drought-related information for the Drought Steering Committee. Two key federal agencies that monitor important drought related information on an on-going basis are the U. S. Geological Survey (USGS) and the National Weather Service (NWS). The USGS monitors groundwater and surface water levels at several locations throughout the state and analyzes current water resource conditions compared to historical records. The NWS tracks current precipitation data for Rhode Island and maintains information of historical averages and records for precipitation. The NWS also provides short and long-term weather forecasts, as well as the Palmer Drought Index (See Section 04-05-01, Drought Indices and Phases).

Other sources for precipitation data include the University of Rhode Island and local news station meteorologists. Individual water suppliers and local governments can also provide valuable data on the status of local water supplies and drought conditions. A description of the data collection responsibilities for each agency is provided in Table 724-(2) below.

**Table 724-(2)  
Drought Related Information Collection**

<b>Information</b>	<b>Agency</b>
Ground water levels, surface water levels, and stream flow conditions Surface water flows for rivers receiving major RIPDES discharges	United States Geological Survey Water Resources Board Department of Environmental Management
Extended weather forecast (3-month intervals) Summary of historical comparisons	National Weather Service, Local news stations, University of Rhode Island
Precipitation data	National Weather Service University of Rhode Island
Wells both static and pumping levels	Water Suppliers Water Resources Board
Suppliers with restrictions and water emergencies	Water Resources Board
Scituate Reservoir level	Providence Water Supply Board
Levels of other major reservoirs	Water Resources Board
Forest fire conditions and fire danger levels	Department of Environmental Management State Fire Marshal's Office
Crop, soil, and agriculture conditions	Department of Environmental Management United States Department of Agriculture RI Agricultural Council
Regulated utility issues	Division of Public Utilities and Carriers Public Utilities Commission
Public health and drinking water quality issues	Department of Health
Drought indices	Water Resources Board
Impacts to ecosystems, flora, and fauna	Department of Environmental Management Designated Watershed Associations

## 04-04-02 Drought Indices and Phases

### *Drought Phases*

The drought indices and drought phases of this Plan have been adopted after considering national indices from the National Drought Mitigation Center and the National Weather Service and reviewing historic precipitation patterns and historical drought events in Rhode Island. The indices chosen are designed to anticipate drought conditions in order to begin early public education and outreach efforts on a statewide basis. The drought phases are also consistent with those used by the State of Massachusetts and are designed to coordinate with the WSSMPs of large public suppliers, particularly in the later and more severe phases of drought. Five drought phases are established for the Water Resources Board and the Drought Steering Committee to describe drought conditions:

1. Normal
2. Advisory
3. Watch
4. Warning
5. Emergency

### *Drought Indices*

The WRB shall work closely with water suppliers to identify and assess local indicators including but not limited to, source of supply, static groundwater levels, reservoir levels and other storage and capacity issues. This information will be collected by the WRB and used to help assess drought levels, taking into account the time of year and the severity of the drought event. The WRB will provide such information to the Drought Steering Committee as is necessary to assess conditions and to make recommendations to the Governor regarding drought phases for the state. The Drought Steering Committee shall make its recommendations on phases based on the supplier's information and the following hydrological indices gathered by the WRB:

- **Palmer Drought Index (PDI)** - available from the National Weather Service or the National Climatic Data Center, this index reflects soil moisture and weather conditions including temperature.
- **Crop Moisture Index (CMI)** - available from the National Weather Service or the National Climatic Data Center, this index reflects short-term soil moisture conditions as used for agriculture. (The agricultural sector is usually the first to be affected because of its heavy dependence on stored soil water, which can be rapidly depleted in extended dry periods.)

- **Precipitation** - data is collected at eight data points and reported by county in Rhode Island. The data is evaluated relative to normal conditions in three, six, and twelve-month intervals by the National Weather Service to determine drought level. Additional sources of data may be available through other sources such as local news networks.
- **Stream flow** - condition maps showing areas of above-normal, normal, and below-normal are provided monthly by the USGS. A drought level determination is based on the number of months the stream flow levels are below normal (lowest 25% or period of record).
- **Ground water levels** - condition maps showing areas of above-normal, normal, and below-normal groundwater are provided monthly by the USGS. A drought level determination is based on the number of months the groundwater levels are below normal (lowest 25% or period of record).
- **Reservoir levels** - level data will be considered relative to normal conditions. The Water Resources Board, as part of its monthly conditions report, will maintain a list of water supply reservoirs and their percent of capacity. Drought phases will also be based on the water levels of small, medium, and large reservoirs across the state.

#### **04-05 Setting Drought Phases**

The Water Resources Board shall work with the National Weather Service, USGS, and water suppliers to correlate information for the Drought Steering Committee in order to prepare recommendations on drought phases for the Governor. Table 724-(3), Rhode Island Drought Indices and Phases, shows the thresholds for each of the indices by drought phase. To assign a drought phase, the Water Resources Board, as advised by the Drought Steering Committee, must determine that three of the four major hydrologic indicators have reached the designated threshold. The major hydrologic indicators are the Palmer Index (PDI), precipitation, stream flow and groundwater. However, it is important to note that time of year may influence the process considerably. In the fall and winter months, the Crop Moisture Index and PDI may react slowly but decline rapidly once the spring green-up occurs. The lag between surface water levels and groundwater levels could similarly skew the relative importance and number of indicators that are critical to determining the phase of drought. Finally, in the last two phases, groundwater and reservoir data particular to an area will also be used in conjunction with statewide data to determine drought phases. Local triggers developed by large water suppliers in WSSMPs shall be coordinated with the state drought phases by the Water Resources Board. The local WSSMPs' thresholds will also be used in conjunction with the statewide indices to help determine those regional areas that have entered the warning and emergency phases.

## 04-06 Drought Regions

The Water Resources Board, as advised by the Drought Steering Committee, will recommend drought phases statewide for the first three phases of drought, **Normal**, **Advisory** and **Watch** for the Governor to declare. The Water Resources Board, as advised by the Drought Steering Committee, will recommend drought phases by drought planning regions for the final two phases of drought, **Warning** and **Emergency** for the Governor to declare. The Governor shall declare the phase of drought for the state during a long-term drought. Figure 724-(4) Rhode Island Drought Regions shows the seven drought planning regions for the state. The seven regions are:

1. Northwest Region
2. Northeast Region
3. Central West Region
4. Central East Region
5. Southern Region
6. Eastern Region
7. New Shoreham Region

The regions are based upon a number of considerations, including existing water supply area boundaries, areas that are not served by large public water suppliers, precipitation differences, temperature variations, soils, municipal boundaries, and source of water supplies. The drought planning regions have been delineated to facilitate more focused monitoring of drought conditions and to differentiate areas of the state by basic water-related characteristics. For areas not served by major water suppliers and where the Water Resources Board will be conveying information to the general public through various media, Figure 724-4, Rhode Island Drought Regions, is an important reference.



RHODE ISLAND SOUND

BLOCK ISLAND SOUND

3 0 3 6 Miles

**LEGEND**  
[Red outline] DELINEATED DROUGHT REGIONS  
[Thin grey outline] RHODE ISLAND TOWN BOUNDARY

*New Shoreham Region*

Figure 724-(4)  
**RHODE ISLAND DROUGHT REGIONS**

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MAP BY THE RHODE ISLAND WATER RESOURCES BOARD

July 21, 2002

**Table 724-(3) Rhode Island Drought Indices and Phases**

<b>Drought Phase</b>	<b>Palmer Drought Index †</b>	<b>Crop Moisture Index</b>	<b>Precipitation †</b>	<b>Ground Water** †</b>	<b>Stream flow †</b>	<b>Reservoirs**</b>
Normal	-1.0 to -1.99	0.0 to -1.0 Slightly Dry	1 month below normal	1 month below normal	2 consecutive months below normal	Reservoir levels at or near normal for the time of year
Advisory	-2.0 to -2.99	-1.0 to -1.9 Abnormally Dry	2 month cumulative below 65% of normal	At least 2 out of 3 months below normal	3 consecutive months below normal	Small index Reservoirs below normal
Watch	-3.0 to -3.99	-2.0 to -2.9 Excessively Dry	1 of the following criteria met: 3 month cum. < 65% or 6 month cum. < 70% or 12 month cum. < 70%	4-5 consecutive months below normal	At least 4 out of 5 consecutive months below normal	Medium index Reservoirs below normal
Warning	-4.0 and below	> -2.9 Severely Dry	2 out of 3 of the above criteria met: 3 month cum. < 65% and 6 month cum. <65% or 6 month cum. <65% and 12 month cum. <65% or 3 month cum. <65% and 12 month cum. <65%	6-7 consecutive months below normal observation wells recording monthly record lows	At least 6 out of 7 consecutive months below normal	Large index reservoirs below normal
Emergency	-4.0 and below	> -2.9 Severely dry	Same criteria as Warning and Previous month was Warning or Emergency	>7 months below normal observation wells recording monthly record lows	>7 months below normal	Continuation of previous month's conditions

† Major hydrologic indicators.

\*\* Local triggers from the water system supply management plans will also be considered in assessing drought phases on a regional basis. The Water Resources Board will review local plans and work with suppliers to coordinate regarding drought phases and to collect, review and report surface reservoir and ground water data.

**Normal** is defined as the statistical average of the data for the period of record. Percentages for precipitation are relative to normal.

## 04-07 Communication

Effective drought response will be dependant upon effective communication of accurate, timely and consistent information on drought conditions and response actions to the public, major water users, and other targeted interests. One of the primary responsibilities of the Water Resources Board is to use the Drought Steering Committee to develop and disseminate clear and consistent information.

The Water Resources Board is primarily responsible for communicating the declarations of the Governor and the recommendations of the Drought Steering Committee to the public and targeted water users. Individual water suppliers are primarily responsible for communicating the decisions and recommendations of both the Governor and the Water Resources Board to their customers. Other agency members of the Drought Steering Committee will communicate the decisions and recommendations of the Drought Steering Committee to constituencies and interests they serve. Table 724-(4), Communication of Drought Steering Committee Recommendations, outlines the agencies and audiences for communication during the time of a drought.

**Table 724-(4)  
Communication of Drought Steering Committee Recommendations**

<b>Agency/Organization</b>	<b>Audience</b>
Water Resources Board Governor's Office	General Public
Water Resources Board,	Local Government, Watershed Councils
Water Suppliers RI Water Works Association	Customers, Water Resources Board
Water Resources Board Department of Health	Water Suppliers
Department of Environmental Management	Foresters
Department of Environmental Management RI Agricultural Council	Farmers/Agricultural Interests
Water Resources Board Department of Environmental Management	Other Large Water Non-agricultural users e.g. Industrial, golf courses, etc.
Narragansett and Mashantucket Pequot Indian Tribes	Indian Tribes
Water Resources Board State Fire Marshal	Local Fire Departments
RI Economic Development Corporation Chambers of Commerce	Industries/Businesses

## **04-08 Rhode Island Drought Management Actions**

This section describes the drought management actions for each of the five phases of drought. The process evolves from general information collection and sharing under normal or drought advisory conditions to preparation and declaration of an emergency situation by the Governor for drought emergencies. All response actions in early phases of drought will be continued in later phases of drought as needed. A given drought action phase can change in one of three ways:

1. If conditions worsen and reach the criteria for the next most severe drought phase, the drought severity level will be increased accordingly.
2. If conditions persist but do not reach the next phase, the drought phase will be held constant.
3. If conditions begin to improve the drought phase may be reduced.

In all cases, the Water Resources Board, as advised by the Drought Steering Committee, will recommend to the Governor whether conditions warrant a change in drought phase. Once the precipitation index triggers a drought phase of warning or emergency, conditions must improve beyond the previous level to reduce the drought phase. Table 724-(5) Rhode Island Drought Management Actions on the following pages lists the actions to be undertaken during the five phases of drought.

**Table 724-(5) RHODE ISLAND DROUGHT MANAGEMENT ACTIONS**

***Drought Phase: Normal***

1. WRB collects basic weather and hydrological data.
2. USGS monitors surface and groundwater levels.
3. WRB works with municipalities on drought related contingency plans and to adopt drought related ordinances.

***Drought Phase: Drought Advisory***

1. WRB communicates with public, municipalities and water suppliers about dry conditions.
2. WRB convenes Drought Steering Committee and recommends to the Governor to declare an advisory phase.
3. WRB develops press announcements as advised by the Drought Steering Committee.
4. WRB collects information and advises Drought Steering Committee on list of water restrictions.
5. WRB coordinates regular meetings of the Drought Steering Committee to review information and circulate educational materials.
6. WRB works with DEM and USGS in order to expand data collection and monitoring.
7. WRB forwards "Current Conditions" report to the Drought Steering Committee, general public, municipalities and major water suppliers.
8. WRB develops and recommends statewide voluntary conservation measures and begins public awareness campaign on water conservation.
9. WRB works with the DEM and USGS to measure stream flow and groundwater levels and to relay this data to farmers, golf courses, other water users and watershed councils in the affected watershed(s).
10. DEM-Agriculture mails listing of water conservation techniques to farmers, requests farmers to conserve, and initiates appropriate steps of the Drought Response Plan for Agriculture (See Appendix E).
11. WRB offers technical assistance to water suppliers to enhance efficiency of their major users

### ***Drought Phase: Drought Watch***

1. WRB distributes monthly Current Conditions Report to the Governor, Drought Steering Committee, major water suppliers, and municipalities.
2. WRB and the Drought Steering Committee recommend to the Governor to declare a watch phase.
3. WRB works with the Drought Steering Committee to develop and distribute clear and consistent public information regarding current conditions and general water conservation measures.
4. WRB offers technical assistance to municipalities on managing water use during dry conditions.
5. WRB works with state agencies to intensify monitoring and appraisal of drought situation.
6. WRB, as advised by the Drought Steering Committee, reports on status of the drought to the Governor, Senate and House leadership.
7. WRB works with state agencies to initiate contact and planning efforts with federal agencies.
8. WRB develops, recommends and encourages continued water conservation and use restrictions.
9. The WRB updates and distributes the statewide map reporting the drought status by region.
10. Large water systems follow triggers and actions from WSSMPs to determine their drought level.
11. DEM-Agriculture continues to implement response plan for agriculture.
12. When rivers approach their 7Q10 low flow (a standard used to measure stream flow), DEM requests voluntary reductions in the quantity of pollutants discharged from industrial sources.
13. WRB works with DEM-Agriculture to provide a list of water suppliers and water transporters willing to supply farmers.
14. WRB develops and distributes a list of well drillers.

*Drought Phase: Drought Watch* (continued)

15. DOH provides a list of private laboratories for water testing.
16. DOH expedites permitting and gives priority reviews to replace public wells that have gone dry, where practical.
17. Fire districts/departments identify alternative sources of water or call on a regional tanker force, when water bodies are low.
18. WRB, as advised by the Drought Steering Committee, encourages fire departments to distribute educational materials stating that dry conditions may cause problems for sprinkler systems.
19. DEM expedites dry hydrant permits for fire departments

*Drought Phase: Drought Warning*

1. WRB, as advised by the Drought Steering Committee, recommends to the Governor to declare a warning phase and WRB works with all constituencies (the public, municipalities, suppliers, etc.) to implement measures to reduce water use.
2. WRB, as advised by the Drought Steering Committee, implements and promotes public information and provides technical assistance to conserve water and reduce water demand.
3. WRB, as advised by the Drought Steering Committee, intensifies media coverage and public education efforts.
4. WRB, works with local suppliers and updates statewide maps to report those regions that have entered the warning stage.
5. WRB, as advised by the Drought Steering Committee, adopts list of non-essential water uses and strongly recommends that water users cease all non-essential water uses.
6. WRB, reviews readiness and availability of emergency interconnections and sources of water.

*Drought Phase: Drought Warning* (continued)

7. DOH assesses public health threats and acts as needed.
8. WRB, initiates contact and planning with northeast states regarding regional conditions and responses.
9. WRB, works with the Governor's Office to declare a warning phase and to prepare a proclamation for the Governor in case of a drought emergency and develops a communications strategy.
10. WRB, informs the House and the Senate leadership about drought conditions.
11. WRB, as advised by the Drought Steering Committee, coordinates with RIEMA to investigate potential funding and assistance.
12. Individual water systems implement drought-response actions outlined in their WSSMPs.
13. DEM-Agriculture follows steps in the Drought Response Plan for Agriculture.
14. Regulated water suppliers may petition the Public Utilities Commission for emergency rate relief.
15. DEM and WRB identify adverse environmental impacts and advise the Drought Steering Committee regarding mitigation.

*Drought Phase: Drought Emergency*

1. WRB, as advised by the Drought Steering Committee, recommends to the Governor to declare an emergency, and recommends to the Senate and House leadership on implementing emergency responses and mitigation measures.
2. The Governor may issue a proclamation of a drought emergency. The proclamation may stipulate mandatory bans on non-essential water use as recommended by the WRB. Water use restrictions shall be in accordance with WSSMPs for large water suppliers. More restrictive measures may be required according to the Governor's Emergency Proclamation.
3. WRB, as advised by the Drought Steering Committee, continues to coordinate the responses of state, local and federal agencies.
4. WRB, as advised by the Drought Steering Committee, coordinates with RIEMA to seek disaster declarations and secure emergency funding/assistance.

## **04-09 Non-Essential Water Uses**

Water is a basic and essential need of every creature. It is a natural resource of tremendous value and important to every citizen of the state. Maintaining water supplies is essential to protect the public health, to support the economy of the state and to protect the environment. Yet water can be depleted quickly and used faster than it can be replenished during a long-term drought. An important drought mitigation measure for water suppliers and users is demand reduction. Demand reduction measures implemented for water shortages generally follow a logical progression from voluntary reductions in usage to mandatory reductions in usage, and, finally under severe water shortage conditions, to water rationing.

Large water suppliers will implement demand reduction strategies as outlined in their WSSMPs. The second two phases of this plan, advisory and watch, require voluntary water use reduction. During the warning phase the Water Resources Board, as advised by the Drought Steering Committee, shall recommend more stringent use reductions and, in the final severe emergency stage, provide the Governor with recommendations on bans for non-essential water uses.

The actual uses banned may depend upon the time of year of the drought emergency since many non-essential water uses are seasonal in nature and often are outdoor household or workplace water uses such as landscape and lawn watering. Water suppliers should promote water conservation practices as a part of normal operating procedures and early during developing drought conditions. Water users should be alerted to developing drought conditions, informed of actions required to respond to water shortages and updated as more severe conditions develop. An important aspect of implementing the demand reductions will be early notification to appropriate municipal officials and water suppliers of the non-essential water uses ban and the measures they must use to enforce them.

The Long-term Drought Management Task Force strongly recommended the following listing of non-essential water uses be used during the times of warnings and emergency drought phases.

**Table 724-(6) Non-essential Water Uses in  
Rhode Island during Drought**

*(Recommended by Long-term Drought Management Task Force, March 2002)*

**Note: To encourage use of treated wastewater as a conservation measure, water uses which employ treated wastewater or recycled water are exempted from this list.**

1. Washing down any hard surface areas, including streets, gutters, sidewalks, walkways, driveways, parking lots, and tennis courts.
2. Washing down any building or structures other than for immediate fire protection.
3. Washing any vehicle including automobiles, motor bikes, boats, trailers, and airplanes.
4. Supplying water to any decorative water bodies, including all fountains and scenic and recreational ponds and lakes, except for the minimum necessary to support aquatic life.
5. Filling or maintaining the water level in private swimming pools.
6. Watering any lawns, plants, trees and other flora in daylight hours, with consideration to priority agricultural uses pursuant to *Rhode Island General Law 46-15.7-1(5) Management of the Withdrawal and Use of the Waters of the State*.
7. Obtaining water from hydrants for any purpose other than fire-fighting, including use of water for construction and hydrant testing.
8. Flushing of sewers.
9. Serving water in restaurants, except upon request.
10. Continuing water service to customers who have been issued a ten-day notice to repair one or more leaks and who have failed to comply.

## **04-10 Returning to Normal**

The Water Resources Board, as advised by the Drought Steering Committee shall recommend any reductions in drought phases to the Governor. After return to normal conditions, the Water Resources Board will provide a post-drought evaluation report to the Governor and the Drought Steering Committee. The report shall describe lessons learned and problems experienced during the drought situation and may make recommendations for amendments to this plan.

In order to determine the end of a drought, the two key indices, precipitation and ground water levels, will be examined. These two indices have the greatest long-term impact on stream flow, water supply, reservoir levels, soil moisture and potential for forest fires.

A majority of the indices will not be considered because they will return to normal at some point during the year. For example, the Crop Moisture Index returns to normal at the end of the growing season. Precipitation is a key factor because it is the overall cause of improving conditions. The water table responds slowly to improving conditions and is a good indicator for monitoring the return to normal conditions. According to the National Drought Mitigation Center, when precipitation levels return to normal, surface and sub-surface supplies return to normal in the same sequence they were affected. Soil water reserves are replenished first, followed by stream flow, reservoirs and lakes, and then groundwater. The length of the recovery period is a function of the intensity of the drought, its duration and the quantity of precipitation received as the drought ends.

In order to ensure long-term improvement, the reduction of a drought level in any given region should be limited to no more than one reduction every two months. Generally, drought phases should only be revised to a less severe phase when normal conditions for both precipitation and groundwater have been reached for a sustained period of time, as set forth in Table 724-(7) Returning to Normal. (Please note that Table 724-(3) Rhode Island Drought Indices and Phases, establishes the baseline references). Due to the complexity of factors to be examined, the Board and Committee will rely heavily on the professional judgment of key members.

Precipitation from large storms such as hurricanes will need to be weighed based on the individual impact of the large storm. While these storms may return long-term precipitation totals to normal and may fill reservoirs, they often do little to replenish groundwater levels necessary for long-term water resource protection. The long-term cumulative precipitation deficits listed in Table 724-(7) can be changed to up to twelve months depending on the time of year and length of the drought. For example, the fall and spring months are ideal for groundwater recharge, and precipitation that occurs during the fall and spring can result in a quicker return to normal conditions.

**Table 724-(5)  
Returning to Normal**

<b>Current Drought Phase</b>	<b>Next Drought Phase</b>	<b>Reduce Drought Phase by one category</b>
Emergency	Emergency-continued below normal conditions	Groundwater levels at or above normal and no precipitation deficit for past 3 months; and/or water resource problems which prompted the emergency have abated
Warning	Emergency-worsening conditions or continued below normal conditions	Two consecutive months of groundwater levels at or above normal and near normal precipitation for past 6 months
Watch	Warning-worsening conditions Watch continued below normal	Two consecutive months of groundwater levels at or above normal and near normal precipitation for past 6 months
Advisory	Watch-worsening conditions	Two consecutive months of groundwater levels at or above normal and near normal precipitation for past 3 months

## 724-05: CONCLUSION

This *Drought Management Plan* is the fourth in the series of State Guide Plan elements dealing with water supply. A plan for dealing with periodic episodes of precipitation at below-normal levels is an essential component of the state's organization and procedures for management of its water resources. Current conditions may or may not lead to a drought emergency this year, but one will certainly happen in the future. The plan shows that the state has experienced at least six major droughts since 1929.

The plan sets forth goals, objectives and strategies for drought management as well as policies, which serve as guiding principles for both short and long-term actions. They illustrate the high degree of cooperation among state agencies, local governments, and water suppliers, major water users and the public as a whole that must be achieved if the effects of drought are to be minimized. The plan establishes the mechanism for interagency coordination that will result in effective drought management. Drought levels are defined and drought indices are identified so that all parties will have consistent data and terminology to use in evaluating conditions on a continuing basis. A list of "Response Actions" specifies the actors and actions to be taken at each level from "normal" to "emergency."

The long-term goals, objectives and strategies are comprehensive but not excessively demanding. They continue and strengthen programs that the Water Resources Board and many other agencies, organizations, and individuals have pursued since completion of the *Water Supply Analysis for the State of Rhode Island* in 1990 and adoption of the State Guide Plan Element 722, *Water Supply Plan for Rhode Island*, by the State Planning Council in 1991.

*From the public hearing statement of Daniel W. Varin, Chair, Water Resources Board, May 5, 2002.*

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## **APPENDIX A: STATE GUIDE PLAN ELEMENTS RELATED TO WATER RESOURCE MANAGEMENT**

### *SGP Element 721 – Water Supply Policies for Rhode Island, 1997*

- The key objective of this plan is protection of water quantity and quality in the most cost-effective and environmentally sound manner. Specific policies include:
- Demand management, including the establishment of attainable and targeted water use reduction objectives, shall be an integral part of water resource management.
- Water suppliers shall implement conservation programs to encourage their customers to use water efficiently.
- Water suppliers shall strive to reduce peak demands.
- Commercial and industrial consumers proposing new uses, or major changes of use, shall utilize appropriate technical standards for consumption projections and shall utilize cost-effective, state-of-the-art equipment for controlling water use.
- Withdrawals from both surface and groundwater sources shall be managed based on improved data taking into consideration the safe yield of surface reservoirs and the recharge rate of groundwater aquifers.
- Water suppliers shall strive to minimize non-account water.
- Technical information shall be made available to consumers to facilitate demand management and to guide the resource management activities of water systems.

### *SGP Element 722 – Water Supply Plan for Rhode Island, 1991.*

This plan presents data on baseline water use, demand management, and supply and supply management. The findings, conclusions, and recommendations presented in the plan reflect the results of an extensive study involving the analysis of water supply in the State of Rhode Island to determine current water use and project future water needs. The main conclusion is that water needs to the year 2120 can be met if positive actions are taken toward supply management (protecting existing supplies from loss) and demand management (implementing conservation programs). Recommendations provided concern general planning, operating, and regulatory policy, supply management, demand management and supply augmentation.

*SGP Element 723 – Water Emergency Response Plan for the State of Rhode Island, 1993.*

This plan established a framework for response to water emergencies as they may occur throughout the state. The Plan outlines the existing emergency response capacity of state, local, and federal entities and structures response efforts relative to the extent of the threat to public health and safety. Specific policies include:

- A separate drought management plan should be developed to address preparedness and policy regarding long-term drought issues for the State.

**APPENDIX B:  
HISTORIC METEOROLOGICAL DATA**

- B-1: Historical Precipitation Data Kingston, RI Weather Station 1889-2001
- B-2: Providence, RI Precipitation Rates T.F. Green Airport Weather Station 1905-2001
- B-3: Scituate Reservoir Levels 2000-2002
- B-4: Scituate Reservoir Elevations 1928-2002
- B-5: RI 2002 Groundwater Levels

**APPENDIX B-1:**  
**HISTORICAL PRECIPITATION DATA**  
 Kingston, RI Weather Station  
 1889-2001

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	JUN, JUL, AUG
1889	8.27	2.92	4.7	4.14	6.06	4.25	8.7	5.5	5.52	5.18	7.38	2.91	65.53	18.45
1890	2.99	3.54	8.45	4.28	5.33	4	2.33	4.01	5.48	10.04	0.96	6.16	57.57	10.34
1891	8.45	7.2	6.96	4.2	2.43	1.12	2.29	2.25	2.11	6.12	2.83	3.99	49.95	5.66
1892	5.58	1.87	5.22	3.35	5.39	2.23	2.78	3.18	2.58	1.51	7.01	1.93	42.63	8.19
1893	3.14	9.44	6.47	5.98	6.12	3.92	0.95	5.84	3.76	3.02	3.37	5.52	57.53	10.71
1894	4.63	4.95	1.93	4.07	4.5	0.5	1.35	2.74	3.96	9.14	5.26	5.66	48.69	4.59
1895	4.94	1.75	4	6.54	4.28	3.83	5.36	2.7	1.29	7.89	4.25	2.45	49.28	11.89
1896	2.59	6.37	4.49	1.45	2.92	5.01	3.11	3.67	7.44	4.2	4.52	2.17	47.94	11.79
1897	5.19	2.73	3.96	4.81	3.95	4.43	6.35	4.31	1.76	0.89	10.25	6.25	54.88	15.09
1898	6.83	8.13	3.71	5.56	8.95	0.77	7.11	6.85	2.11	12.05	7.44	2.71	72.22	14.73
1899	5.66	5.08	9.67	2.63	1.88	1.87	2.71	6	7.26	2.43	2.7	1.8	49.69	10.58
1900	5.14	7.19	5.77	3.67	5.02	1.21	2.13	2.17	3.04	3.66	5.02	3.22	47.24	5.51
1901	2.44	1.13	8.58	8.78	6.98	1.32	4.05	1.98	4.05	2.93	3.04	10.3	55.58	7.35
1902	2.62	6.46	7.29	4.93	1.34	4.15	3.23	1.69	4.05	4.26	2.12	8.03	50.17	9.07
1903	5.5	7.04	9.19	6.91	0.7	6.55	3.59	6.55	0.75	3.05	2.5	3.77	56.1	16.69
1904	5.45	4.21	2.88	9.7	3.17	4.44	2.47	7.63	1.97	2.3	3.15	4.97	52.34	14.54
1905	4.37	2.18	2.86	2.83	1.69	5.22	3.71	4.66	5.86	1.75	4.23	5.71	45.07	13.59
1906	5.16	4.71	6.34	3.72	4.56	3.16	4.05	1.02	4.28	5.68	3.48	5.82	51.98	8.23
1907	4.11	3.75	3.19	4.04	5.64	2.95	0.72	1.49	6.89	3.06	8.03	7.99	51.86	5.16
1908	3.61	5.66	4.38	2.72	5.89	3.31	1.81	6.77	0.97	4.27	1.45	5.07	45.91	11.89
1909	6.44	6.68	3.38	6.56	4.92	2.93	1.51	2.39	4.62	2.28	3.97	4.04	49.72	6.83
1910	7.03	5.13	1.62	2.02	3.81	5.29	2.95	3.96	2.67	2.09	5.47	3.1	45.14	12.20
1911	4.88	2.36	4.04	4.96	1.97	3.26	3.71	6.24	2.31	5.01	8.99	4.8	52.53	13.21
1912	4.29	3.78	9.59	4.61	4.89	0.8	2.93	4.62	2.87	2.13	4.5	6.87	51.88	8.35
1913	4.7	3.4	4.83	7.49	2.51	1.45	2.94	3.65	3.12	7.29	2.48	5.64	49.5	8.04
1914	3.97	3.51	4.95	6.22	2.82	1.01	4.79	3.06	1.13	4.56	2.79	6.03	44.84	8.86
1915	11.43	4.87	0.23	1.85	2.64	1.36	2.28	7.74	3.02	3.84	2.86	6.35	48.47	11.38
1916	1.84	5.96	3.68	4.57	4.6	5.77	11.75	2.77	1.05	3.22	2.91	4.86	52.98	20.29
1917	4.05	3.38	6.22	3.01	5.48	5.25	1.71	2.85	3.8	6.46	0.41	2.3	44.92	9.81
1918	3.77	4.79	2.72	5.6	2.09	4.71	2.53	2.61	5.46	1.42	3.05	4.81	43.56	9.85
1919	5.96	5.06	5.76	4.43	6.88	2.52	5.29	8.33	7.61	3.03	4.17	3.51	62.55	16.14
1920	3.75	5.21	5.08	6.12	5.07	7.42	3.11	3.04	2.32	1.7	5.35	6.05	54.22	13.57
1921	3.24	2.63	4.23	4.33	4	3.31	5.18	2.7	1.58	1.07	7.98	3.19	43.44	11.19
1922	3.88	4.65	5.87	3.31	5.5	5.93	3.26	10.99	1.46	3.7	1.19	4.28	54.92	20.18
1923	8.97	2.1	5.93	6.7	1.39	2.81	1.96	2.26	2.75	7.78	4.14	7.05	53.81	7.03
1924	6.4	4.32	1.84	5.91	5.41	1.76	1.13	7.99	4.85	0.27	2.55	3.29	45.72	10.88
1925	4.29	2.18	3.34	2.37	3.64	3.53	2.52	3.27	3.91	5.52	5.23	7.06	46.86	9.32
1926	3.97	6.08	4.6	2.28	4.08	2.03	3.81	3.96	1.34	5.62	6.81	3.49	48.07	9.80
1927	3.05	3.16	2.19	2.27	2.9	5.69	5.47	11.65	4.06	5.02	5.81	5.8	57.07	22.81
1928	2.93	4.14	3.54	6.39	1.31	5.64	4.66	1.29	7.76	3.94	2.51	4.37	48.48	11.59
1929	4.56	4.29	4.99	8.57	4.2	0.75	2.52	5.29	5.25	3.01	3.35	6.01	52.79	8.56
1930	3.37	4.15	2.84	1.7	3.45	2.5	3.35	2.49	1.39	2.92	3.75	4.16	36.07	8.34
1931	4.86	2.92	5.52	2.63	3.07	5.36	3.73	3.99	1.03	2.64	1.09	2.59	39.43	13.08
1932	8.05	2.38	5.4	2	2.76	2.4	2.81	5.4	12.66	7.82	7.34	2.19	61.21	10.61
1933	2.52	3.97	4.85	7.63	2.18	2.15	2.03	5.08	8.09	2.87	2.78	4.28	48.43	9.26
1934	3.56	5.02	3.01	5.92	4.24	3.19	1.38	1.62	3.23	3.2	2.85	3.89	41.11	6.19
1935	5.52	2.89	2.31	4.28	1.95	5.89	3.92	1.49	5.21	1.04	7.04	0.84	42.38	11.30
1936	6.85	4.21	6.47	3.41	1.81	4.29	1.56	4.46	7.91	2.45	1.19	11.59	56.2	10.31
1937	4.45	2.47	4.07	5.47	3.31	4.36	0.97	4.06	3.24	4.02	5.73	2.71	44.86	9.39
1938	3.93	2.29	2.57	3.33	5.84	7.05	4.49	3.51	5.91	3.95	4.42	3.57	50.86	15.05
1939	3.85	4.73	6.63	5.39	0.67	3.33	1	8.82	2.29	4.77	1.55	2.71	45.74	13.15
1940	2.34	4.4	3.6	5.15	4.78	1.93	3.46	0.81	3.59	2.38	7.16	2.04	41.64	6.20

**APPENDIX B-1:**  
**HISTORICAL PRECIPITATION DATA**  
 Kingston, RI Weather Station  
 1889-2001

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	JUN, JUL, AUG
1941	3.75	1.56	3.27	1.99	2.48	6.83	4.15	1.87	0.35	2.19	3.75	2.83	35.02	12.85
1942	3.61	4.60	7.10	0.72	1.72	2.65	4.26	6.00	2.21	4.27	5.19	6.38	48.71	12.91
1943	3.43	2.10	2.60	3.33	3.61	1.40	2.69	2.63	1.20	4.57	2.66	1.54	31.76	6.72
1944	2.03	1.82	5.61	3.32	0.76	2.10	0.67	1.82	6.10	2.46	9.90	2.89	39.48	4.59
1945	3.14	3.18	2.28	2.59	4.86	2.84	1.22	3.83	1.25	2.33	8.16	7.17	42.85	7.89
1946	4.47	2.60	1.73	2.53	4.77	2.83	2.04	11.12	2.24	0.57	0.96	3.38	39.24	15.99
1947	3.41	0.67	3.33	5.26	4.42	3.31	4.79	1.62	2.35	3.60	6.12	2.80	41.68	9.72
1948	5.79	2.77	4.43	4.20	8.61	2.37	1.87	0.79	0.96	4.22	4.52	2.20	42.73	5.03
1949	5.22	4.39	2.58	4.57	2.63	0.04	1.89	2.51	4.02	1.60	3.40	3.00	35.85	4.44
1950	3.55	3.97	3.46	2.14	3.02	2.00	1.18	2.94	1.28	1.56	6.76	3.55	35.41	6.12
1951	4.07	3.67	4.48	2.81	3.90	2.38	1.05	3.55	2.55	2.60	6.84	4.75	42.65	6.98
1952	5.02	3.60	4.76	3.06	4.18	2.43	0.43	13.56	1.17	0.88	1.86	4.00	44.95	16.42
1953	6.14	4.48	9.02	6.39	4.27	0.47	6.24	5.10	2.49	4.72	6.02	5.77	61.11	11.81
1954	2.65	2.63	3.15	5.14	5.63	1.75	2.55	9.77	7.00	2.19	5.23	6.13	53.82	14.07
1955	0.83	4.38	4.25	2.60	1.86	3.14	3.79	10.08	5.26	7.45	5.93	0.83	50.40	17.01
1956	4.31	4.75	5.15	3.31	2.51	2.31	6.96	1.07	2.96	3.87	3.73	4.70	45.63	10.34
1957	2.03	1.45	3.85	4.34	1.99	0.12	1.46	4.60	1.71	3.03	3.94	5.48	34.00	6.18
1958	7.79	3.37	4.25	7.73	4.44	2.81	4.29	7.18	5.71	3.77	3.00	1.48	55.82	14.28
1959	2.19	2.47	5.45	2.99	2.90	6.92	4.23	3.88	0.83	4.45	4.07	4.09	44.47	15.03
1960	2.67	7.55	2.95	3.24	3.90	1.84	4.22	1.77	7.27	3.22	3.81	3.94	46.38	7.83
1961	1.80	2.94	3.68	8.02	5.83	2.63	1.05	6.46	10.62	3.14	3.66	3.32	53.15	10.14
1962	6.44	3.84	2.21	3.09	1.89	5.54	1.77	4.08	3.86	8.26	4.88	3.75	49.61	11.39
1963	3.65	3.31	3.60	2.17	4.82	1.45	4.69	2.81	3.93	1.94	6.89	2.78	42.04	8.95
1964	5.53	3.47	2.67	7.95	0.67	0.86	4.46	0.88	4.18	2.49	3.04	4.45	40.65	6.20
1965	3.37	3.65	1.73	3.69	1.94	1.55	2.30	2.83	2.99	3.14	1.68	1.82	30.69	6.68
1966	2.72	3.71	2.85	1.40	6.61	2.28	2.13	1.47	4.92	2.71	4.82	2.92	38.54	5.88
1967	1.64	2.51	7.22	4.43	8.22	3.22	3.44	2.87	3.24	3.00	3.36	7.46	50.61	9.53
1968	4.41	1.97	10.07	1.25	3.44	4.70	1.91	1.05	1.16	2.82	7.08	7.48	47.34	7.66
1969	2.31	4.10	3.31	3.89	3.05	1.60	4.05	3.79	4.38	2.83	7.13	10.23	50.67	9.44
1970	1.82	5.59	5.97	4.68	3.64	3.87	1.93	4.17	5.46	4.48	7.29	3.49	52.39	9.97
1971	2.29	6.44	4.47	3.12	5.10	0.87	3.78	3.28	1.11	4.65	6.81	3.12	45.04	7.93
1972	2.94	6.51	6.45	4.91	6.91	9.97	1.84	2.73	6.09	5.14	8.42	6.57	68.48	14.54
1973	4.01	3.95	4.15	7.77	4.89	3.67	4.96	4.11	4.38	3.37	2.87	8.04	56.17	12.74
1974	4.74	2.40	4.83	2.99	3.15	3.61	1.47	2.10	7.06	2.40	2.21	5.10	42.06	7.18
1975	7.57	4.07	3.18	3.65	3.34	5.11	3.58	3.16	6.30	5.29	7.19	4.94	57.38	11.85
1976	6.75	3.16	3.66	1.69	3.15	0.78	2.28	7.49	2.48	6.13	0.76	3.76	42.09	10.55
1977	3.53	2.91	5.92	4.40	3.05	5.41	1.46	4.78	5.26	8.02	3.61	7.79	56.14	11.65
1978	9.48	1.78	3.24	2.17	9.60	1.44	3.14	4.82	2.62	3.81	4.02	5.61	51.73	9.40
1979	12.41	4.69	2.91	5.39	7.09	1.95	2.23	8.56	5.24	4.63	5.35	1.54	61.99	12.74
1980	1.69	1.42	10.06	5.61	1.64	2.80	1.88	1.77	0.92	4.22	4.11	2.09	38.21	6.45
1981	0.90	4.89	0.92	5.23	1.75	5.08	2.54	0.91	2.76	4.19	3.99	7.32	40.48	8.53
1982	5.93	3.03	3.26	4.96	2.05	14.35	1.54	3.35	4.12	2.79	4.37	2.47	52.22	19.24
1983	4.81	4.64	7.95	12.96	4.86	3.33	1.74	3.69	1.57	4.89	13.00	6.77	70.21	8.76
1984	2.94	6.77	5.50	4.32	8.42	6.52	7.03	1.09	2.02	3.77	2.02	3.94	54.34	14.64
1985	1.02	1.65	3.92	1.21	5.86	4.71	2.91	12.71	2.75	2.47	9.17	1.00	49.38	20.33
1986	5.87	3.41	3.37	2.17	1.95	4.30	6.61	4.18	0.92	2.71	8.11	9.78	53.38	15.09
1987	6.19	0.91	5.09	8.26	1.81	1.46	1.05	3.15	6.11	2.37	3.79	3.51	43.70	5.66
1988	3.41	6.85	4.70	3.01	3.01	2.00	7.19	1.06	2.99	2.81	9.87	1.83	48.73	10.25
1989	1.84	3.26	4.86	6.44	6.03	5.06	6.54	5.71	6.24	7.04	7.51	0.90	61.43	17.31
1990	6.10	3.29	1.98	5.94	6.38	1.04	6.45	2.29	3.24	3.49	2.43	5.32	47.95	9.78
1991	3.39	2.32	6.28	4.44	3.04	1.03	1.72	7.60	6.59	2.37	4.78	3.33	46.89	10.35
1992	4.37	2.43	3.55	2.20	1.03	3.70	3.18	9.98	5.85	2.15	5.32	7.52	51.28	16.86

**APPENDIX B-1:  
HISTORICAL PRECIPITATION DATA**  
Kingston, RI Weather Station  
1889-2001

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	JUN, JUL, AUG
1993	2.26	4.94	7.24	5.29	1.16	1.51	4.17	0.54	4.82	3.74	3.52	5.81	45.00	6.22
1994	4.88	2.23	8.39	2.07	3.03	2.00	1.85	6.30	3.90	0.63	5.75	5.67	46.70	10.15
1995	4.04	3.85	2.55	3.04	4.23	3.55	1.25	2.28	4.05	5.97	5.14	3.75	43.70	7.08
1996	5.51	3.59	3.24	6.63	4.39	2.58	7.35	2.82	6.41	6.75	2.17	8.67	60.11	12.75
1997	4.35	2.59	6.75	5.61	2.93	1.77	2.07	9.73	1.03	2.31	6.23	3.65	49.02	13.57
1998	7.33	7.31	6.71	7.85	5.99	12.58	1.91	4.01	3.28	3.41	2.44	1.56	64.38	18.50
1999	6.34	6.23	5.47	1.54	5.60	0.05	1.06	2.94	7.60	5.35	3.46	2.71	48.35	4.05
2000	4.80	3.46	7.08	6.41	2.74	5.86	4.45	4.85	7.17	0.69	5.00	4.59	57.10	15.16
2001	3.24	3.04	12.29	2.40	6.31	5.52	3.40	3.42	3.25	2.35	0.95		46.17	12.34
<b>YEARLY AVERAGES</b>														
1889-1940	4.80	4.30	4.73	4.63	3.86	3.46	3.34	4.30	3.90	4.05	4.24	4.61	50.22	3.70
1941-2001	4.18	3.59	4.58	4.24	3.95	3.27	3.09	4.29	3.75	3.65	4.98	4.38	47.87	3.55
1889-2001	4.46	3.92	4.72	4.40	3.93	3.38	3.22	4.29	3.84	3.79	4.61	4.45	49.02	3.63
<b>10-YEAR AVERAGES</b>														
1892-1901	4.61	4.86	5.38	4.68	5.00	2.51	3.59	3.94	3.73	4.77	5.29	4.20	52.57	3.35
1902-1911	5.68	4.82	4.52	4.84	3.37	4.13	2.78	4.24	3.44	3.38	4.34	5.33	50.08	3.71
1912-1921	4.70	4.26	4.73	4.82	4.10	3.36	4.25	4.14	3.20	3.47	3.65	4.96	49.64	3.92
1922-1931	4.63	3.80	4.07	4.21	3.50	3.60	3.24	5.32	3.38	4.04	3.64	4.81	175.08	4.05
1932-1941	4.48	3.39	4.22	4.46	3.00	4.14	2.58	3.71	5.25	3.47	4.38	0.00	46.75	3.48
1942-1951	3.87	2.98	3.76	3.15	3.83	2.19	2.17	3.68	2.42	2.78	5.45	3.77	40.04	2.68
1952-1961	3.54	3.76	4.65	4.68	3.75	2.44	3.52	6.35	4.50	3.67	4.13	3.97	48.97	4.10
1962-1971	3.42	3.86	4.41	3.57	3.94	2.59	3.05	2.72	3.52	3.63	5.30	4.75	29.95	2.79
1972-1981	5.40	3.58	4.53	5.19	4.46	3.98	2.54	4.04	4.31	4.72	4.25	5.28	55.98	3.52
1982-1991	4.15	3.61	4.69	5.37	4.34	4.38	4.28	4.48	3.66	3.47	6.51	3.89	52.82	4.38
1992-2001	4.71	3.97	6.33	4.30	3.74	3.91	3.07	4.69	4.74	3.34	4.00	4.39	51.18	3.89
<b>20-YEAR AVERAGES</b>														
1902-1921	4.81	3.89	4.62	4.83	2.94	3.74	3.51	4.19	3.32	3.42	3.99	5.15	49.86	3.81
1922-1941	4.56	3.60	4.14	4.34	3.25	3.87	2.91	4.52	4.31	3.76	4.01	4.24	47.53	3.77
1942-1961	3.71	3.37	4.21	3.91	3.79	2.32	2.84	5.01	3.46	3.23	4.79	3.87	44.50	3.39
1962-1981	4.41	3.72	4.47	3.97	4.20	3.29	2.79	3.38	3.92	4.18	4.78	5.01	48.12	3.15
1982-2001	4.43	3.79	5.51	4.84	4.04	4.15	3.67	4.59	4.20	3.40	5.25	4.14	52.00	4.13
<b>40-YEAR AVERAGES</b>														
1922-1961	4.13	3.48	4.17	4.12	3.52	3.09	2.88	4.76	3.89	3.49	4.40	4.05	46.02	3.58
1962-2001	4.42	3.75	4.99	4.41	4.12	3.72	3.23	3.98	4.06	3.79	5.01	4.58	50.06	3.64
<b>50-YEAR AVERAGES</b>														
1902-1951	4.52	3.85	4.26	4.30	3.56	3.40	3.00	4.22	3.54	3.43	4.29	4.51	46.96	3.54
1952-2001	4.25	3.76	4.92	4.46	4.05	3.46	3.29	4.46	4.15	3.77	4.84	4.46	49.84	3.74

**APPENDIX B-2:**

Providence, RI Precipitation Rates - T.F. Green Airport Weather Station  
1905-2001

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1905	2.45	1.18	1.98	3.09	1.62	5.63	2.64	3	5.7	1.88	1.57	3.92	34.66
1906	2.59	2.88	4.29	2.07	4.51	3.4	5.29	2.51	3.18	4.91	1.9	3.81	41.34
1907	2.63	2.36	1.78	4.24	3.72	2.22	1.06	0.88	8.66	3.44	4.6	4.96	40.55
1908	2.93	4	3.42	1.77	4.18	2.01	4.33	5.16	0.88	3.37	0.92	3.12	36.09
1909	3.06	5.8	2.86	5.07	2.09	1.61	0.58	2.5	3.28	1.25	2.95	2.7	33.75
1910	4.85	3.86	1.32	1.64	2.9	3.98	2.86	2.62	2.68	1.6	3.37	2.53	34.21
1911	2.71	2.38	3.16	3.14	2.04	1.86	3.23	4.86	2.01	2.79	5.61	3.01	36.8
1912	4.09	2.65	6.36	3.61	3.99	0.63	1.76	2.9	1.87	2.37	2.81	5.61	38.65
1913	2.9	2.97	4.3	5.32	1.84	1.19	2.29	2.36	2.9	5.45	1.96	3.46	36.94
1914	3.56	2.99	3.38	3.94	1.88	0.58	2.81	2.02	0.48	2.97	1.96	2.93	29.5
1915	6.86	3.3	0.07	1.58	1.82	1.29	6.35	4.48	0.88	1.86	1.67	3.8	33.96
1916	1.35	4.34	2.46	2.89	3.85	4.2	6.37	0.78	0.86	2.39	1.92	3.03	34.44
1917	3.01	1.97	4.14	2.62	2.99	4.33	1.09	5.9	2.28	5.02	0.31	2.1	35.76
1918	3.11	2.87	1.77	3.74	2.07	3.12	4.44	2.41	8.04	0.65	2.01	3.14	37.37
1919	4.34	3.09	4.31	3.32	3.79	3.23	3.68	5.14	5.8	1.49	3.79	2.11	44.09
1920	2.6	4.56	3.66	4.7	4.92	6.8	3	3.17	2.11	1.44	3.69	3.91	44.56
1921	3.32	2.23	2.5	4.21	2.6	3.35	5.35	1.88	1.33	1.23	6.35	2.43	36.78
1922	1.36	2.42	4.67	2.18	4.24	6.58	6.88	6.96	3.28	2.66	1.09	2.58	44.9
1923	6.55	1.97	3.14	4.75	1.19	4.31	3.09	1.48	1.52	4.09	3.62	5.13	40.84
1924	4.13	3.67	1.34	3.77	2.71	1.05	1.12	5.39	6.71	0.15	1.48	1.96	33.48
1925	3.21	2.08	3.79	1.95	1.92	1.73	3.56	1.88	2.58	3.53	4.11	3.28	33.62
1926	2.69	3.82	3.14	2.12	2.48	1.52	2.88	4.2	1.58	4.62	5.3	2.75	37.1
1927	2.69	2.02	1.47	1.88	2.76	3.04	4.16	10.88	2.48	4.18	3.11	4.69	43.36
1928	2.27	2.85	2.64	3.69	1.18	3.7	5	4.03	3.25	3.63	2.13	2.87	37.24
1929	4.49	3.04	3.17	5.94	3.45	0.96	1.41	2.44	2.27	2.7	2.47	3.84	36.18
1930	2.62	2.57	3.02	1.08	2.21	2.71	3.8	2.14	1.23	3.6	3.32	2.67	30.97
1931	3.42	1.98	4.14	2.68	4.07	4.95	3.03	4.99	1.37	2.4	0.83	3.2	37.06
1932	4.45	1.76	4.69	1.98	2.51	2.44	2.83	4.86	8.48	4.49	4.49	1.66	44.64
1933	2.02	3.15	5.7	5.33	4.1	2.85	2.24	2.68	6.2	2.59	1.35	2.96	41.17
1934	3.8	3.38	3.82	4	3.5	3.33	0.82	2.34	4.13	2.26	3.88	3.1	38.36
1935	6.02	2.64	1.6	3.37	1.51	4.53	2.72	1.14	2.95	0.76	4.29	1.05	32.58
1936	6.84	3.77	6.78	3.79	1.68	2.92	2.34	3	5.29	2.49	1.05	9.44	49.39
1937	4.61	1.75	3.82	5.27	2.54	3.14	1.16	4.13	3.01	4.06	5.42	3.22	42.13
1938	4.37	2.34	2.39	2.22	4.49	7.21	6.92	2.21	5.16	3.01	3.4	3.31	47.03
1939	2.3	4.09	4.62	4.33	0.57	2.7	1.07	4.08	2.39	4.31	0.76	3.12	34.34
1940	2.5	3.13	3.69	5.3	5.01	2.22	3.24	0.99	2.57	1.86	6.38	2.15	39.04

Source: National Weather Service

**APPENDIX B-2:**

Providence, RI Precipitation Rates - T.F. Green Airport Weather Station  
1905-2001

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1941	3.57	2.34	3.54	1.53	3.1	4.01	5.68	2.45	1.03	1.07	2.79	3.37	34.48
1942	3.98	3.84	7.98	0.72	1.77	3.44	4.56	4.54	1.68	3.09	5.03	6.39	47.02
1943	4.07	1.61	3.74	3.72	3.34	1.88	1.97	0.82	1.24	4.39	2.32	1.15	30.25
1944	2.58	2.52	5	3.82	0.86	4.16	0.96	1.34	9.74	3.33	7.52	3.42	45.25
1945	4.08	4.26	2.21	2.57	4.25	3.97	1.98	2.63	1.87	2.29	8.5	7.82	46.43
1946	3.63	3.55	1.49	2.25	3.99	2.91	1.25	12.24	1.7	0.16	0.67	3.84	37.68
1947	2.85	1.83	3.36	4.91	3.73	3.93	4.71	2.01	2.96	2.27	5.42	3.73	41.71
1948	6.01	2.21	3.5	3.86	10.6	2.73	4.93	2.88	1.41	4.14	4.65	2.34	49.24
1949	4.35	3.48	1.97	4.85	2.72	0.05	1.56	4.73	4.85	2.11	2.96	2.02	35.65
1950	3.51	3.83	3.79	2.92	2.51	2.02	1.42	3.6	2.09	2.71	6.89	4.22	39.51
1951	4.5	3.39	5.29	3.57	4.5	2.64	0.91	2.36	1.74	3.27	8.26	5.17	45.6
1952	4.59	4.37	4.72	4.3	4.22	2.11	0.32	7.45	2.64	1.62	1.78	3.42	41.54
1953	6.46	4.71	7.92	5.99	3.25	0.55	4.43	3.99	2.99	4.71	6.59	5.42	57.01
1954	2.84	2.68	3.53	4.91	5.92	1.31	2.56	8.3	6.04	2.79	4.92	5.73	51.53
1955	0.78	4.97	5.35	3.61	2.37	3.72	3.34	11.12	3.27	7	5.6	0.58	51.71
1956	4.92	4.6	5.51	3.08	1.43	1.57	4.92	0.91	3.1	3.74	3.62	5.27	42.67
1957	2.17	1.68	3.29	4.46	0.93	0.39	1.41	2.51	0.87	2.52	3.99	5.86	30.08
1958	7.12	2.95	3.45	7.21	4.05	3.15	6.29	5.15	5.02	3.08	2.58	1.49	51.54
1959	2.27	3.67	6.04	3.83	1.46	4.83	4.01	3.53	0.77	4.71	3.85	4.17	43.14
1960	3.02	5.63	2.48	2.94	3.79	1.26	4.61	1.06	5.98	2.24	2.77	4.3	40.08
1961	3.52	4.68	4.16	7.32	5.21	1.48	2.76	3.86	7.92	2.39	3.1	3.16	49.56
1962	4.7	5.16	1.93	3.85	2.14	5.52	1.62	2.73	3.67	13.1	4.49	2.63	51.52
1963	3.4	3.15	3.78	1.62	4.69	3.54	3.35	1.56	4.1	1.63	6.53	2.15	39.5
1964	5.65	3.15	2.26	5.34	0.71	2.34	2.63	2.38	3.95	2.11	2.43	5.46	38.41
1965	3.46	3.77	1.72	2.43	1.08	1.91	1.28	1.9	1.64	2.75	2.08	1.42	25.44
1966	3.4	4.3	2.4	1.48	3.85	2.31	2.77	3.37	5.23	2.6	3.93	3.04	38.68
1967	1.6	2.51	5.49	4.19	7.27	2.72	3.95	3.24	3.17	2.25	2.75	7.36	46.5
1968	3.5	1.31	7.83	1.49	3.54	4.74	1.49	1.61	1.14	1.79	6.22	6.7	41.36
1969	2.23	4.3	3.1	3.95	2.41	1.23	2.98	2.58	3.09	1.62	6.35	10.8	44.59
1970	0.5	5.34	4.75	3.91	3.03	4.25	1	6.59	1.79	4.41	5.31	4.54	45.42
1971	2.01	5.36	3.81	2.31	3.83	1.64	3.48	3.03	2.54	2.88	5.16	2.37	38.42
1972	1.85	5.19	6.7	3.71	5.73	6.83	4.25	2.98	7.31	4.36	8.45	7.7	65.06
1973	3.06	3.55	2.78	7.16	3.99	3.48	2.92	5.17	3.04	3.17	2.29	7.63	48.24
1974	4.45	3.04	4.51	2.86	2.74	3.28	1.64	3.1	6.15	2.79	1.56	4.54	40.66
1975	6.78	3.29	3.07	2.99	2.06	4.73	3.51	2.19	6.15	4.66	6.29	5.11	50.83
1976	6.38	2.91	3.44	2	2.53	1.6	8.08	7.01	1.57	6.52	0.81	3.47	46.32

Source: National Weather Service

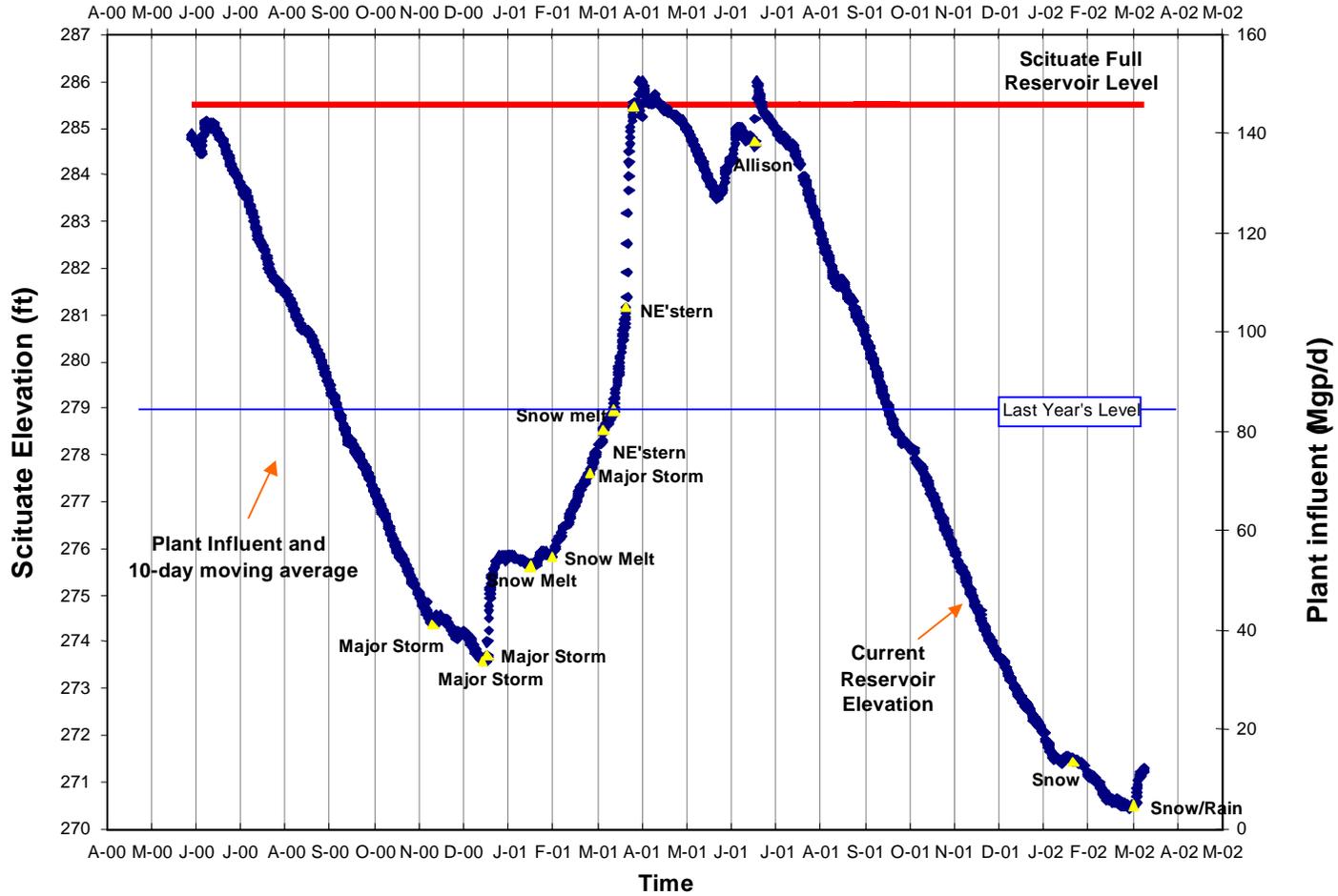
**APPENDIX B-2:**

Providence, RI Precipitation Rates - T.F. Green Airport Weather Station  
1905-2001

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1977	3.9	2.87	5.62	3.35	3.43	3.92	2.04	2.12	5.6	6.9	3.24	5.85	48.84
1978	9.01	3.2	3.1	2.53	5.27	1.97	2.63	6.46	1.82	3.22	2.61	5.19	47.01
1979	11.7	4.08	2.21	5.12	7.62	1.44	1.65	10.09	4.08	3.94	4.49	1.81	58.19
1980	1.4	1.16	8.11	6.18	1.78	3.85	2.03	1.99	0.9	3.41	3.73	1.57	36.11
1981	0.77	4.79	0.56	4.1	1.92	2.31	3.75	2.65	2.58	3.38	3.2	6.36	36.37
1982	6.09	3.08	3.76	3.64	1.61	11.1	3.51	3.67	3.61	3.08	4.32	1.81	49.26
1983	4.32	4.81	8.84	12.7	4.67	1.91	2.14	2.71	2.16	4.5	11	7.71	67.52
1984	2	7.2	5.77	4.3	8.38	4.09	5.16	0.71	1.77	4.25	1.95	3.16	48.74
1985	1.18	1.57	3.08	1.65	4.76	4.7	2.88	8.57	1.69	1.78	7.14	1.42	40.42
1986	5.88	3.18	2.86	2.1	2.29	3.27	5.95	3.29	0.97	2.48	5.77	8.09	46.13
1987	4.73	0.39	5.62	6.91	1.8	2	1.2	2.58	7.47	2.28	3.4	2.29	40.67
1988	2.69	5.29	4.09	3.11	2.83	0.91	5.73	0.94	2.38	1.77	7.6	1.03	38.37
1989	1.17	2.69	4.13	5.3	6.07	5.84	5.59	6.14	4.75	8.37	4.35	1.66	56.06
1990	5.01	2.93	2.01	5.57	5.7	1.13	3.52	3.74	2.28	4.96	2.45	5.48	44.78
1991	3.44	2.31	6.61	4.8	3.3	0.93	2.76	5.98	5.09	2.65	4.65	3.17	45.69
1992	4.82	2.1	4.04	2.34	1.42	4.61	3.59	6.06	5.09	1.53	5.05	6.83	47.48
1993	2.42	5.06	6.99	5.02	1.12	1.4	2.18	1.23	4.08	3.55	3.35	5.76	42.16
1994	5.53	2.1	7.19	2.07	2.98	2.7	1.34	6.34	4.12	0.4	5.34	4.58	44.69
1995	3.67	3.14	2.03	3.34	2.83	2.89	1.17	1.8	4.06	6.37	4.76	2.18	38.24
1996	5.02	2.19	2.71	4.88	2.44	2.17	5.57	2.19	5.72	6.2	2.38	6.59	48.06
1997	4.27	1.89	4.68	3.25	2.68	2.23	0.96	6.32	0.99	1.8	6.06	2.84	37.97
1998	6.55	5.85	5.86	4.91	6.05	9.61	1.37	2.39	2.3	3.78	2.76	1.27	52.7
1999	6.7	5.45	3.33	1.55	4.25	0.17	0.82	3.25	7	4.5	2.85	2.39	42.26
2000	4.19	2.74	5.37	5.06	3.72	4.78	3.64	2.41	3.79	1.31	4.73	4.26	46
2001	2.4	1.96	8.78	2.04	3.96	6.72	1.92	4.5	4.4	0.64	0.41	2.46	40.19

Source: National Weather Service

### APPENDIX B-3: Scituate Reservoir Levels 2000-2002



Source: Providence Water Supply Board

**APPENDIX B-4:**  
Scituate Reservoir Elevations 1928-2002

YEAR	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
1928-29	284.43	283.63	283.08	282.87	282.65	282.11	282.34	284	284.32	284.28	284.53	284.1
1929-30	282.77	280.87	278.95	276.88	274.83	273.09	272.6	273.57	275.38	277.54	278.29	277.51
1930-31	276.23	274.28	272.18	269.8	267.58	266.14	264.86	265.82	267.39	275.51	278.84	281.37
1931-32	283.32	281.56	280.11	278.25	276.34	274.45	273.35	276.56	277.96	281.85	283.83	283.17
1932-33	281.06	278.86	277.16	279.75	282.5	284.6	283.61	282.8	282.86	284.23	284.16	283.09
1933-34	282.68	280.42	278.39	278.26	277.64	276.86	277.58	280.96	280.38	285.04	284.14	284.09
1934-35	283.14	280.72	278.62	278.55	278.2	278.73	281.17	283.23	281.23	281.2	284.37	283.14
1935-36	283.5	281.93	279.32	277.32	275.01	274.3	273.13	277.33	278.48	285.48	283.95	282.22
1936-37	280.91	279.07	277.06	275.97	274.43	273.12	280.27	280.85	279.18	281.83	284.3	285.19
1937-38	284.06	282.09	281.43	279.8	278.13	280.96	279.49	279.19	279.73	280.86	282.48	283.04
1938-39	284.87	285.14	280.58	281.12	279.83	278.23	280.01	279.17	281.31	282.72	283.74	282.57
1939-40	280.86	278.48	276.67	274.62	272.85	273.1	273.18	274.28	274.7	280.08	284.55	285.11
1940-41	283.53	282.87	280.63	278.35	275.88	276.19	276.21	276.22	278.63	279.7	280.39	280.01
1941-42	280.07	278.99	277.15	274.75	272.38	270.88	270.02	270.95	273.39	282.29	281.65	281.25
1942-43	280.34	279.81	278.31	276.16	274.55	275.4	280.05	279.69	280	280.98	281.53	283.91
1943-44	282.46	280.43	278.21	275.93	274.41	273.57	271.84	270.65	270.52	273.95	277.75	277.5
1944-45	276.2	273.86	271.2	271.68	270.27	273.47	277.37	279.19	279.43	283.76	283.73	283.88
1945-46	283.76	282.03	279.81	277.63	275.45	275.88	280.85	281.92	282.59	283.71	283.56	284.67
1946-47	283.41	281.23	282.51	281.16	279.95	278.3	277.97	279.17	279.62	283.18	283.87	284.5
1947-48	283.91	282.73	280.97	279.29	277.37	279.63	279.66	277.97	280.01	285.22	284.61	285.56
1948-49	284.69	282.83	281.01	278.73	277.01	278.13	279	281.61	281.56	282.64	284.16	284.66
1949-50	282.5	280.17	278.1	276.05	273.94	272.4	272.07	273.29	275.58	280.13	282.78	284.07
1950-51	283.58	281.33	279.64	277.64	275.63	275.99	277.74	279.77	282.17	283.41	284.66	285.08
1951-52	284.19	282.41	280.57	278.54	276.71	281.24	283.4	282.84	281.44	283.39	284.31	285.1
1952-53	283.92	281.34	280.02	277.76	275.37	273.52	272.74	278.12	282.29	285.13	284.68	284.49
1953-54	282.38	280.5	278.36	276.08	274.38	274.86	279.6	280.19	281.5	283.75	284.92	284.48
1954-55	283.05	281.11	280.22	282.61	281.65	282.94	284.57	281.49	282.33	282.66	284.05	284.35
1955-56	283.65	281.04	282.47	279.97	285.21	284.6	281.1	282.2	282.41	282.16	285.06	283.8
1956-57	282.87	281.39	278.96	276.87	274.79	274.14	276.52	278.15	279.67	282.1	284.36	283.34
1957-58	281	278.38	275.91	273.47	271.19	269.42	270.66	279.27	280.98	284.82	285.62	284.67
1958-59	283.8	282.1	280.42	279.27	279.43	279.32	278.74	278.12	279.12	282.98	284.62	283.82
1959-60	283.61	283.91	281.28	279.01	278.35	279.54	282.6	282.15	284.19	283.12	284.27	284.62
1960-61	282.55	280.89	278.84	279	278.37	279.44	280.03	278.86	281.01	282.99	284.92	285.35
1961-62	283.23	281.41	279.11	279.99	279.76	279.36	278.81	280.96	279.87	283.34	284.04	284.15
1962-63	283.45	281.29	279.08	277.14	277.54	280.09	280.12	278.98	279.05	283.61	283.64	284.54
1963-64	283.55	282.41	280.07	278.08	275.77	279.9	275.36	280.15	280.37	282.17	284.68	283.53

Source: Providence Water Supply Board  
B-4-1

**APPENDIX B-4:**  
Scituate Reservoir Elevations 1928-2002

YEAR	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
1964-65	281.43	279.43	277.21	274.98	272.78	271.28	273.08	273.83	277.38	280.27	281.38	281.06
1965-66	279.6	277.26	274.89	272.71	270.7	269.01	267.69	266.76	268.84	272.57	272.61	273.71
1966-67	275.84	274.08	272	270.63	269.64	271.24	271.94	274.09	275.21	280.45	283.59	285.27
1967-68	285.05	284.3	282.48	280.59	279.74	279.97	281.26	279.15	279.05	285.3	284.18	284.21
1968-69	284.41	281.48	279.26	277.25	275.21	275.47	279.28	280.3	280.89	284.78	285.12	284.77
1969-70	283.38	281.73	280.04	278.43	276.7	278.08	283.45	282.99	283.99	284.44	284.21	284.03
1970-71	283.63	281.21	279.11	277.1	275.29	275.41	275.73	275.87	279.66	284.28	284.5	284.9
1971-72	283.42	280.96	278.39	276.39	274.87	274.19	275.15	277.06	279.58	285	284.48	284.47
1972-73	284.73	284.04	282.85	282.06	281.95	285.16	285.65	283.8	282.83	280.67	284.31	283.71
1973-74	282.86	282.05	280.53	279.1	277.85	277.82	284.69	283.94	282.12	284.44	283.35	283.05
1974-75	281.94	279.25	276.35	274.93	274.37	273.81	277.47	282	282.26	282.68	283.71	282.96
1975-76	282.2	279.77	277.3	276.16	277.67	281.34	280.27	282.72	282.07	283.17	283.94	284.22
1976-77	281.99	280.03	279.49	277.55	277.1	275.63	275.7	276.31	277.25	284.75	284.84	284.49
1977-78	283.27	280.68	278.26	277.22	280.05	280.65	282.32	285.31	281.7	284.96	284.17	285.06
1978-79	283.11	280.41	279.08	276.52	274.7	273.21	274.38	285.29	283.96	283.64	284.8	285.51
1979-80	283.8	280.96	279.43	277.6	276.58	278.5	277.65	276.16	274.87	282.99	285.24	284.08
1980-81	282.4	280.28	277.81	275	272.97	272.07	270.96	269.13	274.7	275.56	277.38	277.7
1981-82	275.81	273.35	270.39	268.01	266.84	267.53	273.26	279.98	284.02	284.26	284.38	282.67
1982-83	284.77	281.97	279.18	275.83	273.56	274.46	275.22	277.81	281.81	285.53	285.65	284.32
1983-84	282.58	278.67	274.85	271.43	269.11	272.09	278.49	278.64	283.06	284.83	284.29	285.14
1984-85	283.93	281.93	278.07	274.94	272.16	270.37	270.05	268.24	268.35	270.04	269.9	270.61
1985-86	270.16	268.17	266.18	264.97	262.97	267.1	268.94	271.27	274.13	278.2	278.66	277.95
1986-87	277.36	276.33	277.22	274.95	273.24	276.81	284.05	282.67	279.44	282.01	284.35	282.72
1987-88	280.1	277.03	273.94	272.15	270.99	270.58	271.4	272.07	277.05	279.91	281.74	283.33
1988-89	280.94	278.68	276.12	272.8	270.43	272.88	273.12	273.06	274.04	276.1	279.96	283.51
1989-90	284.51	283.45	283.47	282.57	284.7	284.67	284	285.29	284.61	284.35	284.61	284.78
1990-91	283.25	281.21	283.02	281.12	284.14	284.13	284.78	284.46	284.33	284.83	284.79	283.83
1991-92	281.52	278.57	278.29	277.51	277.53	280.63	282.78	285.35	285.47	285.45	285.02	283.99
1992-93	283.57	281.62	281.24	279.94	278.65	281.12	285.63	284.87	284.8	286.03	285.57	284.4
1993-94	282.32	279.2	276.77	273.95	271.59	270.15	274.43	275.5	280.1	285.77	285.31	284.83
1994-95	282.61	279.5	277.35	275.33	275.48	272.7	275.55	278.58	280.26	283.12	284.2	284.48
1995-96	283.1	279.9	276.5	273.8	272.5	274	273.8	280.4	284.9	285.4	285.1	284.1
1996-97	282.23	280.96	278.4	277.49	280.17	280.25	285.4	285.45	285.07	285.35	285.4	284.9
1997-98	282.38	278.72	276.25	274.38	271.75	272.75	273.12	279.45	284.98	284.75	284.74	284.82
1998-99	286.2	283.6	281.8	279.89	278.63	278	277.29	283.84	285.45	285.06	284.14	284.29
1999-00	281	277.5	274.51	275.13	275.31	275.98	277.19	278.61	281.47	284.98	285.19	284.72

Source: Providence Water Supply Board  
B-4-2

**APPENDIX B-4:**  
Scituate Reservoir Elevations 1928-2002

<b>YEAR</b>	<b>JUL</b>	<b>AUG</b>	<b>SEP</b>	<b>OCT</b>	<b>NOV</b>	<b>DEC</b>	<b>JAN</b>	<b>FEB</b>	<b>MAR</b>	<b>APR</b>	<b>MAY</b>	<b>JUN</b>
2000-01	283.87	281.54	279.4	277.24	274.95	274.17	275.85	276.02	278.08	285.97	284.98	284.3
2001-02	284.98	282.65	280.39	278.12	275.73	273.58	271.83	271.07	270.5			
<b>AVERAGE</b>	282.35	280.32	278.44	276.81	275.73	276.09	277.32	278.61	279.72	282.52	283.35	283.33
<b>MAXIMUM</b>	286.17	285.14	283.47	282.87	285.21	285.16	285.65	285.45	285.47	286.03	285.65	285.56
<b>MINIMUM</b>	270.16	268.17	266.18	264.97	262.97	266.14	264.86	265.82	267.39	270.04	269.9	270.61

**APPENDIX B-5:  
Rhode Island 2002 Groundwater Levels**

<b>Observation Wells New Historical Low Water Levels</b>	<b>Well Number</b>	<b>Start Year Of Record</b>	<b>Lithology and Topographic Setting</b>	<b>Month-End Measurement and Date Measured  (ft below land surface)</b>	<b>Previous Historical Minimum Level  and Date Measured (ft below land surface)</b>
<b>February 2002</b>					
Richmond	785	1989	Sand & Gravel, Flat	26.64 22	25.21 Feb. 28, 2000
Coventry	342	1991	Sand and Gravel, Valley	10.17 21	8.89 Feb. 22, 2001
Exeter	6	1948	Sand and Gravel, Valley	6.65 21	6.60 Feb. 26, 1966
Exeter	158	1991	Till, Hillside	13.32 21	6.97 Feb. 28, 1991
Exeter	278	1991	Till, Hilltop	20.23 22	13.64 Feb. 28, 2000
Exeter	475	1981	Sand and Gravel, Valley	16.59 21	15.50 Feb. 28, 1985
Exeter	554	1988	Sand and Gravel, Hilltop	11.00 22	10.10 Feb. 28, 1989
Hopkinton	67	1991	Till, Hillside	20.80 22	16.73 Feb. 22, 1994
New Shoreham (Block Island)	258	1991	Till, Undulating	13.10 28	11.69 Feb. 29, 2000
Richmond	417	1976	Sand and Gravel, Valley	7.48 22	7.36 Feb. 28, 1985
Richmond	785	1989	Sand and Gravel, Flat	26.64 22	25.21 Feb. 28, 2000
Tiverton	274	1990	Till, Terrace	2.77 26	2.01 Feb. 19, 1996
Warwick	59	1991	Till, Hillside	8.21 21	4.93 Feb. 26, 1997
Westerly	522	1969	Sand and Gravel, Flat	13.35 22	13.07 Feb. 21, 1981
West Greenwich	206	1991	Till, Hillside	4.72 22	4.02 Feb. 28, 1989
<b>March 2002</b>					
Richmond	785	1989	Sand & Gravel, Flat	26.92 20	25.21 Feb. 28, 2000

Source: United States Geological Survey

**Appendix C:  
WATER RESOURCES BOARD EMERGENCY INTERCONNECTIONS PROGRAM**

<b>System</b>	<b>Location</b>	<b>Cost</b>	<b>Description</b>	<b>Anticipated Start Up</b>
Bristol	Raw Water Line	\$3,781,00		not emerg. interconnect.
County WA	EP	\$600,000	EP connection	completed 1997
	EP	\$200k-1.5M	reinforce EP trans	redundancy to E.Bay Pipeline
	Touisset Point	\$1,669,000		not emerg. interconnect.
Cumberland	Woonsocket	\$163,200		2 years away
	Woonsocket	\$102,500		1 year away
E.Smithfield	Providence	\$135,600	Bicentennial Rd	normal connection
	Providence	\$1,423,700	Ridge Rd-Waterman Rd	
Stone Bridge	Fall River, Ma	\$191,600		remote possibility
Greenville	Johnston	\$1,738,100		redundancy of supply
	Smithfield	\$964,800	Pleasant View Ave	6 - 9 months
Harrisville	Pascoag	\$757,700	Steere farm-Lapham farm Rd	completed 1997
KCWA	RIEDC	\$35,930		
	N.Kingstown	\$32,290	Post Rd (Abandoned)	1 year
Kingston	URI	\$201,400	Field House-Rte 138	Mar-02
	United Water	\$174,300	Rte 138	2 years away
Lincoln	Smithfield	\$369,700	Twin River Rd	1-2 years away
	Smithfield	\$377,700	Rte 116	1-2 years away
Narragansett	Narragansett	\$659,100	Galilee-Jerusalem	substantially complete
	United Water	\$350,800	South Ferry Rd	1-2 years away
Newport	Portsmouth	\$45,200	W.Main Rd@Lawton Valley	
N.Kingstown	Ladd Center	\$1,478,000	Exeter Rd	3-4 years away
	RIEDC	\$206,000	Kiefer Prk(A)& 22Essex RD	2 years away
	Warwick	\$30,000	Old Forge Rd	1 year
N.Smithfield	Woonsocket	\$848,500	Great Rd(NS)& Rhodes (W)	
N.Tiverton FD	Stone Bridge	\$628,800		
Pawtucket	Providence	\$461,800	Unknown	
Providence	Warwick	\$1,000,000	102" butterfly valve	
Lincoln	Woonsocket	\$20,028		Completed 1997
Providence	Woonsocket	unknown		wheel through Lincoln
S.Kingstown	United Water	\$1,463,700	Tuckertown Rd-Post Rd	2 years away
Westerly	Stonington	\$2,00,700	West Broad St	
Warwick	Warwick	\$8,779	convert meter pit	complete
	Total Cost	\$21,920,727		

Source: Water Resources Board

**APPENDIX D:  
FEDERAL FUNDING ASSISTANCE**

**United States Department of Agriculture**

**Farm Services Agency**

- Noninsured Crop Disaster Assistance Program
- Emergency Conservation Program
- Emergency Loans
- Farm Ownership Loans
- Farm Operating Loans

**Natural Resources Conservation Service**

- Agricultural Management Assistance Program
- Environmental Quality Incentives Program
- Resource Conservation and Development
- Watershed Planning River Basin Surveys and Investigations
- Emergency Watershed Protection Program
- Watershed Protection and Flood Prevention Program\*

**Rural Development, Rural Utilities Service**

- Emergency Community Water Assistance Grants
- Water and Wastewater Disposal Loans and Grants

**Risk Management Agency**

- Federal Crop Insurance

**Federal Emergency Management Agency**

- Disaster Relief and Emergency Assistance Program
- Hazard Mitigation Grant Program (geared toward disasters such as flood)

**United States Army Corps of Engineers**

- Emergency Water Supply/Drought Assistance Program

**United States Department of the Interior**

**United States Geological Survey**

- National Stream Gauging Program

**United States Department of Commerce**

**Economic Development Administration**

- Economic Adjustment Program

**United States Small Business Administration**

- Economic Injury Disaster Loan

**APPENDIX E:  
DEM DROUGHT RESPONSE PLAN FOR AGRICULTURE**

A. Monitoring - The Division of Agriculture (DAG) will monitor stream flow at the United States Geological Survey gauging stations, predominately within the Pawcatuck Basin. Stream flows will be evaluated in relation to selected flow levels indicative of low flow or drought conditions, as well as in relation to rainfall and groundwater levels. DAG will provide written information on stream flow and precipitation levels on a regular basis to farmers and stakeholders.

B. Disaster Funding - DAG, in coordination with the United States Department of Agriculture (USDA), will seek federal and state disaster and emergency response funding for agriculture as necessary. DAG will coordinate with the Governor's Office for a disaster declaration, if necessary, which will enable the state to seek federal disaster assistance. Federal disaster assistance will be sought to provide compensation for crop losses attributable to drought and cost sharing on ponds and wells constructed for emergency water supply.

C. Media Campaigns and Marketing - DAG will conduct a media campaign and special marketing program to increase and maintain public awareness of the importance of local agriculture, and foster support under drought conditions. The campaign will use a variety of available media to deliver information.

D. Emergency Water Supply - DAG will coordinate with appropriate state and federal agencies to provide emergency water supplies. The DAG and the Water Resources Board will develop and provide to farmers a list of water suppliers and transporters available to provide and/or transport water. DAG in coordination with USDA and the Emergency Management Agency will provide and set up water bladders at farms where water supply is critically low and where there is imminent danger of livestock or crop losses. DAG in coordination with appropriate offices of DEM, Army Corps of Engineers and USDA will issue emergency permits for pond or well construction in accordance with the protocol listed below in item G. DAG will facilitate any available effort to provide water to farmers under drought conditions.

F. Long Term Planning - DAG in coordination with the USDA shall continue long-term planning efforts to reduce the potential vulnerability of farmers to drought conditions, including water supply and use management by farmers of adequate water supplies, improvements to pumping and irrigation conveyance systems, and emergency response planning.

G. Construction and or Expansion of Agricultural Ponds - The Director of DEM may authorize revised and expedited permitting procedures for farmers during a drought. These procedures pertain to the review by DAG of the construction of new ponds, expansion of existing ponds, or the construction of temporary wells by farmers for agricultural purposes. The following standards and conditions shall apply:

1. Project construction shall not initiate prior to written authorization by DAG. The DAG may verbally authorize on site the initiation of construction for critical situations, and shall follow-up in writing within 24-48 hours. Approvals are valid for a period of sixty (60) days and all construction must take place during this period. All plan modifications must be approved by DAG and be reflected in an amendment to the original permit. The DAG shall coordinate all project reviews with the Division of Water Resources.
2. Revised and expedited permitting procedures shall pertain to “legitimate” farmers who do not meet the definition of farmer pursuant to RIGL 2-1-22 (j), where critical water needs exist. Permitting procedures shall also pertain to the construction and use of wells on a temporary basis, and fill for pond embankments where absolutely necessary. Authorization to use wells is limited to drought conditions as determined by the Director. A Memorandum of Understanding shall be executed between the DAG and Division of Water Resources regarding this section.
3. Permits shall be issued only for projects determined to be insignificant alterations for freshwater wetlands. Adverse effects to the flow and circulation patterns, and chemical and biological characteristics of freshwater wetlands and the aquatic environment shall be minimized. The water quality status of surface waters and their tributaries within the project area must not be degraded. Projects shall not divert or impound stream flows.
4. All project plans and proposals shall be consistent with USDA/Natural Resources Conservation Service standards. The farmer is responsible for providing supporting documentation regarding the project, field delineation of the proposed pond footprint, and site characteristics. Supporting documentation for the project shall include plans describing the pond features, wetland edge, and a written description of the project.
5. No fill material may be placed into any wetland either onsite or offsite unless specifically authorized either as a part of the approval for this project or a separate approval. Adequate measures shall be taken prior to, during and following construction to ensure protection of wetlands areas from sediment deposition. Soil and erosion and sediment controls shall remain in place until all areas have stabilized.
6. Approvals issued by DAG do not remove the applicants obligation to obtain necessary permits from other federal, state or local agencies, and must be consistent with the U. S. Army Corp of Engineers Programmatic General Permit for Rhode Island (note - irrigation ponds by farmer are specifically exempt from Section 404 permitting requirements).
7. DAG staff will visit and review the site during construction for conformance.