Report

Presented to:

Rhode Island Water Resources Board

Statewide Supplemental Water Supply Feasibility Assessment Phase II: Executive Summary

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Table of Contents

List of Tables

List of Figures

Introduction and Project Background

The Rhode Island Water Resources Board (RIWRB) commissioned a Statewide Supplemental Water Supplies Feasibility Assessment for major public water supplies throughout the State of Rhode Island. The study used a three-phase approach to identify and evaluate the risks to the major public water suppliers of a catastrophic failure that would result in the need of a supplemental water supply and to determine the quantity of water required from the supplemental or alternate water source. The first phase evaluated the Providence Water Supply Board (PWSB): its retail customers and the seven public water suppliers that are its wholesale customers. They included:

Bristol County Water Authority (Bristol County) (PWSB wholesale only)
East Providence Water Department (EPWD)
East Smithfield Water Department (ESWD)
Greenville Water District (GWD)
Johnston (Town of)
Kent County Water Authority (Kent County) (PWSB wholesale only)
Lincoln Water Commission (LWC)
Smithfield Water District (SWD)
Warwick Water Department

The second phase looked at 24 major public water supplies and their wholesale costumers. They included:

Block Island Water Company (BIWC)
Bristol County Water Authority (BCWA)
Cumberland Water Department (Cumberland)
Harrisville Fire District (Harrisville)
Jamestown Water Division (Jamestown)
Kent County Water Authority (KCWA)
Kingston Water District (KWD)
Narragansett Water Department (Narragansett)
Newport Water Works (Newport)
North Kingstown Water Department (North Kingstown)
North Smithfield Water Department (North Smithfield)
North Tiverton Fire District (NTFD) (including the former Tiverton Water District)
Pascoag Utility District (Pascoag)
Pawtucket Water Supply Board (Pawtucket)
Portsmouth Water and Fire District (Portsmouth)
Quonset Development Corporation (QDC) as agent for the Rhode Island Economic Development Corporation
Richmond Water Supply System (RWSS)
South Kingstown Water Department (SKWD)
Stone Bridge Fire District (SBFD)
University of Rhode Island Facilities and Operations (URI)
United Water Rhode Island (United Water)
Westerly Water Department
Woonsocket Water Department (Woonsocket)
Eleanor Slater Hospital/Zambarano Unit Water System (ESH/ZU)

The third phase of the study was to combine the findings of these two evaluations and develop feasible supplemental water supply sources that would meet local and regional demands for emergency water. The overall intention or premise of this project was to evaluate water supply requirements of the major water suppliers following an event that resulted in a catastrophic loss of service to its customers. For the purposes of this project, the use of the term "supplemental", as in "Supplemental Water Supply," refers to any alternate water supply specifically used for the purpose of providing water after a catastrophic event. The scope and mission of this project was <u>not</u> intended to address new sources to meet or supplement existing or future service demands under normal operational circumstances. The use of the term "supplemental" in the context of this project and specifically used in this report has been replaced with the term "alternate" to more accurately reflect the mission and intention of the premise of this project.

This document provides a summary of the feasibility assessment and the conclusions made. Details of the analysis can be found in the full text of the study, which is a separate document.

Methods of Analysis

Risk Assessment

A general risk assessment of statewide major water supply systems was conducted in order to determine basis and justification of alternate water supply needs. Taking into account key infrastructure characteristics and geographic locations, the major water suppliers were broken down into seven groups: six study areas and the PWSB and its retail and wholesale customers. The study area delineations were based on current infrastructure, location, and availability of source water. These study areas are outlined on Figure 1.

The main objective of the risk assessment was to evaluate the relative risk of the potential loss of major water supply sources within each water supply system and study area. Each water supply source was evaluated in order to determine the relative risk of losing the source through source contamination and/or system failures. Critical water supply sources were evaluated first within their individual water supplier's system and finally in an overall risk evaluation for each study area.

For the PWSB and its retail and wholesale customers, an in-depth risk assessment was conducted in order to ultimately identify if sufficient risk existed for PWSB to develop an alternate water supply. For the other major water suppliers, this was not practical. Therefore, a modified risk assessment methodology was used. More focus was put on each supplier's critical water sources rather than breaking down the systems infrastructure into their more detailed components. A critical water source was identified based on factors including; water quality, water quantity, source location, infrastructure, and emergency provisions in place.

A three-step methodology was also used to evaluate the risk of the potential loss of major water supply sources within each water supply system. However, performing a detailed risk analysis of each of the 24 water supplier to the extent performed on the PWSB was not practical. Therefore, a broader approach was adapted for these suppliers with more emphasis put on the risk of losing each system's critical water supply sources, rather than particular system components.

The risk assessment process used in this evaluation was divided into four separate steps:

- Evaluation of water supply system schematic
- Critical water supply source identification and evaluation
- Risk assessment of critical water supply sources (each supplier)
- Risk assessment of critical water supply sources (by Study Area)

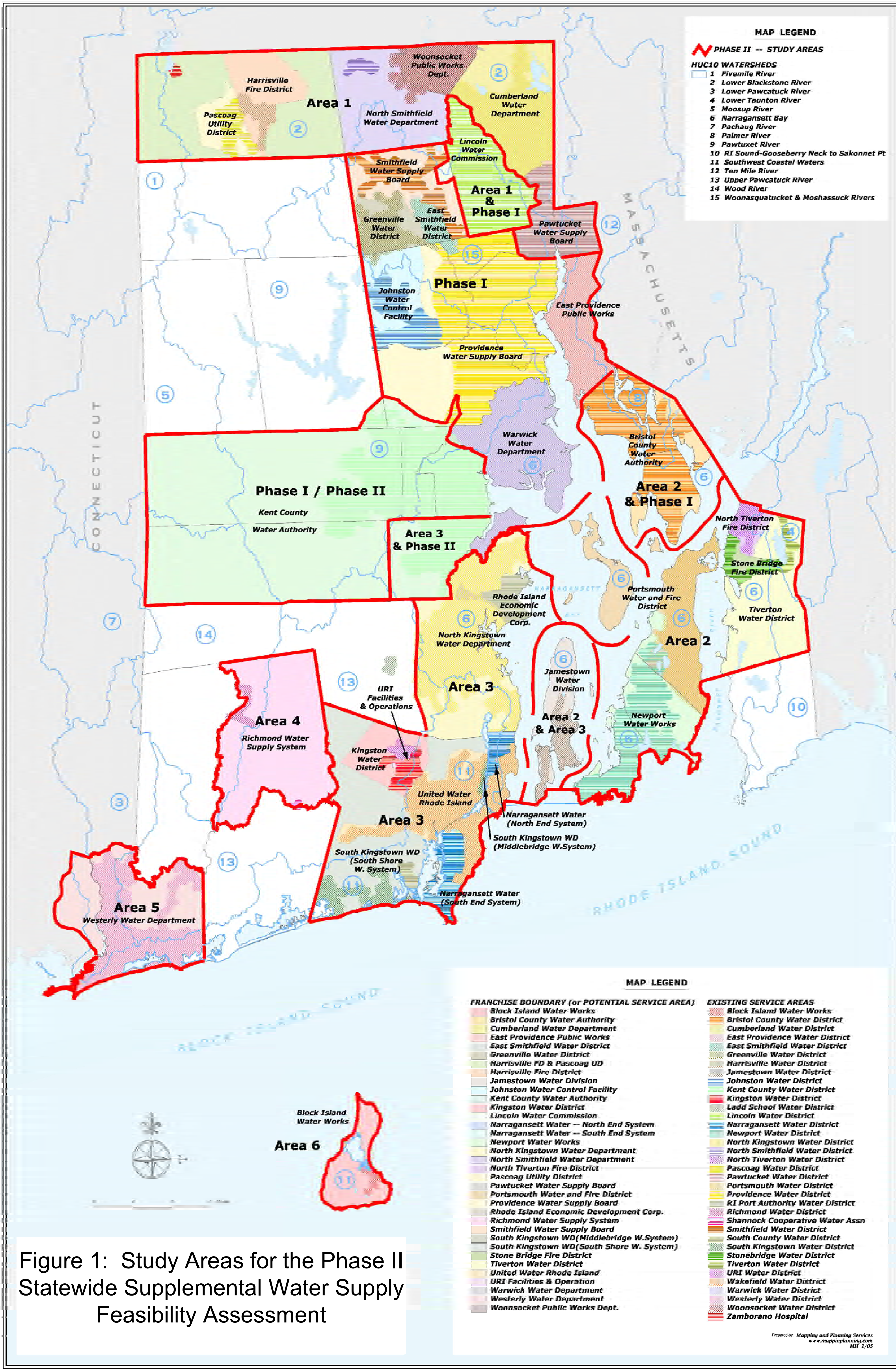

Figure 1: Study Areas for the Phase II Statewide Supplemental Water Supply Feasibility Assessment

Evaluation of Water Supply System Schematic

The first step used in this risk assessment was to evaluate each water supplier's distribution system in order to develop a water system schematic. Information pertaining to the water supply, water demand, and infrastructure of the major public water suppliers of Rhode Island (RI) were collected and reviewed. The main sources of information were: Water System Supply Management Plans (WSSMPs), US Geological Survey (USGS) basin studies for the Blackstone River Basin and Pawcatuck Basin, and the *University of Rhode Island Water Use and Availability, Block Island, Rhode Island*, 2000.

Water distribution systems of larger suppliers can be very complex; therefore breaking down each water system into its finest components was not a necessary approach in order to meet objectives. The emphasis of the assessment was placed on water sources (surface reservoirs, groundwater wells, interconnections, etc.) and critical infrastructure components (water treatment plants, pumping stations, transmission lines, etc.) that allow for treatment and distribution throughout the system. The water supply system schematics developed were simplified to highlight these key components of each system. Since the primary focus of this risk assessment is the potential loss of major water supply sources within each water system, critical infrastructure information such as capacity, yield and system demands were also incorporated into the water system schematics.

The water supply system schematics developed for each water supplier included the following important components:

- Surface water sources (capacity and yield)
- Groundwater supplies (capacity/yield)
- Water treatment facilities (design capacity)
- Interconnections to other suppliers (emergency/supply status and capacity)
- Critical transmission lines
- Service zones (operating pressures)
- System demands (average day, maximum day, emergency demand).

Water Supply Source Identification and Evaluation

The next step of the risk assessment was the identification and evaluation of water supply sources. This was accomplished by using the water supply system schematics to identify the major water sources of each public water supplier. The water sources where then evaluated according to rated well pump capacity (24-hour pumping), "sustainable" well pump capacity (18-hour pumping), yield and reservoir safe yield in order to estimate what percentage of the total system maximum day demand each source was capable of supplying.

Risk Assessment of Critical Water Supply Sources

To evaluate which components of each water system have the greatest relative risk, the ultimate objectives of this risk assessment must be reinforced. The purpose of this risk assessment was to evaluate the relative risk of a critical water source being taken out of service for an extended period of time (greater than six months) in order to determine a basis for supplemental water supply needs. The risk assessment on the PWSB system was more focused on how a source was lost, the probability of certain events occurring that could disrupt the system and preventative measures to reduce risk. The risk assessment of the 24 major water suppliers focused more on the relative risk of losing a critical water supply source. In order to quantify this relative risk, a matrix was created that included all critical water sources within each system and relative risk criteria that would result in a loss of service for an extended period of time. Different risk criteria were assigned to each critical water source depending on the type of source. Risk criteria were developed for groundwater sources, surface water sources, and supply from neighboring water suppliers through interconnections. Each critical water source was evaluated against each risk criteria and then assigned a numeric value that reflects the level of risk.

After assigning numeric risk values for each risk criteria, the totals were summed up to produce a total relative risk value for each water source. This total relative risk value was used to compare overall relative risk between various sources. The total relative risk value was adjusted to reflect the overall importance of each source. To accomplish this, a source importance multiplier was applied to the total relative risk based on the percentage of the max day demand each water source is capable of supplying.

The weighted total risk value incorporates the importance of a source to the system based on the percentage of system maximum day demand each source is capable of providing. The sources were then ranked by this weighted total risk value. The water source with the highest weighted total risk value was deemed the critical water source. The needs assessment will use the critical water source and determine if the water system can function with it out of service and still meet its emergency water demands.

Overall Risk Summary of Critical Water Sources Statewide

The 24 water suppliers were grouped into six study areas. The study area delineations were based on current infrastructure, location, and availability of source water (Figure 1). The majority of water suppliers grouped together in the same study area have distribution systems that are interconnected either directly or indirectly through both emergency and supply interconnections. These interconnections will be critical in determining the ability of water suppliers to wheel supplemental water to other water suppliers not capable of meeting their own emergency water demands.

Critical water sources and their associated total relative risk values were grouped together by study area and compared as a whole. This overall risk comparison helped develop an understanding of which water sources within each study area are most crucial to surrounding water suppliers. It also highlighted which water systems are at the greatest risk of needing supplemental water supplies in the event of a catastrophic failure to a critical water source.

Needs Assessment

The risk assessment phase identified the critical water source for the PWSB and individual water suppliers within each study area. If a failure scenario were to occur to the critical water source, the water supplier’s ability to supply potable water in sufficient quantity and quality would be hindered and public safety would be threatened. A needs assessment was warranted to determine the quantity of water required to maintain a minimal level of service to each water supplier’s customers. The same methods were applied to both the PWSB and the 24 other major water suppliers. The water supply needs assessment was based on the following three criteria:

1. What is the expected duration of the critical water source failure?
2. What is the minimal level of service that each water supplier can expect its customers to accept if service is interrupted?
3. Is an alternative water supply the only means of providing water in the event of a catastrophic failure of a critical water source?

Duration of Impact

For the purposes of this study, a catastrophic failure of any of the critical water sources identified during the risk assessment was not anticipated to result in a permanent loss of the source. Critical water sources and their components could be repaired, rebuilt, or replaced within a reasonable period of time. Estimated impact durations for critical water sources were broken down below in Table 1: Estimated Duration of Impact Summary.

Table 1: Estimated Duration of Impact Summary

Critical Component	Estimated Duration of Impact
Reservoir Dam - (Low)	2 to 3 months
Reservoir Dam - (Med)	6 months to 1 year
Reservoir Dam - (High)	2 to 3 years
Water Treatment Plant	1 to 2 years
Pump Station	6 months
Well Station	9 months
Transmission Main / Interconnection	30 to 90 days
Surface Reservoir (Contamination)	30 to 90 days

Minimum Level of Service

For the purpose of this study, it was assumed that the public will accept water restrictions and live with lower levels of service than is currently provided in the event of a failure. Levels of service (LOSs) were defined based on hardship levels endured by the public.

- **Level of Service A –** No hardship to the public exists.
- **Level of Service B –** The public encounters only a minimum hardship and can be expected to endure the hardship over a two-to-four year period.
- **Level of Service C –** The public reaches a hardship threshold after a one to two year period. The hardship threshold is defined as the level in which the public is no longer willing to accept water restrictions.
- **Level of Service D -** The public reaches a hardship threshold after a short duration of three to six months.
- **Level of Service E -** The minimum LOS that is required to protect public health and safety and maintain sanitation. This level is provided during “emergency” conditions until other service levels can be provided. It is expected that this LOS will be of a very short period of time (less than one month).

Figure 2 examines the relationship between hardship level and impact duration by showing a graphic representation of all five LOSs and the hardship threshold.

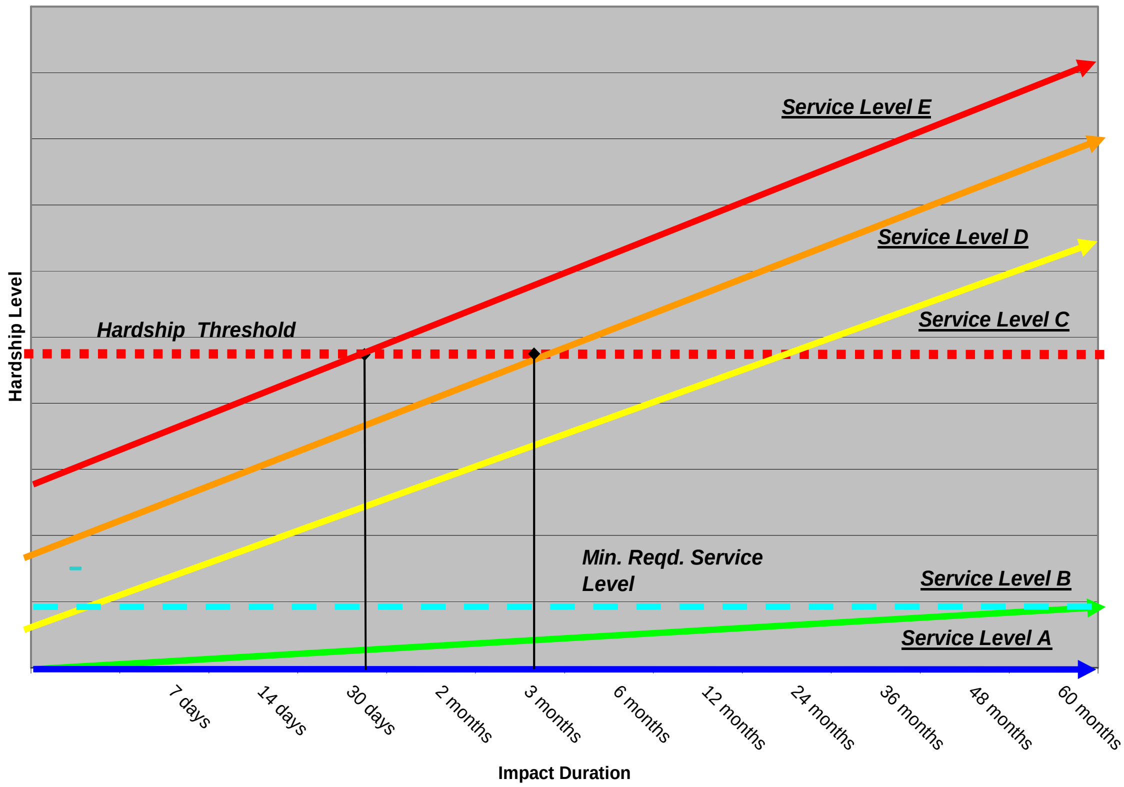

Figure 2: Hardship versus Duration Service Level Chart

Estimated Emergency Water Demands

The five tier LOS approach served as a guide for estimating the quantity of water required if a catastrophic failure of any water supplier's critical water source occurred – the emergency water demand. Each of the five levels is defined to represent a degree of hardship based on an estimated impact duration period as discussed in the previous section. For the purpose of this study, emergency water demands for each supplier were determined using the criteria for either LOS C or LOS D. An estimated water quantity for each LOS was based on decreasing water usage approach for each subsequent and lesser LOS. In other words, the less water customers are allowed to use, the greater the hardship to the customer and the shorter the period of time until the public reaches its hardship threshold. Listed below is a brief summary of the two LOSs utilized in this report and the corresponding quantity of estimated water.

- **Level of Service C** – LOS C imposes a minimum hardship level to the water supplier's customers over a duration period of approximately one to two years. It is assumed a reduction in per capita water usage to approximately 45 gallons used per capita per day (gpcd) would meet this definition. In addition to residential water use reductions, commercial, industrial and government usage would assume a water use reduction of approximately 20 percent. An "aggressive" water usage restriction is required to achieve this reduction.

- **Level of Service D –** LOS D is defined as that quantity of service at which the water supplier's customers would reach their hardship threshold limit after approximately three to six months. It is assumed a reduction in per capita water usage to approximately 30 gpcd would meet this definition. The industrial, commercial and government restrictions remain the same as in LOS C at 20 percent reduction. LOS D is assumed to be the minimal LOS that is required to maintain public health and safety. This level represents a catastrophic event and only essential water service would be provided for a short-term duration.

Critical Water Supply Evaluation Criteria

The critical water sources based on the risk assessment for each supplier were evaluated to determine if it is possible to facilitate the effective replacement of the critical water source without the development of an alternative water supply source. The criteria used were:

1. Will the loss/failure of this component result in the inability of the water supplier to produce/distribute potable water consistent with the current water quality standards?
2. Will the available backup/replacement system be capable of meeting emergency flows for the duration of impact?
3. Will public safety be jeopardized due to the catastrophic loss/failure of this critical source?
4. Is the development of a supplemental water supply the only way to ensure that the catastrophic loss/failure of this source will not impact water quality/quantity to customers?

Each water supplier was evaluated to determine their ability to meet the emergency flows under current conditions (2005), future conditions (2025), and at build out, with the exception of the PWSB. For the other 24 major water suppliers, data was normalized to 2005 and 2025 using linear relationships between demand and population data provided by each water supplier. The normalized data was used to determine the emergency water demands for each water supplier. Build-out conditions were based on methods used by the State of Massachusetts and the Blackstone Valley Heritage Corridor Commission, as developed by Applied Geographics, Inc. (2001). Full build-out was based on the franchise boundaries of each supplier, local zoning and environmental constraints (e.g. conservation lands, floodplains, soil types, wetlands, etc.).

Supplemental Emergency Water Supply Sources

The intention or premise of this study was to evaluate water supply requirements following an event that results in a catastrophic loss of service to its customers. For the purposes of this study, the use of the term "supplemental," as in "Supplemental Water Supply," refers to any alternate water supply specifically used for the purpose of providing water after a catastrophic event. The scope and mission of this project was not intended to address new sources to meet or supplement existing or future service demands under normal operational circumstances.

Development of Alternate Sources

Based on the findings of the Risk and Needs Assessment, alternate water supply sources were investigated for each water supplier in the event that the most critical water supply was lost. Preliminary screening included two strategies for each individual water supplier:

- Develop an alternative water supply source capable of providing the amount of supplemental water that each water supplier requires under emergency demand conditions.
- Make modifications to the storage, treatment and distribution systems of each water supplier that will reduce the risk of loss of supply to acceptable levels.

In order to identify alternative water sources, the study evaluated new groundwater sources, inactive or abandoned wells, and possible interconnections with other suppliers where surplus water exists. Initial review of these sources determined which would most likely meet the needs of the supplier and, if found to be sufficient, underwent preliminary screening evaluation. New surface water sources were not evaluated due to the difficulties in implementation of such sources.

Alternative water sources undergoing a preliminary screening evaluation were reviewed based on the following criteria:

- An estimate of the quantity available from the source,
- An evaluation of the technical and feasibility issues involved with developing the source, and
- A budgetary estimate of the costs involved in developing the source.

Alternatives to Development of Water Supply Sources

In addition to developing new supplies, the study reviewed non-infrastructure approaches that could assist local suppliers in meeting emergency water demands. Non-structural alternatives, including water conservation can reduce the risk of contamination to a water supply and help maintain a surplus in the event an emergency happens.

The evaluation included:

- Review and assess each water supplier's critical component to identify alternatives that will reduce or eliminate the risk of loss of supply.
- Assess the technical feasibility and viability of each alternative and estimate the reduction in impact (duration), risk, and need from implementation of each alternative.
- Develop budgetary costs of feasible alternatives.

During the risk and needs assessment, threats to water supplies were identified. In order for a supplier to reduce the risk of contamination to a water supply source, steps can be taken to reduce the risk of losing a critical source via pollutants, including local regulatory approaches (zoning and land development), land management and/or acquisition, public education, and best management practices. Each supplier's current strategy of source protection was evaluated per this study's risk assessment criteria.

Surplus Water

Surplus water is defined as the difference between the safe yield and or sustainable pumping capacity of available water supply sources for a community and the average day demand of that community. For the other 24 major water suppliers, the safe yield of water sources was not always available; therefore available water is a combination of safe yield estimates, sustainable pumping volumes and available water as stated with a water supplier's Water System Supply Management Plan. Water suppliers within each study area were evaluated to determine if surplus water resources were present that could potentially be made available to supplement surrounding water suppliers in the event of an emergency. In the event of an emergency, water suppliers providing supplemental water would have water restrictions limiting their demands to no greater than average day. Study areas were evaluated as a whole to determine an overall water budget, or total amount of surplus water that is available after all water supplier's average day demands have been met.

Study Findings

Overview

The first phase of this study, which focused on the PWSB, was conducted and completed prior to the second phase, which reviewed the twenty-four other suppliers. Detailed review and analysis of the PWSB system was done in conjunction with agency staff. It was concluded that a failure of certain critical components at the Scituate Reservoir can be corrected only through the use of a supplemental or alternate water supply source. These failure scenarios included the loss of the Holton Water Treatment Plant and Gainer Dam. The failure of these critical system components could result in a loss of service that ranges from one month to three years. For a long term (one to two years) level of service (LOS C), it is estimated that an alternate water supply of 36.95 MGD will be required to meet regional needs of PWSB, Kent County and QDC in 2025. For PWSB, the need is based on 2000 estimates.

For the first phase of this study, alternate water supply sources needed to meet both short and long term emergency demands for PWSB and its customers were developed. During preliminary screening of alternate water supply sources, there was an evaluation to determine the feasibility of utilizing existing interconnections with other suppliers, rehabilitating inactive wells and developing new groundwater sources. Many of the alternate water supply sources reviewed during this phase of the study were carried forward as possible solutions to emergency demands identified while studying the suppliers in the second phase.

For the second phase, the study was conducted in a similar fashion, with as much input from water suppliers as possible. Initial data collection included a review of each supplier's Water Supply System Management Plan (WSSMP). Survey forms about systems and flows were distributed to suppliers and follow-up interviews were conducted. From this information, the risk and needs assessment was prepared. Critical water supply sources were identified for each system and a preliminary screening of potential sources for emergency supplemental water was completed. At this point, outreach to suppliers was performed a second time, but in a different format. Workshops were held by project Study Area to receive feedback on the factual data presented in the draft report as well as to discuss preliminary alternatives for emergency supplemental water. The Study Area workshop sessions provided an opportunity to gauge the feasibility of the proposed alternatives from a regional perspective.

Table 2 lists the average daily demands (ADD) and maximum daily demands (MDD) calculated for each supplier. Table 3 identifies a supplier's sources to meet these demands. Shown are two elements which represent a supplier's total available water: water supply available within the system (internal water supply source) and water available for wholesale purchase from other suppliers. Also shown in Table 3 are the capacity of the supplier's critical water source and the amount of water remaining should this source be lost. Table 4 summarizes the emergency water demands of the state for 2005, 2025 and during build out as projected in this study. PWSB emergency demands shown within Table 4 are based upon 2000 retail and wholesale customer computations. The highlighted areas shown in Figure 3 and supplemental water needed within Table 4 indicate situations in which a supplier cannot meet emergency demands if they were to lose their system's critical water source, even with reduced water usage by residential, commercial and industrial customers.

Table 2: Statewide Average and Maximum Daily Demands in 2005, 2025 and at Build-Out (MGD)

	2005 (MGD)		2025 (MGD)		Build-Out (MGD)	
Water Supplier	**Average Daily Demand**	**Maximum Daily Demand**	**Average Daily Demand**	**Maximum Daily Demand**	**Average Daily Demand**	**Maximum Daily Demand**
Providence Water Supply Board [1] (Includes retail and the wholesale customers not listed below)	60.90[1]		61.90[1]		61.90[1]	
STUDY AREA ONE						
Cumberland Water Department	2.65	5.46	3.24	6.25	4.13	8.25
Harrisville Fire District (with Pascoag)	0.56	0.85	0.69	1.16	1.49	2.48
North Smithfield Water Department	0.12	0.24	0.57	0.85	2.27	3.40
Pascoag Utility District	0.32	0.45	0.41	0.57	0.74	1.05
Pawtucket Water Supply Board	12.33	22.14	14.60	26.21	15.80	28.40
Woonsocket Water Department	5.60	7.20	7.10	8.82	7.12	8.90
Zambarano Unit (ESH)	0.10	0.12	0.10	0.12	0.10	0.12
STUDY AREA TWO						
Bristol County Water Authority	3.65	4.81	3.91	5.23	7.13	9.48
Newport Water Division (includes Portsmouth)	7.21	12.26	8.08	13.74	11.07	19.47
North Tiverton Fire District	0.52	0.87	1.12	1.88	0.90	1.52
Portsmouth Water and Fire District	1.31	2.50	1.55	3.02	2.85	5.49
Stone Bridge Fire District	0.28	0.45	0.74	1.18	0.93	1.48
STUDY AREA THREE						
Jamestown Water Division	0.22	0.39	0.26	0.47	0.47	0.85
Kent County Water Authority	11.00	21.00	13.40	25.60	16.70	31.90
Kingston Water District	0.42	0.65	0.83	1.42	0.90	1.48
Narragansett Water Department - North End	0.26	0.62	0.34	0.82	0.52	1.25
Narragansett Water Department - South End	0.62	1.49	0.75	1.81	1.04	2.53
North Kingstown Water Department	3.99	8.28	4.20	8.72	5.06	10.50
Quonset Development Corporation	0.69	0.91	2.50	3.70	2.50	3.70
South Kingstown Water Department - South Shore	0.42	0.99	0.77	1.84	1.36	3.26
South Kingstown Water Department - Middlebridge	0.06	0.14	0.09	0.22	0.06	0.15
United Water of Rhode Island	2.84	4.97	3.63	6.34	4.38	7.66
URI Facilities and Operations	0.65	0.93	0.65	0.93	0.65	0.93
STUDY AREA FOUR – Richmond Water Supply System	0.06	0.13	0.14	0.31	0.17	0.39
STUDY AREA FIVE – Westerly Water Division	3.31	6.00	3.95	7.47	4.37	8.21
STUDY AREA SIX – Block Island Water Company	0.08	0.16	0.11	0.22	0.14	0.27
TOTAL STATEWIDE DEMANDS (without PWSB)	**59.27**	**104.01**	**73.73**	**128.90**	**92.85**	**163.12**
TOTAL STATEWIDE DEMANDS (with PWSB)	**120.17**		**135.63**		**154.75**	

[1] PWSB ADD consists of the following wholesale demands for 2005/2025/Build-Out: E. Providence=5.88 MGD (1992), E. Smithfield=0.74 MGD (1998), Smithfield=0.82 MGD (1997), Greenville=0.82 MGD (1998), Johnston=0.45 MGD (1999), Lincoln=2.25 MGD (1999), Warwick=9.2 MGD (1992). Retail Non-Account=3.74 MGD (Maguire 2000 Study). For planning purposes, ADD retail demands for 2005 and 2025/Build-out are 37.0 MGD and 38.0 MGD, respectively per PWSB.

Table 3: Capacity of Water Suppliers (safe yield of surface water, 18-hour pumping capacity of wells and interconnection contract limits)

Water Supplier	Internal Water Supply Source (MGD)	Wholesale Purchase (MGD)	Total Available Water (MGD)	Critical Water Source Capacity (MGD)	Capacity of Remaining Sources (MGD)
Providence Water Supply Board [1]	83.00	-	83.00	83.00	0.00
STUDY AREA ONE					
Cumberland Water Department [2]	2.35	7.00	9.35	6.50	2.85
Harrisville Fire District (with Pascoag) [3]	1.10	-	1.10	0.49	0.61
North Smithfield Water Department [4]	0.17	0.40	0.57	0.40	0.17
Pascoag Utility District [5]	0.11	0.60	0.71	0.40	0.31
Pawtucket Water Supply Board [6]	21.65	-	21.65	20.35	1.30
Woonsocket Water Department [7]	7.90	1.00	8.90	7.90	1.00
Zambarano Unit (ESH) [8]	0.22	-	0.22	0.22	0.00
STUDY AREA TWO					
Bristol County Water Authority [9]	3.40	8.50	11.90	8.50	3.40
Newport Water Division [10]	9.80	-	9.80	9.00	7.00
North Tiverton Fire District [11]	-	0.70	1.80/1.34/1.15	1.04	0.76/0.30/0.11
Portsmouth Water and Fire District [12]	-	3.45	3.45	2.25	1.20
Stone Bridge Fire District [13]	1.40	0.52/0/0.14	1.92/1.40/1.54	1.40	0.52/0/0.14
STUDY AREA THREE					
Jamestown Water Division [14]	0.39	0.20	0.59	0.29	0.30
Kent County Water Authority [15]	4.86/3.58 [A]	22.80	27.66/26.38 [A]	22.80	4.86/3.58 [A]
Kingston Water District [16]	2.70	1.00	3.70	1.70	2.00
Narragansett Water Department - North End [17]	-	1.94	1.94	0.50	1.44
Narragansett Water Department - South End [18]	-	2.89	2.89	2.30	0.59
North Kingstown Water Department [19]	8.33/5.58 [A]	-	8.33/5.58 [A]	1.94/1.08 [A]	6.39/4.50 [A]
Quonset Development Corporation [20]	4.76/1.72 [A]	-	4.76/1.72 [A]	1.77/0.00 [A]	2.99/1.72 [A]
South Kingstown Water Department - South Shore [21]	1.58	0.80	2.38	0.48	1.90
South Kingstown Water Department - Middlebridge [22]	-	1.00	1.00	0.50	0.50
United Water of Rhode Island [23]	7.42	-	7.42	3.63	3.79
URI Facilities and Operations [24]	2.21	1.00	3.21	0.96	2.25
STUDY AREA FOUR – Richmond Water Supply System [25]	0.87	-	0.87	0.58	0.29
STUDY AREA FIVE – Westerly Water Division [26]	7.16	-	7.16	1.95	5.21
STUDY AREA SIX – Block Island Water Company [27]	0.29	-	0.29	0.23	0.06
TOTAL	**171.67/164.60** [A]				

[A] If maximum Hunt Aquifer pumping from public water suppliers is 4.0 MGD. The combined Hunt Aquifer reported sustainable pumping capacity of 11.07 MGD for Kent County Water Authority (2 MGD sustainable pumping capacity per supplier WSSMP), North Kingstown Water Department (4.31 MGD sustainable pumping capacity) and Quonset Development Corporation (4.76 MGD sustainable pumping capacity) was proportioned; (2.00 / 11.07)x4=0.72, (4.31 / 11.07)x4=1.56, (4.76 / 11.07)x4=1.72 MGD. The non-Hunt well sustainable pumping capacity added to the proportioned amounts is 2.86, 4.02 and 0.00 MGD, respectively. The RIWRB has not established a Hunt Aquifer safe yield. For planning purposes, this study used estimated base flow gross yield for the lowest summer month. The USGS estimated base flow gross yield minus 7Q10 at the September 25th percentile for the HAP Aquifer of which the Hunt portion has the largest withdrawals, is reported as 5.066

MGD (*2006 USGS Water Use and Availability in the West Narragansett Bay Area, Coastal Rhode Island, 1995-99 Scientific Investigations Report 2005-5256, Table 18*). Hunt Aquifer water availability is 8 MGD per other studies (1968 and 1995 USGS Report). Current Hunt Aquifer average day pumping is approximately 3.8 MGD. For purposes of this Report, Maguire assumed maximum pumping of 4 MGD as a placeholder.

[1] Providence Water Supply Board internal water supply source is the 92 MGD combined safe yield of all six (6) reservoirs less the 9 MGD river discharge requirement.

[2] Cumberland Water Department's (CWD's) 2.35 MGD internal water supply source is the combined Sneech Pond safe yield (0.75 MGD), Abbott Run Well Field sustainable pumping capacity (0.60 MGD) and the Manville Well Field sustainable pumping capacity (1.0 MGD). CWD's 7.0 MGD wholesale purchase is the 6.5 MGD Pawtucket supply interconnection combined with the 0.5 MGD Lincoln emergency interconnection. Critical water source capacity is the 6.5 MGD supply interconnection with Pawtucket. CWD's 2.85 MGD capacity of remaining sources is the 2.35 MGD internal water supply source combined with the 0.5 MGD Lincoln emergency interconnection.

[3] Harrisville Fire District's (HFD's) 1.10 MGD internal water supply source is the combined sustainable pumping capacities of Well #1, #2, #3, #4, #5 and #6 at 0.22, 0.16, 0.23, 0.11, 0.22 and 0.16 MGD, respectively. HFD's 0.49 MGD critical water source capacity is the sustainable pumping capacity of the Eccleston well field (Wells #4, #5, #6). HFD's 0.61 capacity of remaining sources is the primary well field's wells (Wells #1, #2, #3) sustainable pumping capacity.

[4] North Smithfield Water Department's (NSWD's) 0.17 MGD internal water supply source is the combined Halliwell School Well (0.057 MGD) and the Tifft Road Well (0.11 MGD) sustainable pumping capacity. NSWD's wholesale purchase is the 0.40 MGD contract limited supply interconnection with Woonsocket. Critical water source capacity is the 0.40 MGD supply interconnection with Woonsocket. NSWD's capacity of remaining sources is the sustainable pumping capacity of its wells.

[5] Pascoag Utility District's (PUD's) 0.11 MGD internal water supply source is the reported sustainable pumping capacity of Well #5 which was placed on-line January 2008. PUD's 0.6 MGD wholesale purchase is the 0.40 and 0.20 MGD supply and emergency interconnections with HFD, respectively. PUD's critical water source capacity is the 0.40 MGD supply interconnection with HFD. PUD's 0.31 MGD capacity of remaining sources is combined Well #5 (0.11 MGD) and emergency interconnection with HFD (0.20 MGD).

[6] Pawtucket Water Supply Board's (PaWSB's) 21.65 MGD internal water supply source/total available water is the combined six reservoir safe yield (16 MGD) and sustainable pumping capacities (5.65 MGD total) of Well #2, #3, #4, #5, #6, #7, #8 and #9 at 0.43, 0.99, 0.65, 0.65, 0.67, 0.80, 0.66 and 0.80 MGD, respectively. PaWSB's 20.35 MGD critical water source capacity is the sustainable pumping capacity of the wells directed through the Branch Street WTP (Wells #2, #3, #6, #7, #8 and #9), assuming the WTP is inoperable. Wells #4 and #5 supply are not treated at the Branch Street Treatment Plant. PaWSB's capacity of remaining sources is the combined 1.30 MGD sustainable pumping capacity of Wells #4 and #5.

[7] Woonsocket Water Department's (WWD's) 7.90 MGD internal water supply source is the safe yield of Harris Pond (4.4 MGD) combined with the safe yield of Reservoirs #1 and #3 (3.5 MGD). WWD's 1.0 MGD wholesale purchase is the emergency interconnection with Lincoln. WWD's 7.90 MGD critical source capacity is the two reservoir safe yields assuming the Charles Hamman WTP was inoperable.

[8] Zambrano Unit/Eleanor Slater Hospital's (ESH/ZU) 0.22 MGD internal water supply source/total available water/critical water source capacity is Wallum Lake WTP capacity.

[9] Bristol County Water Authority (BCWA) 3.40 MGD internal water supply source is the safe yield of the Anawan Reservoir/Shad Factory Reservoir (2.1 MGD) combined with the safe yield of the Swansea Reservoir/Kickemuit Reservoir (1.3 MGD). BCWA's 8.50 MGD wholesale purchase is the 7.5 MGD East Bay Pipeline combined with a 1.0 MGD East Providence emergency interconnection. BCWA's critical water source capacity is the East Bay Pipeline.

[10] Newport Water Division's (NWDiv's) 9.80 MGD internal water supply source/total available water is the combined safe yield of the Reservoirs; Nonquit Pond (2.0 MGD), Harold E. Watson Reservoir (2.6 MGD), St. Mary's Pond (0.50 MGD), Sisson Pond/Lawton Valley Reservoir (0.90 MGD), North/South Easton Ponds (1.90 MGD) and Nelson Pond/Gardiner Pond (1.90 MGD). NWDiv's 9.0 MGD critical water source capacity is the Station 1 WTP capacity. The 7.0 MGD capacity of remaining sources is the Lawton Valley WTP capacity. It should be noted that NWDiv is in the process of reevaluating the safe yield of their ponds and reservoirs.

[11] North Tiverton Fire District's (NTFD's) 0.70 MGD wholesale purchase is the combined 0.15 and 0.55 MGD contract limits with Stone Bridge and Fall River, respectively. NTFD's 1.80/1.34/1.15 MGD (2005/2025/Build-out) total available water is the 1.04 MGD capacity of the Fall River supply interconnection combined with 0.76/0.30/0.11 MGD supply available from the interconnection with Stone Bridge. The 0.76 MGD available from Stone Bridge is the 1.04 MGD interconnection capacity less the Stone Bridge 0.28 MGD average day demand for purposes of this Study. NTFD's 1.04 MGD critical water source capacity is the capacity of the interconnection with Fall River. NTFD's capacity of remaining sources was taken as the 0.76/0.30/0.11 MGD (2005/2025/Build-out) supply interconnection capacity available from Stone Bridge.

[12] Portsmouth Water and Fire District's (PWFD's) 3.45 MGD wholesale purchase is the NWDiv 2.25 MGD and 0.30 MGD supply and emergency interconnections, respectively, combined with the 0.90 MGD Stone Bridge emergency interconnection. PWFD's critical water source capacity is the 2.25 MGD supply interconnection from the NWDiv Lawton Valley WTP. PWFD's 1.20 MGD capacity of remaining sources is the combined capacities of emergency interconnections with NWDiv (0.30 MGD) and Stone Bridge (0.90 MGD).

[13] Stone Bridge Fire District's (SBFD's) 1.40 MGD internal water supply source is the Stafford Pond WTP capacity. SBFD's wholesale purchase of 0.52/0/0.14 MGD (2005/2025/Build-out) from NTFD is the 1.04 MGD interconnection capacity less NTFD's 0.52/1.12/0.90 MGD average day demand (2005/2025/Build-out).

[14] Jamestown Water Division's (JWD's) 0.39 MGD internal water supply source is the North Pond (0.19 MGD) and the South Pond (0.10 MGD) safe yields combined with the sustainable pumping capacity of well JR-1 (0.05 MGD) and JR-3 (0.05 MGD). JWD's 0.20 MGD wholesale purchase is an emergency interconnection with North Kingstown. JWD's 0.29 MGD critical water source

capacity is the combined Pond safe yields with the Jamestown WTP offline. JWD's 0.30 MGD capacity of remaining sources is the combined sustainable pumping capacity (0.10 MGD) of the wells and 0.20 MGD emergency interconnection with North Kingstown.

[15] Kent County Water Authority (KCWA) 4.86 MGD internal water supply source is the combined sustainable pumping capacities of the Mishnock Well Field (2.6 MGD), Spring Lake Well (0.26 MGD) and E. Greenwich Well (2.0 MGD-Hunt Aq.). KCWA's 22.80 MGD wholesale purchase is the combined Bald Hill Road supply interconnection (4.6 MGD per contract limit), Clinton Ave (18.0 MGD per hydraulic limitation) and the Oaklawn Ave interconnection (0.2 MGD). KCWA's 22.80 MGD critical water source capacity is all of the supply interconnections assuming PWSB is offline.

[16] Kingston Water District's (KWD's) 2.70 MGD internal water supply source is the sustainable pumping capacities of Chipuxet Basin Wells #1 (1.0 MGD) and #2 (0.7 MGD), and Genesee Basin Well #3 (1.0 MGD). KWD's 1.0 MGD wholesale purchase is the largest interconnection capacity with URI. KWD's 3.70 MGD total available water is the sustainable pumping capacity of the wells combined with the largest URI interconnection capacity. KWD's 1.70 MGD critical source capacity is the Chipuxet well field (Wells #1 and #2). KWD's 2.0 MGD capacity of remaining sources is the Genesee Well sustainable pumping capacity combined with the largest URI interconnection capacity. URI wells also draw from the Chipuxet Aquifer. The RIWRB has not established a Chipuxet Aquifer safe yield. For planning purposes, this study used estimated base flow gross yield for the lowest flow summer month. The USGS estimated base flow gross yield minus 7Q10 at the September 25th percentile for the Chipuxet subbasin is reported as 10.08 MGD (*Estimated Water Use and Availability in the Pawcatuck Basin, Southern Rhode Island and Southeastern Connecticut, 1995-99, Scientific Investigations Report 2004-5020, Table 21, p.50)*. The USGS Chipuxet subbasin reported 10.08 MGD contains both the Chipuxet (includes KWD and URI) and Mink (includes UWRI) Aquifers. The USGS identified average summer withdrawals of 4.14 MGD from all sources in the Chipuxet subbasin (Table 22, p. 54) of which approximately 3.5 MGD were public water supply withdrawals (Figure 6, p. 23); Chipuxet Aquifer at 0.9 MGD and the Mink Aquifer at 2.6 MGD. Current Chipuxet and Mink Aquifer average day pumping is approximately 1.1 and 2.8 MGD, respectively. The KWD, URI and UWRI build-out estimated average day demands of 0.90, 0.65 and 4.38 MGD, respectively, totals 5.93 MGD which is less than the USGS identified water availability within the Chipuxet subbasin. The combined sustainable pumping capacity of KWD, URI and UWRI well fields is 1.70, 2.21, and 7.42 MGD, respectively, totals 11.33 MGD, which Maguire assumed as a placeholder for reporting total available water.

[17] Narragansett (North End) Water Department's 1.94 MGD wholesale purchase/total available water is the combined 0.5 MGD contract limited supply interconnection with North Kingstown and the emergency interconnection of 1.44 MGD with United Water. Critical water source capacity is the 0.5 MGD supply interconnection with North Kingstown.

[18] Narragansett (South End) Water Department's 2.89 MGD wholesale purchase/total available water is the 2.3 MGD supply interconnection from United Water and 0.59 MGD supply interconnection with South Kingstown. Critical water source capacity is the 2.3 MGD United Water interconnection. Capacity of remaining sources is the 0.59 MGD South Kingstown interconnection.

[19] North Kingstown Water Department's (NKWD's) 8.33 MGD internal water supply source/total available water is the combined sustainable pumping capacity of Wells #1, #2, #3, #4, #5, #6, #7, #8, #9 and #10 at 0.76, 0.59, 0.24, 0.81, 1.08, 0.81, 0.27, 0.27, 1.56 and 1.94 MGD, respectively. Wells #6, #9 and #10 are within the Hunt Aquifer. NKWD's 1.94 MGD critical water source capacity is Well #10, having the largest capacity. NKWD's 6.39 MGD capacity of remaining sources is the sustainable pumping capacity of the other nine NKWD wells.

[20] Quonset Development Corporation (QDC) is a subsidiary of the R.I. Economic Development Corporation (RIEDC) responsible for the development and management of the Quonset Business Park®. QDC, as agent for the RIEDC pursuant to R.I. Gen. Laws 42-64.10 has an internal water supply source/total available water of 4.76 MGD which consists of Hunt Aquifer Wells #3A, #9A and #14A at 1.66, 1.33 and 1.77 MGD reported sustainable pumping capacity, respectively. QDC's 1.77 MGD critical water source capacity is Well #14A, having the largest sustainable pumping capacity.

[21] South Kingstown (South Shore) Water Department's 1.58 MGD internal water supply source is the combined sustainable pumping capacity of Wells #1, #2 and #3 at 0.67, 0.43 and 0.48 MGD, respectively. Wholesale purchase is the 0.8 MGD interconnection with Narragansett (South End). Critical water source capacity is Well #3 at 0.48 MGD per Risk Assessment Findings.

[22] South Kingstown (Middlebridge) Water Department's 1.00 MGD wholesale purchase/total available water consists of two 0.5 MGD supply interconnections with United Water. Critical water source capacity/capacity of remaining sources is either of the 0.5 MGD supply interconnections.

[23] United Water of Rhode Island's (UWRI) 7.42 MGD internal water supply source/total available water is the combined sustainable pumping capacity of the Tuckertown (3.79 MGD) and Howland (3.63 MGD) Well Fields. UWRI's 3.63 MGD critical source capacity is the Howland Well Field and capacity of remaining sources is the sustainable pumping capacity of the Tuckertown Well Field.

[24] URI Facilities and Operations (URI's) 2.21 MGD internal water supply source is the sustainable pumping capacity of Chipuxet Basin Well #2 (0.48 MGD), Well #3 (0.77 MGD) and Well #4 (0.96 MGD). URI's 1.0 MGD wholesale purchase is the largest interconnection capacity with KWD. URI's 3.21 MGD total available water is the sustainable pumping capacity of the wells combined with the largest KWD interconnection capacity. URI's 0.96 MGD critical water source capacity is Well #4. URI's 2.25 MGD capacity of remaining sources is the sustainable pumping capacity of Wells #2 and #3, combined with the URI interconnection. KWD wells also draw from the Chipuxet Aquifer. The RIWRB has not established a Chipuxet Aquifer safe yield. Refer to KWD for USGS water availability reference.

[25] Richmond Water Supply District's (RWSD's) 0.87 MGD internal water supply source/total available water is the combined sustainable pumping capacity of Well #1 (0.58 MGD) and #2 (0.29 MGD).

[26] Westerly Water Division's (WWD's) 7.16 MGD internal water supply source/total available water is the combined six well field sustainable pumping capacity of White Rock No. 1 (1.95 MGD), White Rock No. 2 (2.0 MGD), White Rock No. 3 (0.78 MGD), Bradford II (0.67 MGD), Bradford III (0.85 MGD) and Crandall Well Field (0.91 MGD). WWD's 1.95 MGD critical water source capacity is the White Rock No. 1 Well Field based upon the Risk Assessment Findings.

[27] Block Island Water Company (BIWC's) 0.29 MGD internal water supply source is the 0.23 and 0.06 MGD capacity of the Reverse Osmosis and Conventional Treatment Plant, respectively. BIWC's 0.23 MGD critical water source capacity is the Reverse Osmosis Plant capacity. BIWC's 0.06 MGD capacity of remaining sources assumes the Sands Pond secondary well field will be treated at its 0.06 MGD backup conventional WTP.

Table 4: Statewide Emergency Demands at LOS C and Supplemental Emergency Water Needed for 2005, 2025 and at Build-Out

Water Supplier	Water Supply Capacity (MGD)	Critical Source Capacity (MGD)	Capacity Remaining Sources (MGD)	2005 (MGD)		2025 (MGD)		Build-Out (MGD)	
				Emergency Demand	Supplemental Water Needed	Emergency Demand	Supplemental Water Needed	Emergency Demand	Supplemental Water Needed
Providence Water Supply Board (Includes retail and the wholesale customers not listed below)	83.00	83.00	0.00	32.47 [A]	32.47 [A]	32.47 [A]	32.47 [A]	32.47 [A]	32.47 [A]
STUDY AREA ONE									
Cumberland Water Department	9.35	6.50	2.85	1.87	-	2.32	-	2.96	0.11
Harrisville Fire District (with Pascoag)	1.10	0.49	0.61	0.32	-	0.40	-	0.96	0.35
North Smithfield Water Department	0.57	0.40	0.17	0.08	-	0.40	0.23	1.36	1.19
Pascoag Utility District	0.71	0.40	0.31	0.19	-	0.24	-	0.47	0.16
Pawtucket Water Supply Board	21.65	20.35	1.30	8.22	6.92	8.39	7.09	8.98	7.68
Woonsocket Water Department	8.90	7.90	1.00	4.55	3.55	5.84	4.84	6.14	5.14
Zambarano Unit (ESH)	0.22	0.22	0.00	0.10	0.10	0.10	0.10	0.10	0.10
STUDY AREA TWO									
Bristol County Water Authority	11.90	8.50	3.40	3.40	-	3.64	0.24	4.90	1.50
Newport Water Division (includes Portsmouth)	9.80	9.00	7.00	6.73	-	7.36	0.36	8.41	1.41
North Tiverton Fire District	1.80/1.34/1.15 [D]	1.04	0.76/0.30/0.11 [D]	0.51	-	1.10	0.80	0.58	0.47
Portsmouth Water and Fire District	3.45	2.25	1.20	1.02	-	1.20	-	1.94	0.74
Stone Bridge Fire District	1.92/1.40/1.54 [D]	1.40	0.52/0.00/0.14 [D]	0.21	-	0.54	0.54	0.79	0.65
STUDY AREA THREE									
Jamestown Water Division	0.59	0.29	0.30	0.21	-	0.23	-	0.33	0.03
Kent County Water Authority	27.66/26.38 [B]	22.80	4.86/3.58 [B]	6.97	2.11/3.39 [B]	7.78	2.92/4.20 [B]	11.29	6.43/7.71 [B]
Kingston Water District	2.70	1.70	1.00	0.37	-	0.74	-	0.69	-
Narragansett Water Department North End	1.94	0.50	1.44	0.23	-	0.30	-	0.35	-
Narragansett Water Department South End	2.89	2.30	0.59	0.53	-	0.64	0.05	0.72	0.13
North Kingstown Water Department	8.33/5.58 [B]	1.94/1.08 [B]	6.39/4.50 [B]	2.99	-	3.72	-	3.99	-
Quonset Development Corporation	4.76/1.72 [B]	1.77/0.00 [B]	2.99/1.72 [B]	0.55	-	2.00	0.00 /0.28 [B]	2.00	0.00 /0.28 [B]
South Kingstown Water Department South Shore	2.38	0.48	1.90	0.31	-	0.44	-	0.95	-
South Kingstown Water Department Middlebridge	1.00	0.50	0.50	0.04	-	0.05	-	0.04	-
United Water of Rhode Island	7.42	3.63	3.79	1.97	-	2.40	-	3.17	-
URI Facilities and Operations	2.21	0.96	1.25	0.23	-	0.23	-	0.23	-

Water Supplier	Water Supply Capacity (MGD)	Critical Source Capacity (MGD)	Capacity Remaining Sources (MGD)	2005 (MGD)		2025 (MGD)		Build-Out (MGD)	
				Emergency Demand	Supplemental Water Needed	Emergency Demand	Supplemental Water Needed	Emergency Demand	Supplemental Water Needed
STUDY AREA FOUR – Richmond Water Supply System	0.87	0.58	0.29	0.13	-	0.19	-	0.21	-
STUDY AREA FIVE – Westerly Water Division	7.16	1.95	5.21	2.25	-	2.47	-	3.01	-
STUDY AREA SIX – Block Island Water Company	0.29	0.23	0.06 [C]	0.07	0.01	0.10	0.04	0.19	0.13
TOTALS				**76.52**	**45.16/46.44** [B]	**85.29**	**49.68/51.24** [B]	**97.23**	**58.69/60.25** [B]

[A] 2000 emergency demand data for PWSB was used for 2005, 2025 and Build-Out.

[B] Assumes Hunt Aquifer withdrawal from public water suppliers at 4.0 MGD annual average.

[C] Assumes that conventional filtration plant can be brought into full regulatory compliance and can treat groundwater and surface water.

[D] Assumes North Tiverton Fire District and Stone Bridge Fire District interconnection capacity less the average day demand of donor.

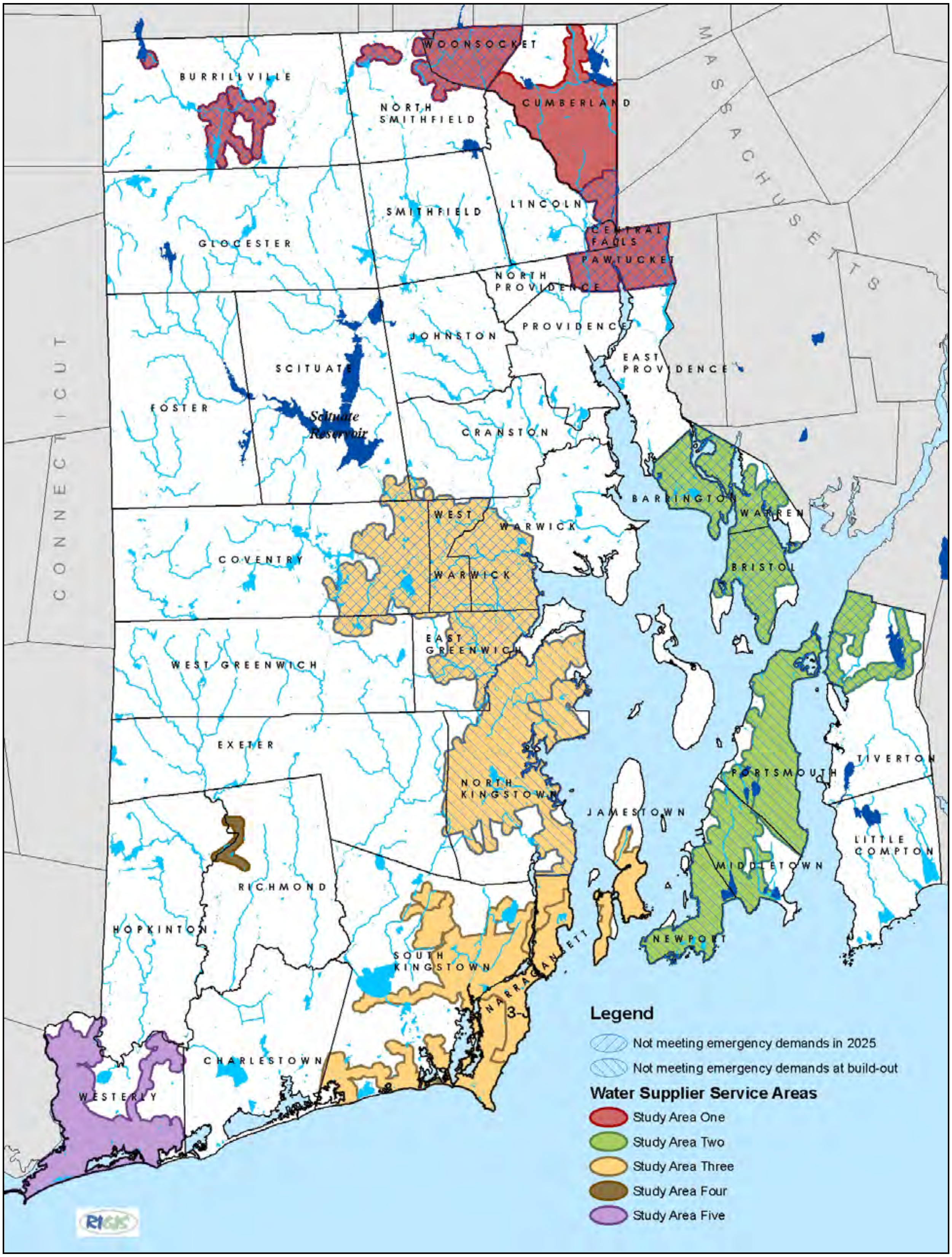

Figure 3: Water Suppliers Not Meeting Local Emergency Demands in 2025 and at Build-Out (Hunt Aquifer withdrawal from public water suppliers at 4.0 MGD).

During non-emergency events, surplus water was calculated for each supplier (water supply capacity less average day demand). Most suppliers show the potential to have water beyond their average needs that could be available during emergency situations of other systems. Interconnections between these suppliers were evaluated as a way of using surplus water as a supplemental emergency water source. Table 5 shows the available surplus water by Study Area in 2025 and at build-out.

Supplemental Emergency Water Supply Sources

Overall, the data indicates that there is a larger regional need in the West Bay, or central, area of the state and in the East Bay area, particularly on Aquidneck Island. The initial review sought the best and most efficient ways to meet emergency demands through local sources. Local examples include existing infrastructure, including rehabilitation of inactive sources, and upgrading or increasing the capacity of existing interconnections. The study also assessed the capacity of local supplies and potential new local sources to meet regional supplemental water demands. Regional supplemental water options include transporting surplus water, rehabilitating inactive wells, developing new groundwater sources, and developing reverse osmosis desalination facilities.

The remainder of this summary addresses these local and regional solutions to meet emergency needs. First, local alternatives are discussed by Study Area. A brief summary of the supplier's critical source is provided along with a discussion of sources a supplier can implement to meet the emergency demands within its system should its source be lost for an extended period of time (LOS C). Preliminary costs are also calculated.

Second, regional alternatives are reviewed. Multiple suppliers are assessed and their demands are combined to determine total region emergency demands and supplemental water needed. Conditions that may exist during an emergency event are assumed and solutions are analyzed that would best meet these demands. These assumptions are presented in the discussion.

Table 5: Available Surplus Water in Each Water Supply System in 2005, 2025, and Build-Out

	(MGD)			2005 (MGD)		2025 (MGD)		Build-out (MGD)	
Water Supplier	Internal Source Supply [A]	Wholesale Purchase (contract limit)	Total Available Water	ADD	"Surplus" Water [B]	ADD	"Surplus" Water	ADD	"Surplus" Water
Providence Water Supply Board (Includes retail and wholesale customers not listed below)	83.00		83.00	60.90 [C]	22.10	61.90	21.10	61.90	21.10
STUDY AREA ONE									
Cumberland Water Department	2.35	7.00	9.35	2.65	-	3.24	-	4.13	-
Harrisville Fire District (with Pascoag)	1.10	-	1.10	0.56	0.54	0.69	0.41	1.49	-
North Smithfield Water Department	0.17	0.40	0.57	0.12	0.05	0.57	-	2.27	-
Pascoag Utility District	0.11	0.60	0.71	0.32	-	0.41	-	0.74	-
Pawtucket Water Supply Board	21.65	-	21.65	12.33	9.02 [D]	14.60	6.16 [D]	15.80	4.07 [D]
Woonsocket Water Department	7.90	1.00	8.90	5.60	2.35 [E]	7.10	0.40 [E]	7.12	---- [E]
Zambarano Unit	0.22	-	0.22	0.10	0.12	0.10	0.12	0.10	0.12
STUDY AREA TWO									
Bristol County Water Authority	3.40	8.50	11.90	3.65	-	3.91	-	7.13	-
Newport Water Division (with Portsmouth)	9.80	-	9.80	7.21	2.59	8.08	1.72	11.07	-
North Tiverton Fire District	-	0.70	0.70	0.52	-	1.12	-	0.90	-
Portsmouth Water and Fire District	-	3.45	3.45	-	-	-	-	-	-
Stone Bridge Fire District	1.40	0.52/0/0.14	1.92/1.40/1.54	0.28	1.12	0.74	0.66	0.93	0.47
STUDY AREA THREE									
Jamestown Water Division	0.39	0.20	0.59	0.22	0.17	0.26	0.13	0.47	-
Kent County Water Authority	4.86/3.58 [F]	22.80	27.66/26.38 [F]	11.00	-	13.40	-	16.70	-
Kingston Water District	2.70	1.00	3.70	0.42	3.28	0.83	2.87	0.90	2.80
Narragansett Water Department - North End	-	1.94	1.94	0.26	-	0.34	-	0.52	-
Narragansett Water Department - South End	-	2.89	2.89	0.62	-	0.75	-	1.04	-
North Kingstown Water Department	8.33/5.58 [F]	-	8.33/5.58 [F]	3.99	4.34/1.59 [F]	4.20	4.13/1.38 [F]	5.06	3.27/0.52 [F]
Quonset Development Corporation	4.76/1.72 [F]	-	4.76/1.72 [F]	0.69	4.07/1.03 [F]	2.50	2.26/0.00 [F]	2.50	2.26/0.00 [F]
South Kingstown Water Dept - South Shore	1.58	0.80	2.38	0.42	1.16	0.77	0.81	1.36	0.22
South Kingstown Water Dept - Middlebridge	-	1.00	0.50	0.06	-	0.09	-	0.06	-
United Water of Rhode Island	7.42	-	7.42	2.84	4.58	3.63	3.79	4.38	3.04
URI Facilities and Operations	2.21 [G]	-	2.21	0.65	---- [G]	0.65	---- [G]	0.65	---- [G]

	(MGD)			2005 (MGD)		2025 (MGD)		Build-out (MGD)	
Water Supplier	**Internal Source Supply [A]**	**Wholesale Purchase (contract limit)**	**Total Available Water**	**ADD**	**"Surplus" Water [B]**	**ADD**	**"Surplus" Water**	**ADD**	**"Surplus" Water**
STUDY AREA FOUR - Richmond Water Supply System	0.87	-	0.87	0.06	0.81	0.14	0.73	0.17	0.70
STUDY AREA FIVE - Westerly Water Division	7.16	-	7.16	3.31	3.85	3.95	3.21	4.37	2.79
STUDY AREA SIX - Block Island Water Company	0.29		0.29	0.08	0.21	0.11	0.18	0.14	0.15
TOTAL STATEWIDE WATER SUPPLY	**171.67/ 164.60** [F]			**118.86**	**60.36/ 54.57** [F]	**134.08**	**48.68/ 43.67** [F]	**151.90**	**40.99/ 35.98**[F]

[A] Safe yield of surface water and sustainable pumping capacity of wells or treatment plant capacity.
[B] Internal source supply less ADD.
[C] Refer to Table 2, Footnote #1 for PWSB data was used for 2005, 2025 and build-out.
[D] Surplus when combined with Cumberland.
[E] Surplus when combined with North Smithfield.
[F] Hunt Aquifer withdrawal from public water suppliers at 4.0 MGD annual average.
[G] URI and Kingston Water District draw from the Chipuxet Aquifer. URI approximate surplus water accounted for within Kingston surplus water.

Local Supplemental Emergency Water Supply Sources

Based on these findings of the risk and needs assessment, supplemental emergency water sources were identified for individual water suppliers. Local solutions were based on review of existing projects proposed by suppliers, rehabilitating inactive sources, or modifying existing conditions. The following provides a summary by Study Area.

Study Area One

Cumberland Water District

The risk and needs assessment for Cumberland indicated the Pawtucket interconnection is the most critical component of the Cumberland water system. In order for water to reach the Cumberland system from Pawtucket, it must pass through the Marshall Avenue pumping station. The interconnection and pump station have recently been upgraded to accommodate higher flows. They are currently in good condition, and backup power is present at the station. An interconnection failure alone would take approximately 30 to 60 days to bring back online. If a catastrophic failure were to occur to the pump station also, it would take approximately six months to bring them both back online. The LOS D emergency water demands for 2005, 2025, and at build-out are 1.55 MGD, 1.96 MGD and 2.50 MGD respectively.

Cumberland is not completely dependent on Pawtucket for water as they have both groundwater and surface water supplies of their own that they use to supplement the wholesale water from Pawtucket. If the interconnection with Pawtucket were to fail, Cumberland would have a water supply capacity of 2.85 MGD, which can meet Cumberland's current and projected LOS D emergency demands. Therefore, supplemental water is not required in the event they lose the Pawtucket interconnection.

Harrisville Fire District

The risk and needs assessment for Harrisville indicated that the Eccleston Well Field is the most critical component of the Harrisville water system. It is the newest and highest producing well field site in the Harrisville system. Harrisville provides Pascoag with approximately 70% of their water supply at this time because of MTBE contamination within Pascoag's well field. Independently, Harrisville with no wholesale commitments to Pascoag could handle the loss of this source because of the available supply from the remaining sources. If Harrisville continues to supply Pascoag as a whole sale customer, it has capability of meeting the average day demands on its own; however the potential loss of this water source would put a tremendous strain on Harrisville's system during summer months when demands are at their highest. The Eccleston Well Field went online in 2003 so the risk of mechanical failure is very low. There is currently adequate back-up power at the site. A well station failure would take approximately nine months to bring back online. Harrisville will be able to meet emergency demands at 2025, but build-out emergency demand conditions can not be met while supplying Pascoag. It is projected that supplemental water needs will be 0.35 MGD for build-out with Harrisville supplying Pascoag. There is no supplemental water need for Harrisville only.

A list of potential alternative water supply sources was developed as a first step in identifying viable alternative water supply sources and is shown in Table 6. Table 7 summarizes the budgetary costs for Harrisville's supplemental water supply sources.

Table 6: Harrisville Potential Alternative Water Supply Sources

Harrisville Water Department	Source Type (Groundwater, Surface water, Interconnection)	Potential Capacity (MGD)	Water Origin Basin (Sub-basin)	Current Status	Comments
Well Field (Harrisville)	Groundwater	1.00	Lower Blackstone River (Clear River Sub-Basin)	Proposed (Report)	
North Smithfield to Harrisville Interconnection	Interconnection	1.00*	Lower Blackstone (Abbott Run)	Proposed (Report)	Woonsocket Water

*Available surplus water from North Smithfield between 0.4 and 0.6 MGD.

Table 7: Budgetary Costs for Harrisville supplemental water supply sources

Supplemental Water Supply Alternatives	Estimated Cost
New well field development	$1,388,400
North Smithfield to Harrisville interconnection	$7,667,026

North Smithfield Water Department

The risk and needs assessment for North Smithfield indicated that the interconnection with Woonsocket is the most critical source. The capacities of North Smithfield's three production wells have been in steady decline over the years and are in danger of being unable to meet North Smithfield's water demands during peak demand periods. The Halliwell School and Tifft Road Well capacities are 0.06 and 0.11 MGD, respectively. The Slater Village Well is currently inactive. The interconnection with Woonsocket was established in order to supply the North Smithfield system with wholesale water and increase the capacity of their system so they are able to meet their peak demands. Since North Smithfield now receives all of its source water via the Woonsocket interconnection, the existing production wells are currently offline and used in emergency situations only. The total production capacity of these wells is only sufficient to meet current emergency demands in the event the interconnection is lost. During 2025, 0.23 MGD of supplemental water for LOS C will be needed, and 1.19 MGD at build-out.

A list of potential alternative water supply sources was developed as a first step in identifying viable alternative water supply sources and is shown in Table 8. Table 9 summarizes the budgetary costs for North Smithfield's supplemental water supply sources.

Table 8: North Smithfield Potential Alternative Water Supply Sources

North Smithfield Water Department	Source Type (Groundwater, Surface water, Interconnection)	Potential Capacity (MGD)	Water Origin Basin (Sub-basin)	Current Status
New Tifft Road Well	Groundwater	0.5	L. Blackstone River Basin (Branch River)	Proposed (North Smithfield)
Interconnection to Harrisville	Interconnection	1.0*	L. Blackstone (Abbott Run)	Proposed (Report)

* Available surplus water from Harrisville is 0.5 MGD

Table 9: Budgetary Costs for North Smithfield supplemental water supply sources

Supplemental Water Supply Alternatives	Estimated Cost
New Tifft Road Well	$546,000
Interconnection with Harrisville	$7,667,026

Pascoag Utility District

The risk and needs assessment for Pascoag indicated that the Main Street interconnection with Harrisville is the most critical component of the Pascoag water system. The 10-inch water main is the primary source of water for the Pascoag water system which purchases all of its water wholesale from Harrisville. Pascoag's main production wells were brought offline in 2001 due to MTBE contamination in the aquifer. LOS C emergency demand supplemental water needs for 2005, 2025 and build-out are 0.19 MGD, 0.24 MGD and 0.47 MGD, respectively. Well 5 was placed online January 2008 and it has a sustainable pumping capacity of 0.11 MGD. During build-out conditions, 0.16 MGD would be needed to meet LOS C with the Main Street interconnection offline.

A list of potential alternative water supply sources was developed as a first step in identifying possible alternative water supply sources and is shown in Table 10. Table 11 summarizes the budgetary costs for Pascoag's supplemental water supply sources.

Table 10: Pascoag Potential Alternative Water Supply Sources

Pascoag Utility District	Source Type (Groundwater, Surface water, Interconnection)	Potential Capacity (MGD)	Water Origin Basin (Sub-basin)	Current Status	Comments
Well No. 2	Groundwater	0.10	L. Blackstone River Basin (Clear River Sub-basin)	Abandoned	High Iron & Manganese, MTBE Contamination
Well No. 3		0.38		Off-line	MTBE Contamination
Well No. 3A		0.58		Off-line	
New Wells	Groundwater	TBD	L. Blackstone	Proposed	Pascoag

Table 11: Budgetary Costs for Pascoag supplemental water supply sources

Supplemental Water Supply Alternatives	Estimated Cost
New groundwater sources	$733,200*
Reestablish wells No. 2, No. 3 and No. 3A	$40,000,000

* Does not include price of land or pipeline connection to system

Pawtucket Water Supply Board

The risk and needs assessment for Pawtucket indicated that the water treatment plant is the most critical component of the Pawtucket water system. All supply water must pass through this plant prior to entering the distribution system. In the event of a water treatment plant failure, the Pawtucket system would lose their entire water supply, with the exception of Wells No. 4 and

No. 5, providing a combined sustainable pumping capacity of 1.3 MGD. There are currently back-up generators capable of running both the plants process equipment along with the transmission pumps responsible for distribution into the system. Catastrophic failure of the water treatment plant would result in a loss of service for approximately one to two years. Projected LOS C emergency demands for 2005, 2025 and build-out are 8.22 MGD, 8.39 MGD and 8.98 MGD respectively. Supplemental water needs for 2005, 2025 and build-out are 6.92, 7.09 and 7.68 MGD, respectively.

A list of potential alternative water supply sources was developed as a first step in identifying viable alternative water supply sources and is shown in Table 12. Table 13 summarizes the budgetary costs for Pawtucket's supplemental water supply sources.

Table 12: Pawtucket Potential Alternative Water Supply Sources

Pawtucket Water Supply Board	Source Type (Groundwater, Surface water, Interconnection)	Potential Capacity (MGD)	Water Origin Basin (Sub-basin)	Current Status	Comments
PWSB* to Pawtucket interconnection A	Interconnection	10	Pawtuxet River	Proposed (Phase I)	24" Water Main & Pump Station
PWSB to Pawtucket interconnection B	Interconnection	5	Pawtuxet River	Proposed (Phase I)	16" Water Main & Pump Station

*Providence Water Supply Board; Fe-Iron, Mn-Manganesse

Table 13: Budgetary Costs for Pawtucket supplemental water supply sources

Supplemental Water Supply Alternatives	Estimated Cost
PWSB to Pawtucket Interconnection A	$9,620,000
PWSB to Pawtucket Interconnection B	$6,890,000 (plus pumping station)

Woonsocket Water Department

The risk and needs assessment for Woonsocket indicated that the water treatment plant is the most critical component of the Woonsocket water system. All supply water must pass through this plant prior to entering the distribution system. In the event of a water treatment plant failure, the Woonsocket system would lose their entire water supply. There are currently back-up generators capable of running both the plants process equipment along with the transmission pumps responsible for distribution into the system. A catastrophic failure to the water treatment plant would result in a loss of service for approximately one to two years. A 1.0 MGD emergency interconnection with Lincoln would be the only available water supply. Supplemental water needed to meet LOS C emergency demands for 2005, 2025, and at build-out are 3.55 MGD, 4.84 MGD and 5.14 MGD respectively.

A list of potential alternative water supply sources was developed as a first step in identifying possible alternative water supply sources and is shown in Table 14. Table 15 summarizes the budgetary costs for Woonsocket's supplemental water supply sources.

Table 14: Woonsocket Potential Alternative Water Supply Sources

Woonsocket Water Department	Source Type (Groundwater, Surface water, Interconnection)	Potential Capacity (MGD)	Water Origin Basin (Sub-basin)	Current Status	Comments
Rehab Existing Interconnection with Lincoln	Interconnection	3.64	Pawtuxet River	Active (Rarely Used)	Current capacity = 1.0 MGD
Woonsocket to Cumberland interconnection	Interconnection	1.5	L. Blackstone (Abbot Run)	Proposed	Pawtucket Water via Cumberland

Table 15: Budgetary Costs for Woonsocket supplemental water supply sources

Supplemental Water Supply Alternatives	Estimated Cost
Rehabilitation of existing interconnection with Lincoln	$2,652,000
Interconnection with Cumberland	$638,040

Eleanor Slater Hospital/Zambarano Unit

ESH/ZU relies on Wallum Lake and the Wallum Lake WTP for all of their water supply water. Therefore, Wallum Lake is ESH/ZU's most critical water source. ESH/ZU currently does not own or operate any groundwater supply wells. A loss of either Wallum Lake or the water treatment facility would result in a total loss of supply for the system. The lake is currently used for recreational use and there is no industry in the area surrounding the lake. A catastrophic failure to the water treatment plant would result in a loss of service for approximately one to two years. Supplemental water needs for 2005, 2025, and at build-out will be 0.10 MGD for each.

A list of potential alternative water supply sources was developed as a first step in identifying possible alternative water supply sources and is shown in Table 16. The remote geographic location of the hospital's campus prevents them from establishing any emergency interconnections with other water suppliers.

Table 16: ESH/ZU Potential Alternative Water Supply Sources

ESH/ZU Water Department	Source Type (Groundwater, Surface water, Interconnection)	Potential Capacity (MGD)	Water Origin Basin (Sub-basin)	Current Status
New Wells	Groundwater – Rock Wells	0.1	Blackstone (Clear River)	Proposed

Total cost for the installation of three 40 gpm water supply bedrock wells with a hypothetical depth range of 50 to 150 feet would range from $223,000 (three 50-foot wells) to $257,400 (3 150-foot wells).

Study Area Two

Bristol County Water Authority

The risk and needs assessment for Bristol County Water Authority indicated that the East Bay Pipeline is the most critical component of the water system. The pipeline has enabled Bristol County to purchase finished water from PWSB in order to supplement their current water sources which have been strained lately. If Bristol County were to lose the East Bay Pipeline, the current sources have a capacity of approximately 3.4 MGD which is below both the average day (3.65 MGD) and maximum day (4.81 MGD) demands of the system. Supplemental water would need to be provided by East Providence, through Bristol County's two emergency interconnections, which have a combined capacity of approximately 1.0 MGD. A failure of the East Bay Pipeline along with the Barrington Booster Pump Station would have an impact duration of approximately six months. However, if the PWSB were to have a failure at the Holton Water Purification Plant (WPP), than the impact duration would be one to two years. Supplemental water needs to meet LOS C emergency demands would be 0.24 and 1.50 MGD for 2025 and build-out, respectively.

A list of potential alternative water supply sources was developed as a first step in identifying viable alternative water supply sources and is shown in Table 17.

Table 17: Bristol County Water Authority Potential Alternative Water Supply Sources

Bristol County	Source Type (Groundwater, Surface water, Interconnection)	Potential Capacity (MGD)	Water Origin Basin (Sub-basin)	Current Status
Reactivate Well Field	groundwater	2.0	Narragansett	inactive

A budgetary cost for reestablishing the Bristol County well field as a supplemental water supply source to obtain 2.00 MGD would be $6,362,304.

Newport Water Division

The risk and needs assessment for Newport indicated that Station 1 is the most vulnerable source. It has a capacity of 9.00 MGD and the capacity to supply over 70 percent of the system's maximum day demand. If Station 1 is out of service, the Lawton Valley WTP is available to provide 7.00 MGD of water to Newport, Middletown, the Naval Station Newport, and Portsmouth. The infrastructure is in place and has been used to allow the Lawton Valley WTP to serve all customers on Aquidneck Island. A catastrophic failure to Station 1 would likely have an impact duration of one to two years. Newport would need 0.36 and 1.41 MGD of supplemental water to meet LOS C emergency demands during 2025 and build-out, respectively.

A connection to Fall River, Massachusetts was developed as a first step in identifying viable alternative water supply sources and is shown in Table 18.

Table 18: Newport Water Division Potential Alternative Water Supply Sources

Newport Water Division	Source Type (Groundwater, Surface water, Interconnection)	Potential Capacity (MGD)	Water Origin Basin (Sub-basin)
Connection to Fall River, MA	interconnection	7.0	Buzzards Bay and Taunton River

If emergency water needs are in excess of the Lawton Valley WTP, water from the City of Fall River via the Portsmouth/Stone Bridge interconnection is available as a supplemental source. The Fall River system produces 26.00 MGD of finished water. Industry in Fall River has steadily declined over the years and the City only uses about 12.00 MGD during the peak summer months. Additionally, the South Watupa Pond reservoir is currently offline, but could be brought back online and would produce another 7.00 MGD. The City is open for further discussions regarding the provision of supplemental water for emergency purposes for Newport and other suppliers in Study Area Two.

A new 12-inch pipe could be constructed from the state line to the Sakonnet River Bridge in Tiverton. The Portsmouth Water and Fire District is proposing that provisions be put in place to allow for future construction of a 16-inch pipe across the bridge. This would allow the Portsmouth Water and Fire District to meet their existing demands and not just emergency demands. Because of the interconnection Newport has with Portsmouth, supplemental water from Fall River can be wheeled to Lawton Valley Reservoir and distributed through the existing Newport infrastructure.

The budgetary cost for a 12-inch pipeline from the state line to the Sakonnet River Bridge in Tiverton, which would supply Aquidneck Island with a supplemental water supply source from Fall River, is estimated to be $2,651,220.

North Tiverton Fire District

The risk and needs assessment for North Tiverton identified that the State Avenue pump station interconnection with Fall River is the most critical source. The current contract allows for a maximum 0.55 MGD to be purchased from Fall River. The loss of this source would leave North Tiverton with approximately 0.15 MGD available from Stone Bridge per contract limits, falling short of the 0.52 MGD average day demand of the system. The Carey Lane interconnection with Stone Bridge Fire District has a capacity of 1.04 MGD and is assumed to be available for purposes of this Study, whereas the available water to North Tiverton is taken as the interconnection capacity of 1.04 MGD less Stone Bridge’s average day demand. It should be noted that the interconnections with both Stone Bridge and Fall River have a combined capacity of over 3 MGD, but the existing contract limit is 0.15 MGD. The current contract with Stone Bridge expires in 2013, and will most likely need to be renegotiated to account for increased demands in the North Tiverton system. Supplemental water is not needed to meet 2005 LOS C emergency demands. Supplemental LOS C water needs for 2025 and at build-out are 0.80 and 0.47 MGD, respectively.

North Tiverton could benefit from supplemental water associated with a new pipeline and connection to the City of Fall River, as discussed for Newport. A new 12-inch pipe from the state line to the Sakonnet River Bridge could supply water from the City of Fall River, which has approximately 20.00 MGD surplus. Refer to the Newport discussion for costs.

Portsmouth Water and Fire District

The risk and needs assessment for Portsmouth found that the two interconnections located at the Lawton Valley WTP are the most critical components of the Portsmouth system. This is due to the fact that Portsmouth purchases all of their water from Newport. A loss of either the 16-inch transmission main that connects the plant with Portsmouth’s Union Street Pumping Station, or a WTP failure would have a critical effect on the Portsmouth system. Lawton Valley WTP currently has the capacity to deliver approximately 2.25 MGD through either the supply connection or the emergency connection. The remaining interconnections do not have the capacity to meet the average day or maximum day demands of the system. Newport's Lawton Valley WTP currently has back up power capable of running all the plant's process equipment and pumps. Portsmouth will be able to meet LOS C emergency water needs, with the exception of build-out, where it will need 0.74 MGD of supplemental water.

Currently, Portsmouth is pursuing the construction of a new 16-inch pipe across the proposed new Sakonnet River Bridge in an effort to meet existing system-wide demand rather than emergency demand. Portsmouth has requested that the RI Department of Transportation in the construction of the new bridge leave a corridor for a 20-inch conduit, which could house the 16-inch carrier pipe. This project in conjunction with a new interconnection with Fall River from the bridge to the state line will assist in acquiring supplemental water from Fall River not only for Portsmouth, but Newport as well. Refer to the Newport discussion for costs.

Stone Bridge Fire District

The risk and needs assessment for Stone Bridge found Stafford Pond, along with its water treatment plant, as the most critical component of the system. Strafford Pond is the sole source for Stone Bridge's raw water supply. A catastrophic failure of either the reservoir or the treatment plant would severely affect not only the Stone Bridge system, but also the North Tiverton Fire District, as they purchase finished water from Stone Bridge. A loss of the treatment plant would essentially result in the loss of the reservoir as Stone Bridge would have no way of providing potable water to its customers. A limited amount of emergency water supply could be provided by North Tiverton through the 1.04 MGD capacity Carey Lane interconnection. North Tiverton does not own any of their own water supplies and relies on the City of Fall River, MA along with Stone Bridge for their finished water. North Tiverton's current contract with Fall River, MA allows for a maximum of 0.55 MGD to be purchased per day, but the pipe capacity at Main Road/State Ave is 1.04 MGD. Assuming the pipe capacity would govern the availability of water, this interconnection would be sufficient to meet the combined 2005 demands of the North Tiverton and Stone Bridge systems, but it would not be sufficient to meet both demands at 2025 or build-out conditions, even with both systems operating at emergency demands. The finished water available to Stone Bridge after accounting for North Tiverton average day demands would be approximately 0.52, 0.0, and 0.14 MGD for 2005, 2025 and build-out, respectively. Stone Bridge LOS C supplemental water needs for 2025 and build-out are 0.54 and 0.65 MGD, respectively.

Although Stone Bridge could benefit from North Tiverton's 2.16 MGD emergency interconnection with Fall River with the existing infrastructure between North Tiverton and Stone Bridge, the unpermitted source was not utilized in this assessment. Therefore, Stone Bridge would also benefit from supplemental water associated with a new pipeline and connection to the City of Fall River, as discussed previously in the Newport Water Division section of this report. A new 12-inch pipe from the state line across the Sakonnet River Bridge could supply water to Aquidneck Island from the City of Fall River, which has approximately 20.00 MGD surplus.

Study Area Three

Jamestown Water Division

The risk and needs assessment for Jamestown indicated North Pond Reservoir and the Jamestown Water Treatment Facility are the most vulnerable sources. The North Pond Reservoir has a capacity of approximately 0.19 MGD and is the primary source of supply water for Jamestown. In order for potable water from the reservoirs to reach the Jamestown customers it must first be treated at the WTP. A failure of either one of these components would affect the Jamestown system greatly. The relative risk of failure of either one of these components was determined be low. Currently, only two groundwater wells are active and have a combined sustainable pumping capacity of approximately 0.1 MGD, roughly half of the Jamestown's average day demand. Emergency water would likely be provided through the 0.2 MGD interconnection with North Kingstown Water in the event that the reservoir or the treatment facility was lost. Jamestown will be able to meet emergency water demands for 2005 and 2025; however, it will need 0.03 MGD of supplemental water at build-out.

The most viable source of supplemental water for Jamestown would be to receive additional water from North Kingstown through the existing emergency connection across the Jamestown-Verrazano Bridge. The 6-inch hose is rolled across the bridge, currently limited by contract to 0.20 MGD. The hydraulics of the 6 inch connection with North Kingstown could be enhanced to allow 0.33 MGD of supplemental water supply.

Kent County Water Authority

The risk and needs assessment for Kent County determined the Clinton Avenue interconnection with PWSB as Kent County's most vulnerable source. Kent County purchases approximately 70 percent of their water supply from PWSB via this interconnection. Water is pumped into the Kent County system via the Clinton Avenue pumping station. The capacity is hydraulically limited by the pump station to approximately 18.0 MGD. A loss of this source would put a tremendous strain on the system, especially during periods of high demand. In the event the interconnection was lost, Kent County would have to rely heavily on the interconnection with Warwick (PWSB supplied water to Warwick) and the three well fields, which still would not provide Kent County with enough water to meet emergency demands at build-out. These LOS C demands would be 6.97 MGD (2005), 7.78 MGD (2025) and 11.29 MGD (build-out).

The estimated well field capacity is 4.86 MGD consisting of the Mishnock, East Greenwich and Spring Lake well fields. It should be noted that the Bald Hill Road/Quaker Lane interconnection with the City of Warwick has a capacity of 4.6 MGD per contract. However, a new agreement with the City of Warwick will increase the Bald Hill Pump Station capacity to 10.1 MGD in conjunction with the final upgrade renovation of the pump station and the completion of the capitol projects to support the upgraded capacity of this station (anticipated 2009). KCWA will not be able to meet emergency demands at 2005, 2025 or build-out conditions if the PWSB system is offline and KCWA has to depend only on their well fields as available water supply. Additionally, the most viable source of supplemental water for Kent County would be new source development of Big River due to its proximity and or completing further interconnections with PWSB to allow wheeling of surplus water from the northern region (e.g., Pawtucket).

Kingston Water District

The Chipuxet Well field is the Kingston Water District's most critical source mainly due to the capacity of the well field. In the event the Chipuxet well field was lost, Kingston would have to rely on both the Genesee Well and the interconnection with URI to meet their emergency demands. The combined capacity of the sources is sufficient to meet both current average day demands and maximum day demands. The loss of the well field would have an impact duration of approximately 9 months. However, both the Genesee Well and the interconnection with URI would provide enough water to meet emergency demands of KWD customers at 2005, 2025 and build-out. Therefore, sources of supplemental emergency water were not explored.

Narragansett Water Department

The risk and needs assessment for the North End of the Narragansett Water Department identified the Boston Neck Road interconnection with North Kingstown as its critical water source. This interconnection is limited to 0.50 MGD by contract which is below the max day demand but its loss would have the greatest adverse effect on the North End water system. This is the water source that primarily is used to fill the North End water storage tank. For this reason this water source was deemed the most critical despite ranking slightly lower on the total weighted relative risk evaluation. An interconnection failure would take approximately one to three months to bring back online.

After evaluation of all the South End's water sources, it was determined that the Point Judith Road interconnection with United Water was its critical water source. A catastrophic failure of the interconnection would likely impact the water system for approximately one to two months in order to replace or repair the interconnection.

For both the North End and South End, Narragansett will be able to meet short term emergency demands at 2005, 2025 and build-out after the loss of critical water sources. Therefore, sources of supplemental emergency water were not explored.

North Kingstown Water Department

The risk and needs assessment for North Kingstown identified that Well Station No. 10 has the highest weighted relative risk and is its critical water source. Other wells rated the same in the risk assessment, but Well 10 was selected as its critical source because it has the largest sustainable pumping capacity of the North Kingstown wells. The weighted risk assessment found the source to be a low risk with all of the other sources being low to very low. If North Kingstown were to lose this well through catastrophic failure, it would take approximately 9 months to repair/replace the well. Remaining sources within the system would be able to meet emergency demands during 2005, 2025 and at build-out.

Quonset Development Corporation

Quonset Development Corporation (QDC), as agent for the Rhode Island Economic Development Corporation pursuant to R.I. Gen. Laws 42-64.10. The risk and needs assessment for QDC determined Well No. 14A to be the QDC's most critical water source. The weighted relative risk value was directly related to well's higher capacity as all three wells were found to have similar total relative risks. The loss of this well would not be critical to the QDC system as the remaining two production wells have a combined sustainable capacity capable of meeting both the average day and maximum day demands. A well failure would likely have an impact duration of six to nine months. Water supply capacity after the loss of Well No. 14A would be able to meet emergency water demands at 2005, 2025 and build-out. Therefore, sources of supplemental emergency water were not explored.

South Kingstown Water Department

SKWD owns and operates two separate water systems; South Shore and Middlebridge. The risk and needs assessment for SKWD determined that Well No. 3 is the most critical water source for the South Shore system. Well No. 3 rated as High on the weighted total relative risk evaluation. While Well No. 2 also rated High, it has a slightly lower capacity and for that reason Well No. 3 was deemed more important. A well failure would likely have an impact duration of six to nine months.

The Torrey Road interconnection was determined to be the critical water source for the Middlebridge system. The Torrey Road interconnection rated as Moderate on the weighted relative risk evaluation. A catastrophic failure of the interconnection would likely impact the water system for approximately one to two months in order to replace or repair the interconnection.

SKWD will be able to meet emergency water demands at 2005, 2025 and build-out if critical water sources were lost in both the South Shore and Middlebridge systems. Therefore, sources of supplemental emergency water were not explored.

United Water of Rhode Island

The risk and needs assessment for United Water found the Howland well field to be United Water’s most critical water source mainly because of its slightly higher contribution to the system and fewer wells. Each well field represents roughly half of the United Water total production capacity of 7.42 MGD and both sites have adequate back up power. If the United Water were to lose either well field, the remaining sources would be capable of meeting the average day demand of 2.84 MGD. The loss of a Howland well field would put a significant strain on the system only in periods of high demand. A catastrophic failure of the Howland well field would have an impact duration of approximately 9 months.

If United Water were to lose access to the Howland well field, the remaining sources within the system would be able to meet emergency demands at 2005, 2025 and build-out. Therefore, supplemental emergency water sources were not explored.

University of Rhode Island Facilities and Operations

The risk and needs assessment for URI found all three production wells to have relatively equal vulnerability. Currently, Well No. 4 is the primary well for the system and is, therefore, more likely to fail than the others. In the event of a failure, Wells No. 2 and No. 3 have sufficient capacity to meet system demands while Well No. 4 is offline. A loss of Well No. 4 would have an impact duration of approximately nine months. Remaining sources within the URI system would have the ability to meet emergency demands during 2005, 2025, and build-out; therefore, supplemental emergency water sources were not explored.

Study Area Four

Study Area Four is located in southwestern Rhode Island and is comprised of one water utility, Richmond Water Supply District, which services the Town of Richmond. Its most critical water source is Well No. 1, which has a sustainable pumping capacity of 0.58 MGD. Well No. 2 is a backup well that would be available and it has a sustainable pumping capacity of 0.29 MGD.

If Well No. 1 is out of service, Well No. 2 has sufficient supply to meet projected 2005, 2025 and build-out LOS C emergency demands of 0.13, 0.19 and 0.21 MGD, respectively. Therefore, supplemental emergency water sources were not explored.

Study Area Five

Study Area Five is located in the southwest corner of Rhode Island. Westerly Water Division is the only water supplier in this study area and provides water to the Town of Westerly and the nearby Pawcatuck section of Stonington, Connecticut.

Westerly's most critical source is the White Rock Well Field 1, which has a sustainable pumping capacity of 1.95 MGD. White Rock Well Field 2 has a slightly higher sustainable pumping capacity of 2.00 MGD and less risk of all its wells being offline at the same time because it contains an emergency well. All three White Rock well fields have back-up generators capable of running all pumps in the event of an area wide power failure. White Rock Well Field 1 does not have an emergency back-up well and a catastrophic loss of the well field would not be critical to the system. The remaining wells have a combined sustainable pumping capacity of approximately 5.21 MGD, which exceeds the average day demand of the system (3.31 MGD). A catastrophic loss of the well field would have an impact duration of approximately nine months. Remaining sources within the Westerly system would meet emergency demands during 2005, 2025 and build-out; therefore supplemental emergency water sources were not explored.

Study Area Six

The Block Island Water Company's most critical source is the reverse osmosis facility, which has a capacity of 0.23 MGD. Well sources are Wells No.5 and No.6, which have a combined sustainable pumping capacity of 0.23 MGD. Should the reverse osmosis facility be off-line, it is presumed that their 0.06 MGD conventional filtration plant would provide supplemental water to meet emergency demands. Wells No.1, No.2 and No.3 have a much lower combined sustainable pumping capacity of 0.060 MGD. Sands Pond, the surface water source, has a safe yield of 0.045 MGD. The conventional filtration plant must be upgraded to meet the requirements of the Surface Water Treatment Rule before Sands Pond can be actively used. The other surface water source, Fresh Pond, has a safe yield of 0.02 MGD, but similar to Sands Pond, it can only be used as an emergency source. It is assumed that Well No. 4 (currently inactive) will be brought back on-line for future conditions (2025 or build-out).

A loss of either Well No.5 or Well No.6 would put a strain on the system. However, with the historic summer average day demand being less then the sustainable pumping capacity of either well, the system could be maintained for a short duration period. In the event of a catastrophic failure to both Well No.5 and Well No.6, the duration of impact would be approximately nine months to develop replacement wells. The impact of a catastrophic failure would be more significant if this period encompassed the summer months (May through September) when the demand for public water is at its annual peak. The historic maximum daily demand is estimated at 0.16 MGD. However, due to the seasonal nature of Block Island, the water demand would be minimized if a catastrophic event happened in an "off-season" month, November through April.

Regional Supplemental Emergency Water Supply Sources

Using the findings of the risk and needs assessments along with consultation with RIWRB staff, local supplemental emergency water sources were assessed for regional application. These sources were evaluated from a statewide perspective identifying where demand for water during emergency conditions was needed and how to meet those demands. The alternates to be included in the evaluation were selected based on their potential to provide supplemental water in the event of an emergency in a cost-effective and sustainable way.

It was concluded that situations in which a supplier could not meet emergency demands, even with reduced water usage by residential, commercial and industrial customers were concentrated in two regions of the state: West Bay (central part of the state) and Aquidneck Island/East Bay (eastern part of the state).

West Bay

Suppliers in the West Bay region that would require emergency water are PWSB, Kent County Water Authority, Quonset Development Corporation and North Kingstown Water Department. In emergency conditions, the PWSB would continue to service its retail and dependent wholesale customers, but it would require certain wholesale customers that have their own water supply sources within their system to find sources to meet their internal demands. As a result, supplemental emergency water supply needs at LOS C at 2025 in the West Bay region were calculated to be the following, totaling 35.39 MGD:

- PWSB retail customers – 23.74 MGD
- Kent County Water Authority – 2.92 MGD (with no Hunt Aquifer limitation considered)
- City of Warwick – 3.90 MGD
- City of East Providence – 3.15 MGD
- Lincoln Water Commission – 0.25 MGD
- East Smithfield, Smithfield, Greenville, and Johnston – 1.43 MGD

A concern for the West Bay region is the low flows that have occurred in the Hunt portion of the Hunt-Annaquatucket-Pettquamscutt (HAP) Aquifer. There are concerns that a prolonged drought event could impact the sustainability of this aquifer and its ability to meet the demands of QDC, North Kingstown and Kent County Water Authority. A calculation of the amount of water needed during emergency conditions was performed, as well as the amount of water available to suppliers should maximum pumping from the Hunt portion of the HAP Aquifer be limited to 4.0 MGD. Table 19 details the amount of supplemental water that would be needed if PWSB was under emergency conditions and could not provide water to Kent County and withdrawals from the Hunt Aquifer were limited. This would also impact North Kingstown and QDC emergency water demands. With Hunt Aquifer withdrawals calculated proportionally to account for a 4.0 MGD assumed withdrawal limitation for public water suppliers, Kent County, North Kingstown and QDC withdrawals would be limited to 0.72 MGD, 1.56 MGD, and 1.72 MGD, respectively. The assumed 4.0 MGD Hunt Aquifer limitation (withdrawal from public water suppliers) was carried forward for the rest of this study. Therefore, the total supplemental water needs for the West Bay are 36.95 MGD in 2025 and 40.46 MGD at build-out.

Table 19: Regional Emergency Water Demands for Kent County West Bay Region if PWSB service were lost and Hunt Aquifer withdrawals were limited

Water Supplier	2025 Emergency Demand (MGD)	Build-out Emergency Demand (MGD)	2025 Deficit w/o Hunt Wells (MGD)	Build-out Deficit w/o Hunt Wells (MGD)	2025 Deficit w/o Hunt Wells & w/o PWSB (MGD)	Build-out Deficit w/o Hunt Wells & w/o PWSB (MGD)
Kent County	7.78	11.29	N/A	N/A	(4.92)	(8.43)
North Kingstown	3.72	3.99	N/A	N/A	0.30	0.03
QDC at Quonset Business Park®	2.00	2.00	(2.00)	(2.00)	(2.00)	(2.00)
Total w/o Hunt Aquifer Wells and w/o PWSB	**13.50**	**17.28**	**(2.00)**	**(2.00)**	(6.62)	(10.40)
Hunt Aquifer withdrawal limited to 2.0 MGD	13.50	17.28	0.00	0.00	(4.62)	(8.40)
Hunt Aquifer withdrawal limited to 4.0 MGD	13.50	17.28	N/A	N/A	(2.62)	(6.40)
Hunt Aquifer withdrawal limited to 5.0 MGD	13.50	17.28	N/A	N/A	(1.62)	(5.40)
Hunt Aquifer withdrawal limited to 7.0 MGD	13.50	17.28	N/A	N/A	0.38	(3.40)

Note: Hunt Aquifer withdrawal limit shown within Table 19 is for public water suppliers. The non-Hunt Aquifer well sustainable pumping capacity available for Kent County, North Kingstown and QDC is 2.86, 4.02 and 0.00 MGD, respectively.

East Bay

Aquidneck Island and the East Bay area of the state also would experience regional constraints in meeting emergency demands. Supplemental emergency water would be needed in 2025 and at build-out conditions. This region's water supply is from surface water sources, and is therefore not impacted by stressed groundwater resources. Supplemental emergency water needed at 2025 and build-out to meet LOS C demands with a water supplier's most critical source offline was calculated to be the following:

- Newport Water Division (includes Portsmouth) – 1.41 MGD
- Portsmouth Water and Fire District – 0.74 MGD
- North Tiverton Fire District – 0.47 MGD
- Stone Bridge Water and Fire District – 0.65 MGD

The emergency demands of the Bristol County Water Authority were not included because they can be met more readily through other regional sources. Table 20 summarizes the supplemental emergency water deficit scenarios for each water supplier with their most critical source offline. The regional interdependency is demonstrated per the scenarios within Table 20.

Table 20: Regional Supplemental Emergency Water Demand Scenarios at Aquidneck Island and East Bay Region if supplier's most critical source were lost

Water Supplier	Critical Source Offline Scenario	Remaining Sources	2025 Emergency Demand (MGD)	Build-out Emergency Demand (MGD)	2025 Deficit w/o Critical Source (MGD)	Build-out Deficit w/o Critical Source (MGD)
Newport Water Division (includes Portsmouth)	Station 1 water treatment facility	Lawton Valley water treatment facility	7.36	8.41	(0.36)	(1.41)
Portsmouth Water & Fire District	Interconnection at Lawton Valley facility	Interconnections with Newport and Stone Bridge	1.20	1.94	N/A	(0.74)
North Tiverton Fire District	Interconnection with Fall River	Interconnection with Stone Bridge	1.10	0.58	(0.80)	(0.47)
Stone Bridge Water & Fire District	Stafford Pond water treatment facility	Interconnection with North Tiverton	0.54	0.79	(0.54)	(0.65)

Regional Solutions

The following alternative water supply approaches were developed to meet regional emergency water demands:

- Wheeling surplus water
- Rehabilitation of inactive wells
- New groundwater source development
- Reverse osmosis desalination

Wheeling Surplus Water

A majority of water suppliers with surplus or deficit available water supplies have distribution systems that are interconnected either directly or indirectly through both emergency and non-emergency supply interconnections. These interconnections are critical in determining the ability of water suppliers to distribute or "wheel" supplemental water to other water suppliers NOT capable of meeting their own water demands. "Wheeling" water in this study is defined as transporting bulk quantities through a system's distribution piping as a primary benefit to receiving system(s). By using existing interconnections, areas with water surplus can share with areas that cannot meet emergency demands. Based on their location and amount of surplus water available, Pawtucket, Woonsocket and Fall River have been chosen to analyze the feasibility of sharing water from their systems to those that would need water in an emergency situation.

Surplus Water from Fall River

The water suppliers in the Aquidneck Island and East Bay area have the ability to meet emergency water demands at 2005; however, some systems will not be able to meet these emergency demands at 2025 and build out. Wheeling water from Fall River could provide the area with needed water during these emergency conditions. There are four major interconnected water suppliers that could benefit; Newport Water Division, North Tiverton Fire District, Portsmouth Water and Fire District, and Stone Bridge Fire District.

The loss of the Newport water treatment system at Station No. 1 would result in a long term (one to two years) failure of the region's most critical source. If Station No. 1 is offline, these four major water suppliers would have a regional deficit of 1.71 MGD at build-out, with Newport operating at LOS C and the other three suppliers operating at average day demand.

The 1.71 MGD regional deficit assumes the Lawton Valley Water Treatment Plant in Portsmouth would continue to furnish water at emergency service levels to the Newport retail customers (at LOS C) and the Navy at Melville. Fall River would continue to provide water to North Tiverton and Stone Bridge through its existing interconnections. Fall River surplus water could potentially be wheeled through the recently constructed (2005) 2.16 MGD capacity emergency one-way interconnection at the Stafford Road pumping station. With minor infrastructure modifications to the systems in North Tiverton and Stone Bridge, needed water could be wheeled to Portsmouth.

Geographically, Fall River abuts the Rhode Island state boundary to the east. Its water system serves a population of 98,000 and has a 24.0 MGD water treatment plant capacity. Their average day demand and maximum day demand (as generally reported in the City's Infrastructure Improvements Program, dated February 2008) are 12 MGD and 16 MGD, respectively. This suggests it is feasible for Fall River to provide up to 8 MGD to water suppliers in Rhode Island, more than enough to fulfill the 1.71 MGD need in this region.

Fall River currently supplies water to both North Tiverton and Stone Bridge. North Tiverton has a pressurized interconnection with Fall River on State Avenue (located north of the Sakonnet River Bridge). Although the contract between the two suppliers allows North Tiverton to receive up to 0.55 MGD of supply water from Fall River at the State Avenue interconnection, hydraulically it is reported to be capable of providing 1.04 MGD. Fall River could also provide up to 2.16 MGD to North Tiverton through a recently constructed emergency interconnection.

Fall River provides raw water to Stone Bridge for treatment at their 1.25 MGD treatment facility (1.40 MGD maximum). This is accomplished through a connection between the Fall River raw water transmission system and Stafford Pond which has a safe yield of 2.04 MGD; from there, Stone Bridge treats the surface water at their purification plant (Stone Bridge treatment plant). Fall River owns the water rights to the pond and is required to maintain a flow rate of 1.90 MGD to the pond for use by Stone Bridge in treatment.

Because of the existing interconnections and the apparent surplus water in Fall River, the existing infrastructure was reviewed to determine the feasibility of meeting supplemental emergency water needs in the region from the Fall River system. Two steps would need to be taken: contract modifications and infrastructure improvements.

Contract Modifications

For the existing surplus water resources to be wheeled freely through existing interconnections, the existing contract limitations would need to be renegotiated, as shown in Table 21. The emergency interconnection at Stafford Road is not known to have a contractual limitation and therefore it is assumed the full 2.16 MGD capacity is available to North Tiverton.

Table 21: Required Modifications to Interconnection Contract Limitations

Interconnection	Existing Contract Limitation	New Contract Limit
State Street PS Fall River supply to North Tiverton	0.55 MGD	1.04 MGD*
Carey Lane PS Stone Bridge supply North Tiverton	0.15 MGD	1.04 MGD*

*Based upon reported hydraulic capacity

Infrastructure Improvements

The surplus supply water from North Tiverton and Stone Bridge can be transferred to Portsmouth using existing infrastructure; the physical path exists and the hydraulic capacity is available. The only existing limiting factor is the existing contract limitations addressed above. All of this surplus supply water from these two systems would be transferred to Portsmouth through the metering station on the east side of the Sakonnet River Bridge without need for any infrastructure improvements. However, there are two major physical infrastructure limitations that need to be addressed to allow the 1.71 MGD from the Fall River emergency interconnection with North Tiverton to be transferred to Portsmouth.

First, approximately 13,000 linear feet of pipe in the North Tiverton service area would need to be increased from 8-inch diameter to 12-inch diameter. This would allow for the 1.71 MGD of flow needed to go to Portsmouth, plus the demand of North Tiverton under the suggested maximum five feet per second design velocity. In addition, 8,000 linear feet of 8-inch pipe in the Stone Bridge system would also need to be replaced with 12-inch main. Thus, a total of 21,000 linear feet of 12-inch transmission main would need to be installed to get the water from Fall River to the Sakonnet River Bridge area at an appropriate velocity. Table 22 summarizes the construction costs to install the 21,000 linear feet of pipe from the Fall River area to the bridge crossing.

Table 22: Estimated Construction Costs for Distribution Piping Upgrades

Item	Unit Price	Units	Quantity	Total Cost
12” DI Pipe	$72	LF	21,000	$1,512,000
Valves	$26,500	LS	1	$ 27,000
Trench (Excavation, Backfill, Bedding)	$40	LF	21,000	$ 840,000
Trench Repair (pavement removal, pavement, topsoil & seed)	$13	LF	21,000	$ 273,000
Erosion Control	$2	LF	21,000	$ 42,000
			Sub Total	$ 2,694,000
			Contractor O&P (10%)	$ 269,000
			Total Estimated Construction Cost	**$ 2,963,000**

Not considered in this analysis is the approximately 8,000 linear feet of 12-inch transmission main that would need to be installed in Portsmouth service area to convey the water from the Sakonnet River Bridge to the Fort Butts Tanks. The existing 10-inch distribution piping is not large enough. The existing 10-inch piping would remain and the 12-inch piping would be installed separately. Utilizing the values above, the total estimated cost per linear foot is approximately $150. Applying this to the 8,000 feet of transmission main for Portsmouth, the probable construction cost would be $1,200,000.

The existing metered interconnection that Stone Bridge maintains to provide emergency service to Portsmouth is hydraulically limited to 0.9 MGD. It has been suggested in previous reports that Portsmouth has a long term plan to ultimately receive supply water from Fall River (not just emergency water). For this reason, Portsmouth has worked with the RI DOT to include a 20-inch conduit on the Sakonnet River Bridge to accommodate the planned 16-inch water main.

Along with this infrastructure improvement, the meter size must be increased and the meter station upgraded. The existing 10-inch sub-aqueous pipe under the Sakonnet River should be kept in operation (versus abandoned) to allow for a redundant crossing should the new 16-inch bridge crossing need to closed. This can easily be achieved with a small amount of piping and valves.

A 1.75 MGD pumping station (approximately sized to pump the 1.71 MGD flow needed for Portsmouth) would transfer supplemental water over the bridge to the Portsmouth system. The pumping station would include a small building, and the necessary chemical additions (refer to Water Quality Section below) would be constructed near, or as part of, the metering station. Table 23 summarizes the construction cost to install the upgrades needed at the metering vault, including a pumping station and chemical addition, the bridge crossing and any ancillary piping modifications.

Table 23: Estimated Construction Costs for Pumping Station, Metering and Bridge Crossing

Item	Unit Price	Units	Quantity	Total Cost
12" DI Pipe From Vault to Bridge	$72	LF	1,500	$108,000
Valves	$5,000	LS	1	$5,000
Trench (Excavation, Backfill, Bedding)	$40	LF	1,500	$60,000
Trench Repair (pavement removal, pavement, topsoil & seed)	$13	LF	1,500	$19,500
16" Bridge Crossing	$128	LF	2,000	$256,000
Erosion Control	$2	LF	3,500	$7,000
Metering, Backflow, Chemical Addition	$80,000	LS	1	$80,000
Pumping Station	$500,000	LS	1	$500,000
Sub Total				$ 1,035,500
Contractor O&P (10%)				$ 103,550
Total Estimated Construction Cost				**$ 1,139,050**

Table 24 summarizes the construction costs of each infrastructure task outlined above, and includes a separate item for a 30 percent contingency (typical of planning level cost estimates) and Design, Engineering and Administration costs at 20 percent of the overall project costs (including contingency).

Table 24: Estimated Total Project Costs

Item	Total Cost
12" DI Pipe From Fall River, MA area to Bridge Crossing	$2,963,400
Bridge Crossing, Meter Vault, Pumping Station	$1,139,050
Subtotal	$4,102,450
Design, Engineering and Administration (20%)	$820,490
Subtotal	$4,922,940
Contingency (30%)	$1,476,882
TOTAL PROJECT COSTS	**$6,399,822**

Regulatory and Policy Requirements

Moving water from Fall River to Study Area Two will require two permits from the Commonwealth of Massachusetts: a Massachusetts Interbasin Water Transfer Permit and a Water Management Withdrawal Permit. The existing interconnection between Fall River and North Tiverton at Stafford Road is not currently required to hold these permits because of the emergency status. The interconnection is not currently used on an ongoing regular basis. During the loss of Newport Station No.1, Newport customers will be limited to a LOS C demand, which by definition is an event with a duration of one to two years. Thus, for this interconnection to be available for continuous use to North Tiverton, these permits must be put in place.

The Massachusetts Interbasin Transfer Act defines interbasin transfer as "any transfer of the surface and groundwaters, including wastewater, of the Commonwealth outside a river basin. If a city or town partially situated within a river basin takes waters from that basin, extension of water services to a portion of the same city or town outside the basin shall not be deemed an interbasin transfer of water." In order to be considered as an interbasin transfer, a donor basin would increase the transfer of water to a recipient basin while crossing both a municipal and river basin boundary. Interbasin transfer approvals are reviewed by the Massachusetts Water Resources Commission under the Department of Conservation and Recreation, Office of Water Resources.

The Massachusetts Department of Environmental Protection (DEP) requires water suppliers to obtain a Water Management Act Program Permit for withdrawals over 100,000 gallons per day annually from watersheds to ensure that new withdrawals will not negatively impact water resources or existing users. DEP issues permits that typically run for 20 years. They are issued for an average daily withdrawal rate and are authorized in five year increments. DEP may also set seasonal peaks.

In accordance with the Rhode Island General Laws, Title 46 Water and Navigation, Section 6 of Chapter 46-13 Public Drinking Water Supply, any connections between distribution systems must be approved by the Director of the Rhode Island Department of Health (RIDOH). Thus, all of the existing interconnections outlined above as needing an increase in the contract limitation, including the upgraded hydraulic capacity of the interconnection between Stone Bridge and Portsmouth, must ultimately be approved by the RIDOH.

Water Quality Issues

Finally, water quality issues would have to be addressed. Newport has a plan submitted to the RIDOH to address the disinfection and disinfection byproducts rule requirements for their system through the use of chloramines. All of the water received from Fall River and wheeled through the North Tiverton and Stone Bridge distribution systems, including the surplus water from North Tiverton and Stone Bridge, utilize chlorine for disinfection. Thus, before these sources of emergency water are distributed to Portsmouth, the water must be boosted and/or converted to be compatible with the chloramine disinfection used in the Newport distribution system. The pH of the water may also have to be modified to achieve the ideal pH level of 7.5 so that the chloramine boosting process is affective.

Chemical addition and pH adjustment are planned for at the upgrade of the metering station / pumping station and are included in the cost estimated presented above.

Surplus Water from Pawtucket and Woonsocket

Pawtucket has surplus water available at 2025 and build-out after accounting for its own average day demand and Cumberland's wholesale demand. Woonsocket has surplus water available at 2025 and build-out after accounting for its own average day demand, but there would only be surplus available at 2025 after accounting for the North Smithfield wholesale demand. There is potential for this surplus water to be used as a supplemental emergency water source for those suppliers that have deficiencies during these periods, in particular the West Bay area, which includes Kent County Water Authority and Quonset Development Corporation (QDC). Should the PWSB lose their water treatment plant or Gainer Dam, PWSB would require its retail customers to reduce usage to emergency levels and maintain service to only wholesale customers completely dependent on them to make most efficient use of its system. These would include East Smithfield, Smithfield, Greenville, and Johnston. As a result, Kent County, along with Warwick, would be required to find additional water to meet emergency demands during these time frames.

For QDC, they would not be able to meet emergency demands during 2025 or at build out if withdrawal from the Hunt Aquifer were limited to 4.0 MGD. There are concerns that a prolonged drought event could impact the sustainability of this aquifer and its ability to meet the demands of QDC and other suppliers that withdraw from it, including North Kingstown as well as Kent County. North Kingstown has some availability of surplus water from its well field that is not within the Hunt Aquifer during emergency demand conditions at 2025 and build-out. For this study, it is assumed that the Hunt Aquifer withdrawal for public water suppliers is limited to 4.0 MGD, and available water from these suppliers is limited based on that assumption (see Table 5). Therefore, QDC and Kent County, in the central region of the state, are at risk and could potentially benefit from surplus water from Pawtucket and Woonsocket, in the northern region.

The Study evaluated the surplus water available from the Woonsocket and Pawtucket systems with their retail and wholesale customer water demands at both ADD and LOS C conditions. Cumberland is a wholesale customer of Pawtucket and North Smithfield is a wholesale customer of Woonsocket. As shown in Table 25, maintaining service to these customers at their ADD would result in surplus water from both Pawtucket and Woonsocket in 2025 (6.16 MGD and 0.40 MGD respectively), but only from Pawtucket at build-out (4.07 MGD). If Pawtucket and Woonsocket customers were to reduce their usage to emergency demand LOS C, additional surplus water of 15.12 MGD and 12.63 MGD would be available during both 2025 and at build-out, respectively.

Table 25: Northern RI Regional Surplus Water Available

Major System	Total Available Water[1] (MGD)	2025 ADD[2] (MGD)	Build-out ADD[3] (MGD)	2025 Surplus[4] (MGD)	Build-out Surplus[4] (MGD)
Average Daily Demand					
Pawtucket & Cumberland Water Department	24.00	17.84	19.93	6.16	4.07
Woonsocket & N. Smithfield Water Department	8.07	7.67	9.39	0.40	(1.32)
Total	**32.07**	**25.51**	**29.32**	**6.56**	**2.75**
Emergency Demand LOS C					
Pawtucket & Cumberland Water Department	24.00	10.71	11.94	13.29	12.06
Woonsocket & N. Smithfield Water Department	8.07	6.24	7.50	1.83	0.57
Total	**32.07**	**16.95**	**19.44**	**15.12**	**12.63**

[1] Pawtucket/Cumberland Total Available Water (TAW) = Reservoir Safe Yield (16 MGD) + Pawtucket Wells Sustainable Pumping Capacity (5.65 MGD) + Cumberland Sneech Pond Safe Yield (0.75 MGD) + Cumberland Wells Sustainable Pumping Capacity (1.6 MGD). Woonsocket/North Smithfield Total Available Water =North Smithfield Wells Sustainable Pumping Capacity (0.17 MGD) + Woonsocket Reservoir#1/#3 Safe Yield (3.5 MGD) & Woonsocket Harris Pond Safe Yield (4.4 MGD).

[2] 2025 ADD is the sum of Pawtucket & Cumberland or Woonsocket & North Smithfield.

[3] Build-out ADD is the sum of Pawtucket & Cumberland or Woonsocket & North Smithfield.

[4] Surplus is total available water less average daily demand.

Wheeling surplus available water from the northern region to the central region of the state requires new or upgraded interconnections to transmit sufficient volumes of water. It is intended to wheel up to approximately 6.16 MGD of surplus available water from Pawtucket and 0.40 MGD of surplus available water from Woonsocket to supply 6.56 MGD of emergency water needed in the central region of Rhode Island under an emergency in 2025. Similarly, 15.12 MGD surplus would be provided by Pawtucket and Woonsocket if their system were to operate at LOS C at 2025 conditions. Per an assessment of existing infrastructure, it was determined that proposed Pawtucket and Woonsocket to Providence interconnections along with active interconnections provide sufficient capacity to wheel surplus water to deficit regions. These interconnections are listed below:

1. Pawtucket to Providence (Proposed Emergency Interconnection)
2. Woonsocket to Providence (Proposed Emergency Interconnection)
3. Woonsocket to Lincoln (Active Emergency Interconnection)
4. Lincoln to North Providence (Active Supply Interconnection)
5. Providence to Warwick (Active Supply Interconnection)
6. North Providence to East Smithfield (Active Supply Interconnection)
7. North Providence to Greenville (Active Supply Interconnection)
8. North Providence to Johnston (Active Supply Interconnection)
9. North Providence to Smithfield (Active Supply Interconnection)
10. Providence to West Warwick (Active Emergency Interconnection) – Wheel from Surplus Region through PWSB to Kent County served communities)
11. North Kingstown to Quonset Development Corp. (Active Emergency Interconnection)
12. East Greenwich to North Kingstown (Active Emergency Interconnection)
13. East Greenwich to Quonset Development Corp. (Active Emergency Interconnection)

Pawtucket and Woonsocket wheeling water construction costs for 2025 are summarized in the following tables.

Table 26: Capital Costs (Conveyance) for Wheeling Surplus Water from Pawtucket at LOS C (13.29 MGD)

Item Description	Unit Cost	Unit	Qty	Cost
30" finish water piping	$400	LF	13,200	$5,280,000
Booster Station	$1,760,766	LS	1	$1,760,766
Subtotal				$7,040,766
Permits, Studies, Engineering			20%	$1,408,153
Subtotal				$8,448,919
Contingency			30%	$2,534,676
Project Construction Cost Estimate				**$10,983,594**

Table 27: Capital Costs (Conveyance) for Wheeling Surplus Water from Woonsocket at LOS C (1.83 MGD)

Item Description	Unit Cost	Unit	Qty	Cost
10" finish water piping	$200	LF	4,000	$800,000
Subtotal				$800,000
Permits, Studies, Engineering			20%	$160,000
Subtotal				$960,000
Contingency			30%	$288,000
Project Construction Cost Estimate				**$1,248,000**

Table 28: Capital Costs (Conveyance) for Wheeling Surplus Water from Pawtucket at Average Day Demand (6.16 MGD)

Item Description	Unit Cost	Unit	Qty	Cost $
20" finish water piping	$250	LF	13,200	$3,300,000
Booster Station	$827,810	LS	1	$827,810
Subtotal				$4,127,810
Permits, Studies, Engineering			20%	$825,562
Subtotal				$4,953,372
Contingency			30%	$1,486,012
Project Construction Cost Estimate				**$6,439,384**

Table 29: Capital Costs (Conveyance) for Wheeling Surplus Water from Woonsocket at Average Day Demand (0.40 MGD)

Item Description	Unit Cost	Unit	Qty	Cost $
10" finish water piping	$200	LF	4,000	$800,000
Subtotal				$800,000
Permits, Studies, Engineering			20%	$160,000
Subtotal				$960,000
Contingency			30%	$288,000
Project Construction Cost Estimate				**$1,248,000**

Rehabilitation of Inactive Wells

Previous studies have identified numerous inactive well fields throughout Rhode Island that could be utilized as part of an alternate emergency water supply plan. Many of these sites were reviewed as potential alternate sources for PWSB. As part of this study, five inactive well fields were examined:

- Lonsdale Well Field in Lincoln
- Manville Well Field in Lincoln
- Turner Reservoir Well Field in East Providence
- University of Rhode Island backup Well Field
- Ladd School Well Field in Exeter

All of these locations have the capability to produce favorable quantities of water. However, most well fields have known or potential water quality or supply issues which will require various levels of treatment or withdrawal management as part of the implementation.

The reactivation of inactive wells was estimated to potentially provide up to 19.35 MGD of supply. Budgetary costs were estimated to reactivate the proposed alternate water supply well fields and shown in Table 30. The construction cost estimate for each well field was developed based on the cost to upgrade existing infrastructure and rehabilitate wells.

Table 30: Budgetary Costs Summary for Rehabilitating Inactive Wells

Well Field	Estimated Capacity / Flow (MGD)	Budgetary Rehabilitation / Construction Cost
Lonsdale Wells - Lincoln	1.73	$13,089,086
Manville Wells – Lincoln	7.92	$55,371,297
Turner Reservoir Wells – East Providence	6.05	$35,731,017
URI – Kingston	1.87	$12,220,104
Ladd School Wells – Exeter	1.78	$16,523,520

New Well Development

Big River Well Field

In 1960 the State of Rhode Island acquired 8,400 acres of land in the Big River watershed, which is located mostly in West Greenwich but straddles into Coventry and Exeter, as shown below in Figure 4.

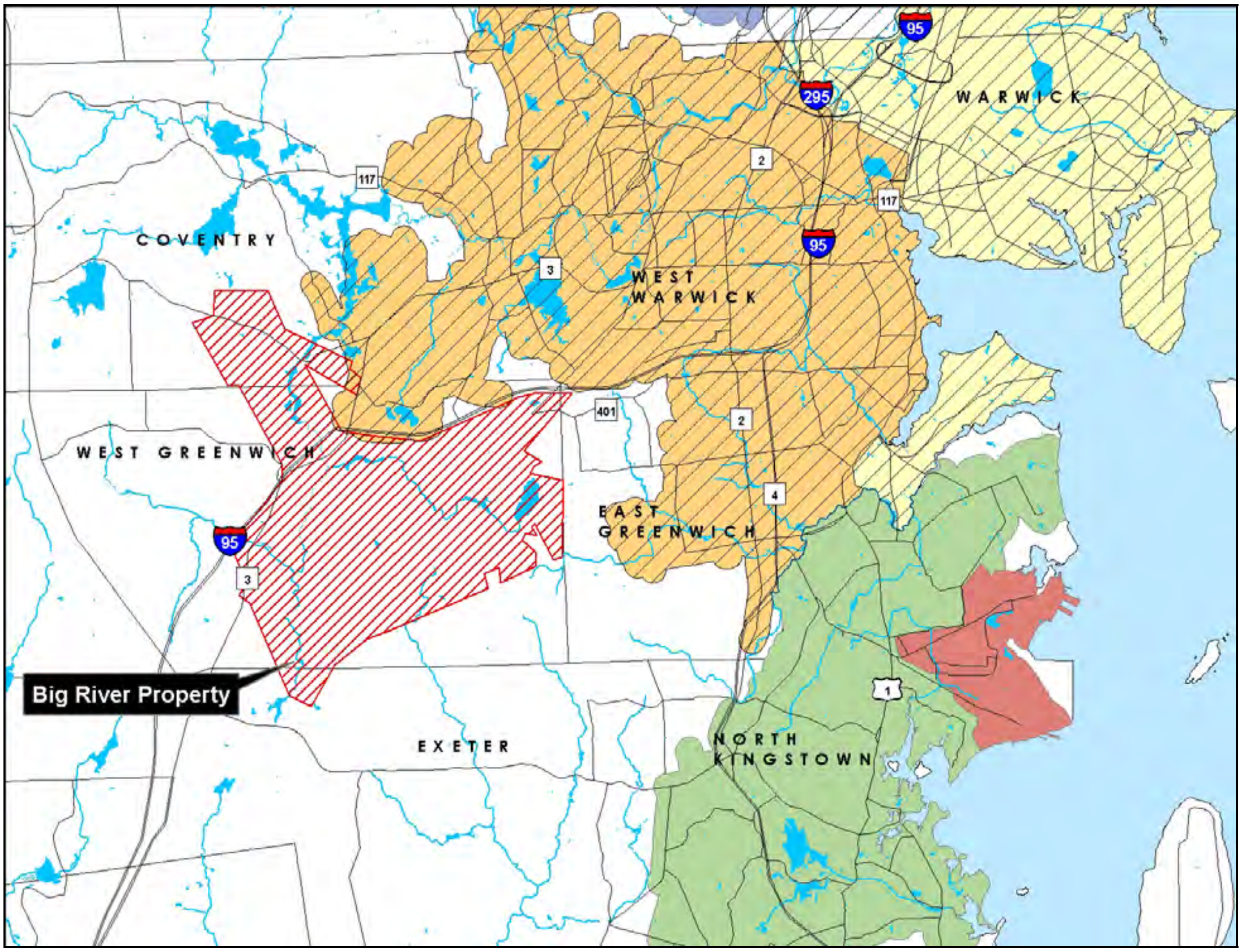

Figure 4: Location of Big River Property.

The RIWRB and USGS have completed several hydrogeology reports to support efforts to develop the ground water resources of the Big River area. In 2005, Scientific Investigations Report 2004-5301 was published, which presents several water management models encompassing the Mishnock, Carr and Big River Basins.

Management Model 09 (MM-09) was used as a starting point to develop the Big River wells water supply alternative for this study. From the model, five project wells in the Big River Basin were evaluated: two pump test wells, two observation wells and one hypothetical well. The approximate location of these wells is shown in Figure 5. According to USGS Report 2004-5301 (Table 2-19, page 101), the monthly withdrawal rates from the Big River Basin wells are:

- 7.00 MGD (10 months)
- 3.07 MGD (September)
- 1.97 MGD (August)

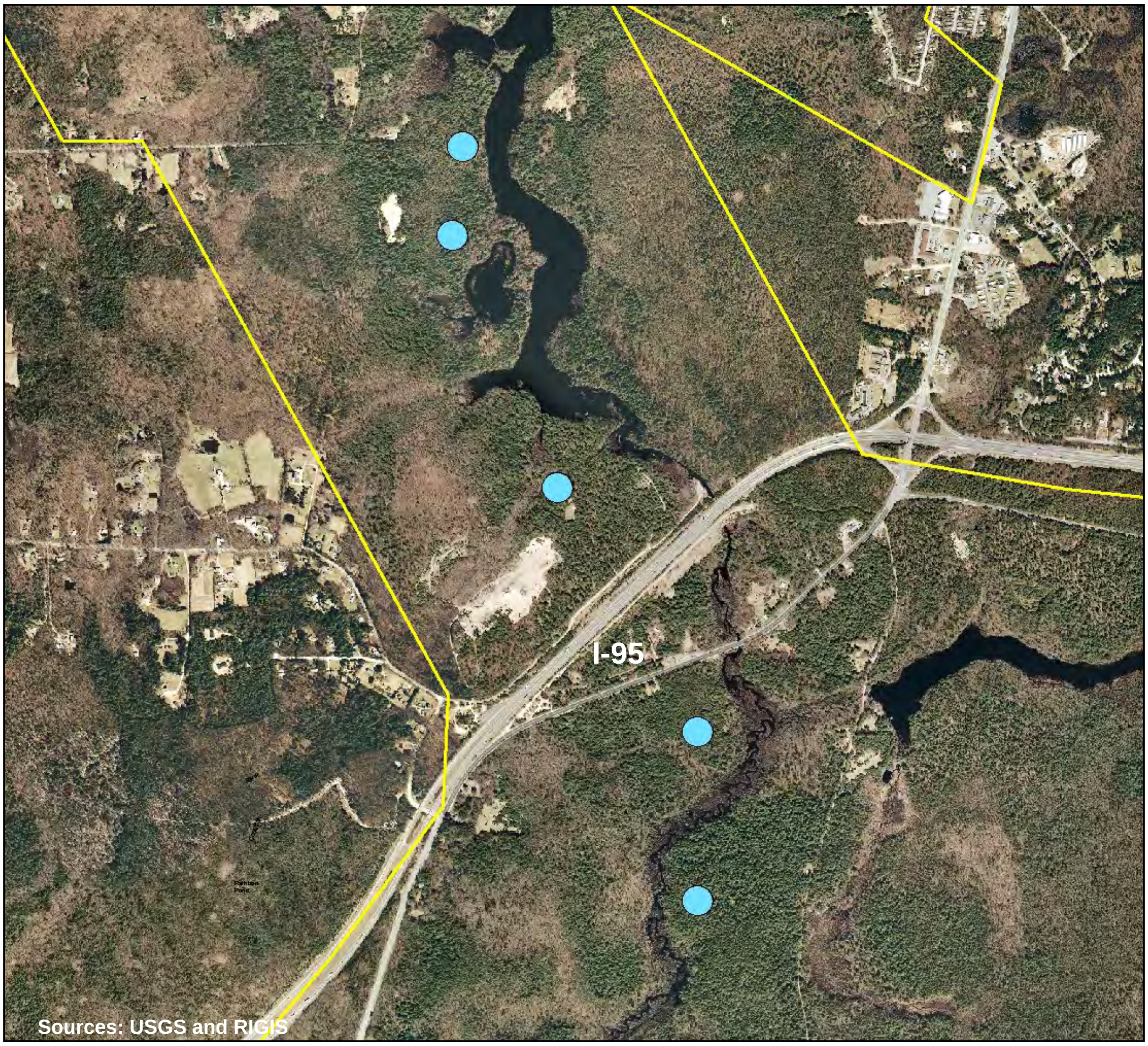

Figure 5: Location of USGS Project Wells on the Big River Property.

In developing the design, well pumping and costing, the following assumptions were made:

- Four wells are proposed north of I-95, with the group having a maximum daily withdrawal rate of 4.2 MGD. The withdrawal rate of 4.2 MGD provides the functional equivalent or same theoretical net withdrawal rate of the three MM-09 1.4 MGD wells located north of I-95.
- The individual production wells in the Big River Basin will only be pumped 18 hours a day (to allow for recovery).
- The well depths and design are based upon the well pump test data from USGS pump test wells WGW 356 and WGW 411.

A theoretical 4.2 MGD facility was evaluated, locating four wells north of I-95 and the water treatment plant just south of I-95 along Nooseneck Hill Road. Once actual production wells are drilled and prolonged pump draw down tests performed, actual withdrawal and pumping rates for each well would be established. The following was assumed with regards to treatment:

- The water plant processes proposed assume the final production wells will be sited so that they are not under the influence of surface water. The costs of pressure filters are sufficient for iron, manganese and arsenic removal.
- The costs for air stripping are sufficient for radon removal and CO_2 stripping (for pH alkalinity adjustment).
- On-site residuals disposal costs are for iron and manganese removal.

Figure 6 shows a sketch of a conceptual water treatment plant and well development of the Big River Basin. From this site, three alternative routes were analyzed to reach areas in need of supplemental emergency water, including Quonset Development Corporation at Quonset Business Park® and Kent County Water Authority. Kent County would be the most feasible because of its close proximity to the water treatment plant, as shown in Figure 7. This distribution route is to the high service area along Division Road, connecting at Hopkins Hill Road. Details of the two other routes can be found in the study's full report.

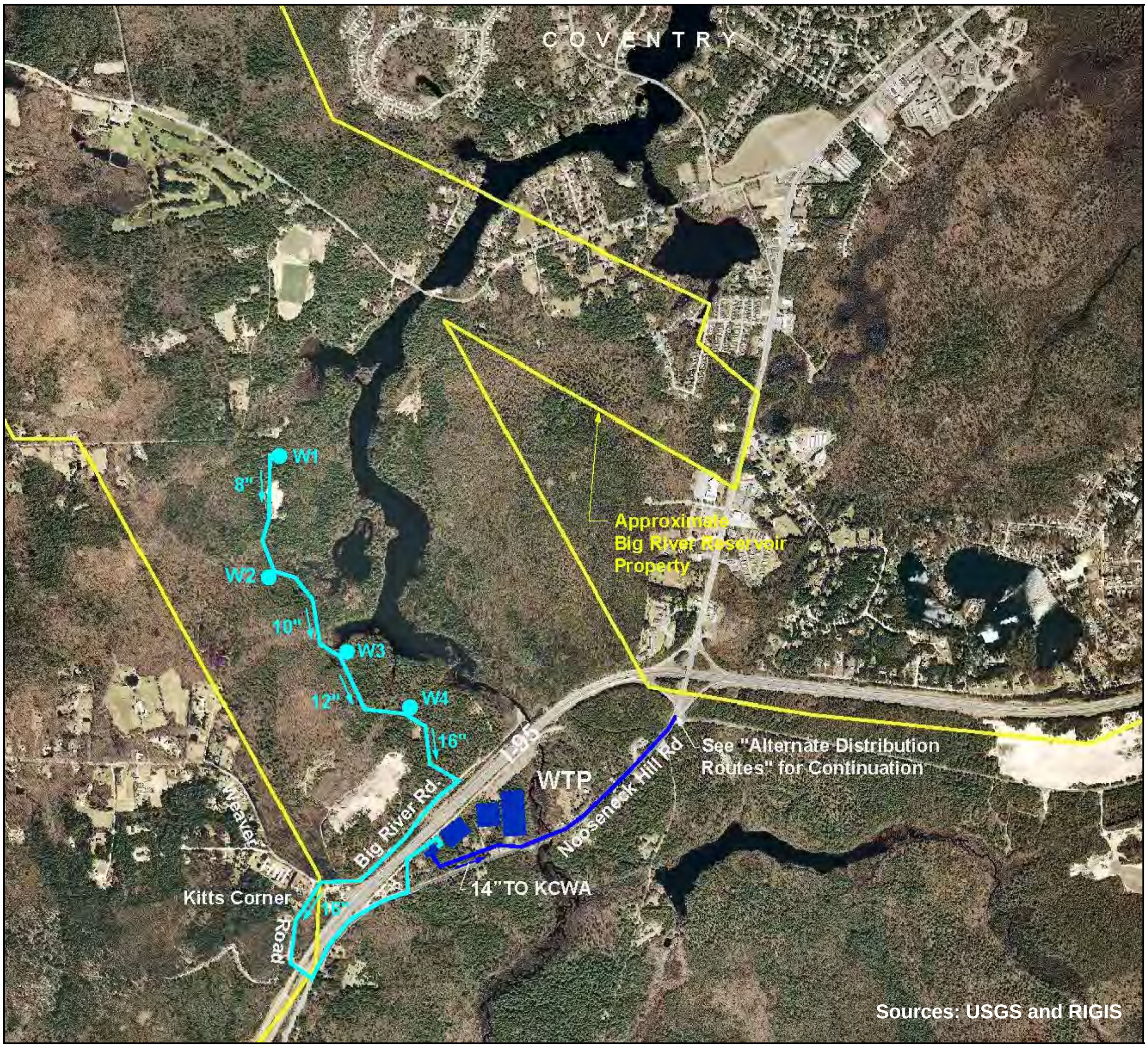

Figure 6: Conceptual Big River Water Treatment Plant and Well Development Scenario

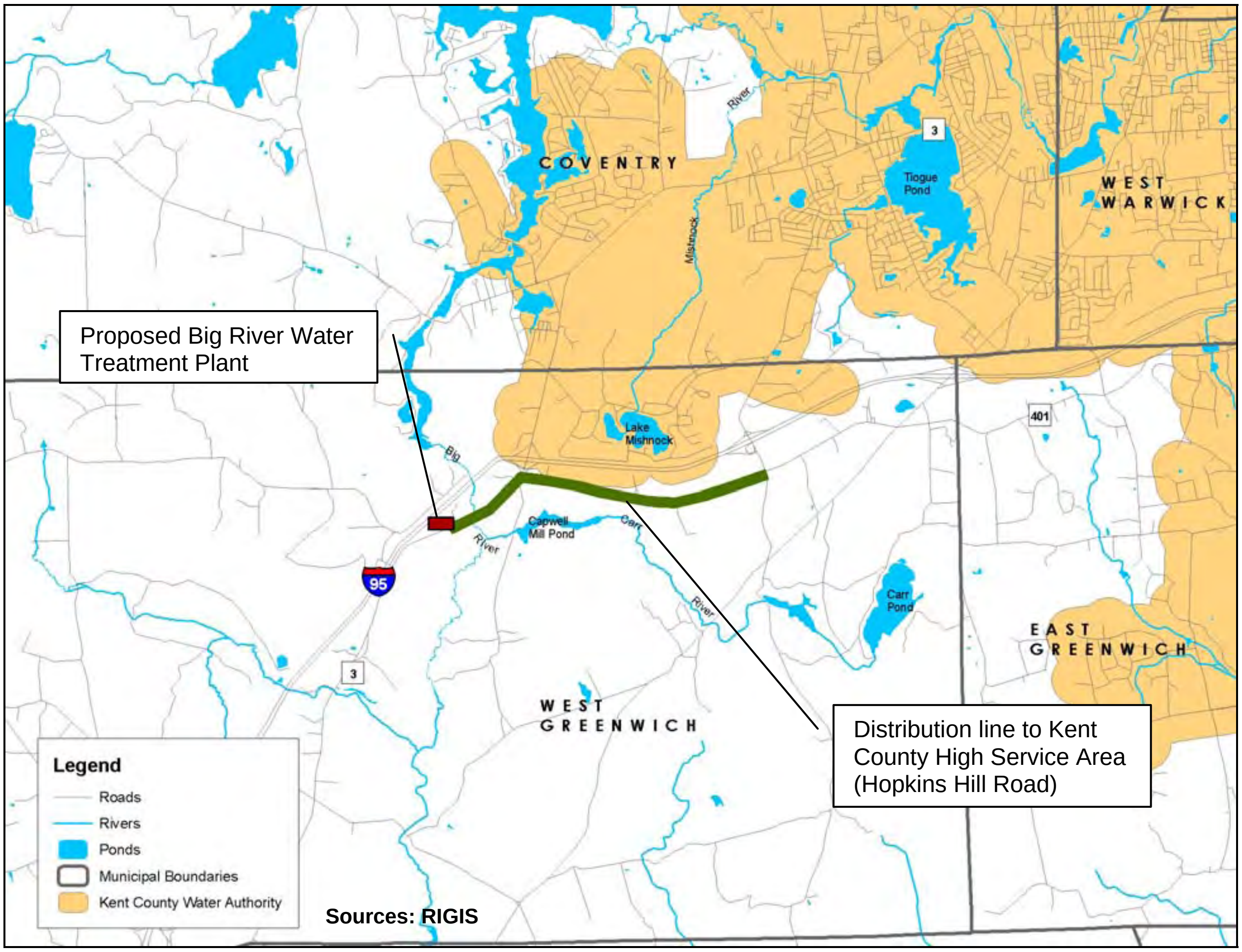

Figure 7: Map showing potential distribution route from conceptual Big River WTP to Kent County high service area (Hopkins Hill Road)

The following tables provide estimated costs associated with developing the Big River groundwater wells. These costs are based on a 4.2 MGD facility to the Kent County High Service Area connection on Hopkins Hill Road. Various production capacities are provided for comparison, considering the facility would not necessarily be producing at its full capacity for operational reasons and environmental and sustainability concerns.

Table 31: Estimated Capital Costs - 4.2 MGD Big River Water Treatment Plant (with distribution to Kent County High Service Area)

Item Description	Unit Cost	Units	Quantity	Cost
Well Facilities	$500,000	each	4	$2,000,000
Raw Water Piping	$75	LF	13,200	$990,000
Buried Electrical Service	$90	LF	13,200	$1,188,000
Buried I&C Conduit and Wiring	$35	LF	13,200	$462,000
Site Access	$100	LF	12,000	$1,200,000
Finished Water Piping	$175	LF	13,000	$2,275,000
Water Treatment Plant	$9,000,000	each	1	$9,000,000
Subtotal				*$17,115,000*
Permits, Studies & Engineering	-	each	1	$3,423,000
	Subtotal			$20,538,000
	Contingency 30%			$6,161,400
	Project Construction Cost Estimate			**$26,699,400**
Amortized Capital Costs ($/year)	20-years at 6%			**$2,327,775**

Table 32: Operation and Maintenance Cost Factors - Big River Water Treatment Plant

Cost Factor	Value
Labor - Salary and Benefits	$60,000/year
Labor - Full Time Staff	3 staff
Power Rate	$0.15/kWhr
Insurance	0.5 percent of total capital cost

Table 33: Annual Operation and Maintenance Costs - Big River Water Treatment Plant (with distribution to Kent County High Service Area)

Cost Component	Annual Cost - June 2008 Dollars ($)/year		
	2.0-MGD Produced	**3.0-MGD Produced**	**4.2-MGD Produced**
Labor	$180,000	$180,000	$180,000
Power	$259,124	$388,685	$544,159
Chemicals	$252,146	$377,928	$529,506
Insurance	$85,575	$85,575	$85,575
Total Annual O&M Cost	**$776,844**	**$1,032,189**	**$1,339,240**

Table 34: Total Cost of Water – Big River Water Treatment Plant (with distribution to Kent County High Service Area)

Cost Component	2.0-MGD Produced	3.0-MGD Produced	4.2-MGD Produced
Amortized Capital Cost ($/year)	$2,327,775	$2,327,775	$2,327,775
Annual O&M Cost ($/year)	$776,844	$1,032,189	$1,339,240
Total Amortized and O&M Costs ($/year)	$3,104,620	$3,359,964	$3,667,016
Total Cost of Water ($/1,000 gallons)	$4.25	$3.07	$2.39[1]

[1] Production at full capacity of 4.2 MGD may not be possible in all months and will need to be further evaluated. USGS calculated environmental limitations (bottom of p.45) for five wells North and South of I-95. Future calculations based on the elimination of the two wells South of I-95 and environmental requirements will change those limitations and the final cost of water.

Roger Williams Park

Roger Williams Park is located near the Cranston-Providence city line on Elmwood Avenue. The site is located approximately one mile from the Providence Harbor, which is tidally influenced. Roberts and Brashears (1945) indicated that salt-water intrusion caused by pumping near the harbor could potentially be a problem with continued aquifer development. However, salt water intrusion was not observed at this location during field investigations conducted in 2002.

According to Lang (1961), the area is underlain by isolated deposits of glacial till and widespread sheets of glacial outwash. According to the boring logs, it appears that the site is located within the outwash deposits. The outwash is characterized as having thicknesses ranging from 50 to 100 feet, but can have local deposits as thick as 200 feet. Refusal in geotechnical boring B-9, according to a prior report conducted by Maguire, occurred at a depth of 58.7 feet below ground surface (Figure 22). Because the deepest borings at the site extend to 60 feet in depth, the thickness of the outwash deposits is unknown.

The site consists of numerous kame and esker deposits. These deposits are known to be excellent groundwater-producing formations. A large portion of water to potentially developed wells at this site would be derived by means of induced infiltration from numerous lakes located in this area.

During field investigations conducted in 2002, one 60-foot deep test well was installed in Roger Williams Park. The results of a preliminary pumping test indicated an estimated specific capacity and transmissivity for the site of 20 gpm/ft and 30,000 gpd/ft, respectively. Based upon a short duration pump test (utilizing specific capacity data), four large diameter gravel wells in this area could potentially yield approximately 520 gpm (0.75 MGD) each for a total of approximately 2,080 gpm (3.0 MGD). Wells at the Roger Williams Park site would receive most of their water by means of induced infiltration from the numerous lakes located in the park area. Only a small portion of the water pumped from hypothetical wells in this area would be from groundwater in storage.

The test borings did not indicate any water quality issues. However, the park is surrounded by a historically industrialized area and the groundwater classification for the Site, as referenced in the Groundwater Division of the RIDEM, is GB. This indicates that it will likely be necessary to provide treatment while pumping this source at high rates for extended periods of time.

Budgetary costs were estimated to a new well source as an alternate water supply. The construction cost estimate for the well field was developed based on the cost to construct a pump house, develop a new well, construct a new treatment facility, and provide the required transmission/distribution systems for the new water source. It was estimated that to install a new well field with an estimated capacity of 3.00 MGD at Roger Williams Park would cost $17,067,648.

Reverse Osmosis Desalination

Reverse osmosis (RO) was developed as a feasible desalination process during the 1950s and early 1960s. Until the mid-1980s, most commercial RO systems were used for desalination of brackish water. However, advances over the last decade in membrane technology and performance have led to much broader applications of RO and now RO systems provide more than 50 percent of the world's desalination capacity.

Osmosis is a naturally occurring process in which pure water from a less concentrated solution diffuses through a semi-permeable membrane and dilutes a more concentrated solution. The semi-permeable membrane essentially inhibits the passage of the dissolved salts. Pure water will continue to flow through the membrane as it attempts to equalize the concentrations. If enough pressure is applied to the concentrated side of the membrane, the flow of pure water can be stopped. This pressure is directly proportional to the salt concentration of the more concentrated solution and is referred to as the osmotic pressure. Applying more than the osmotic pressure to the concentrated solution reverses the process and pure water flows through the membrane to the less concentrated solution. This is the principle by which RO produces pure water from concentrated solutions such as brackish water and seawater. RO relies on the ability of water molecules to diffuse through the membrane more readily than salts and larger molecular weight compounds. As such it is not a true filtration process since dissolved salts and other constituents are not removed based on their size.

Because Rhode Island is a coastal state, it seems appropriate to research desalination as an option to meet emergency demands in its coastal communities. Currently, the Block Island Water Company uses a reverse osmosis desalination facility. This study evaluates three possible reverse osmosis facility locations: East Bay, West Bay and Aquidneck Island, as shown generally in Figure 8. Estimated capacities are shown in Table 35, based on emergency demands projected in this study.

Table 35: Estimate Production Capacities of Evaluated RO Facilities

Facility Location	Production Capacity Evaluated
Aquidneck Island	1.5 MGD
West Bay	8.0 MGD 10.0 MGD
East Bay	3.5 MGD 5.25 MGD

Facility Design

Raw water from each location was evaluated to determine if the desalination process was capable of treating water to meet current drinking water standards. Characteristics reviewed included:

- Salinity
- Inorganic contaminants
- Volatile organic compounds
- Synthetic organic chemicals
- Natural organic matter
- Particles
- Radionuclides

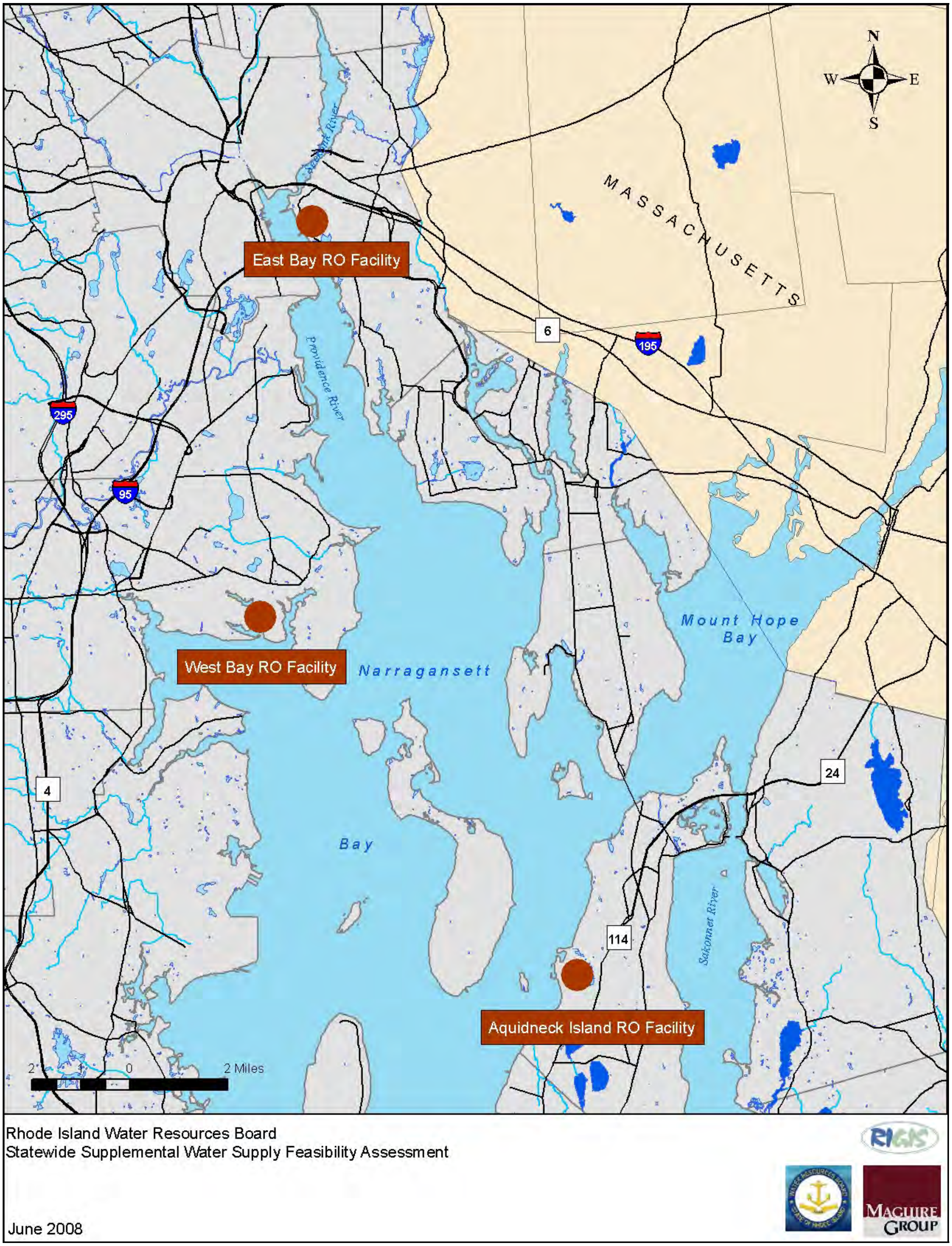

Figure 8: General Locations of Evaluated RO Facilities

The potential intake and treatment processes were also evaluated for each location. Intake structures capture and collect raw water for treatment. Intake structure design issues include the following:

- Offshore intake location – storms may change physical conditions (e.g., erosion), damage by marine vessel traffic (e.g., accidental spills of chemicals) and desired constant water quality
- Materials of construction – use of corrosion resistant materials
- Biofouling control – caused by marine organisms and eliminated by performing periodic maintenance
- Debris control

Effective pretreatment is dependent on the raw water source and is necessary to obtain the design efficiency and to maximize the useful life of the RO membranes. Pretreatment issues include the following:

- Fouling – accumulation of foreign material in the feedwater
- Scaling – precipitation and deposition of salts
- Membrane degradation – chemical breakdown of membrane itself

Source water is pumped from its intake location through transmission piping to a wetwell located within the desalination facility. Following pretreatment, a coagulant and oxidant are added in advance of the RO process equipment. The approximate building footprint for each of the respective facilities to accommodate build-out conditions are listed in Table 36. For the West Bay and East Bay facilities, treatment equipment is initially sized to produce the 2025 finished water capacities (8.0 MGD and 3.5 MGD respectively). The building footprints would accommodate additional treatment equipment to meet the respective build-out finished water capacities (10.0 MGD for West Bay and 5.25 MGD for East Bay). Infrastructure components to and from these two desalination facilities can accommodate the build-out finished water capacities of each facility.

Table 36: Approximate Building Dimensions for RO Facilities

Desalination Facility Location/ Year 2025 Capacity: Build-out Capacity	Building	
	Dimensions (ft x ft.)	Area (sq. ft.)
Aquidneck Island / 1.5 :1.5-mgd	105 x 110	11,550
West Bay / 8.0 : 10.0-mgd	120 x 200	24,000
East Bay / 3.5:5.25-mgd	135 x 155	20,925

Capital and Operations and Maintenance Costs

A preliminary cost estimate (capital and annual operation and maintenance (O&M)) for a specific capacity desalination facility treating typical seawater at each location was developed. Each capacity of the desalination facilities is sufficient to meet the demands in the year 2025 and for eventual build-out of each area. These estimated costs were derived primarily from data published in July 2003 by the United States Department of the Interior (DOI) for membrane desalination plants. The DOI capital cost data was developed from actual bids and vendor quotations, while its O&M data were developed, in part, from actual desalination plants in service, supplemented by performance estimates. The DOI cost data was presented in the form of curves showing cost as a function of desalination plant capacity. The accuracy of the DOI data is stated as approximately ± 30 percent.

The cost basis year for the DOI published data was 2000. This cost data was updated to a June 2008 cost year basis by multiplying the 2000 cost data by the ratio of the Engineering News Record (ENR) Building Cost Index for June 2008 (4,640) to that used as the basis of the curves (3,539) for a resultant cost adjustment factor of 1.30 (4,640 ÷ 3,539).

Capital Cost Projections

The DOI published capital cost data consisted of three components: direct, indirect, and non-depreciating cost components. The total capital cost is the sum of these three components. The direct capital cost component includes the following:

- Raw water intake and raw water supply piping to the facility
- Pre-treatment, RO membrane treatment, and post-treatment equipment
- Treatment equipment housing (building)
- Emergency generators
- RO concentrate disposal outfall
- Site preparation, paving, and grading

The direct capital cost for all of these components were from the DOI cost curves. The indirect capital cost component is based on various percentages of the total direct capital cost component and includes the following:

- Freight and insurance – 5 percent
- Engineering – 20 percent
- Contingency – 30 percent

Interest during construction is also included as part of the indirect capital cost component. This cost is calculated by multiplying the direct capital cost by the interest rate based on the location for a period of one-half of the assumed construction time, also based on location. The non-depreciating capital cost component includes the cost of land. It is assumed that the desalination facilities would be located on state-owned land and therefore no land cost is included.

Estimated capital costs for the three evaluated facilities are shown in Table 37.

Table 37: Estimated Capital Costs for Evaluated RO Facilities (June 2008 Dollars)

Cost Component	Aquidneck Island	East Bay		West Bay	
Facility Capacity	1.5 MGD	3.5 MGD	5.25 MGD	8.0 MGD	10.0 MGD
Direct Capital	NA	NA	NA	NA	NA
Intake and Supply Piping	$959,000	$1,763,000	2,064,000	$2,881,000	3,311,000
Pre-, Membrane, and Post-Treatment Equipment, Building, Site Preparation, and Emergency Generators	$14,255,000	$27,867,000	$39,130,000	$53,257,000	$61,597,000
Concentrate Waste Outfall	$245,000	$310,000	$393,000	$491,000	$550,000
Direct Capital Cost Subtotal	$15,459,000	$29,940,000	$41,587,000	$56,629,000	$65,458,000
Freight and Insurance	$773,000	$1,497,000	$2,079,000	$2,831,000	$3,273,000
Interest During Construction	$348,000	$898,000	$1,248,000	$2,548,000	$2,946,000
Engineering (20%)	$3,092,000	$5,988,000	$8,316,000	$11,326,000	$13,092,000
Contingency (30%)	$4,638,000	$8,982,000	$12,474,000	$16,988,000	$19,638,000
Indirect Capital Cost Subtotal	$8,851,000	$17,365,000	$24,117,000	$33,693,000	$38,949,000
Total Capital	$24,310,000	$47,305,000	$65,704,000	$90,322,000	$104,407,000
Amortized Capital Cost ($/year)	$2,119,000	$4,153,000	$5,769,000	$7,874,000	$9,102,000

Operation and Maintenance Costs

The annual operation and maintenance (O&M) cost includes the following components:

- Labor
- Chemicals
- Energy
- Spare parts
- RO membrane replacement
- Pre-treatment disposal to the local sewer
- Insurance

Estimated O&M costs for the three evaluated facilities are shown in Table 38.

Table 38: Annual Operation and Maintenance Costs of Evaluated RO Faculties ($/year, June 2008 Dollars)

Cost Component	Aquidneck Island	East Bay		West Bay	
Facility Capacity	1.5 MGD	3.5 MGD	5.25 MGD	8.0 MGD	10.0 MGD
Labor	$200,000	$240,000	$280,000	$320,000	$360,000
Power	$833,000	$2,167,000	$2,833,000	$4,500,000	$5,333,000
Chemicals	$130,000	$300,000	$440,000	$700,000	$800,000
RO Membrane Replacement	$56,000	$140,000	$300,000	$410,000	$490,000
Spare Parts	$77,000	$150,000	$185,000	$283,000	$327,000
Liquid Waste Disposal	$216,000	$8,000	$12,000	$24,000	$27,000
Insurance	$77,000	$150,000	$185,000	$283,000	$327,000
Total Annual O&M Cost	$1,589,000	$3,155,000	$4,235,000	$6,520,000	$7,664,000

Total Cost of Water

The total cost of water for a water treatment facility is calculated as the sum of its amortized capital and the annual O&M cost components presented above divided by the total annual finished water production. These costs for the three facilities are shown in Table 39.

Table 39: Total Cost of Water for Evaluated RO Facilities

Cost Component	Aquidneck Island	East Bay		West Bay	
Facility Capacity	1.5 MGD	3.5 MGD	5.25 MGD	8.0 MGD	10.0 MGD
Gallons per year	547.5 million	1.15 billion	1.725 billion	2.628 billion	3.285 billion
Plant availability factor	0.90	0.90	0.90	0.90	0.90
Amortized Capital Cost ($/year)	$2,119,000	$4,153,000	$5,769,000	$7,874,000	$9,102,000
Capital Costs ($/1,000 gallons)	$4.30	$3.61	$3.34	$3.00	$2.77
OPERATION & MAINTENANCE					
O&M ($/year)	$1,589,000	$3,155,000	$4,235,000	$6,520,000	$7,664,000
O&M ($/1,000 gallons)	$3.23	$2.75	$2.46	$2.48	$2.33
Total Amortized and O&M Costs ($/year)	$3,708,000	$7,308,000	$10,004,000	$14,394,000	$16,766,000
Total Cost of Water ($/1,000 gal.)	$7.53	$6.36	$5.80	$5.48	$5.10

Distribution of Treated Water

In conjunction with the RO treatment facility components, the distribution of the treated water to the respective water distribution systems must be planned for. This primarily includes pumping stations and transmission mains, appropriately sized for each location, to bring water to the intended service areas.

For the Aquidneck Island location, connection to the existing distribution system is relatively straight forward as the Portsmouth distribution piping is generally near the location of this RO Facility. Table 40 summarizes the costs associated with distributing the treated water from the RO Facility to the existing transmission systems.

Table 40: Capital Costs (Conveyance) for Distribution of Water from Aquidneck Island RO Facility

Item Description	Unit Cost	Unit	Qty	Cost
12" finish water piping from R.O.	$160	LF	1600	$256,000
Booster Station	$744,000	LS	1	$744,000
Subtotal				$1,000,000
Contingency			30%	$300,000
Permits, Studies, Engineering (20%)			20%	$260,000
Project Construction Cost Estimate				$1,560,000
Amortized Capital Costs ($/year)				$136,007
Capital Costs ($/1,000 gallons)				$0.25
OPERATION & MAINTENANCE				
O&M ($/year)				$119,500
O&M ($/1,000 gallons)				$0.22
Total Amortized and O&M Costs ($/year)				$255,508
Total Cost of Water ($/1,000 gallons)				$0.47

For the East Bay location, connection to the existing distribution system was assumed to be made to an existing 30-inch pipeline near Veteran's Memorial Parkway and Fifth Street in East Providence. Table 41 summarizes the costs associated with distributing the treated water from the RO facility to the existing transmission systems at 3.5 MGD.

Table 41: Capital Costs (Conveyance) for Distribution of Water from East Bay RO Facility

Item Description	Unit Cost	Unit	Qty	Cost
14" finish water piping from R.O.	$250	LF	600	$150,000
Booster Station	$631,944	LS	1	$631,944
Subtotal				$781,944
Contingency			30%	$156,389
Permits, Studies, Engineering (20%)			20%	$281,500
Project Construction Cost Estimate				$1,219,833
Amortized Capital Costs ($/year)				$106,345
Capital Costs ($/1,000 gallons)				$0.08
OPERATION & MAINTENANCE				
Insurance	0.5%			$3,910
Power (kWhr)	$0.15			$294,073
O&M ($/year)				$297,983
O&M ($/1,000 gallons)				$0.23
Total Amortized and O&M Costs ($/year)				$404,328
Total Cost of Water ($/1,000 gallons)				$0.31

For the West Bay location, connection to the existing distribution system was assumed to be made at an existing 24-inch pipeline at Post Road in Warwick. Table 42 summarizes the costs associated with distributing the treated water from the RO facility to the existing transmission systems at 8.0 MGD.

Table 42: Capital Costs (Conveyance) for Distribution of Water from West Bay RO Facility

Item Description	Unit Cost	Unit	Qty	Cost
20" finish water piping from R.O.	$250	LF	14,256	$3,564,000
Booster Station	$952,978	LS	1	$952,978
Subtotal				$4,516,978
Contingency			30%	$903,396
Permits, Studies, Engineering (20%)			20%	$1,626,112
Project Construction Cost Estimate				$7,046,486
Amortized Capital Costs ($/year)				$614,313
Capital Costs ($/1,000 gallons)				$0.21
OPERATION & MAINTENANCE				
Insurance	0.5%			$22,585
Power (kWhr)	$0.15			$637,159
O&M ($/year)				$659,743
O&M ($/1,000 gallons)				$0.23
Total Amortized and O&M Costs ($/year)				$1,274,056
Total Cost of Water ($/1,000 gallons)				$0.44

Table 43: Total Cost of Water for Evaluated RO Facilities Including Distribution

Cost Component	Aquidneck Island	East Bay		West Bay	
Facility Capacity	1.5 MGD	3.5 MGD	5.25 MGD	8.0 MGD	10.0 MGD
CAPITAL COSTS					
Facility Capital Costs ($/1,000 gallons)	$4.30	$3.61	$3.34	$3.00	$2.77
Distribution Capital Costs ($/1,000 gallons)	$0.25	$0.08	$0.05	$0.21	$0.17
Total Capital Costs ($/1,000 gallons)	$4.55	$3.69	$3.39	$3.21	$2.94
OPERATION & MAINTENANCE					
Facility O&M ($/1,000 gallons)	$3.23	$2.75	$2.46	$2.48	$2.33
Distribution O&M ($/1,000 gallons)	$0.22	$0.23	$0.15	$0.23	$0.18
Total O&M Costs ($/1,000 gallons)	$3.45	$2.98	$2.61	$2.71	$2.51
Total Cost of Water ($/1,000 gallons)	**$8.00**	**$6.67**	**$6.00**	**$5.92**	**$5.45**

Conclusion

The goal of this study was to assess the potential risk of losing critical water sources of the State's major water suppliers and identify potential supplemental emergency water sources to meet projected emergency demands. Local supplemental sources are the most feasible. These alternatives would be the most viable to meet emergency supplemental water needs and should take a priority over regional solutions. Table 44 summarizes these alternatives and the costs associated with each.

With the loss of the PWSB water, the West Bay region would be short 36.95 MGD in 2025 and 40.46 MGD at build out, with supplier operation limited to an emergency level of service. By wheeling water and optimizing existing water sources, the deficit can be reduced by 15.12 MGD (2025) to 12.63 MGD (Build out). This leaves an emergency water supply short fall of 21.83 MGD (2025) to 27.83 MGD (build out) that needs to be supplied from undeveloped water sources. Table 45 and Figure 9 summarize the alternative water supply sources identified in the study that could be used to satisfy the emergency water supply need.

All of these regional sources have positive implications to meet regional emergency demands as well as hurdles to overcome for implementation. Table 46 compares costs associated with development of the supplemental emergency water sources and costs for its operation and maintenance in dollars per 1,000 gallons. Table 47 provides a comparison of the supplemental emergency water sources using non-cost factors; environmental impacts, economic viability, permitting requirements and water quality issues.

This report should be used as input to stakeholders going forward when developing water supply and distribution improvement plans as well as when rehabbing or replacing existing infrastructure. Water Suppliers should be encouraged to consider statewide emergency water supply needs as well as local water district needs when proposing water supply and distribution improvements.

Table 44: Comparison of Costs for Alternatives to Meet Local Supplemental Water Needs (LOS C)

Water Supplier	2005 Supplemental Water Need (MGD)	2025 Supplemental Water Need (MGD)	Build-Out Supplemental Water Need (MGD)	Supplemental Emergency Water Source Alternative	Potential Capacity (MGD)	Construction Cost	Amortized Capital Cost	O & M Cost	Alternative Total Cost $/1,000 gallons
STUDY AREA ONE									
Cumberland Water Department	-	-	0.11	None needed at LOS D	NA	NA	NA	NA	NA
Harrisville Fire District (with Pascoag)	-	-	0.35	Develop new well field	1.00	$1,388,400	$121,041	$255,635	$1.03
				North Smithfield to Harrisville interconnection	1.00	$7,667,026	$668,411	$255,635	$2.53
North Smithfield Water Department	-	0.23	1.19	Tifft Road Well	0.50	$546,000	$47,600	$127,818	$0.96
				Interconnection to Harrisville	1.00	$7,667,026	$668,411	$255,635	$2.53
Pascoag Utility District	-	-	0.16	Develop new well field	0.16	$733,200	$63,920	$28,120	$1.58
				Reestablish contaminated wells (3)	1.06	$40,000,000	$3,487,200	$355,333	$9.93
Pawtucket Water Supply Board	6.92	7.09	7.68	PWSB interconnection A	10.00	$9,620,000	$838,672	$476,314	$0.36
				PWSB interconnection B	5.00	$6,890,000	$600,670	$238,157	$0.46
Woonsocket Water Department	3.55	4.84	5.14	Interconnection w/PWSB via LWC	3.64	$2,652,000	$231,201	$253,561	$0.36
				Interconnection with Cumberland	1.50	$638,040	$55,624	$42,752	$0.18
Zambarano Unit (ESH)	0.10	0.10	0.10	Develop new well field	0.10	$257,400	$22,440	$25,564	$1.32
STUDY AREA TWO									
Bristol County Water Authority	-	0.24	1.50	Reactivate Bristol County well field	2.00	$6,362,304	$554,666	$511,270	$1.46
Newport Water Division	-	0.36	1.41	Interconnection with Fall River	1.41	$2,651,220	$231,133	$182,682	$0.80
North Tiverton Fire District	-	0.80	0.47	Interconnection with Fall River	0.47	$2,651,220	$231,133	$55,712	$1.67
Portsmouth Water and Fire District	-	-	0.74	Interconnection with Fall River	0.74	$2,651,220	$231,133	$95,876	$1.21
Stone Bridge Fire District	-	0.54	0.65	Interconnection with Fall River	0.65	$2,651,220	$231,133	$80,328	$1.31
STUDY AREA THREE									
Jamestown Water Division	-	-	0.03	Modify contract with North Kingstown	0.03	NA	NA	NA	NA
Kent County Water Authority	2.11	2.92	6.43	Regional Alternatives–Table 43					
Kingston Water District	-	-	-	None needed	NA	NA	NA	NA	NA
Narragansett Water Department - North End	-	-	-	None needed	NA	NA	NA	NA	NA
Narragansett Water Department - South End	-	0.05	0.13	None needed at LOS D – establish backfeed capacity for Ocean Road	NA	NA	NA	NA	NA
North Kingstown Water Department	-	-	-	None needed	NA	NA	NA	NA	NA
Quonset Development Corporation	-	-	-	None needed	NA	NA	NA	NA	NA
South Kingstown Water Dept - South Shore	-	-	-	None needed	NA	NA	NA	NA	NA
South Kingstown Water Dept - Middlebridge	-	-	-	None needed	NA	NA	NA	NA	NA

Water Supplier	2005 Supplemental Water Need (MGD)	2025 Supplemental Water Need (MGD)	Build-Out Supplemental Water Need (MGD)	Supplemental Emergency Water Source Alternative	Potential Capacity (MGD)	Construction Cost	Amortized Capital Cost	O & M Cost	Alternative Total Cost $/1,000 gallons
United Water of Rhode Island	-	-	-	None needed	NA	NA	NA	NA	NA
URI Facilities and Operations	-	-	-	None needed	NA	NA	NA	NA	NA
STUDY AREA FOUR – Richmond Water Supply System	-	-	-	None needed	NA	NA	NA	NA	NA
STUDY AREA FIVE – Westerly Water Division	-	-	-	None needed	NA	NA	NA	NA	NA
STUDY AREA SIX – Block Island Water Company	0.01	0.04	0.13	None needed at LOS D	NA	NA	NA	NA	NA

Table 45: West Bay Regional Water Balance with PWSB Facility Off-Line and Hunt Aquifer withdrawal limited to 4.0 MGD

WEST BAY REGIONAL SUPPLEMENTAL WATER NEEDED AT LOS C	2025 Deficit (MGD)		Build-Out Deficit (MGD)	
Providence Water Supply Board (PWSB)				
Retail Customers (2005)	23.74		23.74	
East Providence Water Department (2005)	3.15		3.15	
East Smithfield, Smithfield, Greenville, Johnston (2005)	1.43		1.43	
Lincoln Water Commission (2005)	0.25		0.25	
Warwick Water Department (2005)	3.90		3.90	
Kent County Water Authority (Kent County) Region				
Kent County Water Authority (Hunt Aquifer limited to 4.0 MGD)	4.20		7.71	
Quonset Development Corp. (Hunt Aquifer limited to 4.0 MGD)	0.28		0.28	
TOTAL SUPPLEMENTAL WATER NEEDED AT LOS C [1] =	**36.95**		**40.46**	
TOTAL WATER DEFICIT AT LOS C [1] =	**(36.95)**		**(40.46)**	
WEST BAY REGIONAL SUPPLEMENTAL SUPPLY SOURCES	**2025 Surplus Sources (MGD)**		**Build-Out Surplus Sources (MGD)**	
	ADD	**LOS C**	**ADD**	**LOS C**
Wheeling Surplus Water				
Pawtucket operating at ADD or LOS C [1]	6.16	13.29	4.07	12.06
Woonsocket operating at ADD or LOS C [1]	0.40	1.83	(1.32)	0.57
North Kingstown operating at ADD to Quonset Development Corp. (Hunt Aquifer limited to 4.0 MGD)	1.38	-	0.52	-
New Well Development				
Big River Facility	4.20	-	4.20	-
Roger Williams Facility	3.00	-	3.00	-
Rehabilitate Inactive Wells				
Lonsdale Wells (Lincoln)	1.73	-	1.73	-
Manville Wells (Lincoln)	7.92	-	7.92	-
Turner Wells (East Providence)	6.05	-	6.05	-
URI Wells (Kingston)	1.87	-	1.87	-
Ladd School Wells (Exeter)	1.78	-	1.78	-
RO Desalination Facility				
West Bay	8.00	-	8.00	-
TOTAL EMERGENCY WATER AVAILABLE (Pawtucket/Woonsocket at ADD) =	**42.49**	-	**37.82**	-
TOTAL EMERGENCY WATER AVAILABLE (Pawtucket/Woonsocket at LOS C) =	-	**51.05**	-	**47.70**
WEST BAY REGIONAL WATER BALANCE AT EMERGENCY SCENARIOS =	**5.54**	**14.10**	**(2.64)**	**7.24**

[1] LOS C = Level of Service C emergency water demand (See pages 6 and 7 for definition), ADD = Average Day Demand

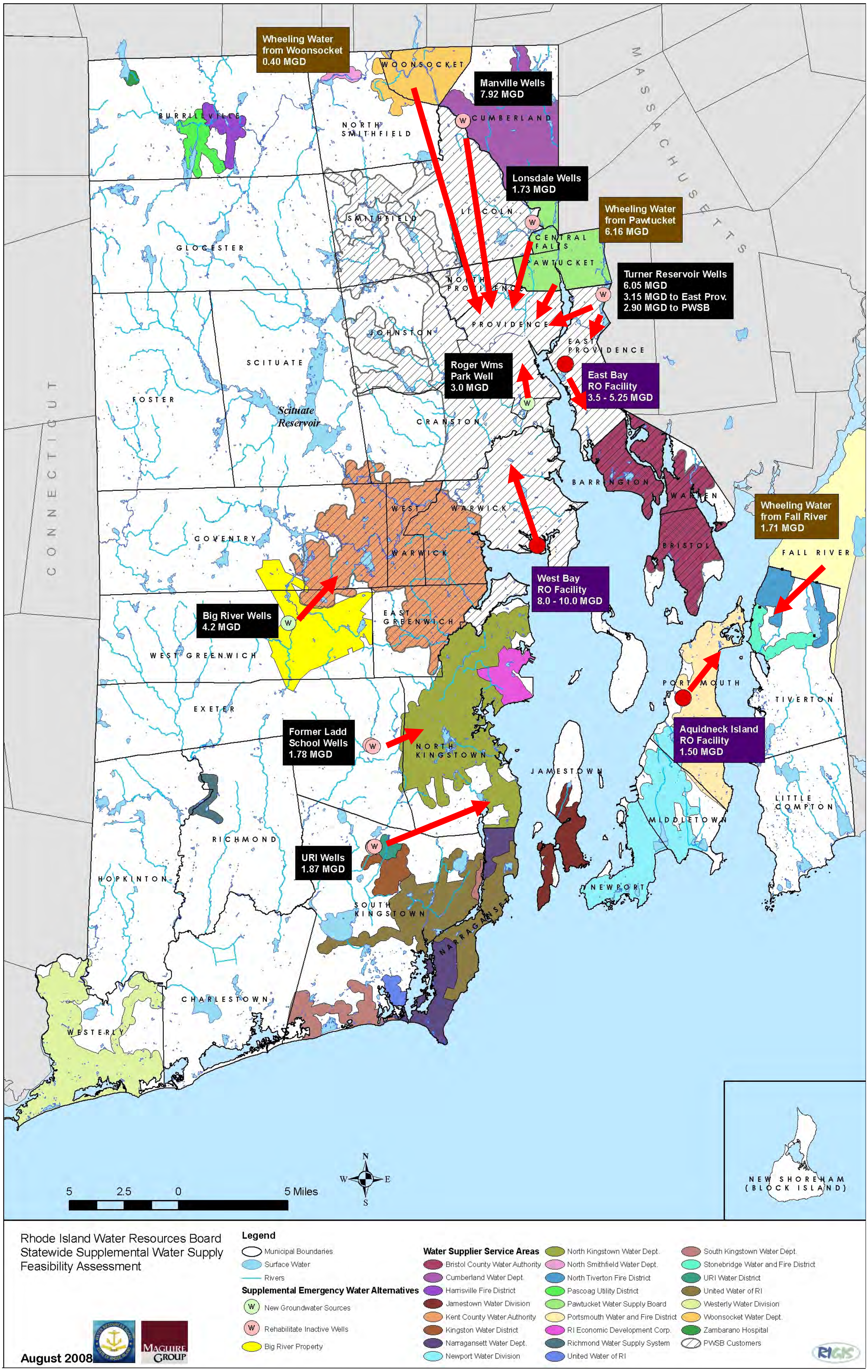

Figure 9: Map of Regional Supplemental Water Supply Sources

Table 46: Comparison of Costs for Regional Supplemental Emergency Water Sources for 2025 demands

		CONSTRUCTION				OPERATION & MAINTENANCE		WHEELING WATER	PURCHASE WATER	ALTERNATIVE TOTAL COST
Alternative	2025 MGD	Total Cost	Total Cost ($/1,000 gallons)	Wells & Facility ($/1,000 gallons)	Conveyance ($/1,000 gallons)	Total Cost	Total Cost ($/1,000 gallons)	Charge $.10/1,000 gal ($/1,000 gallons)	Wholesale Rate ($/1,000 gallons)	$/1,000 gallons
NEW WELL DEVELOPMENT										
Big River [1]	4.2	$26,699,400	$1.52	$1.32	$0.20	$1,266,786	$0.89 [1]	---	---	$2.41 [1]
Roger Williams	3.0	$17,067,648	$1.36	$1.23	$0.13	$976,738	$0.89	---	---	$2.25
RO DESALINATION FACILITIES										
Aquidneck Island	1.5	$28,571,111	$4.55	$4.30	$0.25	$1,885,056	$3.45	---	---	$8.00
East Bay	3.5	$53,780,944	$3.69	$3.61	$0.08	$3,803,539	$2.98	---	---	$6.67
West Bay	8.0	$107,404,264	$3.21	$3.00	$0.21	$7,904,187	$2.71	---	---	$5.92
WHEELING SURPLUS WATER										
Fall River at ADD	1.71	$6,399,822	$0.89	---	$0.89	$138,400	$0.22	$0.20	$5.32	$6.63
Pawtucket at LOS C	13.29	$10,983,594	$0.20	---	$0.20	$476,314	$0.10	$1.26	$3.59	$5.15
Woonsocket at LOS C	1.83	$1,248,000	$0.16		$0.16	$53,012	$0.08	$0.19	$3.59	$4.01
Pawtucket at ADD	6.16	$6,439,384	$0.25		$0.25	$265,700	$0.13	$0.54	$3.59	$4.52
Woonsocket at ADD	0.40	$1,248,000	$0.75	---	$0.75	$18,704	$0.13	$0.04	$3.59	$4.52
REHABILITATE INACTIVE WELLS								---	---	
Ladd School	1.78	$16,523,520	$2.22	$1.55	$0.67	$752,039	$1.16	---	---	$3.38
Lonsdale	1.73	$13,089,086	$1.81	$1.79	$0.02	$670,668	$1.06	---	---	$2.87
URI	1.87	$12,220,104	$1.56	$1.54	$0.02	$700,217	$1.03	$0.19	---	$2.78
Manville	7.92	$55,371,297	$1.67	$0.95	$0.72	$2,627,922	$0.91	---	---	$2.58
Turner	6.05	$35,731,017	$1.41	$0.99	$0.42	$2,133,079	$0.97	---	---	$2.38

Note: Construction costs have been amortized at 6% for 20-years. "Alternate Total Cost" and "Purchase Water" $/1,000 gallons are NOT proposed billing rates. The "Purchase Water" presented is the estimated wholesale rate for wheeling water alternatives based upon current wholesale rates. The "Alternative Total Cost" presented is based upon an engineer estimated construction cost, engineer estimated operation & maintenance, estimated $0.1/1,000 gallon wheeling water fee, and estimated wholesale rates for wheeling water. Table costs provide a means for order of magnitude comparison between alternatives based upon best available information and engineer's assumptions. Additional in depth engineering/hydrogeology analysis is necessary to establish the permit limits of available water capacity (e.g., well field safe yield) for each alternative.

[1] New Well Development Big River alternative total cost presented assumes a 4.2 MGD plant production capacity (total construction cost of $1.52 per 1,000 gallons). Operation & Maintenance total cost was weighted to $0.89 per 1,000 gallons for varied average day demand conditions throughout the year; 4.2-MGD for 10-months of the year at $0.87 per 1,000 gallons, 3.0 MGD for September at $0.94 per 1,000 gallons, and 2.0 MGD for August at $1.06 per 1,000 gallons. These ADD scenarios closely match USGS Management Model MM-09 conditions; combined pumping of three wells north of Route 95 totals 4.2 MGD for 10-months of the year, 3.07 MGD for September, and 1.97 MGD for August.

Non-Cost Factors

Table 47 provides a comparison of the supplemental emergency water sources using non-cost factors; environmental impacts, economic viability, permitting requirements and water quality issues. A brief explanation of the terms and ranking process used in Table 47 follows:

Environmental impacts refers to the alternative's impact on natural resources such as wetlands, surface sources, and groundwater aquifers. Major impacts are classified as adverse and minor impacts have minimal changes to the resource.

Economic viability refers to the ability of a source to be sustainable over time, through costs, maintenance, and general operations of the source to have it ready when an emergency situation arises. Minor impacts indicate that the alternative has a high probability to be a viable emergency water source and a major ranking indicates the source takes more resources to keep it sustainable for emergency use. Pumping and treating potable water requires expensive and complex mechanical equipment. For a supplemental water supply to be available in less than 90 days, the water supply pumping and treatment equipment must be operated in a more or less continuous manner. Also to ensure the water treatment facility is inactivating pathogens and removing contaminants, the water treatment facility must be in continuous use. Therefore in practical terms a supplemental water source must be continuously in use and have a source of revenue from water sales to be economically viable.

Permitting requirements ranks the alternatives complexity in obtaining necessary permits through various local, state and Federal agencies for operations. A major ranking highlights an alternative that requires a long permitting process and a minor ranking indicates the source will have typical permitting activities.

Water quality issues evaluates the source's water quality. A major ranking signifies the alternative will require substantial treatment to address contaminants in the source to meet drinking water standards. Minor water quality identifies a source that requires typical treatment. All other factors being equal, a supplemental water supply with no contamination (or potential for contamination) is preferable to lower quality ground waters or surface waters. In order of severity from a water quality perspective the following ranking was used:

- No contaminants only disinfection and pH/alkalinity adjustment needed to provide potable water.
- Only aesthetic contaminates present such as iron and manganese.
- Ground water or surface water with no industrial contamination.
- Ground water with VOC and SOC contamination.

Costs provides a ranking of costs, where a major ranking signifies high costs associated with development and operation and a minor ranking means lower costs comparatively.

Table 47: Comparison of Regional Supplemental Emergency Water Sources

	Environmental Impacts	Economic Viability	Permitting Requirements	Water Quality Issues	Costs (capital costs, O&M costs, etc.)
Wheeling water from Fall River	+	+	+	+	+++
Wheeling water from Woonsocket & Pawtucket	+	+	+	+	++
Big River Wells	++	++	+++	++	+
Roger Williams Wells	++	++	+++	+++	+
West Bay RO	++	+++	+++	++	+++
East Bay RO	++	+++	+++	++	+++
Aquidneck Island RO	++	+++	+++	++	+++
Reactivate Lonsdale Wells (Lincoln)	+++	++	+++	+++	+
Reactivate Manville Wells (Lincoln)	+++	++	+++	+++	+
Reactivate Turner Reservoir Wells (East Providence)	++	++	+++	+++	+
Reactivate URI Wells (Kingston)	+++	+	+++	++	+
Reactivate Ladd School Wells (Exeter)	++	+	+++	++	++

Ranking
+++ High (major) – Unfavorable for Environmental Impacts, Economic Viability, Permitting Requirements, Water Quality Issues and Costs.
++ Average
+ Low (minor) – Favorable for Environmental Impacts, Economic Viability, Permitting Requirements, Water Quality Issues and Costs.