CAPE COD COMMISSION
3225 Main Street
PO Box 226
Barnstable, MA 02632
(508) 362-3828
Fax: (508) 362-3828
frontdesk@capecodcommission.org

MEMO

TO: DHCD
FROM: Tom Cambareri, Project Manager
DATE: January 15, 2010

RE: DLTA PROJECT: Barnstable ZONE II

This memo is a final report on progress and deliverables for the Barnstable Town-wide Zone II delineation project. All referenced materials are attached to this memo.

Contractual
The conceptual project began in January 2009 when the Town of Barnstable responded to the Cape Cod Commission's request for project proposals. The Commission selected the project from over a dozen that were submitted, and notified the town on February 19, 2009. Commission water staff worked with the town on the scope of work and received signed contracts from the town on April 15, 2009, which were executed in turn by Barnstable County on June 1, 2009.

Existing Information Review
Commission water staff conducted a review of previous wellhead protection and Zone II delineation work in the Town of Barnstable. The town had undertaken several groundwater modeling projects over the last two decades. The Commission summarized this to focus the present effort and to use it as part of the DEP Zone II Re-delineation proposal discussed below.

Kick-off Meeting
The town-wide Zone II delineation project was not a straightforward project in the Town of Barnstable. The town has three separate and independent water districts and one town department district under the Department of Public Works. The four "districts" discussed in this report include:

1. Hyannis Water Division – Barnstable DPW
2. Centerville-Osterville-Marstons Mills Water District
3. Barnstable Fire District
4. Cotuit Water District

Commission staff coordinated a kick-off meeting with Town of Barnstable officials and the superintendents of the four separate water districts on May 11, 2009. The superintendents had been discussing the need for such a project for a number of years so when the opportunity came for the DLTA project, they were enthusiastic participants. Commission staff provided background materials to review the existing Zone II and to determine what type of information would be necessary for the updated Zone II to proceed. Commission staff requested five years of pumping data over the years 2004 to 2008 to update the groundwater model.

Data Compilation
Commission staff worked with the districts to get pumping data for the five–year period. This took more than several weeks. In addition, Commission staff requested and received copies of complete Annual Statistic Reports for the 2008 year that were filed with DEP. DEP provided the complete Cape set of supply information so staff was able to compile that information as well. At the end of the task, Commission staff had produced:

- A five-year summary of pumping data for the four districts
- A Cape-wide summary of pumping statistics for public water suppliers

Commission water staff also prepared at data set of the USGS index-well water-table observations for calibration. The USGS data consists of monthly water-level readings at 28 well sites across the Sagamore Lens. Some of these observation wells have more than 50-year periods of record. Water staff summarized the data for the long-term record and the five-year calibration period.

Groundwater Modeling Preparation
Commission water staff worked on several levels to prepare the model for the Zone II delineation. Water staff downloaded the USGS groundwater "Modflow" model for the Sagamore Lens onto Commission computers and configured it to a proprietary groundwater modeling software called "Groundwater Vistas." Water staff launched the software and performed preliminary model runs to become better familiar with the product.

Data Set Configuration
Commission water and GIS staff configured the pumping data summaries into the "Modflow" format for modeling. This consisted of preparing a special GIS data set of all the public supply wells in the Sagamore Lens and attaching the various pumping rates, including average and maximum pumping for the model calibration and Zone II modeling.

DEP Zone II Re-delineation Proposal Submittal
Commission water staff prepared a Zone II re-delineation proposal for the Town of Barnstable to submit to DEP per the Water Supply Guidelines of 2009. DEP will review the proposal and provide suggestions and/or comments before the Zone II delineation modeling is completed. Unfortunately, delay in receiving initial data sets and required internal review of the letter proposal resulted in a delay of the submittal of the DEP proposal. At the present time the DEP proposal letter is still under review by the town.

Project Completion Schedule
Commission water staff anticipates a meeting with DEP to go over the project proposal before getting a verbal or written go-ahead. The modeling portion of the project is staged to begin immediately, and it is anticipated that project completion, including water superintendent review and final report submittal to DEP, will be before June 30, 2010.

Budget
Project funds under the DLTA grant have been totally spent by the efforts to stage the project. The Commission anticipates using in-kind efforts and potentially submitting a request for additional funding under the 2010 DLTA program.

Interim Project Deliverable Use
The water-supply data set compilations have been used by several different parties as well as by Commission staff for the modeling project:

- The Town of Barnstable consultant preparing the Nutrient Management Plan, which will be the basis of the town's Comprehensive Wastewater Management Plan, recently requested this project's five-year summary. The pumping data allows the consultant to evaluate average and peak demands for the different districts in order to better design the wastewater treatment capacity needs.

- The consultant for the Cape Cod Water Protection Collaborative is using the data to calibrate Cape-wide wastewater generation that will be used to estimate Cape-wide wastewater infrastructure costs.

The Town of Barnstable
Office of Town Manager
367 Main Street, Hyannis MA 02601
www.town.barnstable.ma.us

Office: 508-862-4610
Fax: 508-790-6226
Email: john.klimm@town.barnstable.ma.us

John C. Klimm, Town Manager

Barnstable All-America City 2007

Ms. Patty Daley, Director of Technical Services
Cape Cod Commission, Barnstable County
3225 Main Street, P.O. Box 226
Barnstable, MA 02630

January 15, 2009

RE: Request for Technical Assistance – Town-Wide Zone II Assessment Involving Four Water Districts and neighboring Towns.

Dear Ms. Daley:

The Town of Barnstable requests technical assistance under the District Local Technical Assistance (DLTA) Program for a Zone II Assessment of the four water districts within Barnstable and those Zone IIs shared with neighboring towns. This project can serve as a regional model for other Cape, and off-Cape, municipalities with shared Zone IIs as a mechanism to protect water resources while allowing for smart re-development.

This project has been discussed by, and is supported by, the Water Quality Advisory Committee, comprised of representatives from the four water districts, town staff, and staff from the Commissions Water Resources Office.

Specific technical assistance requested includes the following:

- Evaluate the existing approved Town-wide Zoning map, showing all Zone I, II, WP, GP, AP districts, the Geraghty & Miller "Groundwater Conditions Report" (November 1993), and other pertinent information.
- Update planimetric and associated database information using information gathered from the four water districts and adjacent Towns.
- Update and re-run the groundwater model, with carefully defined parameters.
- Based on the results of the updated groundwater model document recommended changes to Zone IIs

- Based on the results of the updated groundwater model recommend changes to town zoning.

- Assist with the DEP approval process for recommended changes to Zone IIs.

- Assist the town(s) with the process for recommended changes to zoning.

Hans Keijser, Supervisor of the Hyannis Water Supply Division, and Dale Saad, Ph.D., DPW Senior Project Manager for Water & Sewer, will oversee the project for the Town. Cape Cod Commission Water Resources staff will assist in the development of the project timeline, and will develop the cost estimate. Staff from other Town Departments and DPW Divisions will be available to assist as needed.

Thank you very much for your consideration and support of this important project.

Very Truly Yours,

John C. Klimm
Town Manager

Memorandum of Agreement
Between

Barnstable County through
Cape Cod Commission
3225 Main Street
Barnstable, MA 02630

and

Town Manager on behalf of
Town of Barnstable
367 Main Street
Hyannis, MA 02601

This Memorandum of Agreement (Agreement) is entered into this _____ day of March 2009 by and between Sheila Lyons, Mary Pat Flynn and William Doherty as they are the Commissioners of Barnstable County, acting by and through the Cape Cod Commission (hereafter referred to as the "Commission") and the Town of Barnstable (hereafter referred to as the "Town.")

WHEREAS, the Commission has received funding from the Department of Housing and Community Development to provide technical assistance to local communities under the provisions of Chapter 205 of the Acts of 2006, as amended, and

WHEREAS, the Town of Barnstable has requested technical assistance for a town-wide Zone II assessment of four water districts and neighboring towns,

NOW THEREFORE, the Town enters into this Memorandum of Agreement with the Commission.

1. RESPONSIBILITIES OF THE TOWN

A) The Town has requested technical assistance from the Commission in accordance with its letter January 15, 2009. incorporated herein by reference.

B) The Town agrees to work with the Commission as per the attached Scope of Work (Attachment A.)

2. RESPONSIBILITIES OF THE COMMISSION

Upon execution of this Agreement, the Commission agrees to provide the Town with the technical assistance outlined above at an estimated cost of $15,000. Funding for this technical assistance is provided by the Department of Housing and Community Development.

3. DURATION

A) This Memorandum of Agreement shall be effective until December 31, 2009 unless an extension in time is agreed to in writing by both parties.

B) Either the Town or the Commission may terminate this Agreement by written notice to the other party, if the other party substantially fails to fulfill its obligations hereunder through no fault of the terminating party, or if the other party violates or breaches any of the provisions of this Agreement. Such notice shall be delivered by certified mail at least thirty (30) days before such effective date. In the event of such termination or suspension of this Agreement, the Commission shall be entitled to just and equitable compensation for satisfactory work completed, for services performed and for reimbursable expenses necessarily incurred in the performance of this Agreement up to and including the date of receipt of notice of termination or suspension.

4. AMENDMENT

This Agreement may be amended as mutually agreed by both parties in writing.

5. SIGNATORY AUTHORIZATION

The respective signatories hereto represent and warrant that they are duly authorized to execute this Agreement on behalf of the public entity on whose behalf they have signed this Agreement, and that all substantive and procedural preconditions to their effective execution of this Agreement on behalf of said public entities have been satisfied.

6. INTEGRATED INSTRUMENT

This Agreement shall take effect as an integrated instrument.

IN WITNESS WHEREOF, the TOWN and the COMMISSION execute this Agreement this ____ day of March in the year two thousand and nine.

BARNSTABLE COUNTY COMMISSIONERS

_____
Sheila Lyons, Chairman

_____
Mary Pat Flynn

_____
William Doherty

_____
Date

TOWN OF BARNSTABLE

_____
John C. Klimm, Town Manager

_____
Date

CAPE COD COMMISSION

_____
Paul Niedzwiecki, Executive Director

_____
Date

ATTACHMENT A
Scope of Work

The deliverables of this scope of work are predicated on the use and acceptance of the USGS groundwater model for the Sagamore Lens as the tool to redefine the Zone IIs and use of existing available data. If a new model or numerous changes to the existing model boundary conditions are required for the Zone II delineation, the project may require re-scoping and an amendment of the MOU.

1) Assemble available previous Zone II reports and hold a kick off meeting for the Barnstable Water Superintendents. Discuss project goals and information needs. Discuss conditions for previous report and plan a strategy for: defining existing conditions, Zone II conditions and future conditions, and collecting additional data such as pumping records, water level monitoring, etc …..

2) Working with the Town's Project Manager assemble information from Suppliers and prepare a pumping conditions document for the Groundwater modeling project.

3) Meet with DEP to discuss the town's project and methods to update the Zone IIs

4) Update the USGS model for the Sagamore Lens using the new pumping data.

5) Present initial Zone II results and other Zone of Contribution scenarios.

6) Prepare written report documenting the project and results.

7) Provide recommendations to the Water Districts on revised Zone IIs and Town Zoning Overlay district

8) Assist town with the DEP approval process and attend meeting for Town approval

CAPE COD COMMISSION

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MEMO

TO: Dr. Dale Saad
DPW- Town of Barnstable
Hyannis, MA 02601

FROM: Tom Cambareri

Date: June 1, 2009

RE: Zone II MOA

Attached are two signed original copies of the MOA.

Please confirm receipt.

I look forward to working with you and the Districts on this important project.

Town of Barnstable

Water Quality Advisory Committee

May 11, 2009
3:00PM

COMM-Water District
Conference Room
Agenda

District Updates
- Water towers
- MTBE settlement

Town Zone II modeling

Town Nutrient Management Plan

Other

Next Meeting Schedule

Mr. Richard Rondeau, Chief
Drinking Water Program
MassDEP Southeast Region Main Office
20 Riverside Drive
Lakeville, MA 02347

Dear Mr. Rondeau

The Town of Barnstable in 1993 conducted a Town-wide Zone II delineation that made use of a single model of the Sagamore Lens and a single Zone II simulation of numerous wells to delineate the Zone IIs. Since 1993, water districts in the town have added several new wells which have been delineated with different methods. The town of Barnstable proposes to update the town-wide Zone IIs by adding the new wells and using the new US Geological Survey groundwater model to provide one consistent approach. This work is important because it enable the town to better protect its water supplies in the face of efforts to locate new wastewater discharges. The town is working in cooperation with the water three water districts in the town and the Hyannis Water Division. The town has contracted with the Cape Cod Commission to perform the work for the town and the Districts.

The town submits this proposal according to the 2009 Standards & Guidelines for Contaminants in Massachusetts Drinking Water Chapter 4, Section 11: Redelineation of Zone IIs. The attached outlines the Town's technical rationale for redelineation and includes a discussion of the previous methods and proposed use of a more sophisticated model. We understand from the Guidelines that DEP will review the proposal and potentially coordinate a technical meeting and/or supply specific instructions pursuant to the Guidelines.

Please contact Tom Cambareri at the Cape Cod Commission or myself if you have any questions.

Sincerely,

Dale Saad,
Project Manager

Cc: Mark Ells, DPW-Superintendent
Craig Crocker, COMM Superintendent
Chris Wise, Cotuit Water District
Jon Erikson, Barnstable Fire District superintendent
Hans Keijser, Hyannis Water Superintendent
Tom Cambareri, Cape Cod Commission

Barnstable Town-wide Zone II Delineation

Previous Investigations

The Zone II delineations for public water supply wells in the Barnstable Area have a long history. The Town first adopted Zones of Contribution ZOCs were delineated by Cape Cod Planning and Economic Development staff in 1981, making use of the first USGS Regional Water Table Map from 1977 (Leblanc and Guswa, 1977) and using an analytical technique later described by (Horsley and Cambareri, 1986). In the Groundwater and Water Resource Protection Plan of 1986, SEA consultants used the USGS Groundwater model by Guswa and LeBlanc, (1981) to develop new ZOCs. The USGS groundwater model had a half-mile grid discretization, 36 rows, 58 columns and 5 layers. At that time it was unclear how DEP would apply their 1979 definitions for Zone I, II and III that were developed for glacial valley-filled aquifers to the Cape Cod Aquifer. The Town of Barnstable subsequently contracted with SEA Consultants (1989) to perform a DEP Zone II delineation for the public water supply wells. This time the consultants modified the USGS model into the MODFLOW format. Changes to the model included a discretization to 660 ft, a higher hydraulic conductivity in the outwash up to 250 ft/d, incorporation of a river module and the preparation of a town water table map upon which to calibrate the model. The modeling process included two scenarios for the town. One was a Zone II delineation for the existing wells for DEP approval, The second scenario also included future and proven future wells for adoption by the town in as part of their Water Resources Protection bylaw. This bylaw and a map of the district was adopted in 1991. The DEP did not approve the Zone II delineation.

The Town subsequently contracted with Geraghty and Miller (1992) to develop a new groundwater model as part of the Wastewater Facility Plan that Barnstable started in 1988. This effort also imported the initial USGS model into the newer MODFLOW groundwater code. The model which also covered the Sagamore lens had 85 rows and 132 columns and 5 layers. Grid size ranged from half mile to 660 in the East Barnstable area. An observed water table map was developed for the 1992 year from 84 observation points and was used as the basis of calibration. Geraghty and Miller (1993) subsequently prepared a technical document for the Towns Wastewater Facility Plan describing the MODFLOW groundwater model. Geraghty and Miller (1993) were then contracted to delineate the Zone IIs to the public water supply wells in the town. This document was the formal submittal to DEP with agreed upon and specified pumping rates for the public supply wells in the town's four independent water districts. The grid size for the Zone II model was further reduced to 330 ft resulting in a model of 264 rows, 170 columns and 5 layers. The Zone II submittal was approved by DEP and the town adopted the new map as the Water Resource Protection bylaw. Two additional Zone IIs were delineated using a method independent of the Town-wide model and added to the map and the Protection District was subsequently amended.

USGS Groundwater Model

The USGS developed a groundwater model of the Sagamore and Monomoy Lens in 2004 (Walter and Whealan). The USGS three-dimensional, finite-difference groundwater

model MODFLOW-2000 (Harbaugh, et al., 2000) was used to simulate groundwater flow in the aquifer. The USGS particle-tracking program MODPATH4 (Pollock, 2000), which uses output files from MODFLOW-2000 to track the simulated movement of water in the aquifer, was used to delineate the area at the water table that contributes water to wells, streams, ponds, and coastal water bodies. This model has been the used as the basis of watershed boundaries to coastal embayments as well as the definition of pond and stream watersheds for the land use analysis of the MEP technical reports and subsequent DEP and EPA approved TMDLs.

The Sagamore Flow Model grid consists of 246 rows, 365 columns, and 20 layers. The horizontal model discretization, or grid spacing, is 400 by 400 feet. The top 17 layers of the model extend to a depth of 100 feet below sea level and have a uniform thickness of 10 ft. The top of layer 8 resides at sea level with layers 1-7 stacked above sea level to a maximum elevation of +70 feet. In Barnstable study area of the Sagamore Lens water elevations range up to 40 ft so the top 5 layers are not required for model operation. At depth within the aquifer, layer 18 has a thickness of 40 feet and layer 19 extends to 240 feet below sea level. The bottom layer, layer 20, extends to the bedrock surface and has a variable thickness depending upon site characteristics.

The USGS Model incorporated geologic and pump test data to determine hydraulic conductivities from a variety of sources including well logs from USGS, local Town records, and data from previous investigations. Final aquifer parameters were determined through calibration to observed water levels and stream flows. Hydrologic data used for model calibration included historic water-level data obtained from USGS records, Water Districts and local Towns, as well as water level and stream flow data. The model has been calibrated and verified and used as the basis of subsequent work for a variety of projects.

Proposed ZONE II Delineation

The town of Barnstable will use the US Geological Survey Sagamore Lens model as the basis of the new delineation. This model is a significant increase in sophistication over the previously used model. The number and location of wells and their pumping rates will be updated according to the water district superintendent and DEP records of rated capacity. The existing calibration is well documented by the authors. The project will re-evaluate the calibration with the existing available water table information. The town will provide a complete evaluation of the impacts of the proposed Zone II re-delineation on the Water Supply Protection District. The public water supply superintendents shall have an opportunity to review and comment on the Zone II prior to submittal and DEP approval. The Zone II delineation and all records including pumping data and model input and outputs will be documented and submitted in digital form according to the guidelines.

We have assembled pumping data from the suppliers over the last 5 years 2004 to 2008 and compiled that data together with previous data used by the USGS and prior Zone II delineations. This table is included below. Also attached is the Town of Barnstable Zone

II delineation showing the wells and labels. Wells brought on line or permitted since then will be added to the map and table for use in the modeling exercise.

In summary, the use of the updated USGS model and updated list of wells will enable the town and district to better protect the water supply for the future.

References

Geraghty and Miller 1992., Technical Memorandum Three Dimensional Flow Model Construction and Calibration, Town of Barnstable, Hyannis Mass.

Geraghty and Miller, 1993., Groundwater Conditions Town of Barnstable, MA, Report and Figures, September, 1993.

Geraghty and Miller, 1993., Corrections: Zone II Delineation for Public Water Supply Wells, Town of Barnstable, December, 1993.

Guswa J. H. and LeBlanc, D.R., 1981, Digital models of Groundwater flow in the Cape Cod Aquifer system, Ma., U.S. geological survey Water Resources Investigation Report 80-67, 128 pp.

Horsley, S.W. and Cambareri, T.C., 1986. Delineating Zones of Contribution for Public Supply Wells to Protect Ground Water in New England: Journal of the New England Water Works Association, March.

LeBlanc D.R and Guswa, J.H. 1977. Water Table map of Cape Cod: cape Cod Canal to Bass River, May 23-27, 1976, U.S. Geological Survey, Open File Report 77-419

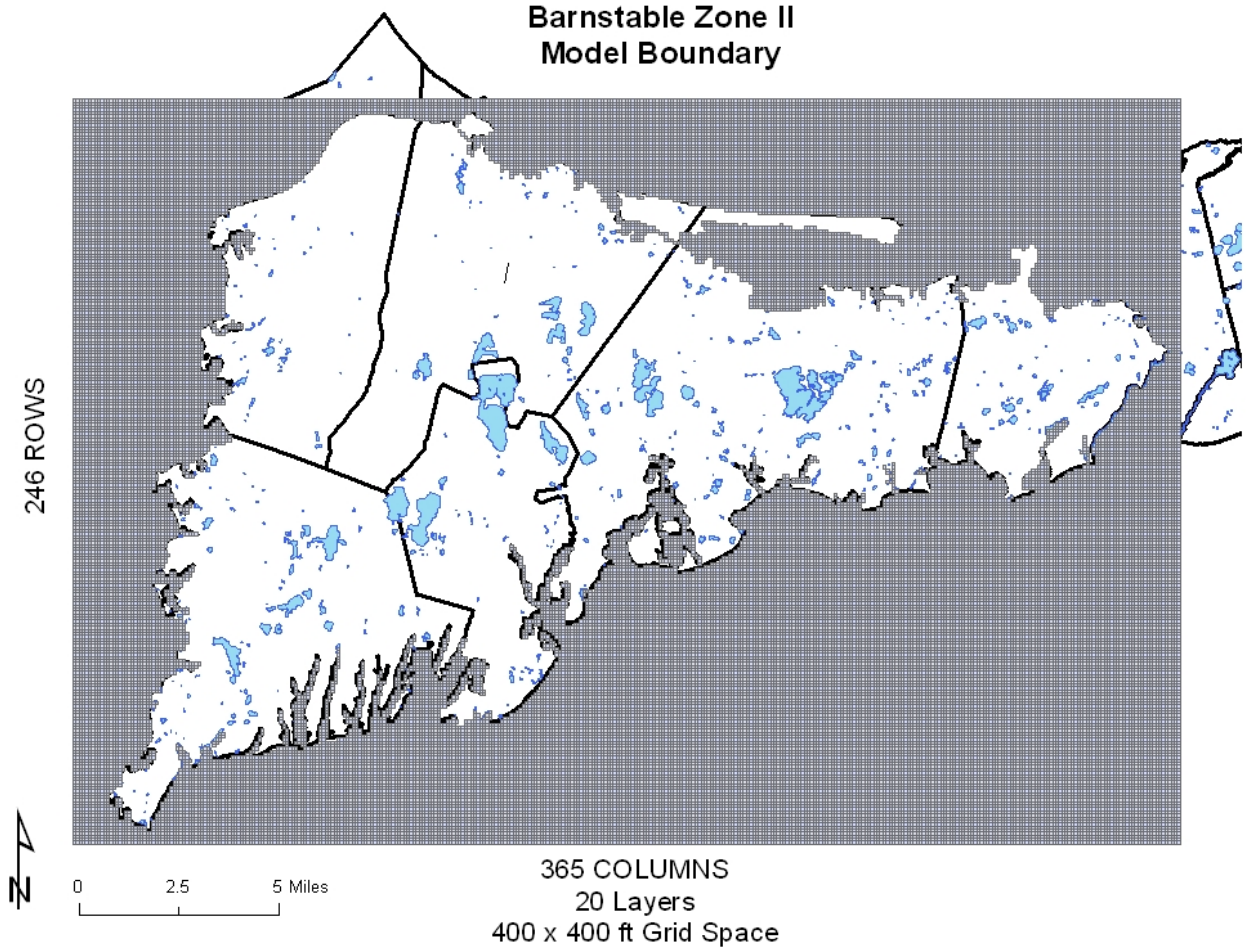
SEA Consultants,. 1986, Update of Town-wide Zones of Contribution of Public Supply Wells, Barnstable Ma, September, Boston, Ma.

Walter, D.A. and A. T. Whealan, 2004. Simulated Sources and Effects of Pumping on Surface water, Sagamore and Monomoy Flow Lenses, Cape Cod Massachusetts. U.S. Geological Survey, Scientific Investigation Report 2004-5181.

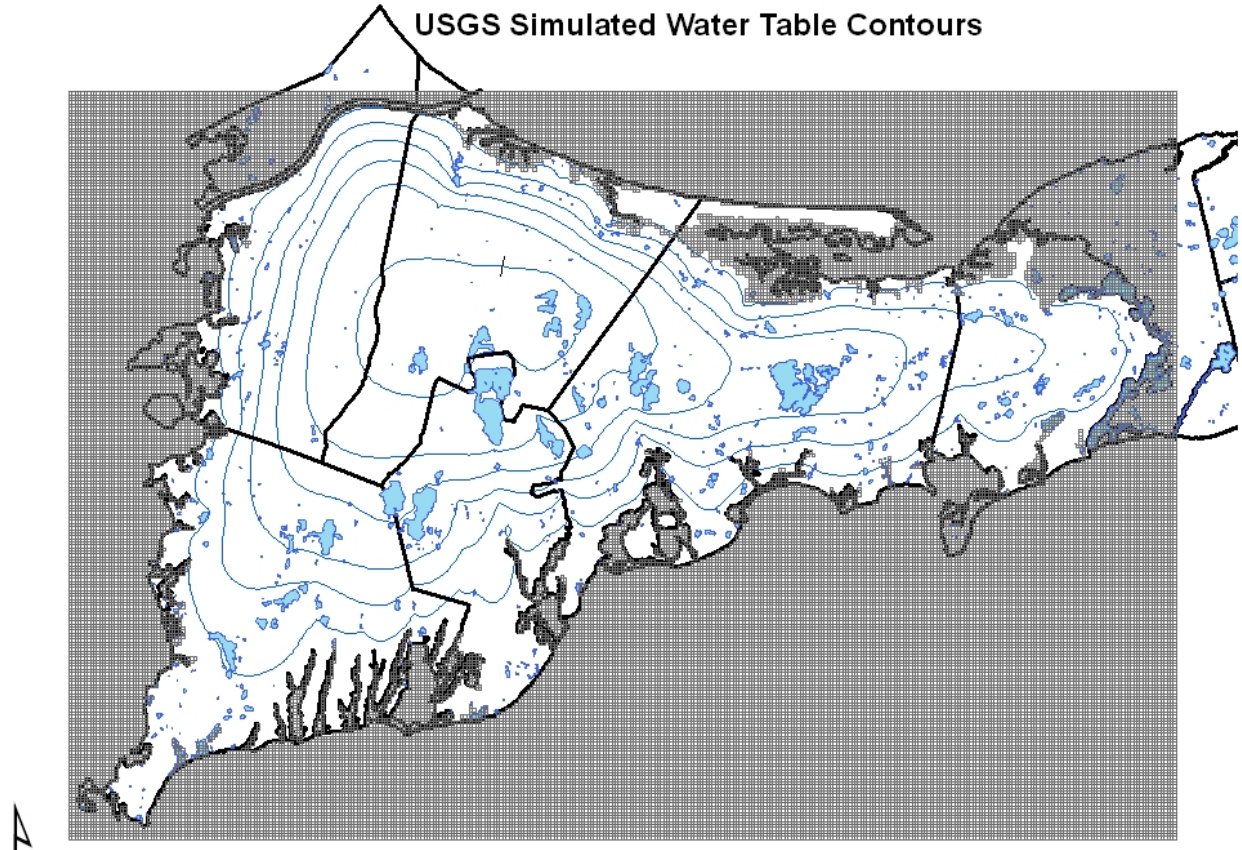
WELL NAME	MA DEP #	In season(Jun-Aug) annualized average daily pumping (04-08)			Off season (Sep-May) annualized average daily pumping (04-08)			In season(May-Sep) annualized average daily pumping (04-08)			Off season (Oct-Apr) annualized average daily pumping (04-08)		
		MG	GPM	FT3/d	MG	GPM	FT3/d	MG	GPM	FT3/d	MG	GPM	FT3/d
BFD1	4020000-01G	0.000	0	0	0.000	0	0	0.000	0	0	0.000	0	0
BFD2	4020000-02G	0.164	114	21885	0.052	36	6966	0.126	88	16848	0.047	33	6308
BFD3	*4020000-03G*	0.349	242	46615	0.161	112	21541	0.303	211	40530	0.140	97	18717
BFD4	*4020000-04G*	0.349	242	46616	0.175	121	23375	0.317	220	42366	0.148	103	19754
BFD5	*4020000-05G*	0.000	0	0	0.000	0	0	0.000	0	0	0.000	0	0
BFD TOTAL			**598.36**			**270**			**518**			**233**	
MD1	4020004-04G	0.274	190	36623	0.099	69	13289	0.245	170	32793	0.070	49	9339
MD2	4020004-05G	0.184	128	24635	0.042	29	5622	0.146	101	19439	0.029	20	3901
MD3	4020004-08G	0.210	146	28074	0.081	57	10882	0.170	118	22778	0.073	51	9757
MD4	4020004-09G	0.030	21	4065	0.027	19	3666	0.033	23	4363	0.025	17	3337
AIRPORT	4020004-10G	0.415	288	55426	0.041	29	5529	0.289	201	38625	0.025	17	3297
ME1s	4020004-07G	0.510	354	68083	0.435	302	58115	0.440	306	58814	0.464	322	61936
ME1d	4020004-07G		0	0		0	0		0	0		0	0
ME2	4020004-02G	0.476	331	63619	0.476	330	63531	0.526	365	70309	0.439	305	58678
ME3	4020004-11G	0.522	363	69782	0.418	290	55807	0.503	349	67223	0.401	279	53633
STWY1	4020004-01G	0.000	0	0	0.000	0	0	0.000	0	0	0.000	0	0
STWY2	4020004-12G	0.397	275	52991	0.102	71	13681	0.320	222	42724	0.073	51	9780
HYPORT	4020004-03G	0.509	353	68005	0.361	251	48193	0.491	341	65619	0.331	230	44215
SIMPOND	4020004-06G	0.282	196	37731	0.200	139	26737	0.264	184	35306	0.190	132	25324
Hyannis Water TOTAL			**2646**			**1586**			**2381**			**1472**	
Cotuit 1	4020003-02G	0.235	163	31370	0.098	68	13109	0.201	139	26810	0.083	0	0
Cotuit 2	4020003-04G	0.177	123	23663	0.079	55	10547	0.160	111	21435	0.063	44	8381
Cotuit 3	4020003-03G	0.060	42	7996	0.020	14	2732	0.052	36	6962	0.015	10	1964
Cotuit 4	4020003-05G	0.159	111	21288	0.082	57	10905	0.144	100	19249	0.070	49	9389
Cotuit 5	4020003-06G	0.388	270	51886	0.131	91	17533	0.328	228	43805	0.101	70	13481
Cotuit 5a	402000301G	0.000	0	0	0.000	0	0	0.000	0	0	0.000	0	0
Cotuit TOTAL			**708**			**285**			**615**			**173**	
CRAIG-7	4020002-04G	0.150	104	20057	0.026	18	3414	0.125	87	16682	0.008	6	1060
CRAIG-8	4020002-07G	0.133	92	17743	0.022	15	2981	0.109	76	14622	0.007	5	987
CRAIG-11	4020002-08G	0.231	160	30835	0.122	84	16253	0.206	143	27511	0.108	75	14456
McShane 1,2,2A	4020002-20G,21G,22G	0.416	289	55589	0.160	111	21374	0.360	250	48051	0.127	88	16969
Arena 3&4	4020002-02G	0.221	153	29506	0.101	70	13539	0.190	132	25391	0.089	62	11914
Lumbert Mill 5	4020002-03G	0.118	82	15822	0.056	39	7470	0.099	69	13211	0.052	36	6951
Lumber Mill 9	4020002-05G	0.260	180	34719	0.110	77	14747	0.230	160	30688	0.089	62	11910
Davis 10	4020002-06G	0.146	102	19547	0.048	33	6392	0.123	85	16441	0.036	25	4849
Murray 12	4020002-09G	0.190	132	25417	0.081	56	10785	0.172	120	23029	0.062	43	8298
Murray 13	4020002-10G	0.199	138	26645	0.075	52	10001	0.172	119	22989	0.059	41	7850
Hayden 14	4020002-11G	0.504	350	67367	0.176	122	23498	0.421	292	56210	0.142	98	18927
Hayden 15	4020002-12G	0.152	105	20269	0.061	42	8146	0.132	92	17682	0.049	34	6526
Harrison 16	4020002-13G	0.485	336	64733	0.189	131	25291	0.406	282	54282	0.161	112	21484
Hayden 17	4020002-14G	0.153	106	20430	0.074	51	9904	0.136	95	18182	0.064	44	8498
Hayden 18	4020002-15G	0.117	81	15670	0.066	46	8775	0.108	75	14411	0.058	40	7699
Harrison 19	4020002-16G	0.604	419	80638	0.225	156	29997	0.505	351	67527	0.186	129	24889
Hayden 20	4020002-17G	0.383	266	51183	0.150	104	20054	0.339	235	45303	0.115	80	15341
Hayden 21	4020002-18G	0.391	271	52192	0.144	100	19205	0.334	232	44615	0.114	79	15181
Hayden 22	4020002-19G	0.407	283	54432	0.182	127	24381	0.364	253	48680	0.149	103	19885
Hayden 23	*4020002-20G,*	na			na			na					
COMM TOTAL			**3653**			**1436**						**1163**	
5 yr. Total			**7605**			**3576**			**3514**			**3040**	
Italic - not in previous Zone II													

WELL NAME	MA DEP #	2002 Pumping USGS		Rated Capacity Zone II RPT 1993		MA DEP approved pumping rates ZONE II RPT 1993		Actual Average Daily Pumping (04-08) total amount pumped/ number of days pumped			Annualized Average Daily Pumping (04-08) total amount pumped/ 365 days		
		GPM	FT3/d	GPM	FT3/d	GPM	FT3/d	MG	GPM	FT3/d	MG	GPM	FT3/d
BFD1	4020000-01G	0	0	350	67335	275	52906	0	0	0	0.000	0	0
BFD2	4020000-02G	0	0	800	153908	600	115431	0.321	223	42886	0.082	57	10946
BFD3	*4020000-03G*	*190*	*36530*	*900*	*173146*	*875*	*168337*	0.282	196	37675	0.209	145	27859
BFD4	*4020000-04G*	*169*	*32420*	*700*	*134669*	*465*	*89459*	0.3	208	40080	0.219	152	29233
BFD5	*4020000-05G*	*0*	*0*		*0*	*900*	*173146*		0	0		0	0
BFD TOTAL		**358**		**2750**		**3115**			**627**			**353.651**	
MD1	4020004-04G	124	23950	500	96192	500	96192	0.246	171	32866	0.143	100	19171
MD2	4020004-05G	101	19370	700	134669	700	134669	0.238	165	31797	0.078	54	10415
MD3	4020004-08G	32	6122	500	96192	500	96192	0.206	143	27522	0.114	79	15215
MD4	4020004-09G	0	0	500	96192	500	96192	0.284	197	37943	0.028	20	3767
AIRPORT	4020004-10G	99	19110	1000	192385	1000	192385	0.325	226	43420	0.136	94	18107
ME1s	4020004-07G	112	21630	400	76954	350	67335	0.634	440	84703	0.404	281	53987
ME1d	4020004-07G	112	21630	400	76954	350	67335		0	0		0	0
ME2	4020004-02G	339	65150	700	134669	700	134669	0.748	519	99933	0.476	330	63553
ME3	4020004-11G	372	71570	700	134669	700	134669	0.641	445	85638	0.444	308	59330
STWY1	4020004-01G	0	0	500	96192	500	96192	0	0	0		0	0
STWY2	4020004-12G	72	13830	1000	192385	1100	211623	0.31	215	41416	0.177	123	23589
HYPORT	4020004-03G	175	33580	500	96192	500	96192	0.409	284	54643	0.398	276	53187
SIMPOND	4020004-06G	338	65110	700	134669	700	134669	0.257	178	34335	0.221	153	29508
Hyannis Water TOTAL		**1877**		**8100**		**8100**			**2985**			**1818**	
Cotuit 1	4020003-02G	83	15898	500	96192	500	96192	0.213	148	28457	0.131	91	17506
Cotuit 2	4020003-04G	56	10822	500	96192	500	96192	0.187	130	24983	0.104	72	13853
Cotuit 3	4020003-03G	37	7214	350	67335	350	67335	0.106	74	14162	0.030	21	4059
Cotuit 4	4020003-05G	67	12826	500	96192	500	96192	0.169	117	22578	0.101	70	13522
Cotuit 5	4020003-06G	59	11356			1200	230862	0.305	212	40748	0.196	136	26192
Cotuit 5a	402000301G								0	0	0.000	0	0
Cotuit TOTAL		**302**		**1850**		**3050**			**681**			**391**	
CRAIG-7	4020002-04G	49	9480	225	43287	220	42325	0.162	112	21643	0.057	40	7611
CRAIG-8	4020002-07G	35	6688	200	38477	200	38477	0.135	94	18036	0.050	35	6725
CRAIG-11	4020002-08G	110	21110	350	67335	350	67335	0.193	134	25785	0.149	104	19968
McShane 1,2,2A	4020002-20G,21G,22G	0	0	800	153908	800	153908	0.262	182	35003	0.225	156	29998
Arena 3&4	4020002-02G	83	16032	500	96192	500	96192	0.165	115	22044	0.131	91	17567
Lumbert Mill 5	4020002-03G	53	10154	300	57715	300	57715	0.135	94	18036	0.072	50	9580
Lumber Mill 9	4020002-05G	99	18971	425	81764	425	81764	0.258	179	34469	0.142	98	18908
Davis 10	4020002-06G	82	15765	320	61563	320	61563	0.18	125	24048	0.073	50	9708
Murray 12	4020002-09G	95	18303	350	67335	350	67335	0.197	137	26319	0.103	72	13757
Murray 13	4020002-10G	99	19105	350	67335	350	67335	0.191	133	25518	0.110	76	14694
Hayden 14	4020002-11G	202	38878	700	134669	700	134669	0.368	256	49165	0.216	150	28821
Hayden 15	4020002-12G	54	10421	300	57715	300	57715	0.189	131	25250	0.089	62	11889
Harrison 16	4020002-13G	192	37007	700	134669	700	134669	0.434	301	57983	0.268	186	35865
Hayden 17	4020002-14G	77	14830	500	96192	500	96192	0.213	148	28457	0.094	65	12557
Hayden 18	4020002-15G	76	14562	400	76954	400	76954	0.166	115	22178	0.077	54	10293
Harrison 19	4020002-16G	307	59051	1000	192385	1000	192385	0.574	399	76687	0.320	222	42762
Hayden 20	4020002-17G	203	39145	700	134669	700	134669	0.404	281	53975	0.209	145	27901
Hayden 21	4020002-18G	12	2405	700	134669	700	134669	0.396	275	52906	0.206	143	27519
Hayden 22	4020002-19G	8	1603	700	134669	700	134669	0.407	283	54375	0.239	166	31956
Hayden 23	*4020002-20G,*	*na*		*na*		*680*	*130822*	na			na		
COMM TOTAL		**1838**		**9520**		**10195**			**3492**			**1965**	
5 yr. Total		**4375**		**22220**		**24460**			**7785**			**4528**	
Italic - not in previous Zone II Delineation													

Legend
Public Supply Wells, Town of Barnstable
Public Supply Wells
Zone II Boundary
Streams
Ponds
CAPE COD COMMISSION
N


Barnstable Zone II
Model Boundary
246 ROWS
N
0
2.5
5 Miles
365 COLUMNS
20 Layers
400 x 400 ft Grid Space

Barnstable Zone II
USGS Simulated Water Table Contours

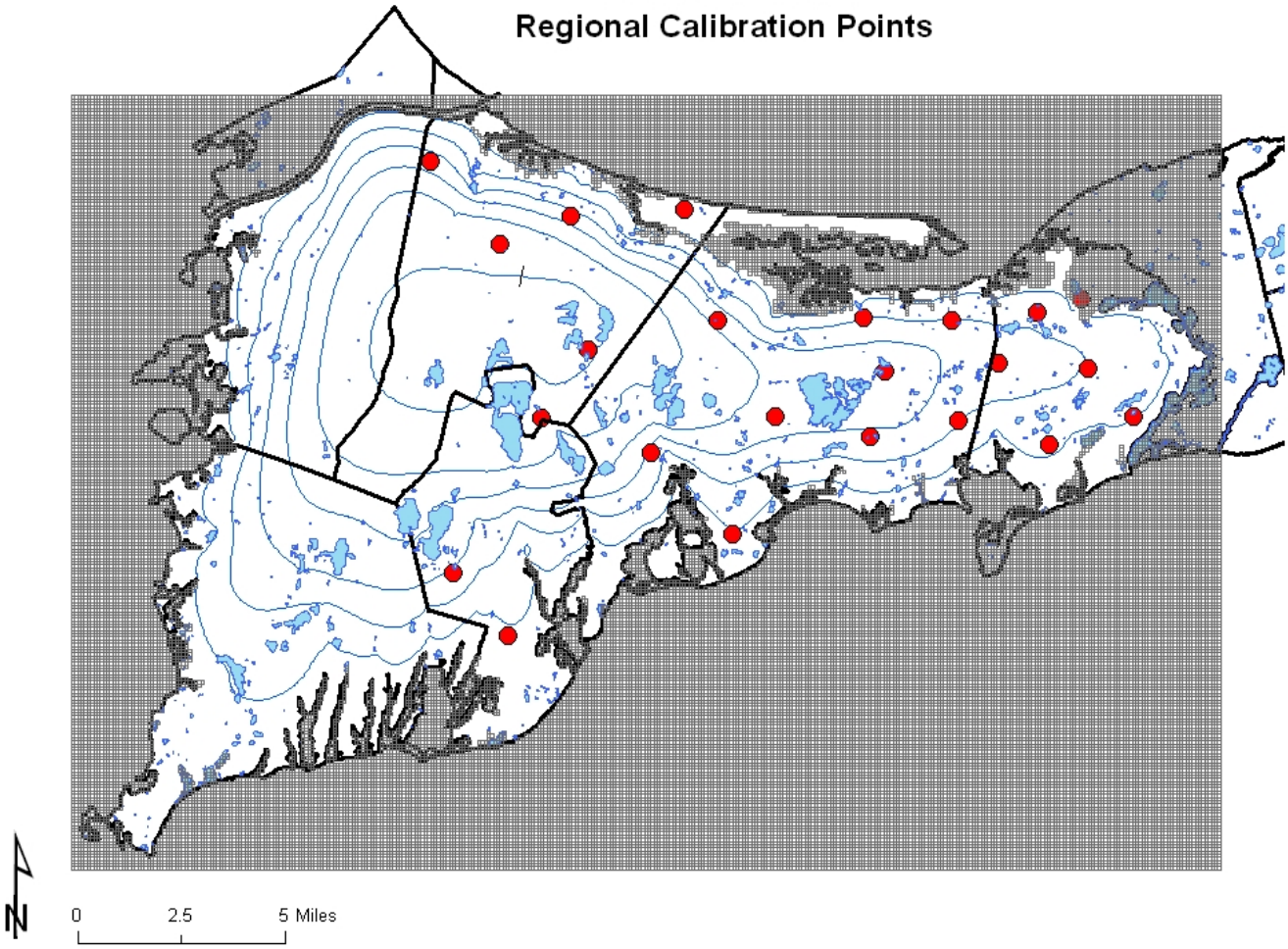


N

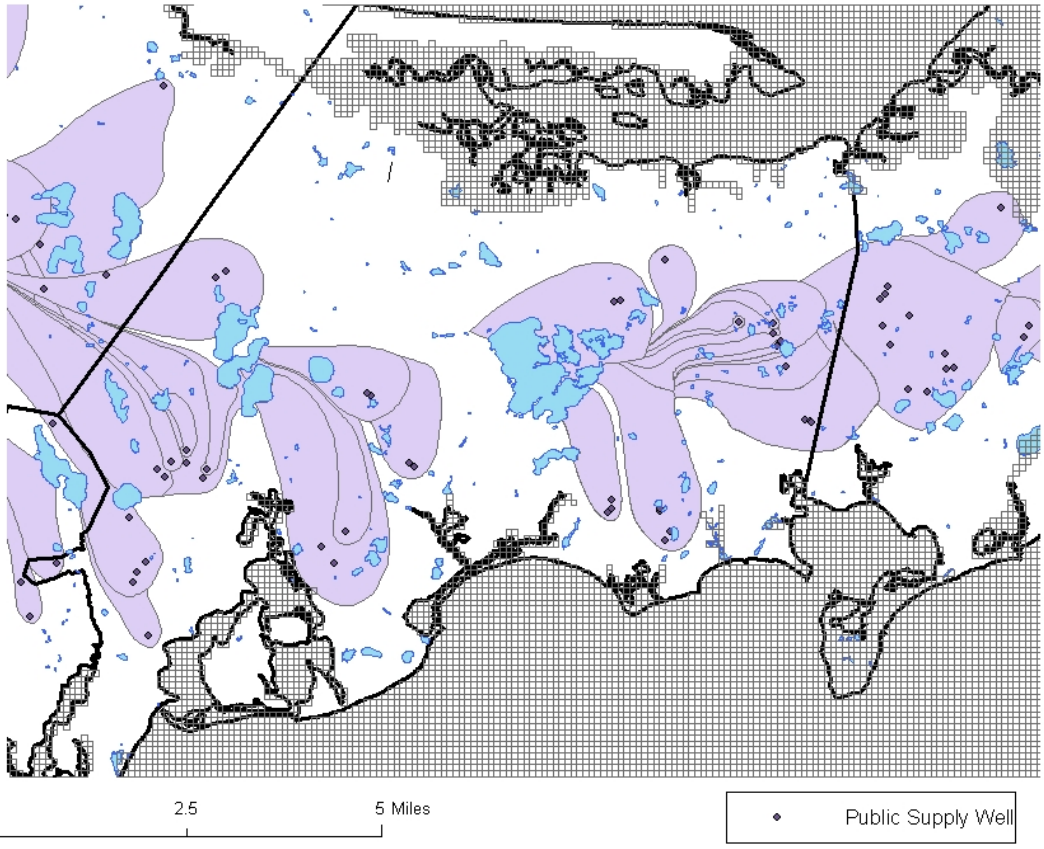
0 2.5 5 Miles

10 Ft Contour Interval
Highest Contour is 60 feet above msl

Barnstable Zone II
Regional Calibration Points



Barnstable Zone II
DEP Zone IIs 2009



N

0 2.5 5 Miles

Public Supply Well