FINAL REPORT

GOVERNOR'S WATER SUPPLY TASK FORCE

December 2, 1999

Prepared by:

Water Resources Agency, Institute for Public Administration,
University of Delaware

Delaware Geological Survey

Delaware Department of Natural Resources and Environmental Control

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December 2, 1999

This report was prepared and approved by the Governor's Water Supply Task Force in accordance with Executive Order No. 65. The members of the task force are in general concurrence and agree in principal with the findings and recommendations of the report as attested by:

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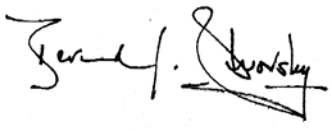

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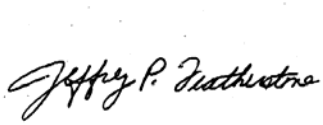

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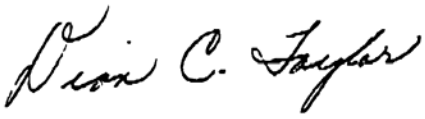

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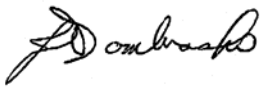

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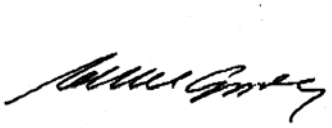

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ACKNOWLEDGEMENTS

This report was compiled by Gerald Kauffman and Martin Wollaston from the Water Resources Agency, Institute for Public Administration, University of Delaware; John Talley of the Delaware Geological Survey; Stewart Lovell of the Delaware Department of Natural Resources and Environmental Control, and Mark Headd of the Governor's office on behalf of the Governor's Water Supply Task Force. This report is designed to facilitate discussion and provide the basis for informed decision-making regarding water supplies in Northern New Castle County in particular and Delaware in general. Information for this report and comments were provided in an expeditious and helpful manner by the five major water purveyors in Northern New Castle County: Artesian Water Company, City of Newark, City of Wilmington, New Castle Board of Water and Light, and United Water Delaware. Excellent cooperation was received from the public-sector members of the task force including New Castle County, the Delaware Division of Public Health, the Public Service Commission, and the Delaware River Basin Commission.

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EXECUTIVE SUMMARY
December 2, 1999

Introduction

The century-ending drought of 1999 was a severe meteorological event, which threatened to interrupt the availability of water supply in Northern New Castle County, Delaware. On August 5, 1999 Governor Carper, at the recommendation of his Drought Advisory Committee, declared a Drought Emergency with mandatory water restrictions in Northern New Castle County. The drought ended in September 1999 with the rains of hurricanes Dennis and Floyd.

During the drought emergency, Governor Carper signed Executive Order No. 65 which appointed a Water Supply Task Force composed of State, Regional, and County agencies and five public and investor-owned water purveyors serving north of the C & D Canal. The charge to the Task Force as summarized in this report was to evaluate the effects of the drought, update the supply and demand curves, and recommend solutions to close the gap between supply and demand in Northern New Castle County during droughts. The task force met on September 14, October 1, October 21, November 5, and November 18, 1999.

Supply and Demand

The Task Force reviewed estimates of supply and demand for worst case drought conditions for planning years 2000, 2010, and 2020. The supply-side estimates involved three scenarios based on assumptions for minimum instream flow standards: (1) Drought Emergency – No 7Q10 minimum flow standard along the Brandywine Creek at Wilmington and White Clay Creek at Stanton, (2) Existing Regulatory Condition – No 7Q10 minimum flow standard along the Brandywine Creek but the 7Q10 standard is in effect along the White Clay Creek, and (3) Future Condition – 7Q10 minimum flow standards in effect along Brandywine Creek and the White Clay Creek. The demand-side estimates were obtained from maximum monthly demand data compiled in the Merna Hurd report in 1998. The supply and demand curves for Northern New Castle County forecast a deficit of 17 mgd or 1020 million gallons (mg) during a 60-day drought period by year 2020 assuming 7Q10 minimum instream flow standards are in effect along both streams.

Scenario Year 2020	Supply (mgd)	Demand (mgd)	+/- (mgd)	Volume (mg)
1. No 7Q10 Flow Standard	93	90	+3	+180
2. 7Q10 along WCC only	85	90	-5	-300
3. 7Q10 along BRCR and WCC	73	90	-17	-1020

Future Water Supply Options

The Task Force then compiled a list of future water supply options available to close the 17-mgd (1020 mg) gap between supply and demand in Northern New Castle County by the year 2020. The following "A" list represents the water supply options which are committed to be installed by the water providers, have few environmental and technical constraints, enjoy community support, and can be implemented in the near term in 1 to 3 years:

A. Future Water Supply Options – Committed to by Water Providers

Newark Reservoir	200 mg	3 mgd
Wilmington Access Hoopes Reservoir Deep Storage[1]	500 mg	8 mgd
United Water Delaware Storage Lagoon - B[2]	25 mg	1 mgd
Artesian Water Co. New Wells N. of the C&D Canal[3]	120 mg	2 mgd
Newark South Wellfield Iron Treatment Plant	60 mg	1 mgd
Artesian Water Co. Aquifer Storage and Recovery Wells	300 mg	5 mgd
Total:	1205 mg	20 mgd

The following "B" list involves water options which can be achieved over a longer term but have technical, cost, environmental and/or policy obstacles that must be addressed:

B. Future Water Supply Options – Achievable in Longer Term

Increase CWA to AWC interconnection	180 mg	3 mgd
Wilmington Raise Hoopes Reservoir Water Level[4]	300 mg	5 mgd
UWD Bread and Cheese Island Reservoir	500 mg	8 mgd
Artesian Water Co. C&D Canal Pipeline[5]	300 mg	5 mgd
Philadelphia to Delaware Pipeline	1200 mg	20 mgd
Total	2480 mg	41 mgd

[1] Subject to financial investment by the public sector and/or water sale agreements with public and private water utilities.

[2] Subject to fiscal and prudency review when compared to other viable options

[3] Subject to the groundwater modeling study by the U.S. Army Corps of Engineers in the year 2000

[4] Subject to financial investment by the public sector and/or water sale agreements with public and private water utilities.

[5] Subject to review of DNREC policy regarding water supply in Southern New Castle County.

And the following "C" list involves water options that are have significant environmental, cost (high), community support (lack of), and technical constraints, and are less likely to be achieved:

C**. Future Water Supply Options - Longer Term, Significant Constraints**

Wilmington Blue Ball Reservoir	350 mg	6 mgd
Artesian Reservoir	900 mg	15 mgd
Thompson Station Reservoir	1200mg	20 mgd
Regional Desalination Facility	1200mg	20 mgd
(Reverse osmosis may be feasible in the future for individual purveyors)		
Indirect Wastewater Reuse	1200mg	20 mgd

Conclusions/Recommendations

The Task Force reviewed and recommended the following institutional/governance/ policy changes that will increase the supply of water and allow for more efficient management and apportionment of water supply in Delaware:

1. Temporary Water Master:

   Appoint an interim water master or central coordinator who would ensure that the "A" list committed to projects and possibly the "B" list projects are implemented according to an agreed upon schedule without slippage. The water coordinator would concentrate efforts on ensuring that providers with supply needs take the appropriate and necessary actions to address their supply deficit. The water coordinator would provide quarterly progress reports to the Governor and Legislature which would include regular updates to this Water Supply Task Force Report as new information is developed.

2. Water Supply Coordinating Council:

   Appoint a Water Supply Coordinating Council composed of State, Regional, New Castle County officials, the five water providers, and the public to work with the water coordinator to implement the water supply options. This forum would be established to offer the five water purveyors the further opportunity to communicate, coordinate, and exchange information as a positive step to better manage water supplies.

   The Artesian Water Company has voiced concerns about the need for a Water Supply Coordinating Council and indicated that the appointment of a water coordinator alone would be sufficient.

The Governor's Water Supply Coordinating Council would be appointed to perform the following specific functions:

- Work cooperatively with the interim water coordinator to implement the "A" list (committed to) and possibly "B" list (longer term) future water supply options in accordance with an agreed upon schedule.

- Conduct hydraulic field tests and/or modeling to optimize and expand the intra-county interconnections to convey water from suppliers with excess capacity to suppliers in need of additional water to meet peak demands during normal and drought periods.

- Encourage the water providers (if they do not have them) to adopt inclining block and/or conservation water rates as a demand side management measure in a manner that does not hinder economic development in New Castle County.

- Work with the utilities to develop cooperative cost and capacity agreements to purchase water supplies during drought.

- Advise the DNREC and provide technical input to ensure the completion of the recently authorized U.S. Corps of Engineers Groundwater Availability Study for Northern New Castle County.

- Review the policy decision made by DNREC to reserve water supply in Southern New Castle County vis-à-vis the C&D Canal Pipeline in light of recent demand and supply analysis and the changing socioeconomic character of Southern New Castle County.

- Develop a water quality sampling plan for Hoopes Reservoir.

3. Overhaul CPCN Process:

   Propose legislation to overhaul the Certificate of Public Convenience and Necessity (CPCN) regulations to tie the awards of new and existing water supply franchise areas to certification by the water purveyor of adequate capacity, pressure, quality, and master plans. Currently the DNREC CPCN regulations require only approval by a property owner and a boundary drawn on a map to award a franchise area to a water purveyor.

   The CPCN language would be revised to relinquish existing service areas or prevent award of future service areas to utilities that do not provide adequate water supply quantity and quality to customers during peak demand and normal or drought (low flow) conditions.

   As a further move to strengthen the process, consider moving the water supply CPCN process from DNREC to the Public Service Commission since the PSC currently has regulatory oversight of water rates and consumer service. The amended CPCN

legislation should include the following checklist tying the approval of water service areas to:

- Regional water planning.
- Certification that the water purveyor has adequate capacity to meet existing peak demands and is working toward meeting future peak monthly water demands for year 2020 during drought of record conditions assuming 7Q10 minimum flow standards are in place along the White Clay Creek and Brandywine Creek.
- Cross linking with the Division of Public Health regarding certification of water quality in accordance with U.S. Environmental Protection Agency and Delaware primary and secondary drinking water standards.
- Requirements for short-term and long-term master plans for a requested franchise area including capital budget, system mapping and hydraulic computer modeling.
- Cross-linking between DNREC well drilling and allocation permits.
- Cross-linking between certification of minimum pressure and capacity by the Fire Marshall and Division of Public Health.
- Standards for water mains, storage, metering, and interconnections in accordance with American Water Works Association standards and existing State and local regulations.

The water purveyors have expressed support for revamping the CPCN process and moving it to the PSC as the "umbrella" for coordinating water supply regulation in Delaware. The City of Wilmington has pointed out that moving the CPCN process from the DNREC to the PSC may be problematic because the PSC currently oversees only investor-owned water purveyors. The DNREC supports moving the CPCN process to the PSC. Both the DNREC and the PSC have pointed out that more labor and resources (more than the current 0.2 full time equivalent) will need to be allocated to administer the CPCN program if the process is expanded.

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CHAPTER 1 - INTRODUCTION

Foreword

The memories of the drought of 1999 are fresh leading to many different opinions regarding water supply solutions. Disagreements and differing opinions are naturally and historically inherent in water resources management hence the derivation of the words "river" and "rival". Both of these words are derived from the Latin *rivalis* which means "one taking from the same stream as another." The most achievable solutions discussed in this report can be implemented by listening to and understanding different opinions and applying the principles of communication, coordination, and cooperation between the public and private entities responsible for water supply in Delaware.

The Drought of 1999

The century-ending drought of 1999 was a severe meteorological event which threatened to interrupt the availability of water supply in Northern New Castle County. The seeds of the drought were planted during the summer and fall of 1998 with many consecutive months of deficit rainfall. After a wet winter, the deficit rainfall continued during the spring and summer of 1999. The abnormally low rainfall culminated in declining ground-water levels (substantially below normal) and declining streams flows in the Christina Basin streams which provide over 70% of the drinking water supply to Northern New Castle County. During July and August 1999, stream flows along Brandywine Creek and White Clay Creek declined to record low levels on 14 days and 18 days, respectively, and reached the 7Q50 - the low flow level likely to occur once every 50 years for a consecutive 7-day period. Because of lack of freshwater inflow from White and Red Clay creeks, the salt front migrated up the tidal portion of White Clay Creek with increasing salt (chloride) concentrations, which exceeded at times the EPA 250 mg/L secondary drinking water standard.

On July 23, Governor Carper, based on the advice of the Governor's Drought Advisory Committee, declared a Drought Warning in Northern New Castle County and called for voluntary water restrictions statewide. On August 5 Governor Carper, at the recommendation of his Drought Advisory Committee, declared a Drought Emergency with mandatory water restrictions in Northern New Castle County. Following significant precipitation associated with Hurricane Dennis during the first week of September which resulted in increased stream flows, Governor Carper rescinded the Drought Emergency and mandatory restrictions on September 5. A Drought Warning with voluntary restrictions replaced the Drought Emergency and mandatory restrictions. The drought of 1999 effectively ended for the time being during the third week of September with record-high precipitation and record-high stream flows in northern New Castle County associated with Hurricane Floyd. For example, total precipitation during September was 14.03 inches at Porter Reservoir (10.08 inches above normal) and flooding on Christina River and White Clay Creek was estimated to have a 500-year recurrence interval.

Water Supply Task Force

During the 1999 Drought Emergency, Governor Carper convened a Water Supply Task Force through Executive Order No. 65 to evaluate the effects of the drought, update the supply and demand curves, and recommend solutions to close the gap between supply and demand in Northern New Castle County. The members of the Task Force and their roles are:

Governor's Office - Chair of the Task Force and responsible for the executive level of State government. Under State law the Governor has the authority to declare a state of emergency, in this instance a Drought Emergency, and manage control of water supply and demand during the emergency.

Delaware Department of Natural Resources and Environmental Control (DNREC) - According to State law the DNREC is custodian of Delaware's water resources and is responsible for regulatory matters pertaining to well drilling, surface-water quality standards, water allocation, and water supply service areas.

Delaware Emergency Management Agency (DEMA) - Responsible for planning for, and response to, natural disasters as well as man-induced disasters, and under State law is given authority during Drought Emergency to assist the Governor with response to drought.

Delaware Division of Public Health (DPH) - Responsible for regulatory matters regarding public health, drinking water quality and enforcement of EPA drinking water standards.

Delaware River Basin Commission (DRBC) - Responsible for water regulation and allocation in the 4-state Delaware River Basin. The DRBC was formed by interstate compact and consists of the Governors of Delaware, New Jersey, New York, and Pennsylvania and the Federal government.

Delaware Geological Survey (DGS) - The mission of the DGS is to conduct geologic and hydrologic research and exploration, and to disseminate information through publication and public service. Significant effort is placed on investigation of surface water, ground water, and mineral resources.

Water Resources Agency, University of Delaware, Institute for Public Administration (WRA) - Mission is to provide regional water supply and water quality planning and management assistance to Delaware's local and State governments. The WRA is nonregulatory and is advised by a Board consisting of the Governor, the New Castle County Executive, the Mayors of Newark and Wilmington, and the University of Delaware.

City of Wilmington - The City, which has the largest water supply in New Castle County, is self sufficient and owns the largest and only major storage facility in New Castle County, Hoopes Reservoir (2 bg total/1.3 bg usable). The City has the capacity to withdraw up to 44 mgd from Brandywine Creek at its Porter and Brandywine pumping stations. Wilmington serves customers both in the City and in surrounding suburban areas.

Artesian Water Company (AWC) - An investor-owned water company serving 200,000 people in suburban New Castle County. AWC is self sufficient to meet maximum month demands from its regional well fields (23 mgd allocated) and water purchased through interconnections with the

Chester Water Authority (CWA), the New Castle Board of Water and Light, and the City of Wilmington.

United Water Delaware (UWD) - An investor-owned water company with about 32,000 connections in suburban areas of the Brandywine Hundred, south of Newark, and the St. Georges area. UWD obtains up to 30 mgd from White Clay Creek at its Stanton Water Treatment Plant (WTP) and up to 6 mgd from the Christina River at Smalley's Pond WTP. UWD also has an allocation to purchase up to 2 mgd from the CWA. UWD operates an inflatable Tidal Control Structure (TCS) in the tidal portion of White Clay Creek that can provide up to 12 mgd of tidal water during low flow periods and drought. The Stanton intake is susceptible to elevated salt (chloride and sodium) levels from the tidal White Clay Creek during drought.

City of Newark - Serves about 27,000 residents of the City including the University of Delaware. The City of Newark is the only water supplier in New Castle County that practices conjunctive use. The City utilizes both ground water (well fields with allocations of 4.8 mgd), surface water (White Clay Creek WTP with an allocation of 3mgd), and interconnections with AWC and UWD). The City experiences water supply deficits because of lack of upstream storage when low stream flows decline below the DRBC instituted instream passby flow standard of 14 mgd. During such times the City must stop taking water from White Clay Creek and cease operations of its WTP.

New Castle Board of Water and Light – New Castle has a surplus water supply and commonly sells surplus water to AWC through interconnection(s). Its peak demand is about 0.7 mgd whereas its available allocated supply is 1.7 mgd.

Exhibit A contains maps that show the Christina River Basin Drought Management Plan, public water supply systems service areas in northern New Castle County, interconnected public water supply systems in northern New Castle County, and future water supply options in northern New Castle County.

CHAPTER 2 - WATER SUPPLY

During the drought of 1999 deficit rainfall, declining ground water levels, and dwindling stream flows threatened the adequacy of water supplies in Northern New Castle County (Exhibit B). Along with declining stream flows, the salt front migrated up White Clay Creek causing chloride concentrations to exceed the 250 ppm chloride standard (Exhibit C). The drought further reaffirmed that, in Northern New Castle County, the availability of surface water supplies are dictated by several key factors: (1) minimum instream flow standards; (2) usable water in Hoopes Reservoir; (3) the EPA chloride standard; and (4) availability of ground water to maintain adequate base flows.

Instream Flow Needs

An analysis of the drought of 1999 was conducted to determine the usability of Hoopes Reservoir and water availability from Brandywine Creek at Wilmington and White Clay Creek at Stanton, assuming the TCS is in operation, for the following minimum instream flow scenarios:

1. Drought Emergency - No 7Q10 minimum instream flow standards along Brandywine Creek at Wilmington and White Clay Creek at Stanton.

2. Existing Condition - No 7Q10 minimum instream flow standard along Brandywine Creek but the 7Q10 minimum instream flow standard in effect along White Clay Creek.

3a. Interim Condition - 7Q50 minimum instream flow standard in effect along Brandywine Creek and the 7Q10 minimum instream flow standard in effect along White Clay Creek.

3b. Future Condition - 7Q10 minimum instream flow standard in effect along Brandywine Creek and the 7Q10 minimum instream flow standard in effect along White Clay Creek.

Figures 1 and 2 contain stream flow hydrographs for Brandywine and White Clay creeks during 1999 and a comparison to the various minimum flow standards. Figure 3 summarizes the operations of Hoopes Reservoir for the various instream flow scenarios. Figure 4 provides a simulated comparison of Hoopes Reservoir storage for drought years 1963, 1966, 1995, and 1999 assuming 7Q10 instream flow requirements on Brandywine and White Clay creeks.

For Scenario 1 (waiving of the flow standards during drought emergency) approximately 95 mg of water was released and the reservoir reached 95% of capacity. For Scenario 2 with a 7Q10 in effect along the White Clay Creek only, the City would have released about 256 mg from the reservoir drawing the level down to 81% of capacity. If a 7Q50 were in effect along Brandywine Creek and 7Q10 along White Clay Creek (Scenario 3a) the City would have released about 974 mg from the reservoir drawing the level down to 28% of capacity. For Scenario 3b, if there were a 7Q10 along both Brandywine Creek and White Clay Creek, the entire1.3 bg usable capacity of Hoopes would have been fully diminished. In fact there would have been a additional shortfall of 120 mg.

Table 1 contains the capacity summary of the Hoopes Reservoir analysis.

Table 1
Summary of Hoopes Reservoir Simulations (mg)
Drought of 1999

Scenario	Description	(1) Released To Wilm.	(2) Released To UWD	(3) Hoopes Refill	(4) Provided by TCS	(5) *Remaining Capacity
1.	No 7Q10	10	85	25	720	1230 (95%)
2.	No 7Q10 BRCR/ but 7Q10 WCC	86	170	12	720	1056 (81%)
3a.	7Q50 BRCR/ 7Q10 WCC	750	224	36	720	363 (28%)
3b.	7Q10 BRCR & WCC	1300	240	120	720	- 120 (-9%)

* (1300 – (1) – (2) + (3) = (5)

Supply-side Assumptions

Key assumptions regarding the supply side of the equation include:

- Minimum Instream Flow Needs
  - Scenario 1 - No 7Q10 along Brandywine Creek and White Clay Creek
  - Scenario 2 - No 7Q10 along Brandywine and 7Q10 along White Clay Creek
  - Scenario 3a – 7Q50 along Brandywine Creek and 7Q10 along White Clay Creek
  - Scenario 3b - 7Q10 along Brandywine Creek and White Clay Creek

- Hoopes Reservoir total capacity = 2 bg; usable capacity = 1.3 bg (1300 mg).

- Hoopes Reservoir refill pumping rate = 12 mgd or 24 mgd.

- Ground water supplies as per sustained pumping during the droughts of 1995 and 1999.

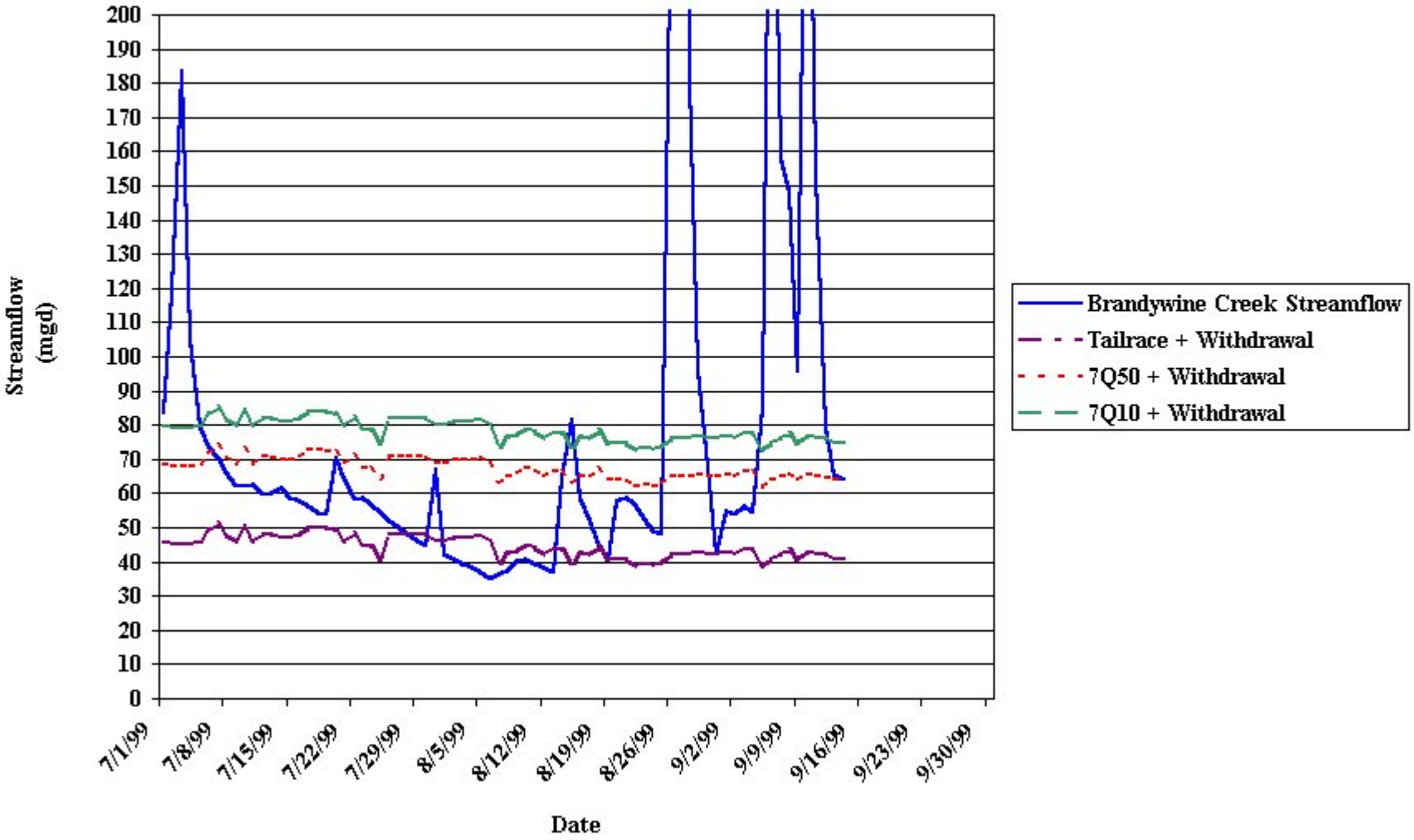
- CWA Interconnections as per experience during 1999 drought.

- Maximum chloride levels in raw/finished water at White Clay Creek at Stanton = 250 mg/L.

- The UWD Tidal Capture Structure is operating (12 mgd).

- Available stream flows based on droughts of record: 1963, 1966, 1995, and 1999. Based on the Hoopes Reservoir analysis, droughts in New Castle County extend for 60 to 75 days.

Figure 1. Streamflow Brandywine Creek at Wilmington WTP (1999)



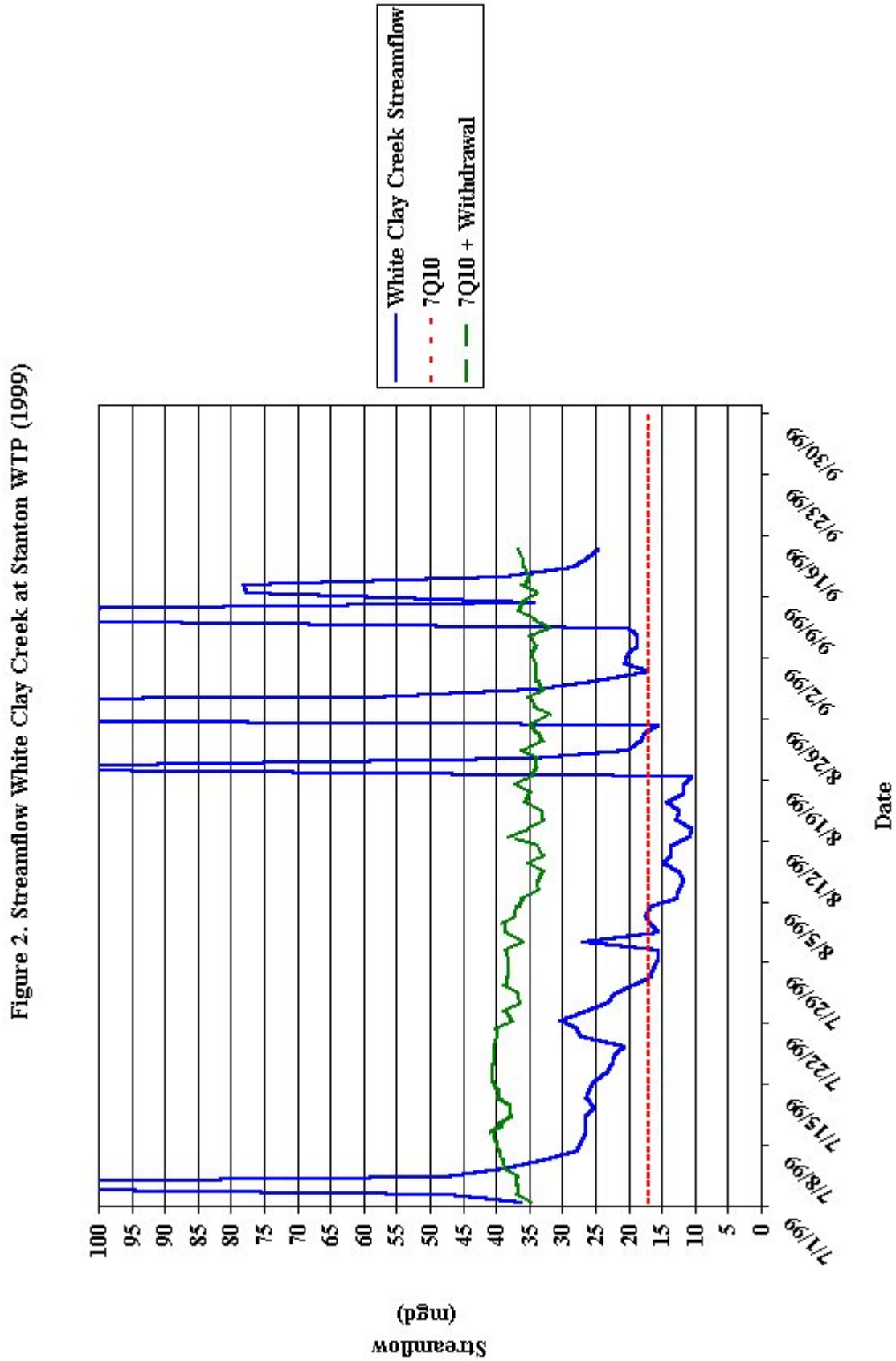


Figure 2. Streamflow White Clay Creek at Stanton WTP (1999)

Figure 3. Hoopes Reservoir Operating Scenarios (Drought of 1999)

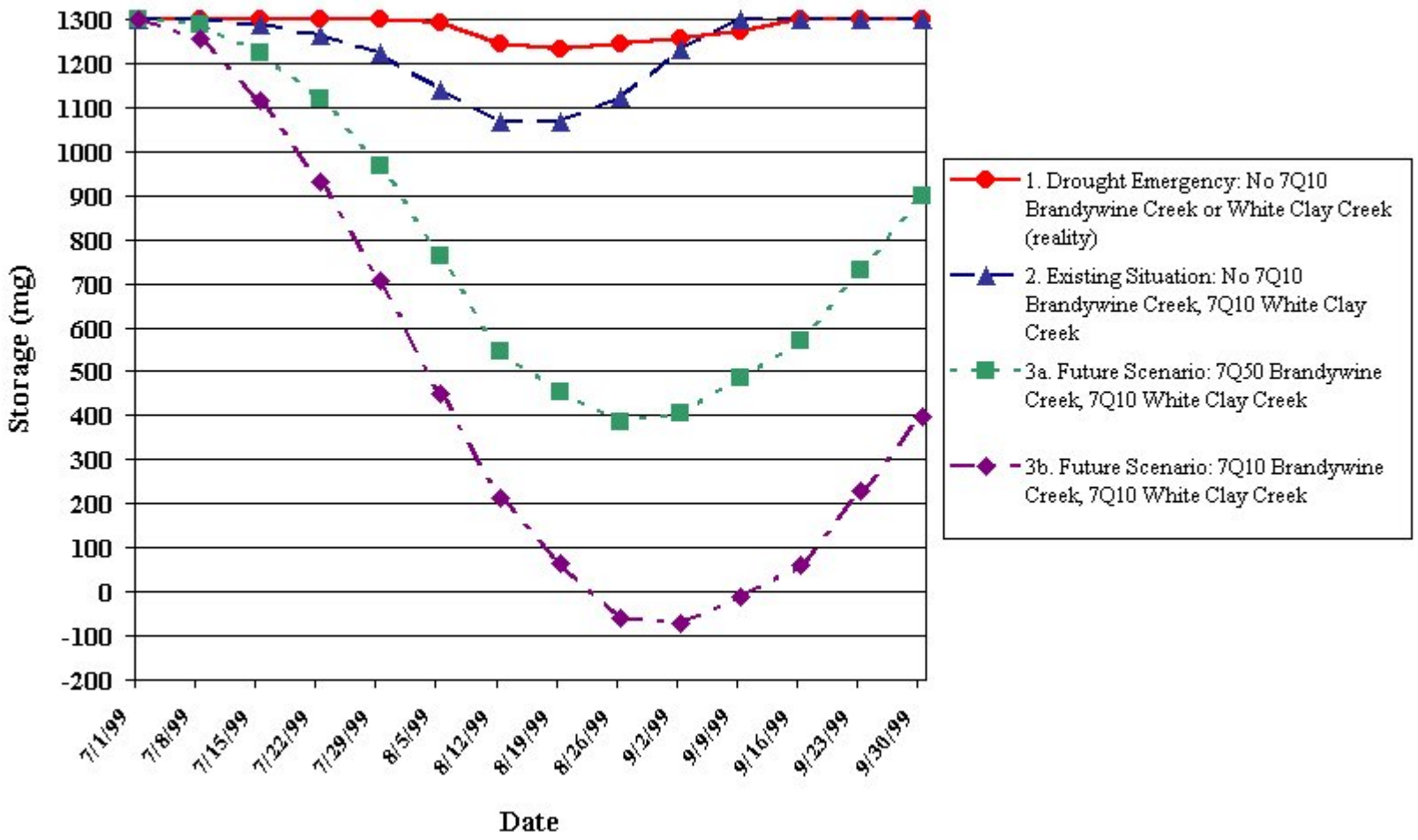


Figure 4. Hoopes Reservoir Storage for the Droughts of 1963, 1966, 1995 and 1999

(Assuming 7Q10 minimum instream flow standards are in place along the Brandywine Creek and White Clay Creek)

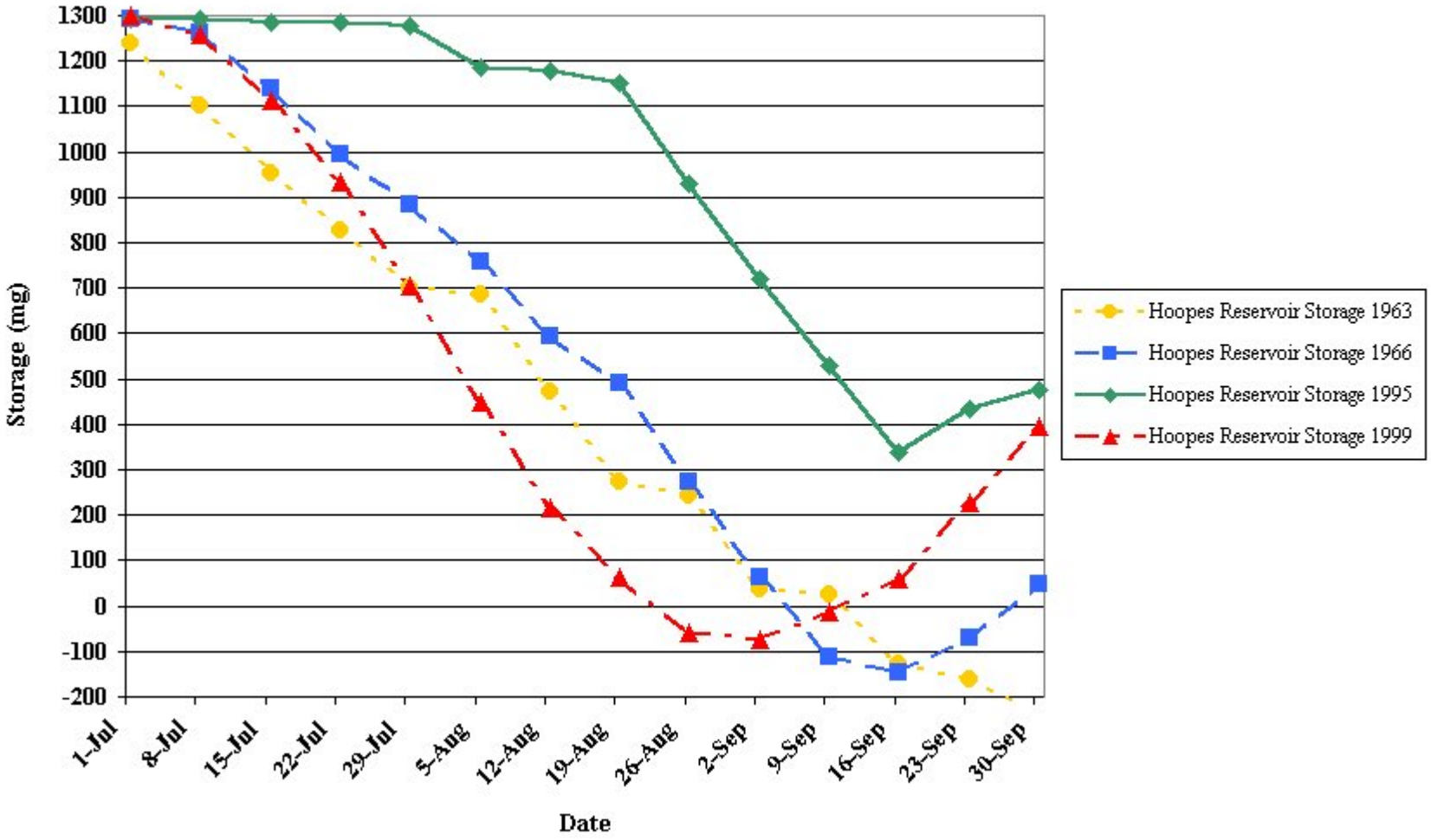


Table 2
Accounting of Water Supply During Drought (Year 2000)
Northern New Castle County

Purveyor	1. No 7Q10	2. No 7Q10 BRCR/ 7Q10 along WCC	3B. 7Q10 along BRCR and WCC
Artesian			
- Ground water (wells)	18	18	18
- CWA Interconnection	4	4	4
- ASR	2	2	2
United Water			
- Stanton WTP	20	12	12
- Christina WTP	3	3	3
- CWA Interconnection	1	1	1
Wilmington			
- Brandywine Cr. WTP	20	20	8
- Hoopes Reservoir	20	20	20
Newark			
- White Clay Cr. WTP	0	0	0
- Ground water (wells)	3	3	3
New Castle BW&L			
- Ground water (wells)	2	2	2
C. Total Drought Supply	93 mgd	85 mgd	73 mgd

CHAPTER 3 - WATER DEMAND

The following demand data are available for planning in Northern New Castle County (Exhibit E):

- Historic Peak Day = 93 mgd (July 18, 1997)
- Drought 1999 Peak Day = 89 mgd (July 19, 1999)
- Estimated Maximum Month = 86 mgd (Year 2000, Merna Hurd, Jan. 1998)
- Actual Maximum Month = 83 mgd (July 1999)

The drought of 1999 was helpful in understanding and verifying the predicted maximum water demand patterns in Northern New Castle County. On July 19, 1999, the peak day for the drought, the water purveyors reported water demands presented in Table 3.

Table 3
Water Demands for the Peak Day of July 19, 1999
Northern New Castle County

Purveyor	Demand (mgd)	
Wilmington		
- Brandywine Filter Plant	9.0	
- Porter Filter Plant	26.0	
Subtotal		35.0
Artesian		
- Wells (No. of C&D Canal)	17.4	
- CWA Interconnection	5.0	
- Wilmington Interconnection	3.9	
- New Castle BW&L Intercon.	0.7	
- Subtotal		27.0
United Water Delaware		
- White Clay Creek at Stanton WTP	23.5	
- Christina WTP	2.9	
- CWA interconnection	1.0	
- Wilmington Interconnection	0.0	
- Artesian Interconnection	0.0	
Subtotal		27.4
Newark		
- White Clay Creek WTP	0.0	
- Wells	2.9	
- United Water Interconnection	2.7	
- Artesian Water Interconnection	0.1	
Subtotal		5.7
New Castle Board of Water & Light		
- Wells	1.2	
Subtotal		1.2
Total		96.3
- Intracounty interconnections		7.3
Total Peak Demand		89.0 mgd

For this analysis, we decided to utilize the maximum monthly demand data published in Merna Hurd's report (1998) for 2000, 2010, and 2020. Hurd's report was adopted unanimously in March 1998 by the Project Management Committee comprised of representatives from the State of Delaware, New Castle County, Water Resources Agency, and the water purveyors (AWC, City of Newark, UWD, and City of Wilmington). The New Castle County Chamber of Commerce recommends that the water demands should be forecasted further into the future than 2020. Predicted water demands of 86 mgd for the year 2000 contained in the Hurd report were within 4% of the actual maximum month demand for July 1999 (83 mgd). The Hurd report projected the demands to 2000, 2010 and 2020 based on expected population increases and allowances for business and industrial growth. It should be noted that maximum monthly demands are used in this analysis as storage tanks can meet peak day demands in each supplier's system. The following maximum monthly water demand projections for Northern New Castle County will be used as published in the Hurd report:

Year 2000	86 mgd
Year 2010	88 mgd
Year 2020	90 mgd

CHAPTER 4 - WATER SUPPLY AND DEMAND CURVES

By comparing the available water supply during drought with the maximum monthly demand, one can estimate the projected surplus or deficit in water supplies for Northern New Castle County as they relate to Scenarios 1, 2, and 3b presented in Chapter 2. The results are presented in Table 4 and Figures 5, 6, and 7.

Table 4
Water Supply Versus Demand
Northern New Castle County

Year/Scenario	Supply (mgd)	Demand (mgd)	Surplus/Deficit (mgd)	(*mg)
2000				
1. No 7Q10	93	86	7	420
2. No 7Q10 BRCR/7Q10 WCC	85	86	-1	- 60
3b. 7Q10 BRCR and WCC	73	86	-13	-780
2010				
1. No 7Q10	93	88	5	300
2. No 7Q10 BRCR/7Q10 WCC	85	88	-3	-180
3b. 7Q10 BRCR and WCC	73	88	-15	-900
2020				
1. No 7Q10	93	90	3	180
2. No 7Q10 BRCR/7Q10 WCC	85	90	-5	-300
3b. 7Q10 BRCR and WCC	73	90	-17	-1020

*Volume required assuming a 60-day drought period.

Tables 5, 6, and 7 contain a full accounting of the water supply and demand analysis.

The Artesian Water Company has provided a table that summarizes the water supply and demand analysis. This table can be reviewed in Exhibit L.

Figure 5.
Water Supply and Demand Curve, Scenario 1.
Drought Emergency, No 7Q10 Flow Standard
along the Brandywine and White Clay Creeks

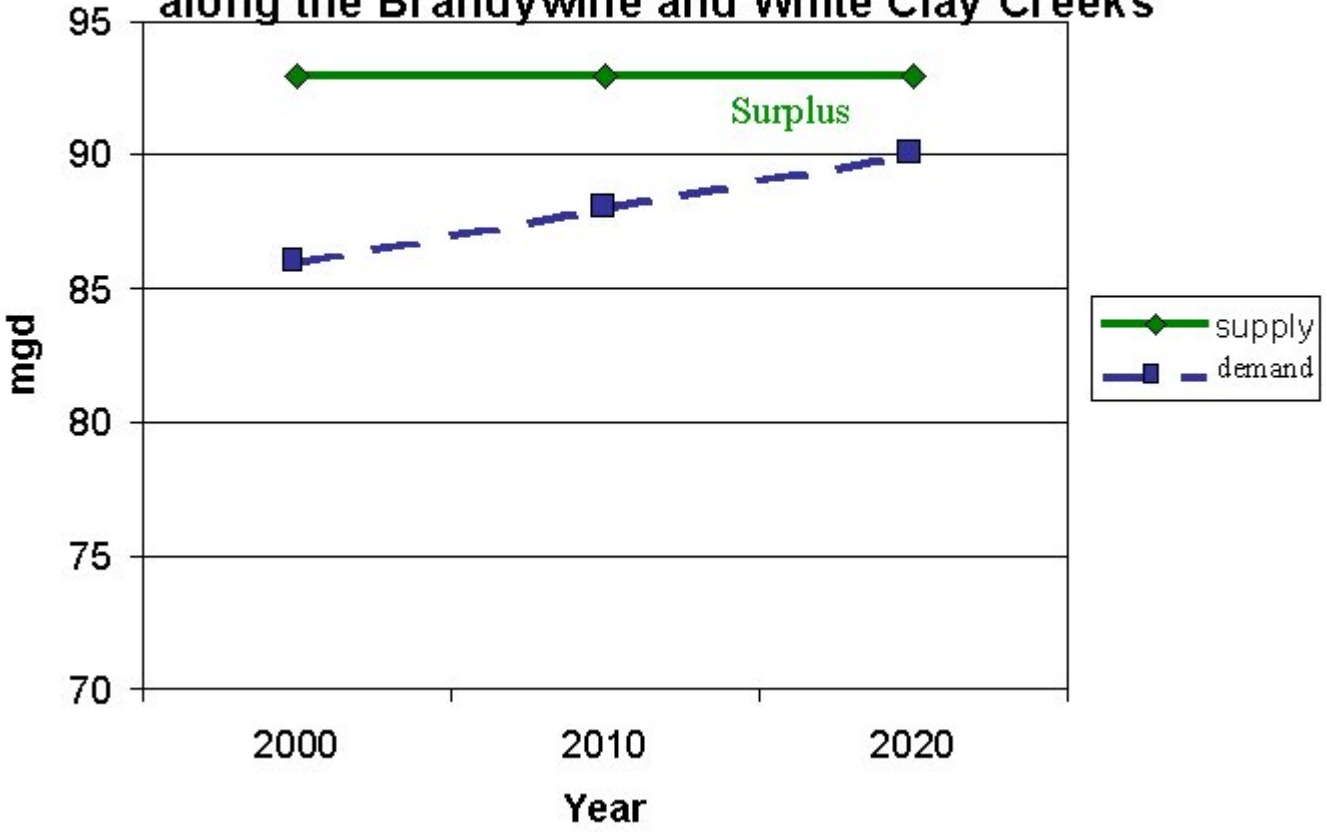


Figure 6.
Supply and Demand Curve, Scenario 2 - Existing Condition, No 7Q10 Flow Standard along the Brandywine Creek But a 7Q10 Flow Standard in place along the White Clay Creek at Stanton

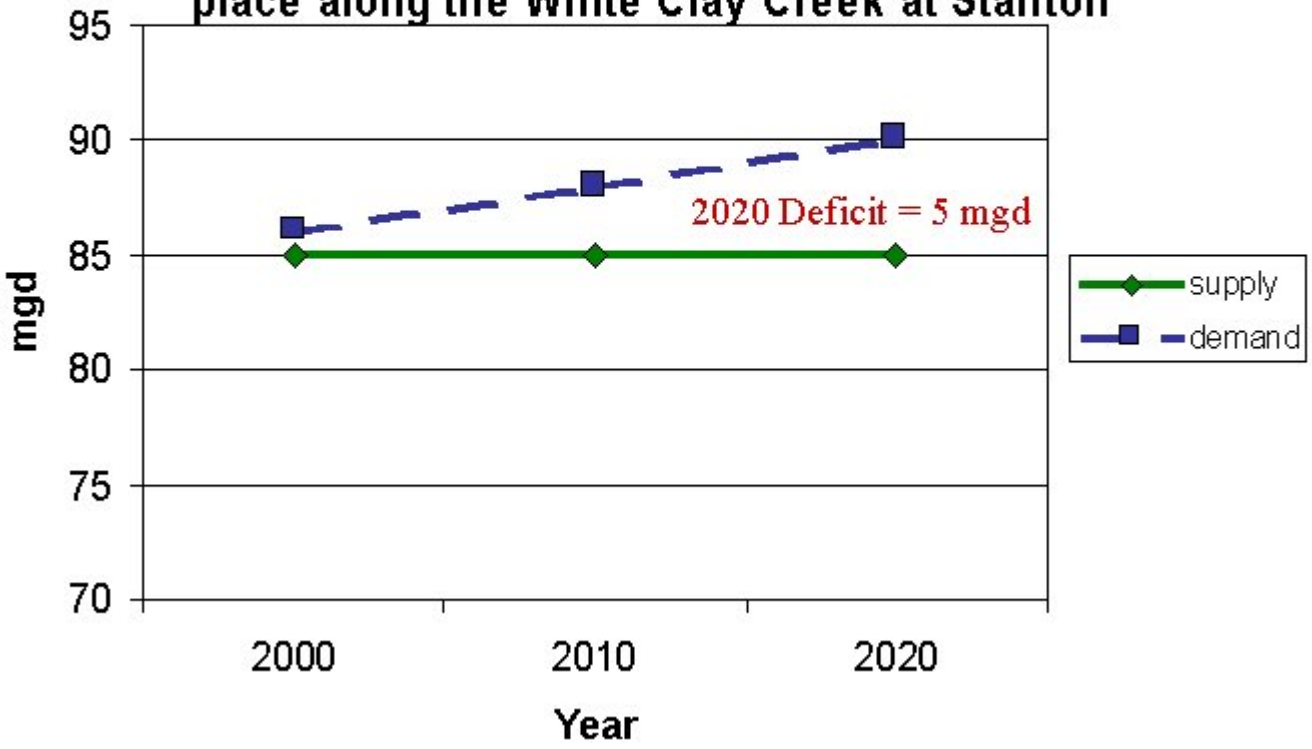


Figure 7. Water Supply and Demand Curve, Scenario 3b - Future Condition, 7Q10 Flow Standards in place along the Brandywine Creek and White Clay Creek at Stanton

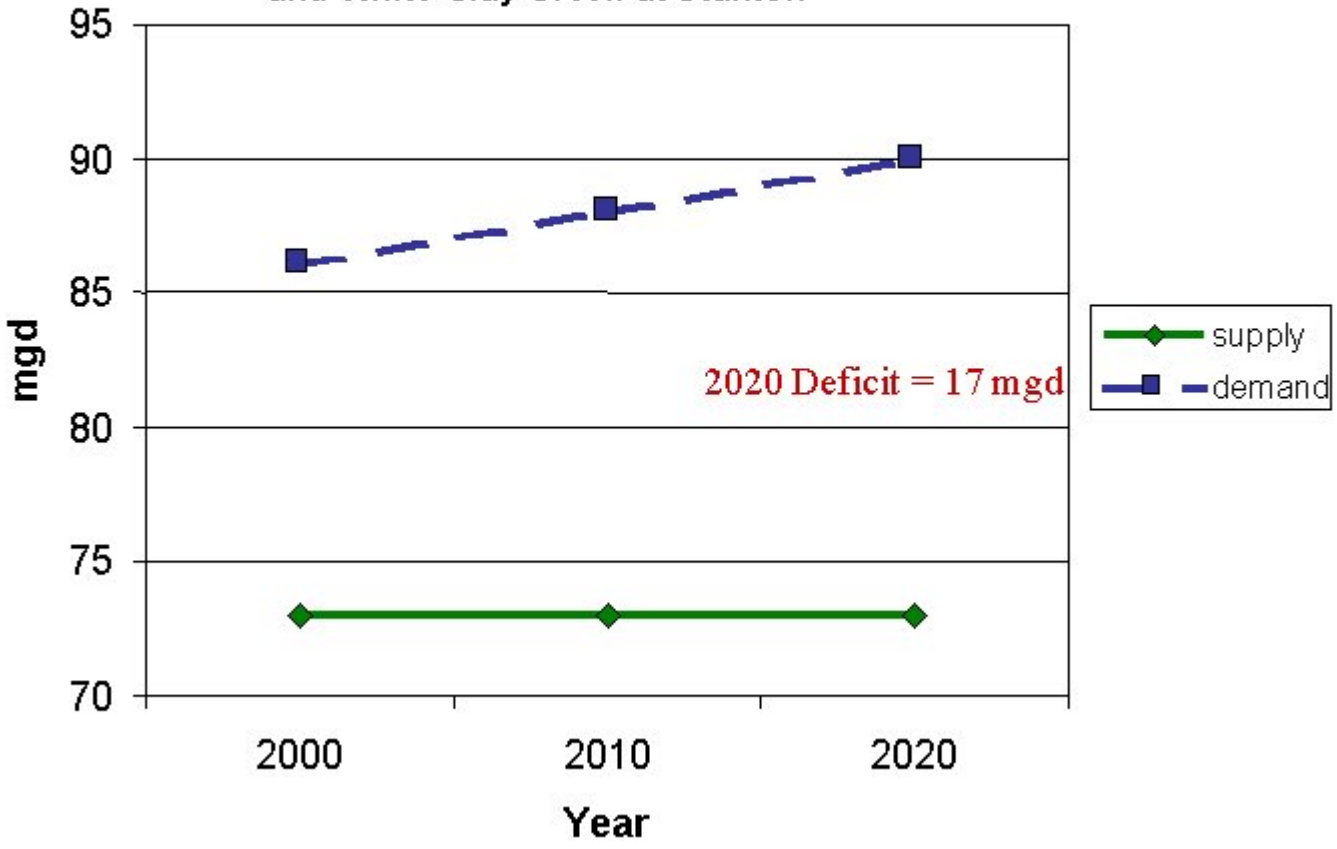


TABLE 5. WATER SUPPLY/DEMAND CALCULATIONS (mgd)
SCENARIO 1. DROUGHT EMERGENCY - NO 7Q10 ALONG BRANDYWINE CREEK AND WHITE CLAY CREEK

Supplier	2000			2010			2020		
	Supply	Maximum Monthly Demand	Surplus/ Deficit (+/-)	Supply	Maximum Monthly Demand	Surplus/ Deficit (+/-)	Supply	Maximum Monthly Demand	Surplus/ Deficit (+/-)
Artesian									
* Groundwater	18.0			18.0			18.0		
* CWA Interconnection	4.0			4.0			4.0		
* ASR	2.0			2.0			2.0		
	24.0	24.0	0.0	24.0	26.0	-2.0	24.0	27.1	-3.1
United Water									
* Stanton WTP	20.0			20.0			20.0		
* Christina WTP	3.0			3.0			3.0		
* CWA Interconnection	1.0			1.0			1.0		
	24.0	26.0	-2.0	24.0	25.9	-1.9	24.0	26.2	-2.2
Wilmington									
* Brandywine Creek	20.0			20.0			20.0		
(w/ Hoopes Reservoir)	20.0			20.0			20.0		
	40.0	31.0	9.0	40.0	31.0	9.0	40.0	31.0	9.0
Newark									
* White Clay Cr. WTP	0.0			0.0			0.0		
* Groundwater	3.0			3.0			3.0		
	3.0	4.5	-1.5	3.0	4.7	-1.7	3.0	4.8	-1.8
New Castle County BWL	2.0	0.5	1.5	2.0	0.5	1.5	2.0	0.5	1.5
Subtotal	**93.0**	**86.0**	**7.0**	**93.0**	**88.1**	**4.9**	**93.0**	**89.6**	**3.4**

Oct. 21, 1999

Water supply available during drought of record conditions with:

(a) No 7Q10 minimum instream flow standards in effect along the Brandywine Creek and White Clay Creek
(b) groundwater supplies as sustained during the 1995 and 1999 droughts
(c) transfers from CWA reduced as per 1999 drought
(d) Maximum monthly demand as per Merna Hurd, Jan. 1998

		Demand	(+/-)		Demand	(+/-)		Demand	(+/-)
Artesian									
* Groundwater	18.0			18.0			18.0		
* CWA Interconnection	4.0			4.0			4.0		
* ASR	2.0			2.0			2.0		
	24.0	24.0	0.0	24.0	26.0	-2.0	24.0	27.1	-3.1
United Water									
* Stanton WTP	12.0			12.0			12.0		
* Christina WTP	3.0			3.0			3.0		
* CWA Interconnection	1.0			1.0			1.0		
	16.0	26.0	-10.0	16.0	26.0	-10.0	16.0	26.2	-10.2
Wilmington									
* Brandywine Creek	20.0			20.0			20.0		
(w/ Hoopes Reservoir)	20.0			20.0			20.0		
	40.0	30.8	9.2	40.0	31.0	9.0	40.0	31.0	9.0
Newark									
* White Clay Cr. WTP	0.0			0.0			0.0		
* Groundwater	3.0			3.0			3.0		
	3.0	4.5	-1.5	3.0	4.7	-1.7	3.0	4.8	-1.8
New Castle County BWL	2.0	0.5	1.5	2.0	0.5	1.5	2.0	0.5	1.5
Subtotal	**85.0**	**85.8**	**-0.8**	**85.0**	**88.2**	**-3.2**	**85.0**	**89.6**	**-4.6**

Oct. 21, 1999

Water supply available during drought of record conditions with:

(a) No 7Q10 minimum instream flow standards in effect along the Brandywine Creek
(b) 7Q10 instream flow in effect along White Clay Creek
(b) groundwater supplies permitted by DNREC allocation permit
(c) transfers from CWA reduced as per 1999 drought
(d) Maximum monthly demand as per Merna Hurd, Jan. 1998

TABLE 7. WATER SUPPLY/DEMAND CALCULATIONS(mgd)
SCENARIO 3b. FUTURE CONDTION - 7Q10 IN EFFECT ALONG BRANDYWINE CREEK
AND 7Q10 IN EFFECT ALONG WHITE CLAY CREEK

Supplier	2000			2010			2020		
	Supply	Maximum Monthly Demand	Surplus/ Deficit (+/-)	Supply	Maximum Monthly Demand	Surplus/ Deficit (+/-)	Supply	Maximum Monthly Demand	Surplus/ Deficit (+/-)
Artesian									
* Groundwater	18.0			18.0			18.0		
* CWA Interconnection	4.0			4.0			4.0		
* ASR	2.0			2.0			2.0		
	24.0	24.0	0.0	24.0	26.0	-2.0	24.0	27.1	-3.1
United Water									
* Stanton WTP	12.0			12.0			12.0		
* Christina WTP	3.0			3.0			3.0		
* CWA Interconnection	1.0			1.0			1.0		
	16.0	26.0	-10.0	16.0	25.9	-9.9	16.0	26.2	-10.2
Wilmington									
* Brandywine Creek	8.0			8.0			8.0		
(w/ Hoopes Reservoir)	20.0			20.0			20.0		
	28.0	31.0	-3.0	28.0	31.0	-3.0	28.0	31.2	-3.2
Newark									
* White Clay Cr. WTP	0.0			0.0			0.0		
* Groundwater	3.0			3.0			3.0		
	3.0	4.5	-1.5	3.0	4.7	-1.7	3.0	4.8	-1.8
New Castle County BWL	2.0	0.5	1.5	2.0	0.5	1.5	2.0	0.5	1.5
Subtotal	**73.0**	**86.0**	**-13.0**	**73.0**	**88.1**	**-15.1**	**73.0**	**89.8**	**-16.8**

10/21/99

CHAPTER 5 - FUTURE SUPPLY OPTIONS

The following options are available to close the gap between water supply and demand in Northern New Castle County:

Storage

- Newark Reservoir (170 mg to 265 mg/3 mgd)
- Expand Hoopes Reservoir
  - Conduct structural, geotechnical, hydraulic inspection of dam and reservoir to determine feasibility to:
  - Access deep, unusable storage (500 mg/8 mgd)
  - Raise Water Level 5 feet (300 mg/5 mgd)
  - Expand pump capacity to refill reservoir (12+ mgd)
  - Conduct water quality investigation
- UWD Offstream Storage Lagoons (18 mgd; 9 mg two times per day, brackish water, 25 mg/ 1 mgd freshwater)
- Thompson Station Reservoir (1.9 bg; 1.4 bg usable/24 mgd)
- AWC Marsh Reservoir (1.2 bg; 900 mg usable/15 mgd)
- UWD Bread and Cheese Island Reservoir (500 mg /8 mgd)
- City of Wilmington Blue Ball Reservoir (350 mg/6 mgd)

Ground Water

- AWC New Wells North of the C&D Canal (2 mgd)
- Newark South Wellfield Iron Treatment Plant (1 mgd)

Pipelines

- Philadelphia to Delaware Pipeline - (15 miles/20 mgd)
- AWC C&D Canal Pipeline (5 mgd)
- Increase to CWA to AWC interconnection (3 mgd)

Innovative Technologies

- Desalination on Christina River (20 mgd)
- Indirect Wastewater Reuse from Wilmington WWTP (20 mgd)
- AWC Aquifer Storage and Recovery (ASR) (300 mg/5 mgd)

TABLE 8. FUTURE WATER SUPPLY OPTIONS
Northern New Castle County
2-Dec-99

Option	Capacity	Cost	Timing	Advantages	Disadvantages
Storage					
Newark Reservoir	170 mg/ 3 mgd 265 mg/ 4 mgd	$ 7.2M Land, $ 9 M Construction $ 7.2M Land, $ 12 M Construction	3 years	* Improves Newark Reliability * Makes Newark Self-sufficient * Few Environmental Constraints * Provides Redundancy/Flexibility * Support from environmental and neighborhood community * Open space and recreational benefits * Precludes 200 homes and added water demand * Adjacent to WCC Water Treatment Plant	* Significant earth work * May require land condemnation
Expand Hoopes Reservoir **Conduct inspection to:** **- Access deep storage**	500 mg/ 8 mgd	$ 1 M to $ 2 M	I year	* Few Environmental Impacts * Deeper water is available but inaccessible	* Underwater work needed * Conduct water quality survey (Mn)
- Raise Water Level 5 feet	300 mg/ 5 mgd	$ 1 M to $ 2 M	I year	* Few Environmental impacts * Water level raised only during drought * Sufficient dam freeboard (15 ft) is available	* Geotechnical/Eng'g inspection needed * Impact to several waterfront landowners and 2 or 3 roads
- Expand Refill Pump Capacity	12 mgd(+) refill	$ 5 M to 10 M	2 years	* Take advantage of storms during drought * Refill reservoir more rapidly * Add pump capacity from Brandywine Creek or Red Clay Creek	* Pump and suction head limitations at Wills Pump station * Hydraulic capacity limitations due to 42 inch pipeline City to Hoopes
UWD Off Stream Storage Lagoon - B	9 mg (twice a day) 18 mgd (brackish water) 25 mg/ 1 mgd (freshwater)	?	2 years	* Utilize tidal flow behind inflatable TCS * Few environmental constraints as existing storage lagoons are utilized * Received US Army Corps of Engineers Permit	* Still subject to salt water from tides during drought (NaCl) * Needs chloride monitoring plan.
Thompson Station Reservoir	1900 mg; 1400 mg useable 24 mgd	$ 7 M Land, $ 56 M Construction	5 years	* Meets full deficit through 2020 * Provides flexibility along White Clay Creek * Would make Newark and UWD water supply fully reliable * Parks and recreation benefits	* Mature forest impacts * Riparian wetlands impacts * Adjacent to suspected Federal protected species habitat.
Artesian Reservoir	1200 mg; 900 mg 15 mgd	$ 82 M to $ 144 M	5 years	* Meets 75% of deficit through 2020 * Land owned by water purveyor * Centrally located * Opportunities for Wetland Mitigation	* Site Sediments are contaminated * 125 acres of wetlands affected * Regulatory permit constraints due to adjacent Federal protected species habitat.
UWD Bread & Cheese Island Reservoir	500 mg/ 8 mgd	$ 37 M	3 years	* Potential to blend and dilute NaCl at Stanton WTP during droughts * Centrally located adjacent to UWD Stanton WTP * Would make UWD fully reliable and self-sufficient Provides flexibility by adding storage along WCC * Few Environmental Impacts	* Minor riparian wetlands impacts * Floodplain regulatory issues * Potential upland forested impacts

TABLE 8. FUTURE WATER SUPPLY OPTIONS
Northern New Castle County
2-Dec-99

Option	Capacity	Cost	Timing	Advantages	Disadvantages
Storage					
Newark Reservoir	170 mg/ 3 mgd 265 mg/ 4 mgd	$ 7.2M Land, $ 9 M Construction $ 7.2M Land, $ 12 M Construction	3 years	* Improves Newark Reliability * Makes Newark Self-sufficient * Few Environmental Constraints * Provides Redundancy/Flexibility * Support from environmental and neighborhood community * Open space and recreational benefits * Precludes 200 homes and added water demand * Adjacent to WCC Water Treatment Plant	* Significant earth work * May require land condemnation
Expand Hoopes Reservoir **Conduct inspection to:**					
- Access deep storage	500 mg/ 8 mgd	$ 1 M to $ 2 M	I year	* Few Environmental Impacts * Deeper water is available but inaccessible	* Underwater work needed * Conduct water quality survey (Mn)
- Raise Water Level 5 feet	300 mg/ 5 mgd	$ 1 M to $ 2 M	I year	* Few Environmental impacts * Water level raised only during drought * Sufficient dam freeboard (15 ft) is available	* Geotechnical/Eng'g inspection needed * Impact to several waterfront landowners and 2 or 3 roads
- Expand Refill Pump Capacity	12 mgd(+) refill	$ 5 M to 10 M	2 years	* Take advantage of storms during drought * Refill reservoir more rapidly * Add pump capacity from Brandywine Creek or Red Clay Creek	* Pump and suction head limitations at Wills Pump station * Hydraulic capacity limitations due to 42 inch pipeline City to Hoopes
UWD Off Stream Storage Lagoon - B	9 mg (twice a day) 18 mgd (brackish water) 25 mg/ 1 mgd (freshwater)	?	2 years	* Utilize tidal flow behind inflatable TCS * Few environmental constraints as existing storage lagoons are utilized * Received US Army Corps of Engineers Permit	* Still subject to salt water from tides during drought (NaCl) * Needs chloride monitoring plan.
Thompson Station Reservoir	1900 mg; 1400 mg useable 24 mgd	$ 7 M Land, $ 56 M Construction	5 years	* Meets full deficit through 2020 * Provides flexibility along White Clay Creek * Would make Newark and UWD water supply fully reliable * Parks and recreation benefits	* Mature forest impacts * Riparian wetlands impacts * Adjacent to suspected Federal protected species habitat.
Artesian Reservoir	1200 mg; 900 mg 15 mgd	$ 82 M to $ 144 M	5 years	* Meets 75% of deficit through 2020 * Land owned by water purveyor * Centrally located * Opportunities for Wetland Mitigation	* Site Sediments are contaminated * 125 acres of wetlands affected * Regulatory permit constraints due to adjacent Federal protected species habitat.
UWD Bread & Cheese Island Reservoir	500 mg/ 8 mgd	$ 37 M	3 years	* Potential to blend and dilute NaCl at Stanton WTP during droughts * Centrally located adjacent to UWD Stanton WTP * Would make UWD fully reliable and self-sufficient Provides flexibility by adding storage along WCC * Few Environmental Impacts	* Minor riparian wetlands impacts * Floodplain regulatory issues * Potential upland forested impacts

Storage

Newark Reservoir

This proposed 170 mg to 265 mg/ 3 mgd reservoir is designed to improve the reliability and self-sufficiency of Newark's water supply system. The proposed reservoir would be constructed on vacant farmland (Koelig Farm) which has little forested area, wetlands, and habitat thus the environmental constraints are few. The proposed site is directly across the street from the City's WTP along White Clay Creek. This option would provide redundancy and flexibility by providing storage along White Clay Creek: Hoopes Reservoir storage is already available along Brandywine and Red Clay creeks. This alternative would provide environmental, open space and recreational benefits. This project has received near unanimous support from the environmental community, adjacent neighborhoods, and Newark City Council. If the Koelig Farm land is not acquired for this project, the developer has received New Castle County approval to build 200 homes which ironically would serve to increase the demand for water in a water short area. Newark City Council has voted to proceed with a public referendum scheduled for November 2 to raise bonds to fund land acquisition for the project. The voters on November 2 approved this referendum by a 3 to 1 margin. This project could proceed as Year 1 - acquire land and receive permits, Year 2 - complete design and commence construction, Year 3 - Fill the reservoir. The estimated costs as per the preliminary engineering report are:

* Land Acquisition $ 7.2 M
* Construction $ 9.0 M (170 mg) or $ 12.3 M (265 mg)

Land acquisition would be funded by bonds paid off with property tax increase and appropriations of $1.7 M per year for two years from the State legislature.

Expand Hoopes Reservoir

The City of Wilmington has made substantial investments in the past to store sufficient water in Hoopes Reservoir to meet its own needs during drought. Expansion of Hoopes Reservoir to meet the regional needs of other suppliers is contingent upon financial investments from the public sector (the State) and/or private suppliers. The following options include retaining a consultant to conduct a structural, geotechnical, and hydraulic inspection of the reservoir and develop a plan to:

* Access additional available storage in the lower portion of the reservoir (500 mg/8 mg). Currently the top 1.3 bg of the 2 bg Hoopes Reservoir is accessible down to minus 40 feet. The gates that would allow access to deeper storage are inoperable. This option would determine if the lower gates could be rehabilitated or rebuilt in the event this deeper water is needed. Alternatively plans could be developed to place portable pumps in the reservoir during drought to access water below the inoperable gates. An investigation of water quality would be required to determine iron and manganese concentrations in the lower portion of the reservoir. This plan would cost about $ 1 to $2 M and could be implemented within one year prior to the next summer's low flow period.

* Install infrastructure (an inflatable gate or flash-board) at the spillway to raise water levels temporarily during future droughts (300 mg/5 mgd). A dam safety and geotechnical engineering investigation would be required to verify the feasibility of this option. During non-drought periods, water levels would remain at current design levels. By raising water levels temporarily, an

additional 300 mg could be maintained for "salt storage" on White Clay Creek via releases to Red Clay Creek when required. UWD would be encouraged to negotiate a cost and capacity agreement with Wilmington prior to obtaining water from Hoopes Reservoir. The environmental impacts would be minimal - a half dozen waterside homeowners may be affected and relatively short portions of two or three roads would have to be evaluated for potential impacts. The cost for this option would be $ 1 to $2 M and could be implemented within one year.

* Expand the existing pumping capacity to refill the reservoir. Currently Hoopes Reservoir can be filled at rates of 12 or 24 mgd. An analysis would have to be conducted to determine if additional pump capacity could be added given the existing constraints of pump and suction head and pipeline capacity between Brandywine Creek and the reservoir. It is our understanding that the City of Wilmington has conceptual plans for improving infrastructure capability to withdraw water from Brandywine Creek and to increase capability for pumping to Hoopes Reservoir. This option could cost up to $10 M and be implemented within 1 to 2 years. An additional option would be to consider installing a pumping station on nearby Red Clay Creek to provide additional capability to refill Hoopes Reservoir during normal to high stream flows.

United Water Delaware Offstream Storage Lagoons

UWD has filed a permit application with the U.S. Army Corps of Engineers to build an off-stream raw water storage facility along White Clay Creek near its Stanton WTP. The proposed basin would be approximately 19 acres in size and have a storage capacity of 9 mg twice per day with the high tide or a total of 18 mgd. The purpose of the storage lagoons is to store more tidal water in conjunction with the inflatable TCS during low flow periods. The environmental constraints are few since the proposed site is the former location of the UWD storage lagoons. This option would not solve the chloride problem because it is designed to retain tidal water, which may be brackish during low flows. The lagoon could also be used to store fresh water (25 mg/ 1 mgd) from natural stream flows as well as water released from Hoopes Reservoir. This option could cost **$?** M and could be permitted and implemented within 1 to 2 years.

Thompson Station Reservoir

This alternative recommends the continued acquisition of open space and State Park land at this potential reservoir site along a tributary to White Clay Creek above Newark. This regional 1.9 bg (1.4 bg usable/24 mgd) regional pumped storage facility was proposed as an alternative under the New Castle County Water Supply Plan (EIS) process. This project would resolve the water supply deficit in Northern New Castle County for the next 40 years. Environmental studies indicate that the 120-acre reservoir pool would impact mature and second growth forest – home to several endangered plant and animal species- and is adjacent to habitat suspected to be favorable for the bog turtle, a Federally protected endangered species. Opportunities for habitat and wetland mitigation could be provided. The cost of this reservoir alternative was projected at $ 7 M for the land and $ 56 million for construction costs. Timing on this project would be at least 5 years.

Artesian Marsh Reservoir

This 900 mg/ 5 mgd reservoir was considered by the EIS process and was proposed on 135 acres of marshland adjacent to Christina River and south of I-95. EIS environmental studies indicate the site sediments are contaminated, 100 acres of wetlands would be impacted, and the site is adjacent to several upstream Superfund sites. Opportunities for wetland mitigation could be provided. In addition the regulatory complexity would be high because of the presence of a federally protected species (bald eagle) within ½ mile. The estimated total capital costs for this alternative are $82 M to $144 M depending on the level of sediment contamination. The timing on this project would be at least 5 years.

United Water Delaware Bread and Cheese Island Reservoir

UWD is investigating the possibility of constructing a 500 mg storage facility at Bread and Cheese Island just to the east of White Clay Creek. The purpose of the facility would be to increase UWD's sustainable supplies, provide for blending or dilution of salt water during drought and eliminate water quality problems associated with salt (sodium and chlorides) thereby making UWD "drought proof." The reservoir would rely on natural filling during high flows on White Clay Creek or be a pumped storage facility. The proposed site is located adjacent to wetlands and floodplains, and may contain environmentally sensitive forested upland habitats. A very preliminary cost estimate is $ 37 M and the facility would take approximately 3 years to complete.

City of Wilmington Blue Ball Reservoir

The City of Wilmington is investigating the feasibility of construction a 350 mg/6 mgd reservoir west of U.S. Route 202 (Concord Pike) opposite Porter Reservoir. The site being considered is currently being used for farming (corn and soy beans) and the environmental constraints are expected to be few. The source of water would be Brandywine Creek (pumped storage). The reservoir could be constructed as part of a multi-purpose recreational and greenway plan in the Blue Ball area. The estimated conceptual level cost of the reservoir is **$???** and the timing for permitting, design, and construction is estimated to be at least 5 years.

Ground Water

Install Additional Wells North of the C&D Canal

This option would entail installing several new wells in the Coastal Plain aquifers in Northern New Castle County. The DGS and the U.S. Geological Survey (USGS) have estimated that about 34 mgd is available from aquifers in the Coastal Plain of Northern New Castle County. The Delaware DNREC Division of Water Resources indicates that about 34 mgd for a peak day and about 28 mgd over the course of a year is currently allocated to existing wells. Therefore, comparing the currently estimated availability (34 mgd) to the peak day allocation (34 mgd) and under the current management practice, aquifers in the Coastal Plain appear to be fully allocated. The DNREC has authorized the U.S. Army Corps of Engineers to conduct a detailed ground water investigation

using computer modeling to update the estimates on ground water availability in Northern New Castle County. Artesian estimates an additional 2 mgd from new wells may be accessed within 2 to 3 years and would cost $ 1 M to $ 2 M.

Newark South Wellfield Iron Treatment Plant

During February 1999, Newark City Council approved a water supply plan that would include the installation of an iron treatment plant which would enable access to an additional 1 mgd of ground water that is currently not always available year round because of high iron and manganese. The City plans to allocate $ 2 M for the treatment plant and the plant could be online within 2 years. The City of Newark owns land on which the facility could be constructed.

Pipelines

Philadelphia to Delaware Pipeline

This out-of-state alternative would transport treated water from the Schuykill River through a 36 inch pipeline from Philadelphia International Airport to the Delaware stateline. The 15-mile pipeline would roughly follow the I-95 corridor and extend through two states, three counties, over a dozen municipalities and through the water service areas of the City of Philadelphia, Philadelphia Suburban, Chester Water Authority, and United Water Delaware. Existing EIS environmental studies indicate the quality of the raw water in the Schuykill River may be a concern and the institutional and regulatory complexity of building the pipeline through the many jurisdictions may present problems. Another issue is that the pipeline would be most cost-effective if utilized on a year-round basis. The need for additional water in northern New Castle County is limited to part of the year during the summer and early fall low flow months. The estimated cost of this pipeline is $28 M to $ 41 M and would take at least 3 to 5 years to permit and build.

AWC C&D Canal Pipeline

Several years ago the WRA advocated the installation of a 5 mgd, 16-inch pipeline across the Canal during the construction of the new Route 1 bridge to take advantage of the economies during bridge construction. The purpose of the 1.5 mile pipeline would be to move water north or south as needed during an emergency. The request was denied by DelDOT citing concerns over bridge aesthetics and bridge structural capacity to carry the pipeline.

Another option would be to install a pipeline under the Canal as suggested by AWC. Technology exists to do this with minimal interruption of landscapes. The estimated cost of this project is $ 1 M and would take about 2 years to complete. AWC reported that this option is included in its 5-year capital plan. This option would also require infrastructure development to tie existing distribution systems both north and south of the Canal together. In a December 22, 1995 letter from Governor Carper to Frank J. Cianfrani of the U.S. Army Corps of Engineers, the Delaware DNREC Division of Water Resources made a policy decision to reserve water supply in Southern New Castle County to meet the projected growth for that area. Use of water from Southern New Castle County to meet needs north of the C&D canal would require a review and revision of that DNREC policy.

Increase CWA to AWC Interconnection

This future option includes the increased interbasin transfer of 3 mgd though the existing CWA interconnection from Pennsylvania. The source of the water is the Octorora Reservoir in the Susquehanna River Basin. Currently, AWC obtains finished water from the Chester Water Authority through an existing interconnection at Limestone Road (Rte. 7) in Hockessin. The maximum hydraulic capacity of the interconnection is normally 6 mgd although only 4 mgd is available during drought. AWC has obtained dockets from the Susquehanna River Basin Commission (SRBC) and Pennsylvania Department of Environmental Protection (PADEP) through 2021 and a contract with the CWA to obtain up to 9 mgd through the interconnection. Possible constraints include restrictions or cutbacks set by PADEP, SRBC, and the CWA during drought and the need to upgrade hydraulic capacity at the pipeline. The estimated cost for needed improvements is $ 2 M and the timing for construction is 2 years.

Innovative Technologies

Desalination

This alternative would consist of a 20 mgd desalination plant along the brackish and tidal Christina River near Newport. Delaware companies such as DuPont manufacture the technology for desalination. The power-intensive project would cost $ 63 M to construct with annual operating costs of $ 7 M. The high costs result from the need to treat the water twice – once for pretreatment to remove sediment and pollutants and once to remove salt. Environmental studies indicate that salt brine disposal would be a concern. This project would be most cost-effective if operated year-round. However, under current conditions the need for additional water is limited to only part of the year, generally during the summer and fall. This project would take up to 5 years to permit and build.

Indirect Wastewater Reuse

This project would involve the construction of a pump station and a 20 mgd pipeline to convey treated wastewater from the Wilmington WWTP to just downstream of Wilmington's water supply intake along Brandywine Creek to help to maintain any promulgated instream flow requirements. The 30 inch pipeline would be about four miles long. The concerns for this project would be the potential for the wastewater to meet Delaware Surface Water Quality Standards (Fishable and Swimmable Criteria) and the upcoming Total Maximum Daily Loads (TMDLs) to be required by the USEPA under the Federal Clean Water Act. This project would cost up to $ 8 M and could be constructed in 1 to 2 years.

Aquifer Storage and Recovery (ASR)

AWC is currently employing this evolving technology at two of its Northern New Castle County wellfields in Coastal Plain aquifers. Although conveniently classified as "innovative" in this report, ASR is indeed a proven underground storage technology now utilized by the Artesian Water Company. ASR involves pumping treated surface or ground water into aquifers during periods when excess water is available and withdrawing water when required, generally during peak demand and relatively dry periods. Concerns with ASR involve the potential for technical difficulties associated with chemical differences between aquifer materials, aquifer water, and water

being pumped into the aquifer. In addition, aquifer geology and hydraulic characteristics must be favorable for ASR to function as designed. AWC has installed ASR systems at two locations and reports that the technology is favorable for additional ASR development. AWC estimates ASR can be developed to provide an additional 5 mgd to meet peak demands within 2 to 5 years at an estimated cost of $ 2 M.. At this time AWC has reported that they have the capability of withdrawing up to 2 mgd for limited time periods from their ASR facilities.

CHAPTER 6 - INSTITUTIONAL/GOVERNANCE/POLICY CHANGES

The following institutional, governance and policy changes will not increase current supplies of water but will provide for more optimal management and apportionment of water supplies and provide a basis for water supply planning to address growth and economic development.

- Appoint Water Master and Water Council, Authority, or Public-Private Consortium
- Increase Intracounty Interconnections
- Demand Side Management Through Pricing
- Review the Delaware Water Supply Regulatory Universe (Overhaul CPCN Regulations)
- Review NCC Subdivisions under Unified Development Code (UDC)

Appoint Water Master, Authority, Public-Private Consortium

Water Master or Coordinator - In the near term or interim, consideration could be given to appointing a person in the Governor's office, DEMA, or DNREC or other who would be responsible for ensuring that all selected options are implemented in accordance with an agreed upon time schedule. Slippage upon the agreed upon schedule should not be tolerated. The WRA and DGS could provide information and technical support to that person. The water coordinator would be appointed to mediate, facilitate, and coordinate with the water purveyors to implement the selected water supply options. The water coordinator would report regularly (say quarterly) back to the Governor's office and legislature regarding progress toward the schedule.

Complete and unified support for options selected by the Water Supply Task Force is needed from the Executive level, DEMA, and members of the Water Supply Task Force. A strong and unified State position regarding the selected options cannot be overstated.

Governors Water Supply Council - Appoint a Governor's Water Supply Coordinating Council composed of State, Regional, New Castle County officials and the five water providers to work with the water master or coordinator to implement the water supply options. The possible options available to constitute this council include: (a) Continue the Water Supply Task Force under Executive Order No. 65, (b) Appoint a new council requiring a new Governor's Executive Order, (c) Bring in an outside mediator to work to implement the options through an agreement between the water purveyors, or (d) Pass legislation creating a new authority to oversee implementation of the water options. Artesian Water has voiced concerns over the need for such a water council citing that the appointment of a water coordinator alone would be sufficient.

Water Authority - As an alternative to a coordinating council, consideration should be given to establishing a State Water Authority, Public Corporation or Public-Private Consortium to oversee water planning and implementation. In April 1997, KPMG Peat Marwick LLP prepared a draft report for the EIS Project Management Committee which evaluated various governance options. Table 9 contains excerpts of that report.

Table 9
Evaluation of Institutional/Governance Options
(modified from KPMG Peat Marwick LLP, 1997)

Option	Advantages	Disadvantages
Regional Authority	* Enables regional and equitable approach to supply solutions * Independence from customers * Region-wide financing capability	* May require new enabling legislation and structure * Operational capability need to be ramped up
State Authority	* State-wide approach to water solutions * Independent from private-public water interests * Enhanced financing and bonding capability * Utilize existing State authority as parent or host	* Upstate vs. downstate issues * Added layer of government * Requires new legislation
Public Corporation	* No new powers needed if parent corporation found	* Need to identify willing organization to incur responsibility. * May not have water experience, start up costs
Utility Consortium	* Could quickly develop projects * Experienced in water operations	* Subject to property taxes * Tax-exempt private financing difficult • Not independent, neutral, Nor regional
Partnership Public Owner, Private Operation	* Operate/maintain facilities owned by public * Public ownership with tax exempt financing * Private operation efficiency	* Need to select private utility from one of two purveyors * Must comply with Federal law for tax exempt financing

Increase Intracounty Interconnections

Each individual water purveyor should examine existing interconnections and make plans to increase hydraulic capacities for providing and/or receiving water where possible. This analysis may require hydraulic modeling and/or a full scale field test to monitor interconnection capacity during peak demand conditions. The existing interconnected capacity is about 8 mgd through 24 interconnections. New interconnections should be installed and existing interconnections modified to increase capacity to move water when and where needed in Northern New Castle County.

Demand Side Management (DSM) Through Pricing

This alternative seeks to save water by depressing demands encouraging water conservation through water rate pricing employing the adage "the more water used the more water costs." The following

DSM hierarchy in decreasing order of preference is available. (1) Water purveyors should consider adopting an inclining block water rate similar to ones used by Artesian Water Company and the City of Newark. (2) The City of Newark recently adopted a conservation water rate by seasonally charging more for water used during the summer and fall low stream flow, high demand period. (3) The Pennsylvania DEP in its Drought Management Plan provides for charging up to $7.00 to $12.00 per 1000 gallons during drought periods with the excess money collected deposited into a drought mitigation bank. By comparison, water rates for municipal purveyors in Northern New Castle County range from $ 2.00 to $ 3.00 per 1000 gallons and investor owned purveyors range from $4.00 to $ 5.00 per 1000 gallons. Last in order of preference would be DSM through Governor declared drought warning and voluntary water restrictions or more severely, drought emergency and mandatory water restrictions.

Delaware Water Supply Regulatory Universe

Figure 8 describes the Delaware Water Regulatory Universe. The following programs regulate water supplies in Delaware:

- Delaware Department of Natural Resources and Environmental Control
- Delaware Division of Public Health
- Public Service Commission
- Office of the State Fire Marshall
- New Castle County
- Delaware River Basin Commission

DNREC - Division of Water Resources, Well Drilling Licensing/Permits

This Division issues licenses to well contractors, drillers, and pump installers and issues well permits. Well permits are usually the first indication of well capacity and location.

DNREC - Division of Water Resources, Water Allocation Permits

The State under law is the trustee of water resources and is therefore responsible for water allocations. Water allocations are required for withdrawals greater than 50,000 gpd. The permitting program establishes maximum withdrawal limits from ground and surface water. Applicants must prove the need in terms of water demand to receive an allocation.

DNREC - Division of Water Resources, Water Service Areas (CPCNs)

Consideration should be given to overhauling Certificate of Public Convenience and Necessity (CPCN) regulations to provide for better water supply planning while accommodating growth in State designated investment areas. Currently, the regulations for water permitting, allocation, and planning are administered in many different State departments. Current water regulations result in award of service areas on a piecemeal subdivision by subdivision basis as opposed to a regional basis resulting in the potential for over allocation of the water resource and excess infrastructure (the case where water mains from two different suppliers are along the same road or water tanks from competing suppliers are across the street from each other). The current CPCN program requires no linkage between award of water service areas with master planning, resource management, or water allocations.

Two sections of the DNREC issue separate well drilling and water allocation permits. Another office of DNREC awards water service areas or Certificates of Public Convenience and Necessity based on little more that a map and an agreement with a property owner. Water permits are also needed for water pressure from the State Fire Marshals office, the Division of Public Health for drinking water quality approval and the Public Service Commission.

As an alternative, consider merging all of these water approvals under the umbrella of the CPCN program. The water supplier would have "one stop" shopping and the necessary and various approvals would be made as condition for the award of a water service area. In addition, the CPCN regulations should be modified to award service areas based on short term (5 year) and long-term master plans prior to approval. There is consideration to move the water CPCN program from the DNREC to the Public Service Commission.

Division of Public Health, Office of Drinking Water

This office in the Department of Health and Social Services regulates the quality and safety of drinking water and establishes health standards for water. The office maintains sampling programs for public water systems, has administrative penalty authority, and can provide funding assistance to purveyors through EPA grant and loan programs.

Office of the State Fire Marshall

This office has offices in all 3 counties and ensures adequate water supply for fire fighting purposes. The fire marshall certifies land development plans requiring minimum fire flow standards for developments within public water systems of 500 to 1000 gpm for 2 hours. Usually, adequate fire flow will provide adequate drinking water supply.

Public Service Commission

The PSC regulates investor-owned water utilities, not municipal. The PSC regulates water rates through review of rate applications and public hearings. The PSC also sets standards for adequacy of service to customers through minimum water pressure (25 psi) and water quality standards. The PSC awards CPCNs to the cable TV and power industry and consideration has been given to transferring the water CPCN process from DNREC to the PSC.

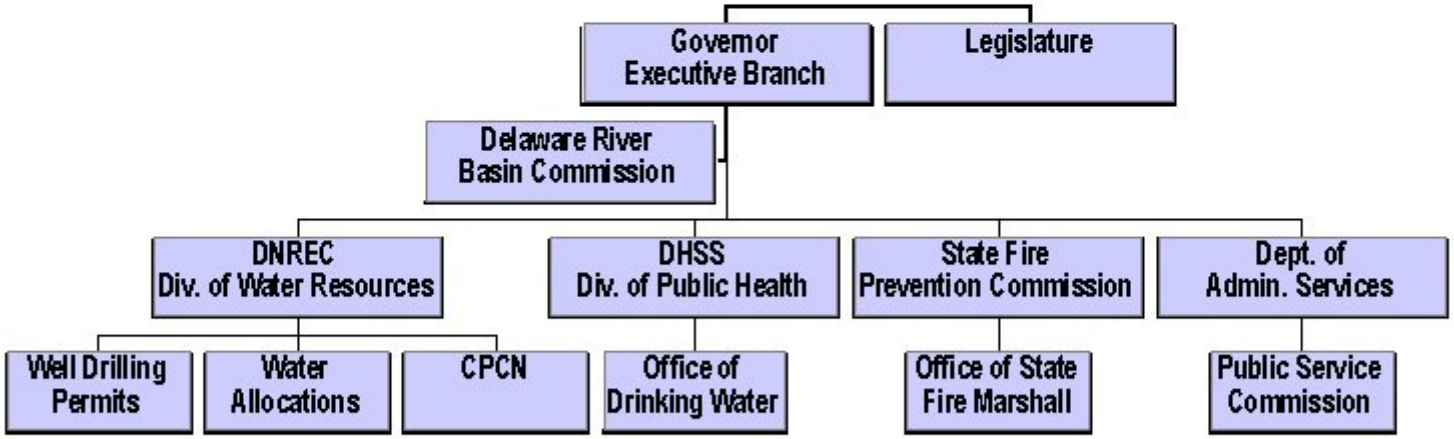
New Castle County

The recently adopted New Castle County Unified Development Code (UDC) requires new developments to fill out a Water Certification Form (Exhibit I) to prove adequate water capacity and pressure to support new growth. Currently there are approximately 10,000 new homes in Southern New Castle County that are grandfathered under the old County code which were not required to submit the water certification form. The State Legislature and New Castle County could consider developing legislation with the intent to roll back the grandfathered approval and require as many new subdivisions as possible to meet the provisions of the UDC Water Certification form.

Delaware River Basin Commission

The DRBC was formed by compact during the 1960's. The Governors of Delaware, New Jersey, New York, and Pennsylvania; and the U.S. government (Corps of Engineers) are the commissioners. The governors and the U.S. commissioner are the DRBC. The DRBC oversees regulatory matters involving water supply management in the 4 States in the Delaware River Basin (watershed). The DRBC issues dockets for new and increased ground and surface withdrawals exceeding 100,000 gpd and establishes minimum instream flow standards (7Q10) along the White Clay Creek in Delaware. The DRBC initiated water conservation standards in Delaware such as metering and low flow plumbing fixture requirements.

Delaware
Drinking Water Regulatory Universe



Advisory: DGS
UD WRA

New Castle County UDC

CHAPTER 7 – CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The century-ending drought of 1999 was a severe meteorological event which threatened to interrupt the availability of water supply in Northern New Castle County, Delaware. On August 5, 1999 Governor Carper, at the recommendation of his Drought Advisory Committee, declared a Drought Emergency with mandatory water restrictions in Northern New Castle County. The drought ended in September 1999 with the rains of hurricanes Dennis and Floyd.

During the Drought Emergency, Governor Carper signed Executive Order No. 65 which appointed a Water Supply Task Force composed of State, Regional, and County agencies and five public and investor-owned water purveyors serving north of the C & D Canal. The charge to the Task Force as summarized in this report was to evaluate the effects of the drought, update the supply and demand curves, and recommend solutions to close the gap between supply and demand in Northern New Castle County during droughts. The Task Force met on September 14, October 1, October 21, November 5, and November 18, 1999. This report is a dynamic document which can be updated regularly as new information is gathered

Supply and Demand

The Task Force reviewed estimates of supply and demand for worst case drought conditions for planning years 2000, 2010, and 2020. Supply-side estimates involved three scenarios based on assumptions for minimum instream flow standards: (1) Drought Emergency – No 7Q10 minimum flow standard along the Brandywine Creek at Wilmington and White Clay Creek at Stanton, (2) Existing Regulatory Condition – No 7Q10 minimum flow standard along Brandywine Creek but the 7Q10 standard in effect along the White Clay Creek, and (3) Future Condition – 7Q10 minimum flow standards in effect along Brandywine Creek and White Clay Creek. The demand-side estimates were obtained from maximum monthly demand data compiled in the Merna Hurd report in 1998. The supply and demand curves for Northern New Castle County forecast a deficit of 17 mgd or 1020 million gallons (mg) during a 60-day drought period by year 2020 assuming 7Q10 minimum instream flow standards are in effect along both streams.

Scenario Year 2020	Supply (mgd)	Demand (mgd)	+/- (mgd)	Volume (mg)
1. No 7Q10 Flow Standard	93	90	+3	+180
2. 7Q10 along WCC only	85	90	-5	-300
3. 7Q10 along BRCR and WCC	73	90	-17	-1020

Future Water Supply Options

The Task Force then compiled a list of future water supply options available to close the 17-mgd (1020 mg) gap between supply and demand in Northern New Castle County by the year 2020. The following “A” list represents water supply options which are committed to be installed by the water

providers, have few environmental and technical constraints, enjoy community support, and can be implemented in the near term in 1 to 3 years:

A. Future Water Supply Options – Committed to by Water Providers

Newark Reservoir	200 mg	3 mgd
Wilmington Access Hoopes Reservoir Deep Storage	500 mg	8 mgd
(Subject to financial investment by public sector and water sale agreements w/ public/private water utilities)		
United Water Delaware Storage Lagoon-B	25 mg	1 mgd
(Subject to fiscal and prudency review when compared to other viable options)		
Artesian Water Co. New Wells N. of the C&D Canal	120 mg	2 mgd
(Subject to the groundwater modeling study by the U.S. Amy Corps of Engineers in year 2000)		
Newark South Wellfield Iron Treatment Plant	60 mg	1 mgd
Artesian Water Co. Aquifer Storage and Recovery Wells	300 mg	5 mgd
Total	1205 mg	20 mgd

The following “B” list involves water options which can be achieved over a longer term but have technical, cost, environmental and/or policy obstacles that must be addressed:

B. Future Water Supply Options – Achievable in Longer Term

Increase CWA to AWC interconnection	180 mg	3 mgd
Wilmington Raise Hoopes Reservoir Water Level	300 mg	5 mgd
(subject to financial investment by the public sector (the State) and/or the private supplier(s)		
UWD Bread and Cheese Island Reservoir	500 mg	8 mgd
Artesian Water Co. C&D Canal Pipeline	300 mg	5 mgd
(subject to review of DNREC policy regarding water supply in Southern New Castle County)		
Philadelphia to Delaware Pipeline	1200 mg	20 mgd
Total	2480 mg	41 mgd

And the following "C" list involves water options that are have significant environmental, cost (high), community support (lack of), and technical constraints, and are less likely to be achieved:

C. Future Water Supply Options - Longer Term, Significant Constraints

Wilmington Blue Ball Reservoir	350 mg	6 mgd
Artesian Reservoir	900 mg	15 mgd
Thompson Station Reservoir	1200mg	20 mgd
Regional Desalination Facility	1200 mg	20 mgd
(Reverse osmosis may be feasible in the future for individual purveyors)		
Indirect Wastewater Reuse	1200mg	20 mgd

Recommendations

The Task Force reviewed and recommended the following institutional/governance/ policy changes that will increase the supply of water and allow for more efficient management and apportionment of water supply in Delaware:

1. Temporary Water Master:

   Appoint an interim water master or central coordinator who would ensure that the "A" list committed to projects and possibly the "B" list projects are implemented according to an agreed upon schedule without slippage. The water coordinator would concentrate efforts on ensuring that providers with supply needs take the appropriate and necessary actions to address their supply deficit. The water coordinator would provide quarterly progress reports to the Governor and Legislature which include regular updates to this Water Supply Task Force Report as new information is developed.

2. Water Supply Coordinating Council:

   Appoint a Water Supply Coordinating Council composed of State, Regional, New Castle County officials, the five water providers, and the public to work with the water coordinator to implement the water supply options. This forum would be established to offer the five water purveyors further opportunity to communicate, coordinate, and exchange information as a positive step to better manage water supplies.

   The Artesian Water Company has voiced concerns about the need for a Water Supply Coordinating Council and indicated that the appointment of a water coordinator alone would be sufficient. The Governor's Water Supply Coordinating Council would be appointed to perform the following specific functions:

   - Work cooperatively with the interim water coordinator to implement the "A" list (committed to) and possibly "B" list (longer term) future water supply options in accordance with an agreed upon schedule.
   - Conduct hydraulic field tests and/or modeling to optimize and expand the intra-county interconnections to convey water from suppliers with excess capacity to suppliers in need of additional water to meet peak demands during normal and drought periods.
   - Encourage the water providers (if they do not have them) to adopt inclining block and/or conservation water rates as a demand side management measure in a manner that does not hinder economic development in New Castle County.
   - Work with the utilities to develop cooperative cost and capacity agreements to purchase water supplies during drought.
   - Advise the DNREC and provide technical input to ensure the completion of the recently authorized U.S. Corps of Engineers Groundwater Availability Study for Northern New Castle County.

- Review the policy decision made by DNREC to reserve water supply in Southern New Castle County vis-à-vis the C&D Canal Pipeline in light of recent demand and supply analysis and the changing socioeconomic character of Southern New Castle County

- Develop a water quality sampling plan for Hoopes Reservoir.

3. Overhaul CPCN Process:

Propose legislation to overhaul the Certificate of Public Convenience and Necessity (CPCN) regulations to tie the awards of new and existing water supply franchise areas to certification by the water purveyor of adequate capacity, pressure, quality, and master plans. Currently the DNREC CPCN regulations require only approval by a property owner and a boundary drawn on a map to award a franchise area to a water purveyor.

The CPCN language would be revised to relinquish existing service areas or prevent award of future service areas to any utility that does not provide adequate water supply quantity and quality to customers during peak demand and normal or drought (low flow) conditions.

As a further move to strengthen the process, move the water supply CPCN process from DNREC to the Public Service Commission since the PSC currently has regulatory oversight of water rates and consumer service. The amended CPCN legislation should include the following checklist tying the approval of water service areas to:

- Regional water planning

- Certification that the water purveyor has adequate capacity to meet existing peak demands and is working toward meeting future peak monthly water demands for the year 2020 during drought of record conditions assuming 7Q10 minimum flow standards are in place along the White Clay Creek and Brandywine Creek

- Cross linking with the Division of Public Health regarding certification of water quality in accordance with U.S. Environmental Protection Agency and Delaware primary and secondary drinking water standards.

- Requirements for short-term and long-term master plans for a requested franchise area including capital budget, system mapping, and hydraulic computer modeling.

- Cross linking between DNREC well drilling and allocation permits

- Cross linking between certification of minimum pressure and capacity by the Fire Marshall and Division of Public Health

- Standards for water mains, storage, metering, and interconnections in accordance with American Water Works Association standards and existing State and local regulations

The water purveyors have expressed support for revamping the CPCN process as the "umbrella" for coordinating water supply regulation in Delaware. The City of Wilmington has pointed out that moving the CPCN process from the DNREC to the PSC may be problematic because the PSC currently oversees only investor-owned water purveyors. The DNREC supports moving the CPCN process to the PSC. Both the DNREC and the PSC have pointed out that more labor and resources (more than the current 0.2 full time equivalent) need to be allocated to administer the CPCN program if the process is expanded.

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