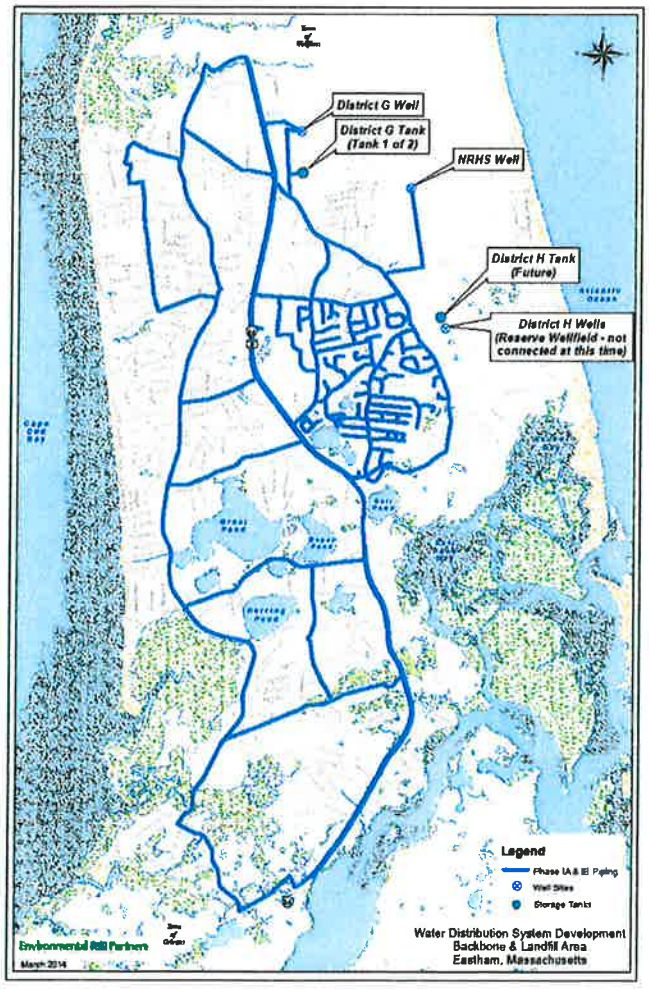
Eastham Water System

BRP WM03 Water Management Withdrawal Permit



September 2014

Environmental Partners

A partnership for engineering solutions

1900 Crown Colony Drive
Suite 402
Quincy, MA 02169

Phone: 617 657 0200
Fax: 617 657 0201
www.envpartners.com

Environmental Partners
A partnership for engineering solutions.

September 24, 2014

Duane LeVangie
Department of Environmental Protection
Drinking Water Program - Water Management Act Program
Massachusetts DEP Headquarters
1 Winter Street
Boston, Massachusetts 02108

RE: Town of Eastham Water System
BRP WM 03 - Water Management Withdrawal Permit
DEP Transmittal: X262593

Dear Mr. LeVangie:

On behalf of the Town of Eastham, attached is the Water Management Act water withdrawal permit application (BRP WM 03) for the proposed Eastham water system. As you are aware, the need for this municipal water system has been seriously considered and debated by the Eastham community for many years and has been the subject of various Town Meeting articles over this time. At their May 2014 Town Meeting the community voted overwhelmingly to proceed with the first phase of this water system, which will include the construction of well fields, a storage tank and 45 miles of distribution system piping.

This Water Management Act Permit application has been prepared in accordance with the requirements of 310 CMR 36.00 and includes the following items:

- The DEP Transmittal Form;
- Bureau of Resource Protection Water Management BRP WM 03 Forms:

  Form A - General Information
  Form B - Groundwater Sources of Supply for each proposed withdrawal location (District G, Nauset Regional High School, and District H)
  Form D1 - Historic (current) water usage
  Form D2 - Projection of water usage
  Form F - Evaluation of Potential Effects of the Withdrawals
  Form G - Alternatives to Proposed Withdrawals
- Supplemental Information and appendices that support Forms A through G
- DEP Water Conservation Questionnaire for Public Water Suppliers (Revised March 2008).

Being the last community on Cape Cod without a water municipal water system, metered water usage records that document historic demands are not available. To develop this information as well as a future demand forecast, a parcel-by-parcel analysis of the 2,021 properties to be served by the water system has been prepared using Assessor's State Classification Code data. The resulting demand estimates are, in our opinion, a realistic representation for the system. The application provides a detailed discussion of how these demand estimates were developed.

We have very much appreciated the input and guidance that you and your staff have provided as this permit application was being prepared. One of the issues we discussed was the process by which this permit would be sequenced with the overall timing of Water Management Act permit renewals for the Cape Cod Basin, currently scheduled for November 2015. It is our understanding that the Department of Environmental Protection's preference is to issue an approval for this permit and request that the Town immediately submit a renewal request for November 2015 so that the Town's permit can thereafter coincide with the renewal schedule.

We also understand that draft revisions to the Water Management Act regulations are being finalized and are expected to be completed this fall. These revisions, which include provisions under the Sustainable Water Management Initiative, and their implications on Eastham are to be discussed as part of the permit renewal process.

Public Notice of this application is to be made in the Cape Cod Times within 14 days of the filing date of this permit, and therefore by mid-October 2014. A copy of the Public Notice is attached to this cover letter.

Please feel free to contact me if you have any questions or need clarification with any of the information contained herein. I can be reached at 617-657-0251.

Very Truly Yours,
Environmental Partners Group, Inc.

Mark N. White
Project Manager

Attachments:
Public Notice of Water Management Act Permit application for Eastham Water System
Water Management Permit application (BRP WM 03) and Supporting Information

Cc: Sheila Vanderhoef, Eastham Town Administrator and Local Water Resources Management Official
John F. Knight, Eastham Water Commissioners Chairman
Richard Friend, Water Management Act Division, DEP-Boston

DEP Water Management Act Program
Water Withdrawal Permit Application

The Town of Eastham has applied to the Commonwealth of Massachusetts – Department of Environmental Protection (DEP) – Water Management Act Program for a permit to withdraw 0.415 million gallons per day of water (an annual average) from the ground water of the Cape Cod basin in Eastham over twenty years. The location of the withdrawal points are at properties owned by the Town of Eastham known as District G (Assessors Parcel 5-005A), Nauset Regional High School (Assessors Parcel 6-140) and District H (Assessors Parcel 24-029).

A copy of this application is available for review Monday – Friday between the hours of 8:00 am and 4:00 pm at the office of the Eastham Administrator at Town Hall, 2500 State Highway, Eastham, MA.

Written comments on the granting of a DEP permit for this withdrawal are required to be filed within thirty (30) days of publication of this Public Notice. Written comments must be submitted to either the Department of Environmental Protection or to Eastham's Local Water Resources Management Official at:

Department of Environmental Protection
Water Management Act Program
DEP – Southeast Regional Office
20 Riverside Drive
Lakeville, MA 02347

Sheila Vanderhoef, Town Administrator
Eastham Town Hall
2500 State Highway
Eastham, MA 02642

Town of Eastham Water System

BRP WM03 Water Management Withdrawal Permit

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Form G – Alternatives to the Proposed Withdrawal

SECTION 3 Supplemental Information

APPENDICES

APPENDIX A	**DEP New Source Approvals for District G, Nauset Regional High School and District H**
APPENDIX B	**Executive Summaries of DEP Pump Test Reports for District G, Nauset Regional High School and District H.**
APPENDIX C	**Water System Parcels and State Code Classifications**

APPENDIX D	**Water Demand Calculations (Current and Future)**
APPENDIX E	**Calculation of Monthly Withdrawal Rates and Supporting Information from DEP Annual Statistical Reports from Orleans, Brewster and Provincetown**
APPENDIX F	**Characterization of Groundwater and Vernal Pool Interactions in District H, from DEP Pumping Test Report for Wellfield Protection Zoning District H, Appendix G (April 2013).**
APPENDIX G	**DEP Conservation Plan**
APPENDIX H	**Studies of Alternative Water Supply Sources**

SECTION 1

DEP TRANSMITTAL FORM

Enter your transmittal number → X262593 (Transmittal Number)

Your unique Transmittal Number can be accessed online: http://mass.gov/dep/service/online/trasmfrm.shtml

Massachusetts Department of Environmental Protection

Transmittal Form for Permit Application and Payment

1. Please type or print. A separate Transmittal Form must be completed for each permit application.

2. Make your check payable to the Commonwealth of Massachusetts and mail it with a copy of this form to: DEP, P.O. Box 4062, Boston, MA 02211.

3. Three copies of this form will be needed.

Copy 1 - the original must accompany your permit application. **Copy 2** must accompany your fee payment. **Copy 3** should be retained for your records

4. Both fee-paying and exempt applicants must mail a copy of this transmittal form to:

MassDEP
P.O. Box 4062
Boston, MA
02211

*** Note:**
For BWSC Permits, enter the LSP.

A. Permit Information

1. Permit Code: 7 or 8 character code from permit instructions	2. Name of Permit Category
BRP WM 03	Water Management Withdrawal Permit

3. Type of Project or Activity: Eastham Water System

B. Applicant Information – Firm or Individual

1. Name of Firm - Or, if party needing this approval is an individual enter name below: Town of Eastham

2. **Last Name** of Individual	3. **First Name** of Individual	4. MI

5. Street Address: 2500 State Highway

6. City/Town	7. State	8. Zip Code	9. Telephone #	10. Ext. #
Eastham	MA	02642-2544	(508) 240-5900	x207

11. Contact Person	12. e-mail address (optional)
Sheila Vanderhoef, Town Administrator	svanderhoef@eastham-ma.gov

C. Facility, Site or Individual Requiring Approval

1. Name of Facility, Site Or Individual: Eastham Water System

2. Street Address: 2500 State Highway

3. City/Town	4. State	5. Zip Code	6. Telephone #	7. Ext. #
Eastham	MA	02642-2544	(508) 240-5900	X207

8. DEP Facility Number (if Known)	9. Federal I.D. Number (if Known)	10. BWSC Tracking # (if Known)

D. Application Prepared by (if different from Section B)*

1. Name of Firm Or Individual: Environmental Partners Group

2. Address: 1900 Crown Colony Drive, Suite 402

3. City/Town	4. State	5. Zip Code	6. Telephone #	7. Ext. #
Quincy	MA	02169	617 657-0251	

8. Contact Person	9. LSP Number (BWSC Permits only)
Mark N.White	

E. Permit - Project Coordination

1. Is this project subject to MEPA review? ☒ yes ☐ no
   If yes, enter the project's EOEA file number - assigned when an Environmental Notification Form is submitted to the MEPA unit:

EOEA File Number

F. Amount Due

DEP Use Only

Permit No:

Rec'd Date:

Reviewer:

Special Provisions:

1. ☒ **Fee** Exempt (city, town or municipal housing authority)(state agency if fee is $100 or less).
   There are no fee exemptions for BWSC permits, regardless of applicant status.
2. ☐ Hardship Request - payment extensions according to 310 CMR 4.04(3)(c).
3. ☐ Alternative Schedule Project (according to 310 CMR 4.05 and 4.10).
4. ☐ Homeowner (according to 310 CMR 4.02).

Check Number	Dollar Amount	Date

SECTION 2

WM03 Permit Application Forms

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Water Management Act Program

WMA Form A - General Information

A. Facility Information

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

1. Name of entity: water system, town, farm, company, or golf course

Eastham Water System
Name

2500 State Highway
Street Address

Eastham	MA	02642-2544
City	State	Zip Code

Sheila Vanderhoef - Town Administrator	(508) 240-5900 x207
Contact Person Name/Title	Phone Number

2. Consultant Contact:

Environmental Partners Group
Consultant Company Name

Mark White	Project Manager
Contact Person	Title

1900 Crown Colony Drive
Mailing Address

Quincy	MA	02169
City	State	Zip Code

(617) 657-0251		mnw@envpartners.com
Phone Number	Fax Number	Email

B. Water Withdrawal Information

(Use totals from Form D - subtract registered volume if applicable.)

1. Volume requested (in MGD) for:

	Days/year to be used	Average day (mgd)	# months to be pumped
Years 1-5:	365	0.378	12
Years 6-10:	365	0.416	12
Years 11-15:	365	0.416	12
Years 16-20:	365	0.416	12

2. Number of withdrawal points: Groundwater (G): 3 Surface Water (S): _____

Name and type of withdrawal points (G or S):		Name of Watershed	Location (Town/City)
(a)District G	☒ G ☐ S	Cape Cod Basin	Eastham
(b)Nauset Regional High School	☒ G ☐ S	Cape Cod Basin	Eastham
(c)District H	☒ G ☐ S	Cape Cod Basin	Eastham
(d)	☐ G ☐ S		

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Water Management Act Program

WMA Form A - General Information

B. Water Withdrawal Information (cont.)

4. For what purpose will this water be used (in percent):

Agriculture:	%	Cranberry:	%
Commercial:	20.5%	Industrial:	0.2%
Residential:	71.6%	Golf:	%
Other (please describe):	Recreational and Tax Exempt Properties		7.7%

5. Is this a public water supply? ☒ Yes ☐ No PWS ID No.:

6. For public water suppliers, are you using DCR Division of Water Supply Protection water needs forecast?

☐ Yes ☒ No

7. Permit time length requested: 20 years
Months or Years

Please refer to Appendix B-Permit End Dates for permit end dates for the watershed of your withdrawal point(s) and refer to 310 CMR 36.34 for permit renewal information. Permits are renewable - refer to 310 CMR 36.24.

8. Do these withdrawal requests have new water withdrawals or construction which requires an Environmental Notification Form submittal to MEPA?

☒ Yes ☐ No

9. Name and address of the chief elected official or local water resources management official in the community(s) in which the withdrawal(s) are located and to whom a copy of this application will be forwarded:

Sheila Vanderhoef, Town Administrator
Name

2500 State Highway
Street Address

Eastham	MA	02642-2544
City	State	Zip Code

10. Which new and existing sources are included in this permit application?

District G		New	0.955 mgd
Source Name and Number	Reg. No. (if applicable)	New or Proposed	Maximum Daily Vol. Requested (mgd)
NRHS		New	0.833 mgd
Source Name and Number	Reg. No. (if applicable)	New or Proposed	Maximum Daily Vol. Requested (mgd)
District H		New	1.310 mgd
Source Name and Number	Reg. No. (if applicable)	New or Proposed	Maximum Daily Vol. Requested (mgd)

11. Are any of these withdrawal points subject to DEP's Source Approval Process for public water suppliers?

☐ Yes ☒ No If yes, list their name(s):

New Source Approvals have been received for all three sources (see Appendix A)
Name(s)

WMA Form A - General Information

B. Water Withdrawal Information (cont.)

12. Is some fraction of the water withdrawn to be discharged out of the basin (include ocean discharge if appropriate)?

☐ Yes ☒ No (check one)

a. If yes (to only one "out of the basin" destination), what fraction of the total discharge and to which basin?

____ % will be discharged to the ____ basin

b. If yes, and to more than one "out of basin" destination, what fraction of your total discharge and to which basins?

1) ____ % will be discharged to the ____ basin

2) ____ % will be discharged to the ____ basin

3) ____ % will be discharged to the ____ basin

4) ____ % will be discharged to the ____ basin

c. What fraction of the water to be used will be discharged to this basin? ____ %

1) ____ % discharged to a public sewer system?

2) ____ % discharged to on-site sewage disposal systems?

3) ____ % discharged to another alternative (please describe)?

____

13. Is there an NPDES discharge permit? ☐ Y ☒ N
(If so, provide permit number) ____ NPDES Permit Number

Provide volume and location of discharge point: ____

Groundwater discharge permit? ☐ Y ☒ N
(If so, provide permit number) ____ Groundwater Discharge Permit Number

Provide volume and location of discharge point: ____

14. What is the authorized NPDES daily discharge volume? N/A gallons per day

15. Is the discharge volume metered? ☒ Yes ☐ No

16. Is, or will, the demand for this withdrawal be supplemented by withdrawals from another river basin? ☐ Yes ☒ No
List withdrawals in other river basins, the location of each and average daily volumes (ADV) withdrawn from each:

____ Watershed ____ ADV

____ Watershed ____ ADV

____ Watershed ____ ADV

WMA Form A - General Information

B. Water Withdrawal Information (cont.)

17. Does this request require an Interbasin Transfer Act application to the Water Resources Commission?

☐ Yes ☒ No

C. Certification

I certify, under penalty of law, that this application and all attachments were prepared under my supervision, in accordance with a system designed to ensure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information submitted in this application, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete.

Sheila Vanderhoef — Signature of Applicant

Town Administrator — Title

25 Sept 2014 — Date

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Water Management Act Program

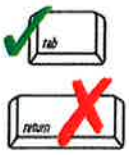
WMA Form B

Groundwater Withdrawal Point

Please provide a separate Form B for each withdrawal point source. Please answer only if the requested information is known and reliable.

A. Withdrawal Point Information

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



1. Name and Address of Withdrawal Point

   District G
   Name of Withdrawal Point

   Street Address

   Eastham | MA | 02642
   City | State | Zip Code

   Source Code (for public water supplies)

2. Has this well been registered? ☐ Yes ☒ No

   Month and year put in operation or planned:

3. Has this well been in regular operation at any time? ☐ Yes ☒ No

   Month and year put in operation or planned:

4. USGS quadrangle name: Orleans

5. Latitude and Longitude: 2781710.32 N (Latitude) | 1069800.85 E (Longitude)

   Please provide a locus map of the withdrawal and any associated reservoirs or ponds.

B. Geologic Information

1. Aquifer type: ☐ Bedrock ☐ Confined ☒ Unconfined
2. Depth to bedrock: >402 feet (feet)

C. Well Information

1. Well type: ☒ Gravel pack ☐ Gravel developed ☐ Tubular well field ☐ Dug well
   ☐ Other (describe):
2. Year to be installed (if not already installed):
3. Well depth: 94 feet (includes 5 foot bottom sump)
4. Depth to water level when installed: 30

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Water Management Act Program

WMA Form B

Groundwater Withdrawal Point

C. Well Information (cont'd)

5. Name and address of well driller:

Boart Longyear E&I (now Cascade Drilling, L.P.)
Name of Withdrawal Point

34 Talbot Road
Street Address

Northborough	MA	01532
City	State	Zip Code

D. Pumping Information

1. Was a pump test conducted on this well? ☒ Yes ☐ No

   If yes, provide date: October 21-28, 2010

   Firm conducting the test: Environmental Partners Group, Inc.

   If no, is one planned? ☐ Yes ☐ No

Items 2-7 are for Public Water Supplies.

2. Has a Zone II delineation been performed for this well? ☒ Yes ☐ No
3. If yes, has this Zone II been approved by the Department? ☒ Yes ☐ No
4. Date of Zone II delineation: April 2012
5. Firm conducting Zone II delineation: Environmental Partners Group, Inc. with McLane Environmental, LLC
6. What is the maximum daily withdrawal rate? 691 gpm (0.955 mgd) - See Appendix A
7. Is this a DEP-approved withdrawal rate? ☒ Yes ☐ No

E. Meter Information

1. If in operation, is this well metered? ☐ Yes ☐ No
2. If proposed, when will meter(s) be installed? 2015
   Date
3. Type of flow measurement device installed or planned:

   ☐ weir ☐ flume ☒ venturi ☐ other meter ☐ other (describe): _____

4. Capacity of flow measurement device: 700 gpm
5. Recordings are: ☒ continuous ☐ manual
6. Last date of calibration, if in operation: _____

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Water Management Act Program

WMA Form B

Groundwater Withdrawal Point

Please provide a separate Form B for each withdrawal point source. Please answer only if the requested information is known and reliable.

A. Withdrawal Point Information

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

1. Name and Address of Withdrawal Point

Nauset Regional High School
Name of Withdrawal Point

100 Cable Road
Street Address

Eastham | MA | 02642
City | State | Zip Code

Source Code (for public water supplies)

2. Has this well been registered? ☐ Yes ☒ No

Month and year put in operation or planned:

3. Has this well been in regular operation at any time? ☐ Yes ☒ No

Month and year put in operation or planned:

4. USGS quadrangle name: Orleans

5. Latitude and Longitude: 2779683.94 N (Latitude) | 1073461.67 E (Longitude)

Please provide a locus map of the withdrawal and any associated reservoirs or ponds.

B. Geologic Information

1. Aquifer type: ☐ Bedrock ☐ Confined ☒ Unconfined

2. Depth to bedrock: >400 feet
feet

C. Well Information

1. Well type: ☒ Gravel pack ☐ Gravel developed ☐ Tubular well field ☐ Dug well

☐ Other (describe):

2. Year to be installed (if not already installed):

3. Well depth: 99 feet (with 5-foot bottom sump)

4. Depth to water level when installed: 52 feet

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Water Management Act Program

WMA Form B

Groundwater Withdrawal Point

C. Well Information (cont'd)

5. Name and address of well driller:

Boart Longyear E&I (now Cascade Drilling, L.P.)
Name of Withdrawal Point

34 Talbot Road
Street Address

Northborough	MA	01532
City	State	Zip Code

D. Pumping Information

1. Was a pump test conducted on this well? ☒ Yes ☐ No

   If yes, provide date: August 25-30, 2010

   Firm conducting the test: Environmental Partners Group, Inc.

   If no, is one planned? ☐ Yes ☐ No

Items 2-7 are for Public Water Supplies.

2. Has a Zone II delineation been performed for this well? ☒ Yes ☐ No
3. If yes, has this Zone II been approved by the Department? ☒ Yes ☐ No
4. Date of Zone II delineation: December 2011
5. Firm conducting Zone II delineation: Environmental Partners Group, Inc. with McLane Environmental, LLC
6. What is the maximum daily withdrawal rate? 613 gpm (0.833 MGD) - see Appendix A
7. Is this a DEP-approved withdrawal rate? ☒ Yes ☐ No

E. Meter Information

1. If in operation, is this well metered? ☐ Yes ☐ No
2. If proposed, when will meter(s) be installed? 2015 (Date)
3. Type of flow measurement device installed or planned:

   ☐ weir ☐ flume ☒ venturi ☐ other meter ☐ other (describe): _____

4. Capacity of flow measurement device: 613 gpm
5. Recordings are: ☒ continuous ☐ manual
6. Last date of calibration, if in operation: _____

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Water Management Act Program

WMA Form B

Groundwater Withdrawal Point

Please provide a separate Form B for each withdrawal point source. Please answer only if the requested information is known and reliable.

A. Withdrawal Point Information

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

1. Name and Address of Withdrawal Point

District H - TPW-3B
Name of Withdrawal Point

Nauset Road
Street Address

Eastham | MA | 02642
City | State | Zip Code

Source Code (for public water supplies)

2. Has this well been registered? ☐ Yes ☒ No

Month and year put in operation or planned:

3. Has this well been in regular operation at any time? ☐ Yes ☒ No

Month and year put in operation or planned:

4. USGS quadrangle name: Orleans

5. Latitude and Longitude: 2779683.94 N (Latitude) | 1073461.67 E (Longitude)

Please provide a locus map of the withdrawal and any associated reservoirs or ponds.

B. Geologic Information

1. Aquifer type: ☐ Bedrock ☒ Confined ☒ Unconfined

2. Depth to bedrock: 400 feet

C. Well Information

1. Well type: ☒ Gravel pack ☐ Gravel developed ☐ Tubular well field ☐ Dug well

☐ Other (describe):

2. Year to be installed (if not already installed):

3. Well depth: 108 feet (with 5-foot bottom sump)

4. Depth to water level when installed: 20 feet

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Water Management Act Program

WMA Form B

Groundwater Withdrawal Point

C. Well Information (cont'd)

5. Name and address of well driller:

Boart Longyear E&I (now Cascade Drilling, L.P.)
Name of Withdrawal Point

34 Talbot Road
Street Address

Northborough	MA	01532
City	State	Zip Code

D. Pumping Information

1. Was a pump test conducted on this well? ☒ Yes ☐ No

   If yes, provide date: December 6-11, 2010

   Firm conducting the test: Environmental Partners Group, Inc.

   If no, is one planned? ☐ Yes ☐ No

Items 2-7 are for Public Water Supplies.

2. Has a Zone II delineation been performed for this well? ☒ Yes ☐ No
3. If yes, has this Zone II been approved by the Department? ☒ Yes ☐ No
4. Date of Zone II delineation: April 2013
5. Firm conducting Zone II delineation: Environmental Partners Group, Inc. with McLane Environmental, LLC
6. What is the maximum daily withdrawal rate? 910 gpm (1.310 MGD)
7. Is this a DEP-approved withdrawal rate? ☒ Yes ☐ No

E. Meter Information

1. If in operation, is this well metered? ☐ Yes ☐ No
2. If proposed, when will meter(s) be installed? 2021 (Date)
3. Type of flow measurement device installed or planned:

   ☐ weir ☐ flume ☒ venturi ☐ other meter ☐ other (describe): _____

4. Capacity of flow measurement device: 910 gpm
5. Recordings are: ☐ continuous ☒ manual
6. Last date of calibration, if in operation: _____

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Water Management Act Program

WMA Form B

Groundwater Withdrawal Point

Please provide a separate Form B for each withdrawal point source. Please answer only if the requested information is known and reliable.

A. Withdrawal Point Information

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

1. Name and Address of Withdrawal Point

District H - TPW-2C
Name of Withdrawal Point

Nauset Road
Street Address

Eastham	MA	02642
City	State	Zip Code

Source Code (for public water supplies)

2. Has this well been registered? ☐ Yes ☒ No

   Month and year put in operation or planned:

3. Has this well been in regular operation at any time? ☐ Yes ☒ No

   Month and year put in operation or planned:

4. USGS quadrangle name: Orleans

5. Latitude and Longitude:

2779683.94 N	1073461.67 E
Latitude	Longitude

Please provide a locus map of the withdrawal and any associated reservoirs or ponds.

B. Geologic Information

1. Aquifer type: ☐ Bedrock ☒ Confined ☒ Unconfined

2. Depth to bedrock: 400 feet
   feet

C. Well Information

1. Well type: ☒ Gravel pack ☐ Gravel developed ☐ Tubular well field ☐ Dug well

   ☐ Other (describe):

2. Year to be installed (if not already installed):

3. Well depth: 210 feet (with 5-foot bottom sump)

4. Depth to water level when installed: 29 feet

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Water Management Act Program

WMA Form B

Groundwater Withdrawal Point

C. Well Information (cont'd)

5. Name and address of well driller:

Boart Longyear E&I (now Cascade Drilling, L.P.)
Name of Withdrawal Point

34 Talbot Road
Street Address

Northborough	MA	01532
City	State	Zip Code

D. Pumping Information

1. Was a pump test conducted on this well? ☒ Yes ☐ No

   If yes, provide date: Dec. 16-21, 2010

   Firm conducting the test: Environmental Partners Group, Inc.

   If no, is one planned? ☐ Yes ☐ No

Items 2-7 are for Public Water Supplies.

2. Has a Zone II delineation been performed for this well? ☒ Yes ☐ No
3. If yes, has this Zone II been approved by the Department? ☒ Yes ☐ No
4. Date of Zone II delineation: April 2013
5. Firm conducting Zone II delineation: Environmental Partners Group, Inc. with McLane Environmental, LLC
6. What is the maximum daily withdrawal rate? 916 gpm (1.32 MGD) - See Appendix A
7. Is this a DEP-approved withdrawal rate? ☒ Yes ☐ No

E. Meter Information

1. If in operation, is this well metered? ☐ Yes ☐ No
2. If proposed, when will meter(s) be installed? 2021 (Date)
3. Type of flow measurement device installed or planned:

   ☐ weir ☐ flume ☒ venturi ☐ other meter ☐ other (describe): _____

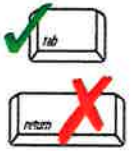
4. Capacity of flow measurement device: 916 gpm
5. Recordings are: ☒ continuous ☐ manual
6. Last date of calibration, if in operation: _____

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Water Management Act Program

Form WMA-D1

Computation of Historic Withdrawal Volume

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



Check applicable item:

☒ Combined grand total form

☐ Individual withdrawal point Withdrawal point name: See Supplemental Information for Form D1 for explanation of how current water demands (historic water withdrawals) are characterized.

1. Even if the withdrawal point is registered, please complete the entire form for each withdrawal point.
2. For each withdrawal point in your application, fill out the charts below to show total monthly historic withdrawal volume in millions of gallons. NOTE: 100,000 gallons = 0.10 MG
3. **Add** the individual withdrawal point volumes and enter onto a separate Form D1 (a Combined Grand Total form) to show the total monthly historic withdrawal volumes.

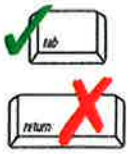
Year	January	February	March	April	May	June	July	August	September	October	November	December	Total

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Water Management Act Program

Form WMA-D2

Projection of Withdrawal Volume - Years 1-20

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



1. Fill in the projected daily average water withdrawal in millions of gallons in Column 1. NOTE: 100,000 gallons = 0.10 MG
2. In Column 2, fill in the number of days you expect to operate. For **year-round withdrawals**, enter 365 days. For **seasonal withdrawals**, multiply the number of months that you will operate each year by 30 to get the days of operation (e.g., a golf course that irrigates during April, May, June, July, August, September, and October would enter 7 months of operation x 30 days = 210 days of operation).
3. Multiply the average daily water withdrawal (Column 1) by the days of operation (Column 2) to get the total annual water withdrawal. Enter the number in Column 3.

	Year	Average Daily Withdrawal Volume	Days of Operation	Total Annual Water Withdrawal
Years 1-5	2016	0.378 mgd	365	138 MG
Years 6-10	2021	0.415 mgd	365	151 MG
Years 11-15	2026	0.415 mgd	365	151 MG
Years 16-20	2031	0.415 mgd	365	151 MG

--Continued on following page--

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Water Management Act Program

Form WMA-D2

Projection of Withdrawal Volume - Years 1-20

4. The requested withdrawal volume during Years 1-5, Years 6-10, Years 11-15 and Years 16-20 of the permit period is shown in Column 1.

	Years 1-5	Years 6-10	Years 11-15	Years 16-20
Average daily withdrawal volumes:	0.378 mgd	0.415 mgd	0.415 mgd	0.415 mgd

5. If part of this volume is registered, subtract the registered volume from the average daily withdrawal volumes for Years 1-5, Years 6-10, Years 11-15 and Years 16-20 to get the requested permit volumes.

Average daily withdrawal volume for		Registered volume		Requested permit volume for
Years 1-5	-		=	Years 1-5
Years 6-10	-		=	Years 6-10
Years 11-15	-		=	Years 11-15
Years 16-20	-		=	Years 16-20

6. Enter these requested permit volumes on Form A, Number 5, Years 1-5, Years 6-10, Years 11-15, and Years 16-20.

For withdrawals with seasonal variation

7. Withdrawals are often made at varying rates over the course of the season or year. For example, golf courses typically irrigate for six or seven months per year, with peak irrigation taking place during the summer months; an industry might eliminate one shift during the summer; or a public water supplier might have a large summer population to supply.

   If your withdrawal has large seasonal variations, please show the pattern of monthly withdrawals for a typical year in the space below. The numbers you use can be actual projections for one year during the permit period.

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
	5%	4%	4%	6%	8%	11%	18%	16%	10%	7%	5%	5%

   If you expect the seasonal variation in your withdrawal to change during the permit period, or if you feel that there is any unique aspect to the pattern of your withdrawal, please provide that information in the space below.

-- Continued on following page --

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Water Management Act Program

Form WMA-D2

Projection of Withdrawal Volume - Years 1-20

8. For each withdrawal point in your application provide the portion (percent) of the projected withdrawal that you expect to take from each withdrawal point, e.g., Well #1 = 25%, Well 2 = 25%, Well 3 = 50%.

Year	District G Point Name	NRHS Point Name	District H (Zone B well)	District H (Zone B well)	Point Name
2016	50%	50%	0%	0%	
2017	50%	50%	0%	0%	
2018	50%	50%	0%	0%	
2019	50%	50%	0%	0%	
2020	50%	50%	0%	0%	
2021	25%	50%	12.5%	12.5%	
2022	25%	50%	12.5%	12.5%	
2023	25%	50%	12.5%	12.5%	
2023	25%	50%	12.5%	12.5%	
2024	25%	50%	12.5%	12.5%	
2025	25%	50%	12.5%	12.5%	
2026	25%	50%	12.5%	12.5%	
2027	25%	50%	12.5%	12.5%	
2028	25%	50%	12.5%	12.5%	
2029	25%	50%	12.5%	12.5%	
2030	25%	50%	12.5%	12.5%	
2031	25%	50%	12.5%	12.5%	
2032	25%	50%	12.5%	12.5%	
2033	25%	50%	12.5%	12.5%	
2034	25%	50%	12.5%	12.5%	

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Water Management Act Program
WMA Form F- Evaluation of Potential Effects of Proposed Withdrawal

Please address these questions separately for each proposed withdrawal point, as well as the effect of your entire withdrawal. Please reference any tests, studies or reports you use to provide information here.

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

If this permit application includes an Interbasin Transfer Act request, use those forms to address these issues and include with the permit application.

1. Withdrawal point(s):

Wastewater Treatment or Assimilation:

Will the water be discharged to a stream ☐ pond ☐ reservoir ☐, individual septic system ☒ ?

If the water will not be discharged to a treatment system, please provide a map showing the points of withdrawal and discharge.

What pollutants will be added or removed in the discharge? Septic tank effluent (TSS, organics)

Will the treatment system have the capacity to process that volume of water? ☐ Yes ☐ No

How does the volume of the discharge compare with the volume of the receiving waters?

85% of overall water usage (allowable credit for septic system discharges under SWMI)

Wetlands:

Will work on any part of the property on which the withdrawal is to be made be covered by or require an Order of Conditions under M.G.L. c. 132, s. 40?

If yes, please attach a copy of the Order of Conditions. ☐ Yes ☐ No

If no, based upon a negative Determination of Applicability issued by the Department, please attach a copy of that determination.

Does this property have wetland restrictions recorded pursuant to M.G.L. c. 130, s. 105?

☐ Yes ☐ No

If yes, and if a negative Determination of Applicability or an Order of Conditions has not been issued, please attach a copy of the Restriction Order.

Wildlife, Fisheries and Floral Habitat:

DEP will conduct a review in conjunction with the MA Division of Fisheries & Wildlife and other State agencies that have information about environmental resources in the vicinity of your proposed withdrawal. To facilitate this review, please complete the following, based on the best information you have available.

Is this withdrawal in the vicinity of any known or designated aquatic habitats for fish and wildlife and flora, such as:

Rare/threatened or special concern species ☒ Yes ☐ No

Priority wildlife habitats ☒ Yes ☐ No

Priority natural communities ☐ Yes ☐ No

Withdrawal points - Wildlife, Fisheries and Floral Habitat: (cont.)

Major coolwater/warmwater fisheries ☐ Yes ☒ No

Native and/or wild salmonid populations ☐ Yes ☒ No

Seasonally stocked trout waters ☐ Yes ☒ No

Agriculture:

Is the withdrawal within ¼ mile of any farming operation? ☐ Yes ☒ No

Describe the effect of the withdrawal on water supply or quality for any of these farming operations.

Navigation or Recreational User:

Is this withdrawal made directly from or adjacent to a navigable:

☐ river ☐ stream ☐ lake ☐ pond?

If so, describe how the withdrawal will affect water levels.

None of the above.

Might the withdrawal result in the surface water becoming unnavigable at any time? ☐ Yes ☒ No

If so, please describe how and when this might occur. If the surface water already becomes unnavigable during certain periods, to what extent would the proposed withdrawal lengthen these periods?

Water-Based Recreation:

Water-based recreation includes fishing, boating, swimming, wading, etc.

Is there any water-based recreation near your withdrawal, or downstream of it? ☐ Yes ☒ No

Please describe the type of activity, seasonal time periods for use, possible number of users, and approximate distance from the withdrawal points.

Would any existing or potential recreational activities be precluded or otherwise impacted due to the approval and implementation of the proposed withdrawal? If so, please describe the nature and extent of the impact.

No recreational activities would be impacted.

WMA Form F- Evaluation of Potential Effects of Proposed Withdrawal

Withdrawal points (cont.)

Groundwater Withdrawals Only - Groundwater Recharge Areas:

Describe any studies that have been done of the recharge area to this well. (Attach a copy of the Form H - Groundwater Hydraulic Analyses for Non-Potable Wells or other studies.)
See Narrative and Appendix B.

Will the project include any paving over of any aquifer recharge area? ☐ Yes ☒ No

Questions for Surface Water Withdrawals

Hydropower Resources:

Is this withdrawal upstream from an existing or proposed hydropower facility? ☐ Yes ☒ No

If so, how far? _____

What is the minimum volume needed for this hydropower facility? _____

Will this withdrawal impact the hydropower facility's ability to withdraw water? ☐ Yes ☐ No

Floodplains:

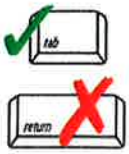
Is the withdrawal within the 100-year floodplain? ☐ Yes ☒ No

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Water Management Act Program

WMA Form G - Alternatives to Proposed Withdrawal

If this permit application includes an Interbasin Transfer Act request, use those forms to address these issues and include with the permit application.

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



1. The proposed withdrawal. (Use the information on the proposed withdrawal for comparison with any other alternatives available.)

   Cost: _____

   Feasibility: See Supplemental Information

   Environmental effect (summarized):

   _____

   Impact on others: _____

2. Leak detection alternative. Cost: _____

   Feasibility: Not Applicable. See Supplemental Information

   Environmental effect (summarized):

   _____

   Impact on others: _____

   Reduction in volume withdrawn: _____

   Other comments: _____

3. Increased conservation and demand management. Cost: _____

   Feasibility: Not Applicable. See Supplemental Information

   Environmental effect (summarized):

   _____

   Impact on others: _____

   Reduction in volume withdrawn: _____

   Other comments: _____

-- continue on next page --

WMA Form G - Alternatives to Proposed Withdrawal

4. Alternative Withdrawal Points. Cost: _____

   Feasibility: See Supplemental Information

   Environmental effect (summarized):

   _____

   Impact on others: _____

   Reduction in volume withdrawn: _____

   Other comments: _____

5. No action alternative. Cost: _____

   Feasibility: See Supplemental Information

   Environmental effect (summarized):

   _____

   Impact on others: _____

   Reduction in volume withdrawn: _____

   Other comments: _____

6. Alternative. Cost: _____

   Feasibility: See Supplemental Information

   Environmental effect (summarized):

   _____

   Impact on others: _____

   Reduction in volume withdrawn: _____

   Other comments: _____

-- Continue in this format for as many alternatives as you have. --

SECTION 3

Supplemental Information

Eastham Water System
BRP WM 03 – Water Management Act Permit

Supplemental Information

Form A – General Information

Item B. Water Withdrawal Information

B.1 Volume Requested

A detailed discussion of the calculation of existing and future water demands is provided with the Supplemental Information for Form D1, below. Overall, 378,000 gallons per day (gpd) of average daily water use is being requested for years 1 – 5, which represents the existing demands of the properties to be connected.

For the purposes of this Water Withdrawal Permit, it has been assumed that this existing demand will increase to the future demand quantity as vacant properties are built out according to their existing land use designations (also discussed in the Supplemental Information for Form D.1), which increases the existing demands by 39,000 gpd to a total of 416,000 gpd. It has also been assumed that these future demands would be experienced after Year 6 of the permit period.

B.2 Water Withdrawal Points

Eastham has completed New Source Permitting of three water supplies known as District G, Nauset Regional High School and District H. The location of these three water supplies is shown on Figure B-1 of the water system. Copies of the Department of Environmental Protection (DEP) New Source Approval of the Pumping Test Report (BRP WS 19) for each of these three well fields is provided in Appendix A. The Executive Summary from the DEP Pump Test Report for each of these is provided in Appendix B.

B.4 Purpose That the Water Will Be Use For

The allocation of the water usage by property type (commercial, residential, industrial, etc.) is based on Massachusetts Department of Revenue Property Type Classification Code, revised March 2014 assigned by the Eastham Assessors Department for each property to be served by the water system. A detailed discussion of the classification codes and parcel assignments is provided with the Supplemental Information for Form D1, below.

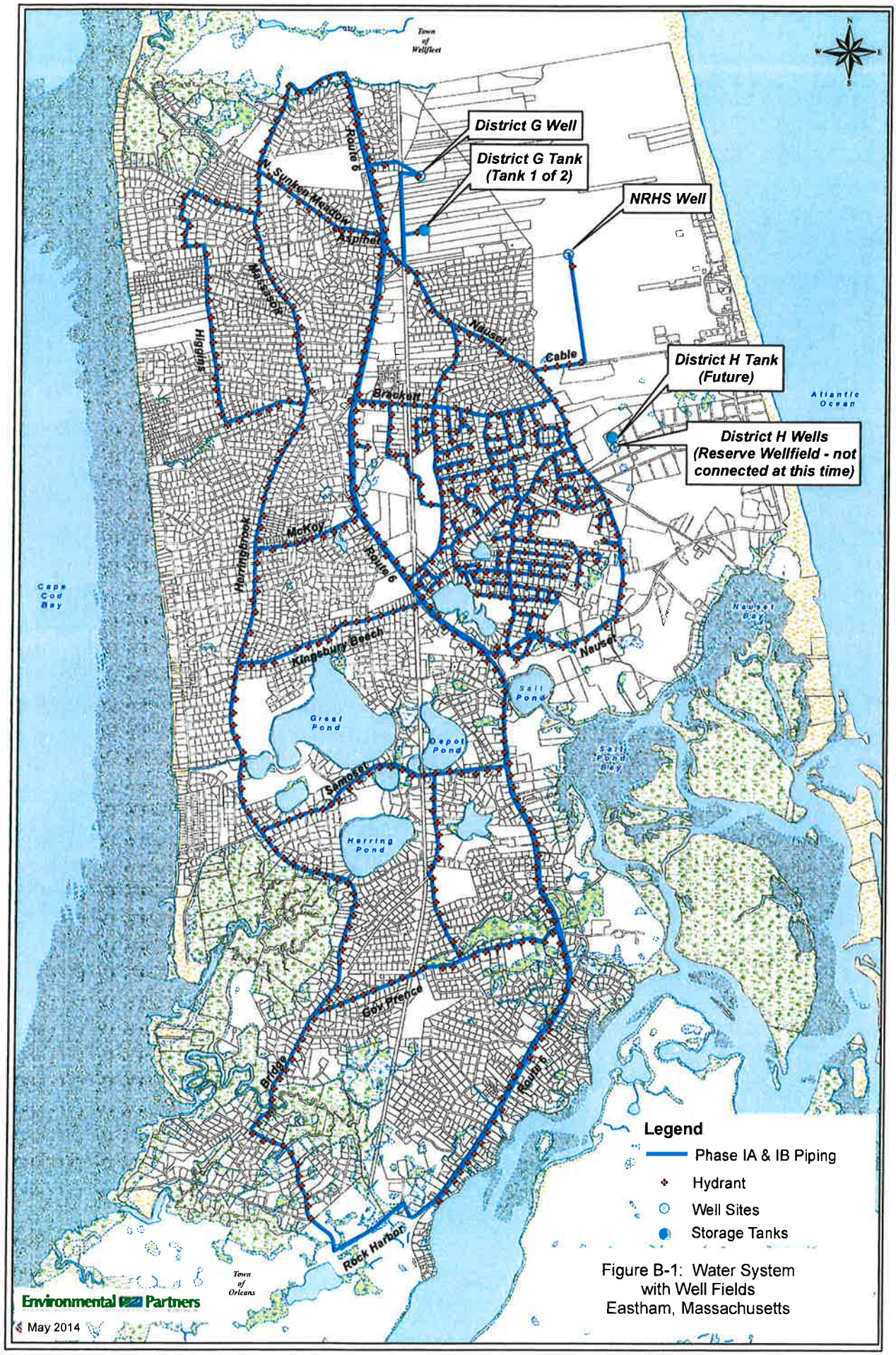


Figure B-1: Water System with Well Fields Eastham, Massachusetts

Environmental Partners

May 2014

B.10 Water Sources Included in this Permit Application

The three water sources that have received DEP New Source Approval (District G, Nauset Regional High School and District H) are included with this permit application. The maximum daily volume requested for each source is that allowed under each of the New Source Permit approvals for each well field (Appendix A).

Form D1 – Historic (Existing) Withdrawal Volumes

All of Eastham is on private or small community (transient and non-transient) water supplies. The Town does not have a municipal water system. The water system will replace these private or community water supplies.

Because there are very few records of water usage from these properties, the calculated water system demands were estimated on the basis of current land uses of individual properties (residential, commercial, industrial, recreational, government-owned, etc.) and accepted standards for usage rates of each property type. Wherever transient or non-transient community water supply records are available from annual reports submitted to the Department of Environmental Protection (DEP), these were also incorporated into the demand estimates.

In addition to these property-specific demands, allowances have also been made for Confidently Estimated Municipal Water Use and Unaccounted for Water, as well as a contingency to allow for variations from the property-specific demand estimates.

D1.A State Classification Code Categories.

Properties are classified by municipal Assessor Departments according to their land use category as defined by the Massachusetts Department of Revenue State Classification Code, and used as the basis of taxation for individual properties. This State Classification Code was revised in March 2014 and provides detailed descriptions of current land uses from which typical water demands for each property type can be identified. In particular, the recent version of these Classification Codes expands the designations for various residential and commercial properties.

The 2014 database of property classifications and descriptions used by the Eastham Assessors office was used to develop estimated water demands for those properties to be served by the water system. A summary of the properties to be served by the water system according to their Classification Code, together with the detailed description of these Classification Codes is provided in Appendix C, and are summarized below. Descriptions are provided for only those classes of properties that are to be served by the water system.

Code 0 Multiple-Use Properties

Properties used for more than one purpose. These properties are classified according to whether: 1) they are primarily residential mixed use (Class 013), such as a building with a retail store on the first floor and apartments on the second floor, or 2) properties that are primarily commercial use (Class 031), such as a building with retail use on the first floor and office space on the second floor.

Code 1 Residential Properties

Residential properties, including single family homes (Class 101) condominiums (Class 102), two-family homes (Class 104), three-family homes (Class 105), accessory land with

improvements such as a garage (Class 106), multiple houses on one parcel (Class 109), and apartments (four to eight units – Class 111, more than eight units – Class 112).

The State Class Code also identifies vacant land and their potential for future development (developable land – Class 130, potentially developable - Class 131, and undevelopable land – Class 132). These vacant land designations were used as the basis of identifying the potential water demands of these properties, discussed in Section D.1.C, below.

Code 3 Commercial

Commercial properties are classified into several descriptive categories: transient group quarters such as motels and inns (Class 301 and 302, respectively), storage warehouses (Class 316), small retail and service stores (Class 325), restaurants (Class 326), auto repair and service stations (Class 332 and 334, respectively), general office buildings (Class 340), banks (Class 341), medical office buildings (Class 342), public service properties such as post offices (Class 350) and fraternal organizations ((Cass 353),athletic clubs (Class 376), and outdoor recreational properties (Class 388).

Similar to the residential class codes, this category also identifies developable and undevelopable properties (Classes 390 and 392, respectively), which were used as the basis of identifying the potential future water system demands.

Code 4 Industrial

The industrial properties within the water system includes warehouses and sand and gravel operations (Class 401), and properties associated with electrical transmission (rights of way – Class 410, and electrical substation (Class 424). Potentially developable and undevelopable industrial properties are also identified (Class 440 and 442) and used to indentify potential future water system demands.

Code 8 Recreational Properties - Chapter 61B

These properties include camp areas used for overnight camping (Class 802) and nature study areas (Class 803). .

Code 9 Tax Exempt Properties

These properties are public properties exempt from taxation and include those owned by the United States Government (Class 900) and State agencies such as the Division of Fish & Wildlife and the Massachusetts Highway Department (Class 911 and 921). It also identifies Eastham-owned vacant and improved land (Class 930), conservation land (Class 932), schools (Class 934), public safety properties (Class 934).

This class of properties also includes cemeteries (Class 953), libraries (Class 956), places of worship (Class 960) and those owned by housing authorities (Class 970).

D.1.B Properties Comprising the Water System

The properties comprising the water system are summarized on Table D1-1. Overall, 2,021 properties are to be served by the water system. The large majority of the properties are residential, consisting of 88.5% of the services. The commercial properties represent 3.0% of

the system. Mixed use properties, being those that have both residential and commercial uses on them, comprise 2% of the parcels. Industrial, recreational and tax-exempt properties (Federal, State or Town owned properties, churches, etc.) comprise 0.9%, 0.1% and 5.5% of the system, respectively.

Table D1-1. Parcels comprising the Eastham Water System, by Massachusetts DOR State Classification Codes.

Property Type	*Total*	*% of Total*	*Developed Parcels*	*Vacant Parcels (Future Water Demands)*	
				Developable	*Undevelopable*
Multiple Use	40	2.0%	40	0	0
Residential	1789	88.5%	1643	109	37
Commercial	60	3.0%	48	11	1
Industrial	18	0.9%	14	3	1
Recreational	2	0.1%	2	0	0
Tax-Exempt	112	5.5%	112	0	0
TOTAL	**2021**	**100%**	**1859**	**123**	**39**

The vacant parcels are those that represent a potential future increase in current water demands. Overall, there are 162 vacant parcels within the water system, of which 123 are potentially developable. The large majority of these vacant and developable parcels are residential (109 properties).

D.1.C Existing Water System Demands

The existing water demands of the properties to be served by the water system were estimated using either per-capita water usage rates, Title 5 criteria for wastewater flows, or DEP reporting data from DEP community (transient and non-transient) systems where they are available. A description of the methodology used for characterizing the existing water demands for each class of property is provided below.

Residential Properties

The residential water demand is based on a residential per capita use calculation. DEP maintains a database of the average household size for Massachusetts communities, which for Eastham is 2.08 residents per household. The water demand was calculated on the basis of the equivalent residential population, multiplied by 65 residential gallons per capita per day (rgpcd), which is DEP's standard for residential water usage. Specific calculations for each class of residential property were based on the following:

Single-family residences. The number of single family resident parcels was multiplied by the resident/household factor of 2.08 to determine the equivalent population, to which was applied the water demand of 65 rgpcd.

Condominiums. The water demand of residential condominiums was determined on the basis of the number of condominium units (e.g., households), the equivalent population of these units (2.08 residents/household), and 65 rgpcd.

Multiple-use Properties. The water demands of multiple use properties that are primarily residential were calculated on the basis of the total number of bedrooms represented by this property class, the equivalent number of households (based on 3.1 bedrooms/household) and therefore population (2.08 residents per household), with an average daily water demand of 65 rgpcd.

Properties having Accessory Land with Improvements. It was assumed that these properties could be developed only if they are 1 acre in size or greater, which is the minimum building lot size under current zoning. There was only one property that met this criterion, and the future water demand for this property was based on the residential per capita water usage. Those properties less than one acre in size are assumed to be undevelopable for future residential use, and therefore do not have water demands associated with them.

Properties with Multiple Houses and Apartments. The water demand for this property class is based on the equivalent number of households (based on 3.1 bedrooms/household) and therefore population (2.08 residents per household), with an average daily water demand of 65 rgpcd.

Vacant, Developable Residential Properties. These properties were assumed to have a single family residence on each property. An equivalent residential population was calculated (3.1 residents/household), and the water demand is based on 65 rgpcd.

Vacant, Undevelopable Residential Properties. These properties are assumed to remain vacant and have no existing or future water demands associated with them.

The supporting calculations used to develop the water demands of each class of residential property are provided in Appendix D.

Commercial Properties

The water demands of commercial properties were determined using the following methods: 1) on the basis of Title 5 wastewater flow criteria, or 2) if available, transient and non-transient community water system data. The Title 5 wastewater flows, recognized to be representative of a peak daily flow condition, were translated to water demands by adjusting the Title 5 wastewater flows by a factor of 0.5 to estimate an average daily wastewater flow, and also using the assumption that wastewater flows are 85% of water demands. A description of the approach used for each class of commercial property is provided below.

Motels and Inns. Water demands are, for most properties, based on per bedroom flows using Title 5 criteria (110 gpd/bedroom), translated to water usage using the approach described

above. Where DEP community water system reports that provide water withdrawal information for specific properties were available, these area used instead of the Title 5 criteria.

Miscellaneous Commercial Enterprises (Retail Stores, Restaurants, Office Buildings, etc.). Title 5 criteria are used for each type of commercial business (small retail – 50 gallons/1000 square feet; restaurants – 35 gallons/seat; office buildings – 75 gallon/1000 square feet, etc.). The specific Title 5 criteria used for each property is provided in the calculation tables included in Appendix D. Where DEP community water system reports that provide water withdrawal information for specific properties are available, these area used instead of the Title 5 criteria.

Vacant, Developable Commercial Properties. The future water demand of vacant, developable properties was estimated on the basis of the average water usage per acre of existing commercial properties. This was calculated to be 675 gpd/acre.

Vacant, Undevelopable Commercial Properties. These properties are assumed to remain vacant and have no existing or future water demands associated with them.

The supporting calculations used to develop the water demands of each class of commercial property are provided in Appendix D.

Industrial Properties

The majority of the industrial properties are classified as warehouses (10 total), one sand and gravel operation and three properties related to electrical transmission (rights of ways and substation). Water demands are only associated with the warehouse and sand/gravel operation and were calculated on the basis of Title 5 criteria (15 gpd/person). The electrical transmission properties have no water usage.

Vacant, Developable Industrial Properties. The future water demand of vacant, developable properties was estimated on the basis of the average water usage per acre of the existing industrial properties. This was calculated to be 12.4 gpd/acre.

Vacant, Undevelopable Industrial Properties. These properties are assumed to remain vacant and have no existing or future water demands associated with them.

The supporting calculations used to develop the water demands of each class of industrial property are provided in Appendix D.

Recreational Properties

There are two recreational properties that are to be served by the water system: a campground (Atlantic Oaks Campground) and a nature study area. DEP community water system data is available for the Atlantic Oaks Campground, and was used to characterize their existing water demands. The water demand of the nature study area was estimated on the basis of the Title 5 criteria for campgrounds of 10 gpd/visitor. It was assumed that the nature study area has a

capacity of 100 people. The water demand calculations for these recreational properties are provided in Appendix D.

Tax-Exempt Properties

The water demands of the tax exempt properties were determined based on the specific use of each property. Of the federal and state-owned parcels (26 owned by the US Government, 7 owned by the Commonwealth of Massachusetts), all but two are open land and will not be developed. The two remaining properties consist of the Salt Pond Visitors Center and a residential home. The Visitor Center water demands were estimated on the basis of Title 5 flow criteria of a public park with toilets (gpd/person), with an average of 500 visitors/day. For the residential home owned by the National Seashore the conventional water demand criteria were applied (2.06 residents/home; 65 rgpcd).

There are 62 parcels owned by the Town of Eastham, most of which (53 properties) are vacant land. The developed properties consist of schools (the Nauset Regional High School and the Eastham Elementary School), and municipal buildings (Town Hall, Town Library, Police Department, Fire Department, Department of Public Works, Department of Natural Resources and the Council on Aging). DEP community water system data is available for the High School, Elementary School and Town Hall, and these were used to characterize their existing water demands. The library demand is based on volume allowed under DEP's approval for the well on this property. For the remaining Town-owned properties Title 5 criteria were used (day care center, function hall, and office buildings). The specific Title 5 criteria for each property are provided in Appendix D.

The remaining tax-exempt properties consist of parcels owned by the Eastham Housing Authority, the Eastham Historical Society and churches. Several of these properties consist of residences, and their water demands are based on the residential demand criteria. The water demands of the remaining properties were determined on the basis of Title 5 criteria, which are listed for each specific property in Appendix D.

Vacant Developable Properties. There are three vacant properties that are Town-owned and potentially developable (the Roach property and two Purcell properties). Future water demands of these properties were estimated using existing zoning criteria for residences with single-family homes (1 acre zoning; 2.06 residents/household; 65 rgpcd). On the basis of these assumptions, these three parcels can support 55 single-family homes, and the water demands were calculated accordingly.

Estimate of Current Water System Demands

Estimates of the current and future water system demands were determined using the methodology described above, and are summarized in Table D-1.2. Detailed parcel counts and water demand calculations for each class of property are provided in Appendix D.

Table D-1.2. Estimate of Existing and Future Average Daily Water Demands of the Eastham Water System.

Classification Code	Land Use	Category	Parcels	Water Demand (gpd, average day)				
				Existing	%	Future	Total Future	%
0	**Multiple-Use Property**							
		Mixed Residential/Commercial	14	1,745		-	1,745	
		Mixed Commercial/Residential	26	7,265		-	7,265	
			40	9,009	2.8%	-	9,009	2.6%
1	**Residential**							
		Single Family	1495	202,124		-	202,124	
		Condominium	30	4,056		-	4,056	
		Two- and Three-Family	49	13,655		-	13,655	
		Accessory Land with Improvement	6	-		135	135	
		Multiple Houses on One Parcel, Apartments, Group Homes	63	8,518		-	8,518	
		Developable Land	109	-		14,737	14,737	
		Undevelopable Land	37	-		-	-	
			1789	228,353	71.4%	14,872	243,225	69.2%
3	**Commercial**							
		Transient Group Quarters (Hotels, Motels)	9	25,850		-	25,850	
		Retail, Auto Service, Office Buildings, Recreation Facilities, Warehouse	39	36,620		-	36,620	
		Commercial Developable Land	11	-		9,806	9,806	
		Commercial Undevelopable Land	1	-		-	-	
			60	62,470	19.5%	9,806	72,276	20.6%
4	**Industrial**	Warehouse, Sand/Gravel, Electric Transmission	14	318	0.1%		318	0.1%
		Industrial Developable Land	3	-		411	411	
		Industrial Undevelopable Land	1	-		-	-	
			18	318		411	729	
8	**Recreational Land**		2	4,334	1.4%	-	4,334	1.2%
9	**Tax Exempt Property**							
		United States Government	26	1,604		-	1,604	
		Commonwealth of Massachusetts	7	-		-	-	
		Town-Owned	62	7,851		7,304	15,155	
		Charitable and Religious Groups, Housing Authorities	17	5,757		-	5,757	
			112	15,213	4.8%	7,304	22,517	6.4%
	Subtotal		**2021**	**319,696**	**100.0%**	**32,393**	**351,679**	**100.0%**
Additional Water Uses								
	Confidentaly Estimated Municipal Water Use (3%)			9,591		972	10,550	
	Unacounted for Water (10%)			31,970		3,239	35,168	
Buffer/Contingency (5%)				15,985		1,620	17,584	
TOTAL PARCELS			**2021**					
TOTAL WATER DEMAND, AVERAGE DAY (gpd)				**377,242**		**38,224**	**414,981**	
TOTAL WATER DEMAND, AVERAGE DAY (Rounded to nearest 1,000 gpd)				**378,000**		**39,000**	**415,000**	

Property Water Demands

The current average daily water system demand generated by the 2,021 parcels to be served by the system is estimated to be 319,696 gallons per day. The large majority of this demand is from residential properties (71%). Commercial businesses comprise 19.5% of these demands, and the remaining demands are from mixed use, industrial, recreational and tax-exempt properties.

Confidently Estimated Municipal Water Use and UAW

In addition to these water demands from properties, two additional categories of water usage has been included in the overall water system demand: Confidently Estimated Municipal Water Use and Unaccounted for Water (UAW). Confidently Estimated Municipal Water Use is unbilled and typically unmetered water that is generated by municipal activities such as fire protection, flushing of water mains and street cleaning. UAW is caused by circumstances such as meter malfunctions or mis-registration, minor leaks, and theft, and is another category of water usage that DEP recognizes to occur in all water systems. DEP recognizes that both of these categories of water use is a typical aspect water system operations, and requests information on these categories as part of the Annual Statistical Report (ASR) prepared by water suppliers each year. The 2013 ASRs for the outer Cape communities of neighboring Orleans, Brewster and Provincetown were reviewed to the quantity; of water used in these two categories, expressed as a percent of the total withdrawal. These are summarized in Table D-1.3 below.

Table D-1.3. Percent of Confidently Estimated Municipal Use and Unaccounted for Water in Orleans, Brewster and Provincetown, as reported in 2013 DEP Annual Statistical Reports.

2013 ASR	*% of Overall Withdrawal*	
	Confidently Estimated Municipal Use	*Unaccounted for Water*
Orleans	2%	6%
Brewster	3%	8%
Provincetown	3%	17%
Average	*3%*	*11%*
Included in Eastham Demand Estimate	**3%**	**10%**

For the purposes of the estimating the current demand of the water system, a 3% factor for Confidently Estimated Water Use has been included. This percentage is consistent with what has been experienced by the water systems on outer Cape Cod (evaluated above) and in water systems in general. An allowance of 10% UAW has been included, because this is the rate that DEP allows as a maximum in water systems.

Contingency

Because these existing water demands are unable to be determined on the basis of metered water usage and therefore have a degree of uncertainty associated with them, a contingency factor of 5% has

been included in the overall estimate of the water system demands. This contingency can be eliminated in future years as metered water usage records of the system become available.

Overall Existing Water Demand

The overall current water system demand for Eastham that includes all categories of uses is estimated to be 378,000 gallons per day, equivalent to 138 Million Gallons per year.

D.1.C.3 Future Water System Demands

The future water system demands are generated by properties that are currently vacant, and their future water demands were estimated under the assumption that they are developed in accordance with their current land use designation and their applicable land use bylaws. Development of these properties will create an additional demand of 32,393 gpd, an increase of approximately 10% over the demand of currently developed properties. The overall future average daily demand of the water system generated by properties is estimated to be 351,679 gpd.

The estimate of the future water system demands includes the corresponding increases in Confidently Estimated Water Use and UAW, and the 5% contingency. Overall, the future demand of Eastham's water system is estimated to be 415,000 gpd, or 151 Million Gallons per year.

Demand Characteristics: Average Day (Annual), Average Day (Peak Season) and Peak Day

In addition to the water system demands for the average gallons per day on a year-round basis, demands are also forecasted for the average day during the peak summer season (July and August) and for the peak day. Ratios of each of these demand conditions were determined based on the water withdrawals reported in the 2013 ASRs for Orleans, Brewster and Provincetown, shown in Table D-1.4.

Table D-1.4. Water demand characteristics for Orleans, Brewster and Provincetown, and estimated for current and future Eastham water system.

Water System	*Daily and Seasonal Demand Characteristics*				
	Ave Day, Annual (gpd)	*Ave Day, Peak Season ((gpd)*		*Peak Day (gallons)*	
		Volume	*Ratio to Q_{ave}*	*Volume*	*Ratio to Q_{ave}*
Orleans	892,904	1,745,775	2.0	2,372,800	2.7
Brewster	1,243,389	2,499,115	2.0	3,651,000	2.9
Provincetown	624,902	1,162,335	1.9	1,799,550	2.9
Average			*1.9*		*2.8*
Eastham, Current	**378,000**	**734,000**		**1,068,000**	
Eastham, Future	**415,000**	**806,000**		**1,172,000**	

Based on the demand characteristics experienced by these other outer Cape water system, the current average daily demand of the Eastham water system is expected to increase during the summer (July and

August) by a factor of 1.9 to an estimated 734,000 gpd. The peak day demand is expected to be approximately 1,068,000 gallons (a factor of 2.8 over the average daily demand). For the future water system, these demands are estimated to be 806,000 gpd and 1,172,000 gallons, respectively.

Form D2 – Projection of Withdrawal Volumes

The estimated current water withdrawals (378,000 gpd, or 138 Million Gallons annually) are anticipated to increase by 39,000 gpd, largely associated with the development of residential and commercial properties, as shown in Table D-1.2. Once this development has taken place the overall future withdrawals are estimated to be 415,000 gpd, or 151 MGY. For the purposes of this Water Witrhdrawal application it is assumed that Eastham will experience this future water demand after five years of the system operation, anticipated to be in 2021.

Seasonal Withdrawals

Eastham is typical of Cape Cod communities that are highly seasonal in nature. The year-round population of the Town is 4,956 (2010 census), which grows by approximately a factor of four during the summer.

The monthly variation in water withdrawals was estimated by reviewing the DEP Annual Statistical Reports (ASRs) for surrounding communities with municipal water systems: Orleans, Brewster and Provincetown. Monthly withdrawal rates reported in the 2013 and 2012 ASRs for Orleans and the 2013 ASRs for Brewster and Provincetown are summarized in Table D-2.1 and used to calculate the average withdrawal/month for these communities. These average withdrawal rates are the basis of the monthly rates provided in Section 7 of Form D2.

Table D-2.1 Monthly Water Withdrawals of Outer Cape Communities as % of Annual Total.

Month	***Orleans***	***Orleans***	***Brewster***	***Provincetown***	***AVERAGE***
ASR	***2013***	***2012***	***2012***	***2012***	
January	5%	4%	5%	4%	**5%**
February	4%	4%	4%	4%	**4%**
March	4%	4%	5%	4%	**4%**
April	5%	7%	6%	7%	**6%**
May	9%	8%	9%	8%	**8%**
June	11%	12%	10%	12%	**11%**
July	17%	19%	17%	19%	**18%**
August	16%	16%	16%	16%	**16%**
September	10%	10%	10%	10%	**10%**
October	8%	6%	8%	6%	**7%**
November	6%	5%	5%	5%	**5%**
December	5%	5%	5%	5%	**5%**

The pertinent sections of the Annual Statistical Reports used for this analysis are provided in Appendix E.

8. Projected Withdrawal from Each Withdrawal Point

During the initial years of operating the water system two well fields are to be connected and used for water withdrawals: District G and Nauset Regional High School. While these two well fields are in operation withdrawals are expected to be divided evenly between them, e.g., 50% from District G, 50% from Nauset Regional High School.

The two wells at District H (Zone B well, Zone C well) are planned to be connected to the system at a later date, which for planning purposes is targeted for five years from system startup (2016), and therefore in the year 2021. Once this well field is connected and all four withdrawal points are available to the system, the allocation of withdrawals is expected to be that shown below in Table D.2.2.

Table D-2.2 Anticipated Allocation of Withdrawals from Well Fields

Withdrawal Location	***%***
District G	25.0%
NRHS	50.0%
H - Zone B	12.5%
H- Zone C	12.5%
Total	100%

Form F – Evaluation of Potential Effects of Proposed Withdrawal

1. Withdrawal Points

Wastewater Treatment or Assimilation:

Eastham does not have a municipal wastewater collection and treatment system; all wastewater discharges are via individual, onsite septic systems. Figure F-1 shows the location of the water withdrawal locations for the water system (District G, Nauset Regional High School, District H-TPW-3B and District H-TPW-2C), and the property parcels to be served by the water system. Each of these parcels are the location of onsite wastewater systems and discharges.

Wetlands:

There are no wetlands on the District G or the Nauset Regional High School withdrawal points. The District H property has a cluster of vernal pools in the area between the Nauset Light Beach and the District H withdrawal points, shown on Figure F-2. Eleven of the vernal pools that occur in this area are designated Certified Vernal Pools under the National Heritage & Endangered Species Program (NHESP) and one is designated a potential vernal pool (Mass DEP 2012).

Vernal Pool Study at District H

Four of the Certified Vernal Pools at the District H well site (E1, E5a, E9, and E11) are located within approximately 1,000 feet from the withdrawal points TPW-3B and TPW-2C. Three of these (E1, E9, and E11) were monitored extensively prior to, during, and after the long-term pumping tests as reviewed and approved by DEP, and the vernal pool aquifer test data were analyzed to investigate the potential effects of future pumping in District H on water levels in the vernal pools. The data from the aquifer test and from previous investigations were used to form a predictive model of the vernal pool behavior in response to changes in groundwater levels that might be associated with water withdrawals from the District H wells. This study, *Characterization of Groundwater and Vernal Pool Interactions in District H,* accompanied the DEP Pumping Test Report – Wellfield Protection Zoning District H (Environmental Partners, April 2013). A copy of this report is provided in Appendix F.

Vernal pools VP-E1 and VP-E9 exhibited no apparent responses during the District H aquifer tests. The conclusion on the modeling performed on VP-11 was that pumping TPW-3B at a rate of 0.5 MGD (the anticipated average pumping rate from this wellfield at complete system build-out) will result in a very small effect on the vernal pool stage (an average drop of 2.5 inches).

The subsurface geology at District H is comprised of four potential glacial sand aquifers zones, designated as Zone A, Zone B, Zone C and Zone D, each separated by silty clay/clayey silt aquacludes. Zone A is unconfined and not considered a viable aquifer zone, because of hydraulic connection with the vernal pools. The Zone B aquifer is overlain by a single aquaclude

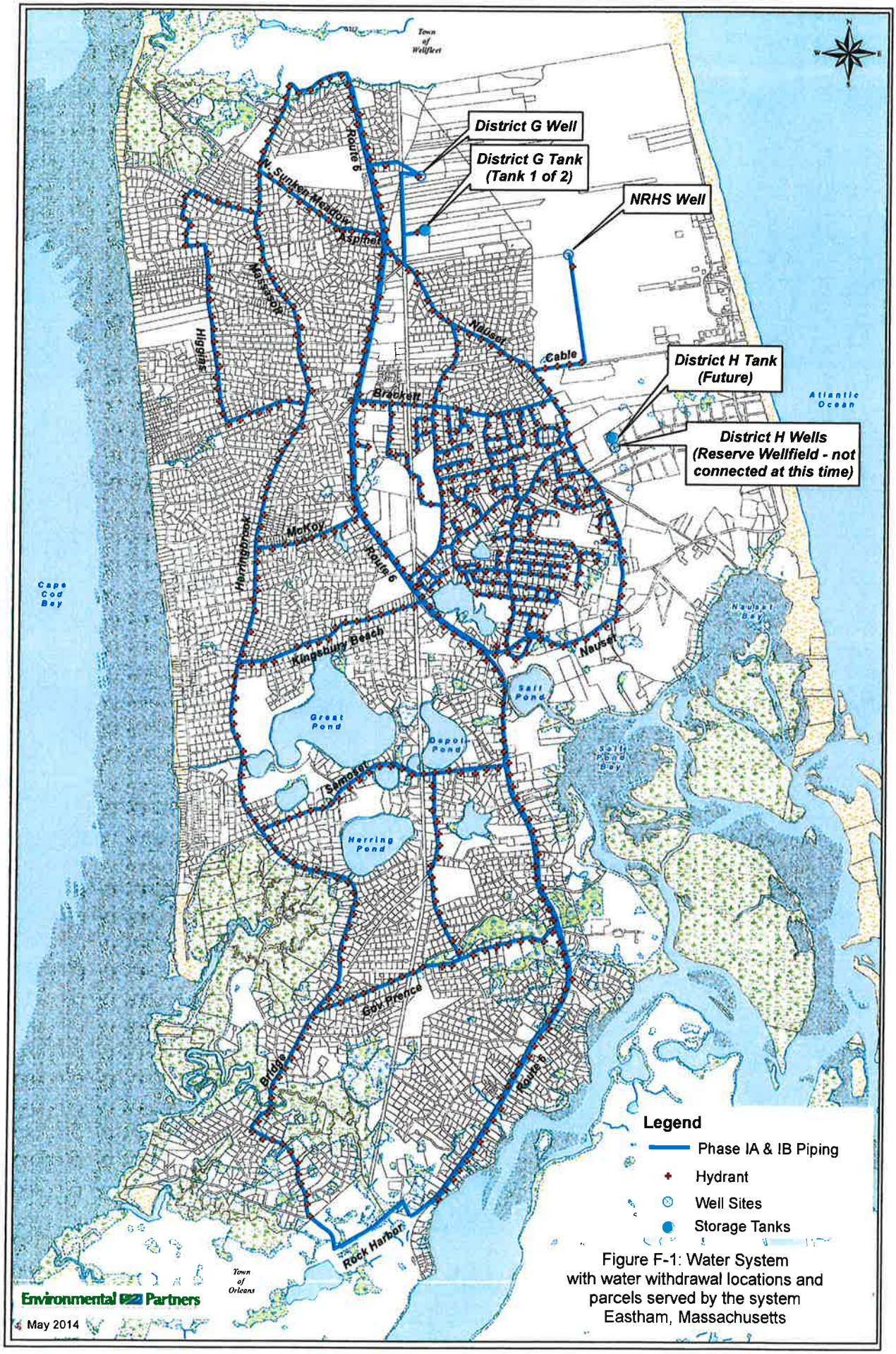


Figure F-1: Water System
with water withdrawal locations and
parcels served by the system
Eastham, Massachusetts

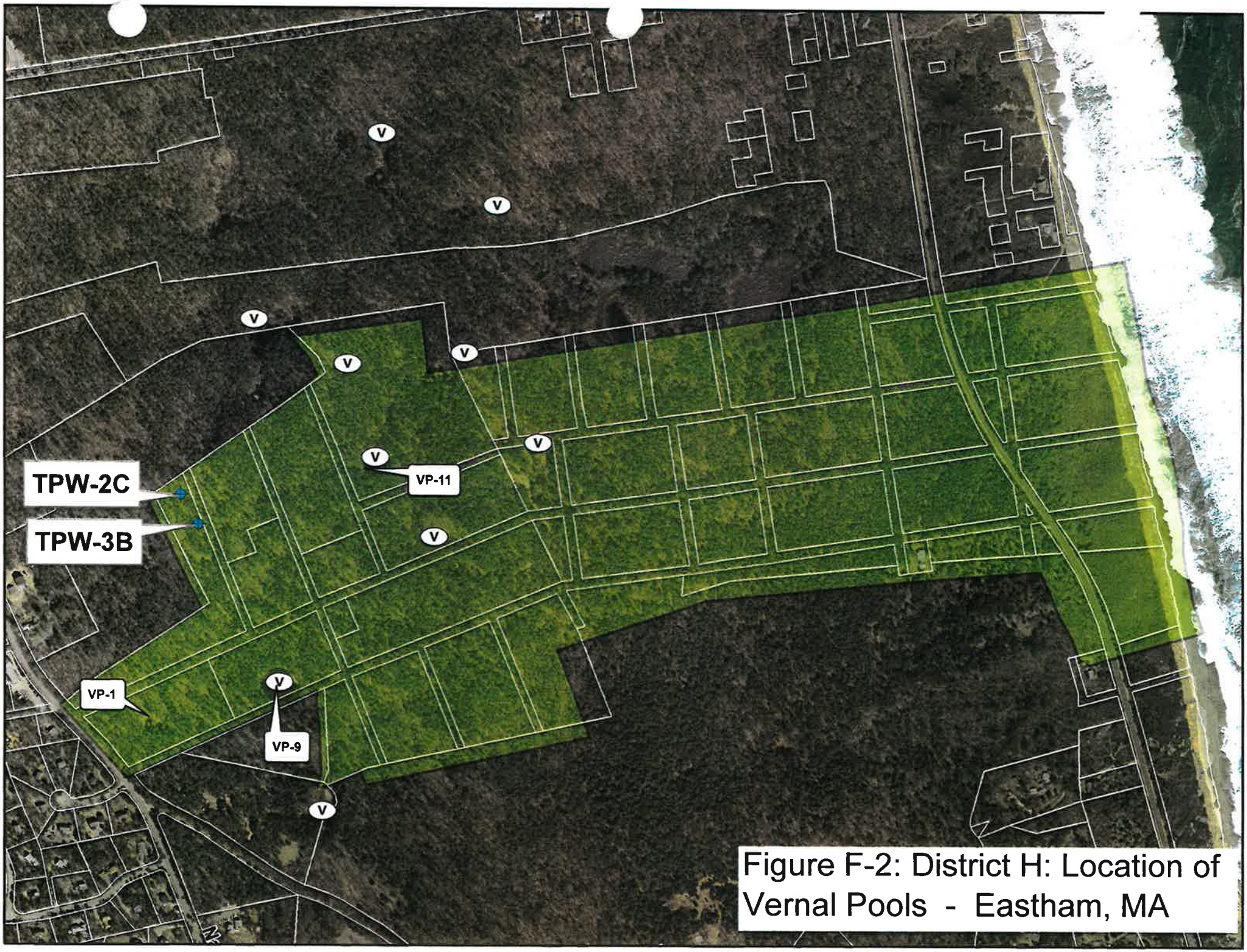


Figure F-2: District H: Location of Vernal Pools - Eastham, MA

and the Zone C aquifer has two overlying aquaclude layers. Production well TPW-3B is screened in the Zone B aquifer and TPW-2C in the Zone C.

The model focused on pumping from TPW-3B, because this well is screened in the shallower (Zone B) semi-confined aquifer and would have the greatest potential effect on the vernal pool water levels. The effect of water withdrawals on water levels within vernal pools are mitigated by the character of the peat layer underlying the pools. The peat layer that underlies these vernal pools is thickest towards the center of the pool and thins towards the edges. The vernal pool model developed in this study demonstrates that seepage is more rapid when the pool stage is high and inundation overlies the areas of thinner peat mat. The model also shows that vernal pool VP-E11 is fed by precipitation and that the vernal pool is most likely not replenished by groundwater. Therefore, a decline in water-table level due to pumping is not anticipated to transmit a similar decline to the vernal pool. As a corollary, while pumping and water level declines do not significantly affect pool water levels, a period with no rainfall would have a much larger impact, regardless of pumping.

The vernal pool VP-E11 model results indicate that groundwater level declines in the vicinity of the pool caused by future District H pumping will result in a very small effect on the vernal pool stage (an average drop of 2.5 inches when TPW-3B is pumped consistently at 0.5 MGD, a condition only representative of system build-out conditions). In addition, because vernal pools VP-E1 and VP-E9 exhibited no apparent responses during the District H aquifer test, it is anticipated that long term District H pumping will have less of an effect on these vernal pools than the very small long-term effect calculated for vernal pool VP-E11. This model and results were reviewed with the DEP, NPS and Cape Cod Commission (CCC) prior to submittal of the District H Pumping Test Report.

The District H Pumping Test Report includes a vernal pool monitoring program, in which a series of vernal pools and observation wells will be monitored to confirm that the effects to vernal pool water levels from production well pumping are consistent with those predicted in the vernal pool model. The vernal pool monitoring plan includes the following four components:

1. Vernal pool water level monitoring in five vernal pools
2. Observation well water level monitoring in Zone A, Zone B and Zone C wells in four well clusters
3. Precipitation monitoring
4. Progress meetings

This vernal pool monitoring program has been approved by DEP, the National Park Service, and the Cape Cod Commission.

Wildlife, Fisheries and Floral Habitats:

A review of the DEP Priority Resources Map for the NRHS, District G and District H withdrawal points indicates that all three well sites are located within an area designated as Priority Habitats of Rare Species and Estimated Habitat of Rare Wetland Wildlife under NHESP and Areas of Critical Environmental Concern.

Agriculture:

None of the three withdrawal points are located within ¼-mile of farming or agricultural activities.

Navigation or Recreation User:

None of the three withdrawal points are located near a recreational river, stream, lake or pond. Hatches Creek is located approximately 2,300 feet north of the District G withdrawal point. The pumping test had no discernible impact on Hatches Creek. Groundwater modeling was performed based on site specific field data to simulate long term pumping effects (over 100 years) on discharge rates to Hatches Creek. The District G well will likely be operated based on demand with an anticipated average annual rate of.25 MGD at full system build-out. The predicted reduction in discharge to Hatches Creek when pumping of the District G well at the rate of 0.25 mgd over 100 year period is 0.06 cubic feet per second (cfs).

Groundwater Recharge Areas:

The groundwater flow system that occurs in the glacial sediments of Lower Cape Cod consists of 1) freshwater lenses where recharge occurs, 2) surface water bodies such as streams and ponds where recharge and discharge occurs, 3) shoreline and nearshore areas where discharge occurs, and 4) underlying saltwater.

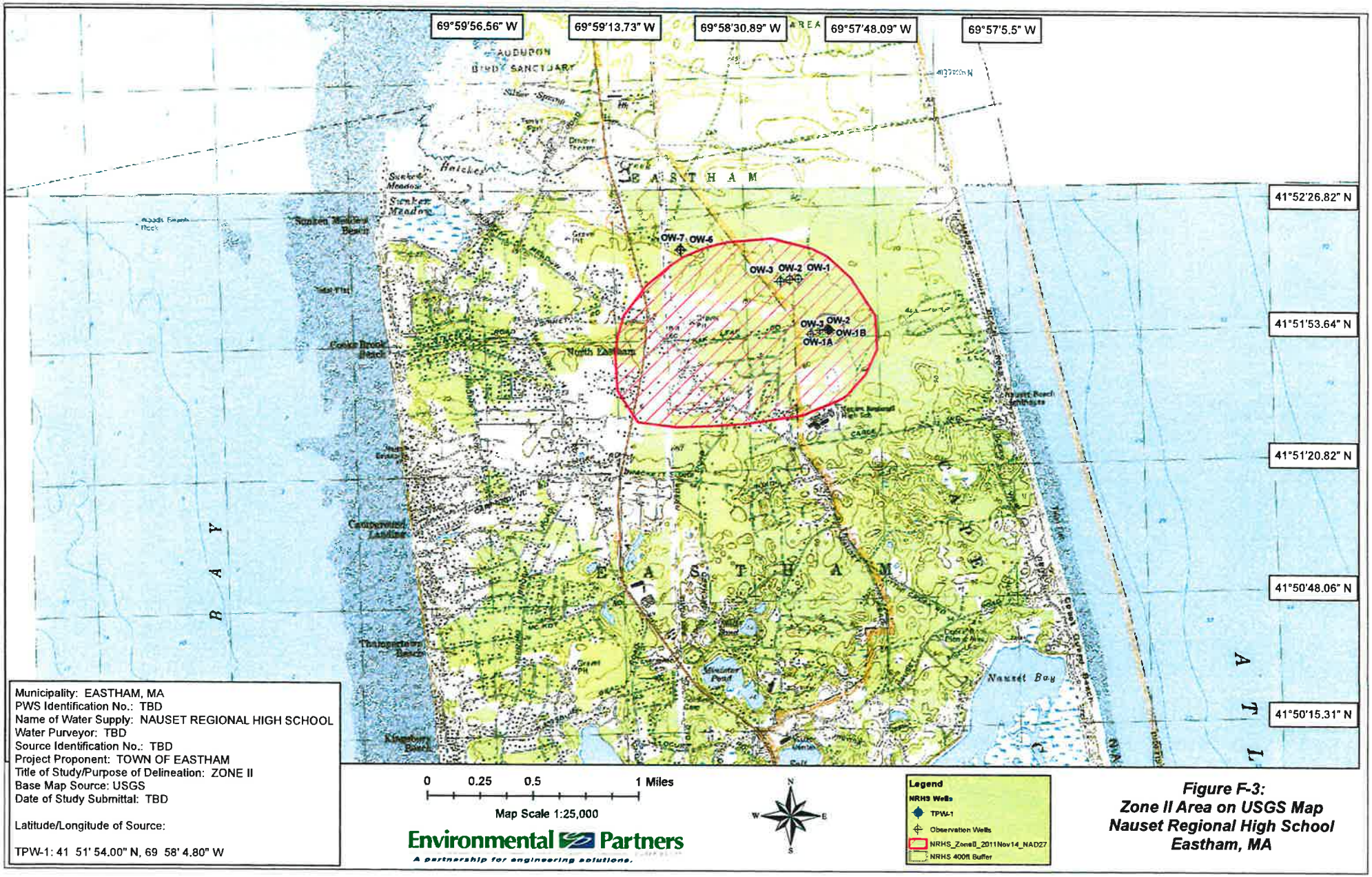
Freshwater contained in Lower Cape Cod sediments is underlain by saltwater (Masterson 2004). The source of fresh water in the aquifer and surface water bodies is entirely from precipitation that recharges the sediments.

Recharge from precipitation on Lower Cape Cod has been estimated to be approximately 45 to 55 percent of annual rainfall based on an average annual precipitation rate of between 40 to 42 inches/year (Le Blanc et al. 1986; Masterson et al. 1998), which yields a recharge rate between 18 to 23 inches/year. Recent modeling studies have reported higher aquifer recharge rates of approximately 24 inches/year (Masterson 2004). Recharge at ponds is reportedly less (14 inches/year) because evaporation rates are higher for surface water bodies than for land surface (Masterson 2004). Although the amount of rainfall reported at the weather station in nearby Chatham, Massachusetts is approximately 3.9 inches per month (NOAA 2011) or 46 inches per year, the amount of recharge varies seasonally due to evapotranspiration (Barlow and Dickerman 2001; Walter and Masterson 2003).

The Zone 2 was determined for the NRHS, District G and District H wells using the SEAWAT Model for the Nauset Lens, updated with site specific data from these three study areas. The Zone 2 for the Nauset Regional High School well is shown on Figure F-3 and provides the area of recharge for the this withdrawal point. A water budget analysis was performed for the Nauset Regional High School withdrawal point that compares the recharge rate against the proposed volume of groundwater withdrawal to confirm that the annual recharge within the Zone II area exceeds the withdrawal volume for the Nauset Regional High School well. Assuming an average recharge rate of 24-inches per year (average recharge), the ratio of annual recharge within the Nauset Regional High School well Zone II to annual maximum pumping is 1.14. Therefore, at the maximum approvable pumping rate (613 gpm or 0.883 MGD), more water will recharge the aquifer than will be withdrawn from pumping. Actual pumping rates at the Nauset Regional High School welll upon build-out of the water system is anticipated to on the order of 0.50 MGD, approximately 55% of the maximum pumping rate, and therefore the aquifer capacity of the delineated Zone II is very protective.

Figure F-4 shows the Zone 2 for the District G withdrawal point. Using the same assumptions, the ratio of annual recharge within the District G wellfield Zone II to annual maximum pumping is 1.00, indicating that the Zone II will provide enough water for the approved pumping rate (691 gpm or 0.955 MGD). The actual pumping rate at District G upon build-out of the water system is anticipated to be on the order of 0.25 MGD, approximately 25% of the maximum pumping rate.

The approvable yield for the District H Site is 910 gpm (single or combined withdrawal from the two production wells) or 1.31 MGD. Figure F-5 shows the Zone 2 for the District H withdrawal points. Assuming an average recharge rate of 24-inches per year and a pumping rate of 1.31 MGD, the ratio of annual recharge within the District H TPW-3B and TPW-2C wellfield Zone II's to annual maximum pumping is 0.96. Using the higher rainfall data from Chatham of 3.9 inches per month, the recharge to pumping ratio is 1.17. The Zone II provides sufficient water for the approved maximum pumping rate. Similar to District G, the actual pumping rates at District H upon build-out of the water system is anticipated to on the order of 0.25 MGD, approximately 20% of the maximum pumping rate, and therefore the aquifer capacity of the delineated Zone II is very protective.



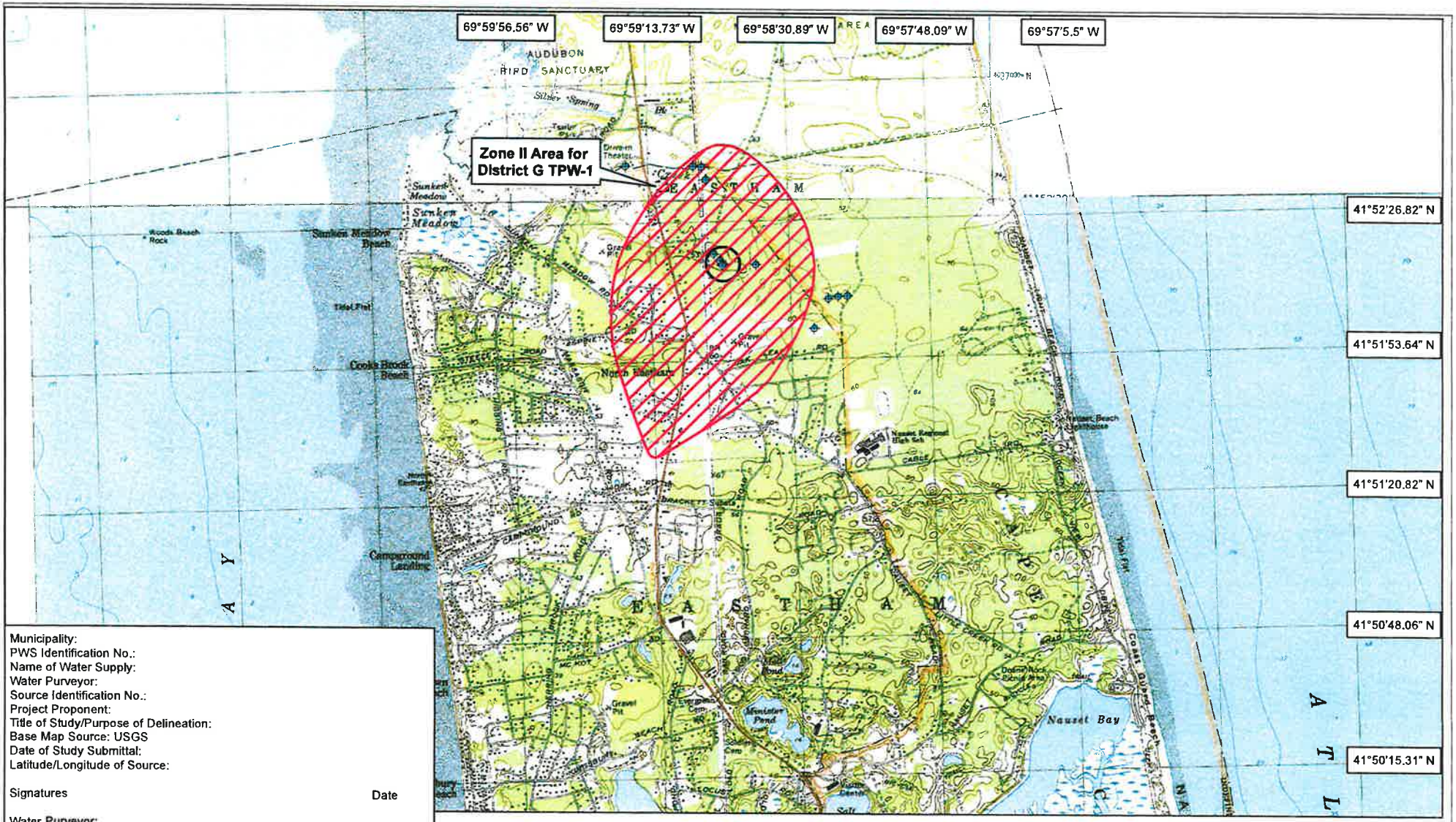
Municipality: EASTHAM, MA
PWS Identification No.: TBD
Name of Water Supply: NAUSET REGIONAL HIGH SCHOOL
Water Purveyor: TBD
Source Identification No.: TBD
Project Proponent: TOWN OF EASTHAM
Title of Study/Purpose of Delineation: ZONE II
Base Map Source: USGS
Date of Study Submittal: TBD

Latitude/Longitude of Source:

TPW-1: 41 51' 54.00" N, 69 58' 4.80" W

Environmental Partners
A partnership for engineering solutions.

Figure F-3:
Zone II Area on USGS Map
Nauset Regional High School
Eastham, MA



Municipality:
PWS Identification No.:
Name of Water Supply:
Water Purveyor:
Source Identification No.:
Project Proponent:
Title of Study/Purpose of Delineation:
Base Map Source: USGS
Date of Study Submittal:
Latitude/Longitude of Source:

Signatures	Date
Water Purveyor:_____	_____
Consultant:_____	_____
Project Proponent:_____	_____
Regional Water Supply Chief:_____	_____

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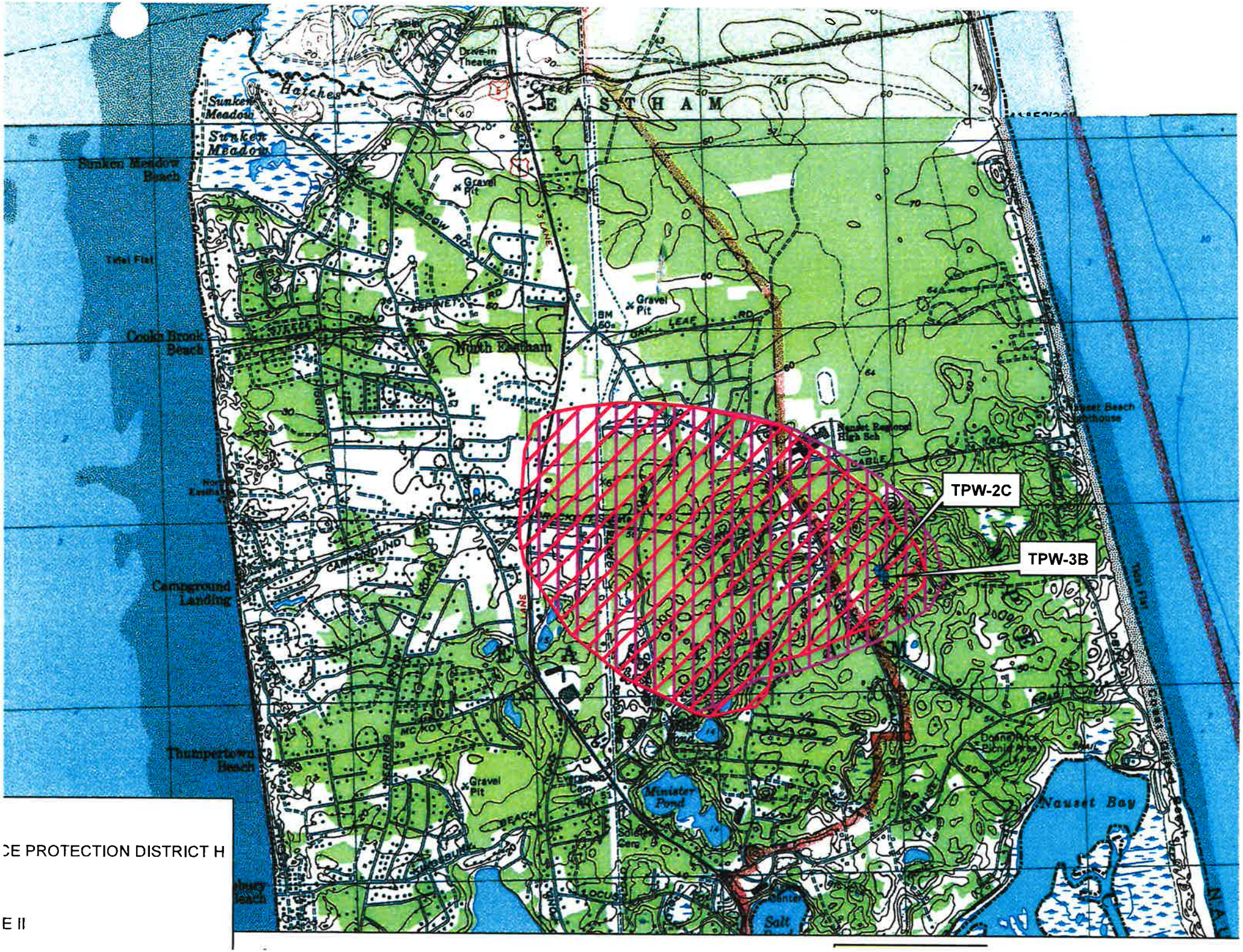
Figure F-4:
Zone II Topographic Map
District G - Well Site
Eastham, MA



CE PROTECTION DISTRICT H

E II

Form G – Alternatives to Proposed Withdrawal

2. The Proposed Withdrawal

At their May 2014 Annual Town Meeting the Town of Eastham voted to establish a municipal water supply and water distribution system that will provide service to approximately one third of the Town's properties (2,021 parcels). A plan showing this water system, as approved at the Town Meeting, is shown on Figure B-1.

Description of the Project

Being an entirely new water system, the project consists of constructing wellfields, a storage tank and distribution system water mains as follows:

Well fields. Eastham has received DEP New Source Approval on three well fields: District G, Nauset Regional High School, and District H (see Appendix A). Initially the system is to be served by two of these well fields, District G and the Nauset Regional High School. For the purposes of this DEP Water Withdrawal Permit application, it has been assumed that the District H wells will be connected to the system in approximately the year 2021.

Water storage tank. The water storage tank is to be located adjacent to the District G well field and is to have a 750,000 gallon capacity. This tank is to be an elevated, composite concrete/steel tank.

Distribution system. The distribution system consists of 45 miles of pipe with associated fire hydrants and valves that will serve 2,021 properties, representing approximately one-third of the community. Looped transmission mains are to be located throughout the Town so as to provide what is referred to as the "backbone" of the distribution system that, should the Town decide to do so in the future, serve a Town-wide water system. In addition to these mains from which future laterals can be connected, this distribution system and its fire hydrants will provide fire protection to approximately 80% of the community, being those properties that are located within ½ mile of the water main. This is a very significant improvement in fire protection for the Town, which now relies on pumper trucks for fire emergencies.

The distribution system is to also provide service to properties in the vicinity of the landfill, where private water supplies have previously been impacted by volatile organic compounds (vinyl chloride) and today are impacted by 1,4-dixoane, an emerging contaminant of concern and suspected carcinogen. The presence of these compounds in the private wells of this area became a significant factor in the Town's decision to implement a municipal water system.

A background on this situation is provided in the following paragraphs.

Water Quality Impacts in the Landfill Area

The Town's landfill operated from the 1930's until 1992, and was closed in 1997. The closure consisted of the construction of a low permeability cap and the implementation of a post-closure groundwater monitoring program.

In 2004 vinyl chloride was detected in a private drinking water well at a concentration of 2 micrograms per Liter (µg/L) that resulted in that homeowner having to use bottled water for its drinking water. Over the following five years the vinyl chloride concentrations gradually diminished, indicating that this contaminant plume had dissipated.

In 2012 DEP's Division of Solid Waste revised the Town's post-closure monitoring program to include sampling and analysis of the compound 1,4-dioxane at both the landfill monitoring wells and private wells. As an emerging contaminant of concern by EPA and DEP, 1,4-dioxane is one of the parameters included in the current (third) round of Unregulated Contaminant Monitoring Rule (UCMR3) monitoring being required of public water providers. DEP has published draft regulations that lower the MCP GW-1 drinking water standard for 1,4 dioxane from 3.0 µg/L to 0.3 µg/L.

The Town has collected water samples from over 300 private wells in the landfill area during 2012, 2013 and 2014 for 1,4-dioxane analysis. The results showed that currently there are 43 properties that have 1,4-dioxane concentrations that exceed the MCP GW-1 standard, and are now on bottled water. In addition to these properties, the well at the Eastham Elementary School had detections of 1,4-dioxane, but at concentrations below the MCP GW-1 drinking water standard. Nonetheless, the school is now using bottled water for drinking water and kitchen use.

The Town's Licensed Site Professional responsible for evaluating these groundwater impacts and for recommending a remedial strategy for these private water supplies has concluded that a municipal water system is the preferred approach to protecting the public health of residents in this area.

3. Leak Detection Alternative

The Town does not currently have a municipal water system, therefore mitigating current system demands is not an applicable conservation strategy at this time. When the water system is put into operation, the Town intends to conduct regularly scheduled (annual or bi-annual) leak detection surveys as part of their strategy for minimizing Unaccounted for Water.

4. Increased Conservation and Demand Management

The Town has completed the Water Conservation Questionnaire for Public Water Suppliers (Massachusetts Water Resources Commission, Revised march 2008), provided in Appendix G. As part of the preparation of this Questionnaire, the June 2012 update of the Massachusetts Water Conservation Standards issued by the Water Resources Commission were reviewed and used as guidance.

Because the Town does not have a municipal water system, most of the items requested in the Water Questionnaire, including various plans and systems targeted toward water conservation practices, have not yet been developed. The Town intends to have these Plans and programs developed prior to when the water system operations are to commence in the spring of 2016. These include:

- A Drought Management Plan that follows AWWA guidance and includes a seasonal demand management strategy that is consistent with those of similar water systems on Cape Cod.
- An Emergency Management Plan
- A written Conservation Plan that addresses conditions associated with the Water Management Act permit the Town is to receive and the 2012 Water Conservation Standards

In addition, the Town intends to take the following actions with respect to their water conservation practices:

- Regularly scheduled (annual or bi-annual) leak detection surveys, as described above.
- Metering of all water system connections and uses, to the extent practicable.
- Implementation of a water meter repair and replacement policy
- Programs for calibrating meters and sealing them for tamper protection
- Establishing a water pricing structure that includes the full cost of operating, maintaining and protecting the water system. A rate evaluation is expected to be conducted periodically, and at a minimum of every five years.
- Implementing a comprehensive residential water conservation program with the goal of achieving a 65 rgpcd use standard, and encourages the use of water-efficient plumbing fixtures.
- Manages municipal and industrial water usage, requiring compliance with plumbing codes and encourages the use of best available technologies for water conservation
- Develop and implement a public education and outreach program that encourages water conservation.

Alternative Withdrawal Points

The Town of Eastham has long considered the implementation of a municipal water system. The Town first evaluated construction of a limited water system in the late 1960's (*Report on Proposed Water System in Eastham, Massachusetts,* by Whitman and Howard, 1970), and then again in the late 1990s in response to the landfill groundwater contamination.

In August, 2005 Environmental Partners Group completed a feasibility study, *Limited Municipal Water System: Task 1 – Project Definition and Feasibility Study*, which evaluated the implementation of a limited water supply system in the vicinity of the landfill. A subsequent study, *Limited Municipal Water System Task 2 – Water Supply Source Identification* (Environmental Partners Group, September 2005), examined alternative drinking water supply sources within Eastham, as well as an interconnection with Orleans and the "No Action" alternative. The comparison matrix from that report (Table G-1, below) summarizes this evaluation and ranking of these water supply alternatives, which included ruling out the No Action alternative. Both of these studies are included in Appendix H. Results of these 2005 studies were incorporated into the subsequent town-wide *Municipal Water Distribution System Master Plan* (Environmental Partners, May 2006), also provided in Appendix H. The Master Plan includes an assessment of potential groundwater supply sources.

Table G-1: Comparison Matrix of Water Supply Alternatives (from the report *Limited Municipal Water System* by Environmental Partners Group, 2005)

Site ID		Ranking	Town Owned	400' Zone I Availability	Expected Water Quality	Potential Yield	CCNS	Distance to Service Area	Environmental Issues
Well-field Protection Zoning District "H"	Test Well No. 1 – East of Nauset Rd. & South of Cable Rd.	Highly Favorable	X	Yes	Good	400 gpm	Inside	0 ft	Vernal Pools, Wetlands
	Test Well No. 3 – East of Nauset Rd. & South of Cable Rd.	Highly Favorable	X	Yes	Good	300 gpm	Inside	0 ft	Vernal Pools, Wetlands
	Test Well No. 4 – East of Nauset Rd. & South of Cable Rd.	Highly Favorable	X	Yes	Good	700 gpm	Inside	0 ft	Vernal Pools, Wetlands
North Eastham		Unfavorable		Yes	Unknown	450 gpm	Inside	18,650 ft	Unknown
Marconi Beach (Wellfleet)		Unfavorable		Yes	Unknown	Unknown	Inside	18,450 ft	Wetlands
Eastham Water Protection District (EWPD)		Less Favorable	X	Yes	Unknown	450 gpm	Outside	12,365 ft	Wetlands
Roach Property		Unfavorable	X	Yes	Unknown	150 gpm	Outside	11,582 ft	Wetlands
Little Creek (Nauset Road)		Unfavorable		Yes	Unknown	Unknown	Inside	0 ft	Vernal Pools, Wetlands
Eastham Elementary School		Unfavorable	X	No	Poor	20 gpm	Outside	0 ft	Minister Pond, Wetlands
Nauset Regional High School		Highly Favorable		Yes	Good	<70 gpm	Inside	7,582 ft	Wetlands, Vernal Pools
Eastham Senior Center		Unfavorable	X	No	Unknown	<70 gpm	Outside	0 ft	Vernal Pools, Wetlands
Nursery School/Day Care		Unfavorable	X	No	Unknown	<70 gpm	Outside	0 ft	Vernal Pools, Wetlands
Town of Orleans Water Supply System		Unfavorable	-	-	Good	-	-	20,000+ ft	-

5. No Action Alternative

The no-action alternative represents a continuation of the existing water supply situation in Eastham, where the Town does not have a municipal water system and only limited fire protection. There are several reasons why the No-Action alternative is not in the best interest of the Town, as described in the following paragraphs.

Impact of Onsite Wastewater Systems on Private Wells

Because the Town relies on private or community wells for water supply and onsite systems for wastewater disposal, these wells and wastewater disposal systems are in close proximity to each other, resulting in impacts to drinking water.

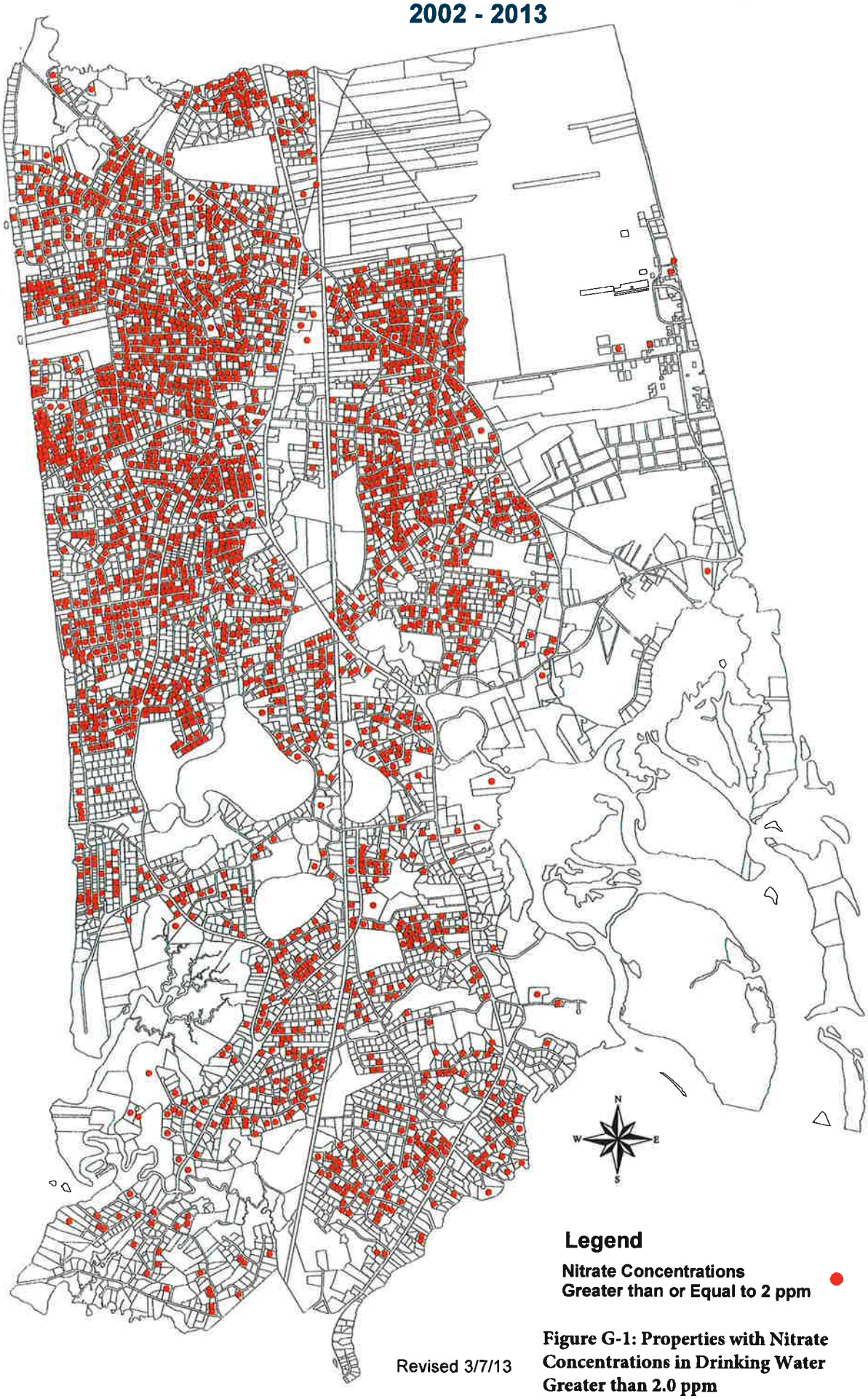
This has been documented through a private well sampling program that has been offered by the Eastham Board of Health to property owners since 2003, where property owners can submit samples of their well water for analysis of nitrate-nitrogen concentrations. Nitrate, in addition to being a contaminant of concern in drinking water, is also an indicator that other compounds may be present that are associated with septic system discharges (phosphorus, volatile organic compounds, personal care products, pharmaceuticals, viruses, etc.) and that may be impacting these private wells. It is generally accepted that nitrate concentrations greater than 0.5 milligrams/Liter (mg/L) are due to anthropogenic (human-based) sources, as either septic system discharges or fertilizer runoff. The Environmental Protection Agency and Massachusetts DEP have established a Maximum Contaminant Level (MCL) for nitrate of 10 mg/L because it can cause adverse health effects at concentrations greater than this MCL. As a result, the Cape Cod Commission has set a groundwater planning limit of 5 mg/L total nitrogen to protect drinking water supplies and other water resources.

Under the Board of Health's nitrate sampling program, each year one-third of the community is offered the opportunity to have their well water tested. This data demonstrates that Eastham's groundwater system has elevated concentrations of nitrate greater than 2.0 mg/l, and that the number of properties with these elevated nitrate concentrations is increasing over time. Figure G-1 shows the properties that have greater than 2.0 mg/l nitrate in their drinking water supply, and that this is a Town-wide problem (e.g., it is not focused in any discrete geographic areas of the community). Evaluations completed by the DEP Massachusetts Estuary Program identify individual on-site septic systems as the largest source of nitrogen and phosphorus to the groundwater. According to the Town's Comprehensive Wastewater Management Plan (Stearns & Wheler, 2009), this groundwater contamination has created a serious threat to the drinking water quality of the individual water supplies at each property and also states that the long-term solution to the problem is a municipal water supply.

Limited Fire Protection

Because there is no municipal water system in Eastham, the Fire Department has limited ability to provide fire protection to the Town. During 2012 the Fire Department responded to 42 fire incidents, including building fires, brush fires and grass fires. The Fire Department has pumper trucks that are filled using either ponds or small buried storage tanks, which delays their response time to these

Eastham Water Survey Program - Nitrate Analysis
2002 - 2013



Revised 3/7/13

Figure G-1: Properties with Nitrate Concentrations in Drinking Water Greater than 2.0 ppm

incidents. A municipal water system that provides hydrant access through the distribution system piping would significantly improve the fire protection and emergency response capabilities of the Fire Department. The Town currently relies on mutual aid support from neighboring communities if additional support or water is required to respond to fire incidents.

The proximity of fire hydrants to properties, especially those within ½ mile of hydrants, will also provide an opportunity for homeowners to potentially receive a reduction in their dwelling insurance rates because of improved Insurance Services Office (ISO) ratings.

1,4-Dioxane Impacts to Private Wells

In the above Section the status of 1,4-dioxane impacts to private wells in the vicinity of the landfill area is described, where currently there are now 43 residential properties and the Eastham Elementary School relying on bottled water for drinking water. The Town currently has no backup system to replace private water supplies that become unusable due to impacted groundwater, other than to use bottled water. Bottled water has limited usefulness to residents, which only addresses drinking water needs but does not address other household needs such as showering, washing clothes, etc.

For all of these reasons, the No-Action alternative for meeting the Town's water supply needs is not recommended.

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The proximity of fire hydrants to properties, especially those within ½ mile of hydrants, will also provide an opportunity for homeowners to potentially receive a reduction in their dwelling insurance rates because of improved Insurance Services Office (ISO) ratings.

1,4-Dioxane Impacts to Private Wells

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For all of these reasons, the No-Action alternative for meeting the Town's water supply needs is not recommended.

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

Southeast Regional Office • 20 Riverside Drive, Lakeville MA 02347 • 508-946-2700

DEVAL L. PATRICK
Governor

TIMOTHY P. MURRAY
Lieutenant Governor

RICHARD K. SULLIVAN JR.
Secretary

KENNETH L. KIMMELL
Commissioner

December 18, 2012

Ms. Sheila Vanderhoef
Town of Eastham
2500 State Highway
Eastham, Massachusetts 02642

RE: EASTHAM--Public Water Supply
Town of Eastham, BRP WS 19,
New Source Approval, Pumping
Test Report Approval, Water Resource
Protection District G Site,
Transmittal Number X241315

Dear Ms. Vanderhoef:

Please find attached the following information: Approval of the pumping test report for the proposed Water Resource Protection District G Site.

Please note that the signature on this cover letter indicates formal issuance of the attached document. If you have any questions regarding this matter, please contact Kermit Studley of this office at (508) 946-2803.

Sincerely,

Richard J. Rondeau, Chief
Drinking Water Program
Bureau of Resource Protection

R/KS/cb
kstudley/Eastham – Water Resource Protection District G - WS19 - X241315.doc
Y:\DWP Archive\SERO\Eastham-X241315-System Modification-2012-12-18

ecc: Mark N. White, Environmental Partners Group: mnw@envpartners.com
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This information is available in alternate format. Call Michelle Waters-Ekanem, Diversity Director, at 617-292-5751. TDD# 1-866-539-7622 or 1-617-574-6868
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BRP WS 19 APPROVAL OF PUMPING TEST REPORT
FOR SOURCE OF 70 GALLONS PER MINUTE OR GREATER
TOWN OF EASTHAM
EASTHAM, MASSACHUSETTS
WATER RESOURCE PROTECTION DISTRICT G SITE
TRANSMITTAL NUMBER X241315

On April 6, 2012, the Department of Environmental Protection (the "Department") received the permit application as referenced above. The application is a request for approval of a prolonged pumping test report, submitted by Environmental Partners Group, Inc. on behalf of the Town of Eastham. The subject document was submitted as part of the process of developing a new public water supply which meets the requirements of 310 CMR 22.00, the Massachusetts Drinking Water Regulations. The report details the results of the pumping test, data analysis and subsequent Zone II delineation. This site was previously approved for further testing in a letter from this office dated November 23, 2010.

PUMPING TEST RESULTS

The Water Resource Protection District G Site (District G Site) is located east of the Cape Cod Rail Trail biking path and approximately 2,600 feet north of the intersection of Oakleaf Road and Nauset Road in Eastham, Massachusetts. TPW-1 is a 12-inch diameter well installed to a depth of 94 feet and equipped with 10 feet of 0.060-inch slot stainless steel, wire wrapped Johnson Hi-Flow well screen and a 5 foot long bottom sump. The pumping test at TPW-1 started on October 21, 2010 and ended on October 28, 2010. The produced water was conveyed approximately 1,500 feet east of the District G Site and discharged onto the ground surface. Groundwater level measurements were recorded at numerous observation wells (see Table 3-3 and Appendix F of the pumping test report) during the antecedent, drawdown and recovery periods of the pumping test. In addition, drive points and staff gauges were each installed in the upper reach of Hatches Creek to evaluate the interaction between surface water and the aquifer. The pumping test was successful in that stabilization of drawdown was achieved at a pumping rate of 691 gallons per minute (gpm).

PUMPING TEST ANALYSES

Pumping test data were analyzed to determine aquifer characteristics and evaluate the groundwater flow regime. The derived values were properly quantified to establish an approvable yield and to delineate the Zone II wellhead protection area.

The relation between the drawdown observed at stabilization and the distance of the observation wells from TPW-1 indicates the cone of depression or the zone of influence extended radially outward approximately 700 feet from the 12-inch diameter production well. The distance-drawdown prediction for TPW-1 pumping at the approvable rate of 691 gpm (see below) for a period of 100 years indicates the cone of depression or zone of influence would extend 7,100 feet to the north, 6,700 feet to south, 7,000 feet to the east and 6,600 feet to the west of the District G Site. The pumping test had no discernible impact on Hatches Creek, which is located approximately 2,300 feet north of the 12-inch diameter production well. Based on the extent of the predicted zone of influence relative to Hatches Creek for the 12-inch diameter production well pumping at its approved yield, the Department recommends that water levels be monitored at the Hatches Creek to decide if operational conditions for the finished production well are warranted.

APPROVABLE YIELD

In accordance with the Department's Guidelines and Policies for Public Water Systems (revised 2008), if the pumping test is performed on the final production well, the approved pumping rate shall not exceed the rate at which the pumping test was conducted. Since TPW-1 will be the final production well, the approvable yield is 691 gpm, or 0.955 million gallons per day (MGD).

ZONE II DELINEATION

The Zone II delineation for the proposed District G Site was performed in accordance with the Department's Guidelines and Policies for Public Water systems, revised 2008. The groundwater model used for the Zone II delineation was originally developed and published by the United States Geological Survey in a report entitled "Simulated Interaction Between Freshwater and Saltwater and Effects of Ground-Water Pumping and Sea-Level Change, Lower Cape Cod Aquifer System, Massachusetts" (Masterson, 2004). The Zone II map for the proposed District G Site is shown on Figure 6-4 in the pumping test report. The latitude for the proposed production well TPW-1 is 41d 52m 15.70sN and the longitude is 69d 58m 52.42sW.

WATER QUALITY

Analytical testing was performed in accordance with the Department's Guidelines and Policies for Public Water Systems (revised 2008). The results of all water quality analyses indicate that, while somewhat corrosive (low pH and alkalinity), the water meets all recognized standards of purity for public water supply purposes. Treatment will likely involve pH adjustment for corrosion control.

GROUNDWATER MONITORING PROGRAM

Based on existing land uses and mapped potential contamination sources, the proposed production well at the District G Site does not appear to be vulnerable to wellhead contamination. Therefore, no additional groundwater quality monitoring will be required beyond the prescribed frequency to be determined once the proposed production well becomes a registered public water supply.

AQUIFER PROTECTION BYLAW

The Town of Eastham must implement appropriate wellhead protection zoning or non-zoning controls for those areas of the District G Site that lie outside the Cape Cod National Seashore and not covered by the Town of Eastham's Water Resource Protection District G (see 310 CMR 22.21(2)). Wellhead protection for that portion of the District G Site Zone II within the Cape Cod National Seashore is provided in accordance with the United States Department of the Interior regulations and policies documented in the "Comprehensive Source Protection Plan, Cape Cod National Seashore" dated 2006. In addition, the Town of Eastham must demonstrate to the Department's satisfaction that it has used its "best efforts" to have the Town of Wellfleet institute appropriate wellhead protection zoning or non-zoning controls for those areas of the District G Site Zone II within the Town of Wellfleet that lie outside the Cape Cod National Seashore (see 310 CMR 22.21(2)).

Also, in a letter dated March 18, 2011 to the Town of Eastham, the National Park Service confirmed its commitment for the "protection of those parts of the Zone I areas that extend from the proposed supply wells at the Nauset Regional School and District H Site onto Seashore property." The Zone I for the District G Site is not located on Seashore property. A resurvey at the District G Site confirmed the Zone I as being entirely under the ownership and control of the Town of Eastham.

WATER MANAGEMENT ACT PERMIT

The District G Site is one of three potential public water supply sources that will provide operational flexibility and meet future water demands for the Town of Eastham by and through a centralized municipal public water supply system. The Department understands that the Town of Eastham will file a Water Management Act (WMA) permit application to include the District G Site, the NRHS Site and the District H Site. The WMA permit will be filed once all three Sites have been approved as sources of public water supply. The review of this application will be conducted by Leslie O'Shea, who may be contacted at (508) 946-2837, or by email at leslie.oshea@state.ma.us.

In addition, the Department understands that the Town of Eastham will file an Environmental Notification Form (ENF) and Mandatory Environmental Impact Report (EIR) as it relates to the development of a town-wide water supply system. The ENF and Mandatory EIR will be filed at the same time as the WMA permit.

Based on review of the above, the Department hereby approves the pumping test report and the Zone II delineation for the District G Site with a maximum daily withdrawal not to exceed 0.955 MGD subject to the following provisions:

1. The Town of Eastham must obtain its Water Management Act permit prior to the use of this source for public water supply.

2. The Town of Eastham must obtain a permit (BRP WS20) from the Department prior to the start of construction for the well, the pumping station and appurtenant equipment.

This correspondence acknowledges that the Administrative Completeness Review and the Technical Review of this application submittal, BRP WS 19, Transmittal Number X241315, have been completed.

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

Southeast Regional Office • 20 Riverside Drive, Lakeville MA 02347 • 508-946-2700

DEVAL L. PATRICK
Governor

TIMOTHY P. MURRAY
Lieutenant Governor

RICHARD K. SULLIVAN JR.
Secretary

KENNETH L. KIMMELL
Commissioner

April 3, 2012

Ms. Sheila Vanderhoef
Town of Eastham
2500 State Highway
Eastham, Massachusetts 02642

RE: EASTHAM--Public Water Supply
Town of Eastham, BRPWS19,
New Source Approval, Pumping
Test Report Approval, Transmittal
Number X240376

Dear Ms. Vanderhoef:

Please find attached the following information: Approval of the pumping test report for the proposed Nauset Regional High School Site.

Please note that the signature on this cover letter indicates formal issuance of the attached document. If you have any questions regarding this matter, please contact Kermit Studley of this office at (508) 946-2803.

Sincerely,

Richard J. Rondeau, Chief
Drinking Water Program
Bureau of Resource Protection

R/KS/cb
kstudley/Eastham – Nauset Regional High School - WS19 - X240376.doc
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Jane Crowley, Eastham Board of Health: jcrowley@eastham-ma.gov
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This information is available in alternate format. Call Michelle Waters-Ekanem, Diversity Director, at 617-292-5761. TDD# 1-866-539-7622 or 1-617-574-6868
MassDEP Website: www.mass.gov/dep

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BRP WS 19 APPROVAL OF PUMPING PUMPING TEST REPORT
FOR SOURCE OF 70 GALLONS PER MINUTE OR GREATER
TOWN OF EASTHAM
EASTHAM, MASSACHUSETTS
NAUSET REGIONAL HIGH SCHOOL SITE
TRANSMITTAL NUMBER X240376

On December 6, 2011, the Department of Environmental Protection (the "Department") received the permit application as referenced above. The application is a request for approval of a prolonged pumping test report, submitted by Environmental Partners Group, Inc. on your behalf. The subject document was submitted as part of the process of developing a new water supply which meets the requirements of 310 CMR 22.00, the Massachusetts Drinking Water Regulations. The report details the results of the pumping test, data analysis and subsequent Zone II delineation. This site was previously approved for further testing in a letter from this office dated May 10, 2011.

PUMPING TEST RESULTS

The Nauset Regional High School Site (NRHS Site) is located approximately 3,000 feet north-northeast of the intersection of Cable Road and Nauset Road in Eastham, Massachusetts. Test production well TP-1 is located at the northeastern corner of the NRHS Site property. TPW-1 is a 12-inch diameter well installed to a depth of 99 feet and equipped with 10 feet of 0.060-inch slot stainless steel, wire wrapped Johnson Hi-Flow well screen and a 5 foot long bottom sump. The pumping test at TPW-1 started on August 25, 2010 and ended on August 30, 2010. The produced water was conveyed approximately 1,620 feet east of the NRHS Site and discharged onto the ground surface. Groundwater level measurements were recorded at numerous observation wells (see Table 3-3) during the antecedent, drawdown and recovery periods of the pumping test. The pumping test was successful in that stabilization of drawdown was achieved at a pumping rate of 613 gallons per minute (gpm).

PUMPING TEST ANALYSES

Pumping test data were analyzed to determine aquifer characteristics and evaluate the groundwater flow regime. The derived values were properly quantified to establish an approvable yield and to delineate the Zone II wellhead protection area.

APPROVABLE YIELD

If the pumping test is performed on the final production well, the approved pumping rate shall not exceed the rate at which the pumping test was conducted. Therefore, the approvable yield is 613 gpm, or 0.833 million gallons per day (MGD).

ZONE II DELINEATION

The Zone II delineation for the proposed NRHS Site was performed in accordance with the Department's Guidelines and Policies for Public Water systems, revised 2008. The groundwater model used for the Zone II delineation was originally developed and published by the United States Geological Survey in a report entitled "Simulated Interaction Between Freshwater and Saltwater and Effects of Ground-Water Pumping and Sea-Level Change, Lower Cape Cod Aquifer System, Massachusetts" (Masterson, 2004). The Zone II map for the proposed NRHS Site is shown on Figure 6.3 in the pumping test report. The latitude for the proposed production well TPW-1 is 41d 51m 54sN and the longitude is 69d 58m 4.8sW.

WATER QUALITY

Analytical testing was performed in accordance with the Department's Guidelines and Policies for Public Water Systems. The results of all water quality analyses indicate that, while somewhat corrosive (low pH and alkalinity), the water meets all recognized standards of purity for public water supply purposes. Treatment will likely involve pH adjustment for corrosion control.

GROUNDWATER MONITORING PROGRAM

Based on existing land uses and mapped potential contamination sources, the proposed production well at the NRHS Site does not appear to be vulnerable to wellhead contamination. Therefore, no additional groundwater quality monitoring will be required beyond the prescribed frequency to be determined once the proposed production well becomes a registered public water supply.

AQUIFER PROTECTION BYLAW

The Town of Eastham must implement appropriate wellhead protection zoning or non-zoning controls for those areas of the NRHS Site that lie outside the Cape Cod National Seashore and not covered by the Town of Eastham's Water Resource Protection District G (see 310 CMR 22.21(2)). Wellhead protection for that portion of the NRHS Site Zone II within the Cape Cod National Seashore is provided in accordance with the United States Department of the Interior regulations and policies documented in the "Comprehensive Source Protection Plan, Cape Cod National Seashore" dated 2006. Also, in a letter dated March 18, 2011 to the Town of Eastham, the National Park Service confirmed its commitment for the "protection of those parts of the Zone I areas that extend from the proposed supply wells at the Nauset Regional School and District H onto Seashore property."

WATER MANAGEMENT ACT PERMIT

The NRHS Site is one of three potential public water supply sources that will provide operational flexibility and meet future water demands for the Town of Eastham by and through a centralized municipal public water supply system. The Department understands that the Town of Eastham will file a Water Management Act (WMA) permit application to include the NRHS Site, the District H Site and the District G Site. The WMA permit will be filed once all three Sites have been approved as sources of public water supply. The review of this application will be conducted by Leslie O'Shea, who may be contacted at (508) 946-2837, or by email at leslie.oshea@state.ma.us.

In addition, the Department understands that the Town of Eastham will file an Environmental Notification Form (ENF) and Mandatory Environmental Impact Report (EIR) as it relates to the development of a town-wide water supply system. The EIR and Mandatory EIR will be filed at the same time as the WMA permit.

Based on review of the above, the Department hereby approves the NRHS Site for the installation of permanent pumping works with a maximum daily withdrawal not to exceed 0.833 MGD subject to the following provisions:

1. The Town of Eastham must obtain its Water Management Act permit prior to construction of this source.

2. The Town of Eastham must obtain a permit (BRP WS20) from the Department prior to the start of construction for the well, the pumping station and appurtenant equipment.

This correspondence acknowledges that the Administrative Completeness Review and the Technical Review of this application submittal, BRP WS 19, Transmittal Number X240376, have been completed.

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

Southeast Regional Office • 20 Riverside Drive, Lakeville MA 02347 • 508-946-2700

DEVAL L. PATRICK
Governor

RICHARD K. SULLIVAN JR.
Secretary

KENNETH L. KIMMELL
Commissioner

September 12, 2013

Ms. Sheila Vanderhoef
Town of Eastham
2500 State Highway
Eastham, Massachusetts 02642

RE: EASTHAM--Public Water Supply
Town of Eastham, BRP WS 19,
New Source Approval, Pumping
Test Report Approval, Wellfield
Protection District H Site,
Transmittal Number X251003

Dear Ms. Vanderhoef:

Please find attached the following information: Approval of the pumping test report for the proposed Wellfield Protection District H Site.

Please note that the signature on this cover letter indicates formal issuance of the attached document. If you have any questions regarding this matter, please contact Kermit Studley of this office at (508) 946-2803.

Sincerely,

Richard J. Rondeau, Chief
Drinking Water Program
Bureau of Resource Protection

R/KS/cb
kstudley/Eastham – Wellfield Protection District H - WS19 - X251003.doc
Y:\DWP Archive\SERO\Eastham-X251003-System Modification-2013-09-12

ecc: Mark N. White, Environmental Partners Group: mnw@envpartners.com
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Duane LeVangie, MassDEP-OWM: duane.levangie@state.ma.us
Leslie O'Shea, MassDEP-DWP: leslie.oshea@state.ma.us
Tom Cambareri, Cape Cod Commission: tcambareri@capecodcommission.org
Jane Crowley, Eastham Board of Health: jcrowley@eastham-ma.gov
Yvette DePeiza, DEP-Boston: yvette.depeiza@state.ma.us

This information is available in alternate format. Call Michelle Waters-Ekanem, Diversity Director, at 617-292-5761. TDD# 1-866-539-7622 or 1-617-574-6868
MassDEP Website: www.mass.gov/dep

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BRP WS 19 APPROVAL OF PUMPING TEST REPORT
FOR SOURCE OF 70 GALLONS PER MINUTE OR GREATER
TOWN OF EASTHAM
EASTHAM, MASSACHUSETTS
WELLFIELD PROTECTION DISTRICT H SITE
TRANSMITTAL NUMBER X251003

On April 23, 2013, the Department of Environmental Protection (the "Department") received the permit application as referenced above. The application is a request for approval of a prolonged pumping test report, titled "WELL FIELD PROTECTION ZONING DISTRICT H, NEW WATER SUPPLY SOURCE, DEP PUMPING TEST REPORT, BRP WS 19", and dated April 2013, submitted by Environmental Partners Group, Inc. on behalf of the Town of Eastham. The subject document was submitted as part of the process of developing a new public water supply which meets the requirements of 310 CMR 22.00, the Massachusetts Drinking Water Regulations. The report details the results of the pumping test, data analysis and subsequent Zone II delineation. This site was previously approved for further testing in a letter from this office dated April 8, 2011.

PUMPING TEST RESULTS

The Wellfield Protection District "H" (District H) Site is located in a heavily wooded area approximately 900 feet east of the intersection of Schoolhouse Road and Nauset Road in Eastham, Massachusetts. The District H well site consists of two 12-inch diameter gravel packed production wells designated TPW-3B and TPW-2C. TPW-3B was installed to a depth of 103 feet and completed with a 10-foot, 80-slot, stainless steel well screen. TPW-2C was installed to a depth of 205 feet and completed with a 20-foot, 50-slot, stainless steel well screen.

Prolonged pumping tests, individual as well as combined, were conducted on the two 12-inch diameter gravel packed production wells. The pumping test at TPW-3B started on December 6, 2010 and ended on December 11, 2010. The pumping test at TPW-2C started on December 16, 2010 and ended on December 21, 2010. The pumping period for the combined pumping test at the District H well site was performed between March 22, 2011 and March 28, 2011. The discharge site for the individual 5-day pumping tests was located in a slight depression located approximately 1,650 and 1,700 feet east-southeast and downgradient of production wells TPW-3B and TPW-2C, respectively. Discharge sites for the combined pumping test were located approximately 1,700 feet and 2,000 feet east-southeast of the two production wells. Groundwater level measurements were recorded at numerous observation wells (see Figure 1-5 and Tables 4-3, 4-4 and 4-5 in the submitted application material) during the antecedent, drawdown and recovery periods of each pumping test. In addition, drive points and staff gauges were each installed in vernal pools VP-01, VP-09 and VP-11 to evaluate the interaction between surface water and the aquifer during the antecedent, drawdown and recovery periods of each pumping test. The individual pumping tests were successful in that stabilization of drawdown was achieved at a pumping rate of 910 gallons per minute (gpm) at TPW-3B and at a pumping rate of 916 gpm at TPW-2C. Stabilization of drawdown was achieved during the combined pumping test with a pumping rate of 1.0 million gallons per day (MGD) at each production well for a combined pumping rate of 2.0 MGD.

PUMPING TEST ANALYSES

Pumping test data were analyzed to determine aquifer characteristics and evaluate the groundwater flow regime, in particular, the response (i.e., saltwater upconing) of the higher-density saltwater zone beneath the District H well site. The derived values were properly quantified to establish an approvable yield based on water quality considerations and to delineate the Zone II wellhead protection area.

The relation between the drawdown observed at stabilization and the distance of the observation wells from TPW-3B indicates the cone of depression or the zone of influence extended radially outward approximately 2,300 feet from the 12-inch diameter production well. Likewise, the cone of depression or zone of influence extended radially outward approximately 1,600 feet from TPW-2C. The distance-drawdown prediction for TPW-3B pumping at the approvable rate of 910 gpm (see below) for a period of 100 years indicates the zone of influence would extend 8,800 feet to the north, 6,900 feet to south, 4,400 feet to the east and 5,600 feet to the west of the District H Site. Likewise, the distance-drawdown prediction for TPW-2C pumping at the approvable rate of 910 gpm (see below) for a period of 100 years indicates the zone of influence would extend 7,700 feet to the north, 6,900 feet to south, 4,400 feet to the east and 4,600 feet to the west of the District H Site.

Water levels within and beneath three vernal pools (VP-01, VP-09 and VP-11) located within 1,000 feet of production wells TPW-3B and TPW-2C were monitored prior to, during and after the three pumping tests. Vernal pool VP-11 is the only vernal pool that showed a response to production well pumping. The maximum drawdown observed at VP-11 in the vernal pool, peat layer and water table was 0.09 feet, 0.19 feet and 0.53 feet, respectively. These drawdowns were observed during the combined test with a combined pumping rate of 2.0 MGD. A vernal pool model was developed to examine the potential response of pond water levels to declines in groundwater elevations that are anticipated to accompany normal pumping conditions at the District H site. The vernal pool model demonstrates that vernal pool VP-11 is replenished by precipitation and that a decline in the water table level due to pumping at the District H site is not anticipated to transmit a similar decline to the vernal pool.

APPROVABLE YIELD

In accordance with the Department's Guidelines and Policies for Public Water systems, revised 2008, if the pumping test is performed on the final production well, the approved pumping rate shall not exceed the rate at which the pumping test was conducted. The maximum approvable yield for TPW-3B is 910 gpm and for TPW-2C is 916 gpm. However, the long term approvable yield of the two wells (single or combined) was evaluated in terms of the water quality (Total Dissolved Solids and chloride concentrations) that results over a prolonged (minimum 100-year) pumping period. A numerical groundwater flow model was used to develop a recommended approvable yield for the District H Site. SEAWAT is a three-dimension numerical model, developed by the United States Geological Survey, that is capable of simulating density dependent groundwater flow and solute (dissolved salt) transport. The simulated Total Dissolved Solids and chloride concentrations in the produced water at a continuous pumping rate of 910 gpm for a period of 100 years were less than the secondary drinking water standards of 500 mg/l and 250 mg/l, respectively. Therefore, the approvable yield for the District H Site is 910 gpm (single or combined withdrawal from the two production wells) or 1.310 million gallons per day (MGD).

ZONE II DELINEATION

The Zone II delineation for the proposed District H well site was performed in accordance with the Department's Guidelines and Policies for Public Water systems, revised 2008. The groundwater model used for the Zone II delineation was originally developed and published by the United States Geological Survey in a report entitled "Simulated Interaction Between Freshwater and Saltwater and Effects of Ground-Water Pumping and Sea-Level Change, Lower Cape Cod Aquifer System, Massachusetts" (Masterson, 2004). The Zone II wellhead protection area was delineated for TPW-3B pumping at 910 gpm (see Figure 10-5) and for TPW-2C pumping at 910 gpm (see Figure 10-6). The Zone II map for the proposed District H well site (see Figure 10-7) shows both the TPW-3B and TPW-2C Zone II wellhead protection areas. The latitude for the proposed production well TPW-2C is 41d 51m 10.292sN and the longitude is 69d 57m 51.419sW. The latitude for the proposed production well TPW-3B is 41d 51m 9.108sN and the longitude is 69d 57m 50.422sW.

WATER QUALITY

Analytical testing was performed in accordance with the Department's Guidelines and Policies for Public Water Systems (revised 2008). The results of all water quality analyses indicate that, while somewhat corrosive (low pH and alkalinity), the water meets all recognized standards of purity for public water supply purposes. Treatment will likely involve pH adjustment for corrosion control.

In response to detections of 1,4-dioxane in groundwater in the vicinity of the Eastham Landfill, the public water supply wells proposed to be developed by the Town of Eastham, consisting of District G, Nauset Regional High School (NRHS) and District H, were sampled on January 17, 2013 and analyzed for 1,4-dioxane. The compound 1,4-dioxane was only detected at the District H Site and at a concentration an order of magnitude less than the Massachusetts Water Quality Guideline of 0.3 parts per billion.

GROUNDWATER MONITORING PROGRAM

The Department approves the proposed Groundwater Monitoring Program (see Section 8.0 and Figure 1-5 of the pumping test report). The groundwater monitoring program is designed to ensure the potability of the produced water by monitoring water quality in the shallow, intermediate and deep aquifer zones beneath the District H Site. The monitoring network will consist of observation well clusters OW-1, OW-2, OW-3, and OW-4 at the District H Site. Water quality data will be collected quarterly beginning approximately two quarters prior to the District H production wells going on-line. Once the production wells are on-line, water quality data from the production wells and the observation well clusters will be collected semi-annually in March and September. Field water quality parameters will include temperature, specific conductance and pH. Laboratory water quality parameters will include sodium, chloride, sulfate, Total Dissolved Solids, iron, and manganese. All laboratory analyses shall be performed at a Massachusetts certified laboratory.

Sentinel monitoring wells are proposed to be located at the western edge of the District H property adjacent to Nauset Road. These wells will provide early warning of impaired water quality conditions upgradient of the production wells. The sentinel wells will be sampled on a semi-annual basis for nitrate, volatile organic compounds and 1,4-dioxane together with standard field parameters of pH, specific conductivity, and temperature. Water quality data from the groundwater monitoring program shall be kept with the Town of Eastham and should only be reported to the Department when detections occur.

Water levels (i.e., vernal pool and water table) in select vernal pools (VP-01, VP-09, VP-11, VP-06, and VP-05 or Vp-05a, as shown on Figure 5-8) will be monitored to confirm the vernal pool modeling predictions under actual operating conditions at the District H Site. The monitoring will be initiated prior to pumping operations for the collection of background data and a semi-annual schedule of monitoring is proposed for the long-term monitoring plan. Water level data trends, along with other operational and hydrologic factors, will be evaluated periodically to decide if modifications to well field operation practices are warranted.

AQUIFER PROTECTION BYLAW

The Town of Eastham must implement appropriate wellhead protection zoning or non-zoning controls for those areas of the District H Site that lie outside the Cape Cod National Seashore and not covered by the Town of Eastham's Wellfield Protection Zoning District H (see 310 CMR 22.21(2)). Wellhead protection for that portion of the District H Site Zone II within the Cape Cod National Seashore is provided in accordance with the United States Department of the Interior regulations and policies documented in the "Comprehensive Source Protection Plan, Cape Cod National Seashore" dated 2006. Also, in a letter dated March 18, 2011 to the Town of Eastham, the National Park Service confirmed its commitment for the "protection of those parts of the Zone I areas that extend from the proposed supply wells at the Nauset Regional School and District H Site onto Seashore property."

WATER MANAGEMENT ACT PERMIT

The District H Site is one of three potential public water supply sources that will provide operational flexibility and meet future water demands for the Town of Eastham by and through a centralized municipal public water supply system. The Department understands that the Town of Eastham will file a Water Management Act (WMA) permit application to include the District H Site, the NRHS Site and the District G Site. The review of this application will be conducted by Leslie O'Shea, who may be contacted at (508) 946-2837, or by email at leslie.oshea@state.ma.us.

In addition, the Department understands that the Town of Eastham will file an Environmental Notification Form (ENF) and Mandatory Environmental Impact Report (EIR) as it relates to the development of a town-wide water supply system. The ENF and Mandatory EIR will be filed at the same time as the WMA permit.

Based on review of the above, the Department hereby approves the pumping test report and the Zone II delineation for the District H Site with a maximum daily withdrawal not to exceed 1.31 MGD subject to the following provisions:

1. The Town of Eastham must obtain its Water Management Act permit prior to the use of this source for public water supply.

2. The Town of Eastham must obtain a permit (BRP WS20) from the Department prior to the start of construction for the well, the pumping station and appurtenant equipment.

This correspondence acknowledges that the Administrative Completeness Review and the Technical Review of this application submittal, BRP WS 19, Transmittal Number X251003, have been completed.

Permit Application #X241315

Water Resource Protection District G Site New Water Supply Source

DEP Pumping Test Report BRP WS 19

Prepared for:
Town of Eastham, Massachusetts

April 2012

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EXECUTIVE SUMMARY

The Town of Eastham has been evaluating potential water resources, with the goal of identifying and permitting sufficient water supplies to serve a town-wide municipal water system. Water system feasibility studies concluded that a town-wide system would have the following estimated demands (in million gallons per day (MGD)):

Daily demand, annual average	1.0 MGD
Daily demand, seasonal average	1.8 MGD
Peak day demand	2.6 MGD

In 2005 ten sites that could potentially serve as public water supplies were evaluated and three were selected for further consideration (shown on Figure ES-1): Wellfield Protection Zoning District "H" (District H), Water Resource Protection District "G" (District G), and Nauset Regional High School (NRHS). In addition to these, an interconnection with the Town of Orleans was considered.

This report fulfills the requirements for the Massachusetts Department of Environmental Protection (DEP) Pumping Test Report for the District G new water supply source. This is submitted as permit application BRP WS 19 in accordance with the requirements of the Massachusetts Drinking Water Regulations. The report describes all soil boring, well installation and aquifer testing activities at District G, analyses of the collected hydrogeologic data to determine site-specific aquifer properties, groundwater modeling performed to determine the recommended yield and Zone II area, and an evaluation of land uses and groundwater protection measures within the proposed Zone II. On the basis of this work, a yield of 995,040 gallons per day (gpd) is recommended for the wellfield.

The District G wellfield is located in north Eastham (a half mile south of the Wellfleet town-line), east of the Cape Cod Rail Trail biking path and north of Oakleaf Road in Eastham, Massachusetts. District G is situated approximately 50 feet above sea level and is comprised predominately of property owned by the Town of Eastham, with a few parcels owned by private entities or the Eastham Conservation Foundation. The District G production well parcel is and has historically been owned by the Town. The land to the north and east of District G is owned by the National Park Service (NPS) Cape Cod National Seashore (CCNS).

The District G wellfield site is located in the northern region of the Nauset Lens aquifer, approximately 4,300 feet north-northeast of the high point of the freshwater mound. Groundwater elevation at the District G site is approximately 16 to 17 feet NAVD 88 and the depth to the water table is approximately

30 feet below ground surface (bgs). The direction of groundwater flow at the site is towards the north-northeast.

In August 2009, Environmental Partners Group installed a deep boring and two observation wells at the District G site. The deep boring was drilled to a total depth of 402 feet bgs. The upper zone of unconsolidated material, known as the Eastham Plain Deposits, extends from the ground surface to a depth of approximately 110 feet bgs (-48 feet NAVD 88) and consists primarily of fine to coarse sand with some gravel. The Eastham Plain deposits are underlain by up to 300 feet of glacial lake deposits, consisting predominately of silts and clays. The aquifer is approximately 80 feet thick and extends from the water table to interface of the Eastham Plain deposits and the glacial lake silts and clays at 110 feet bgs. The saltwater interface was not encountered and is likely located within the low permeability clays or bedrock.

Between June and October 2010 long term aquifer pumping test activities were performed at the District G wellfield site. A seven-day constant rate aquifer test was performed on the District G Test Production Well-1 (TPW-1). The observation well network was equipped with data loggers to record groundwater elevations before, during and after the pumping test. Water quality sampling was also performed on the production well.

The pump test was conducted on the District G TPW-1 well from October 21 through October 28, 2010 at a pump rate of 691 gallons per minute (gpm) or 995,040 gpd. Available water over the well screen was 50.2 feet. Total drawdown at the end of the seven-day test was 26.6 feet, leaving 23.6 feet above the well screen. As a check of the drawdown stabilization, data from the last 24-hours of the pump test was plotted on a semi-log plot extrapolation of the time drawdown curve (time on the logarithmic scale) over a 180-day period. Based on this plot, total drawdown after 180-days would be 29.8 feet, leaving 20.4 feet of water above the well screen. The calculated Approvable Yield for District G TPW-1 was 1,170 gpm (1.68 MGD); however, because the regulations limit the approvable yield to the rate at which the pump test was performed, the maximum approvable yield for District G TPW-1 is 691 gpm (995,040 gpd).

The data derived from the pumping test was used to develop piezometric maps of water level drawdown conditions resulting from water withdrawals during the aquifer performance test and to develop estimates of key aquifer parameters including, hydraulic conductivity, storativity, specific yield, vertical anisotropy, and aquifer thickness.

Groundwater modeling was performed using the SEAWAT numerical model developed by the U.S. Geological Survey (USGS). SEAWAT is a three-dimensional, variable-density, numerical model used to

model groundwater flow and transport. The SEAWAT model was refined in the vicinities of the District G, NRHS and District H sites based on site-specific data collected through field investigations.

The Zone II was defined by the SEAWAT model to simulate the conditions under no recharge (180 days) and a pumping rate of 995,040 gpd. The Zone II boundaries were determined using the particle tracking program MODPATH and takes into consideration natural hydrologic boundaries. Particles were placed at the water table and tracked for 300 years until the particles stopped at a model boundary. The Zone II and associated land use within the Zone II for the District G TPW-1 wellfield is shown on Figure ES-2. As shown on Figure ES-2, land use within the Zone II is comprised predominately of forested and residential use with some recreational and commercial uses. No potential sources of contamination were identified within the Zone II.

The nearest surface water body to the District G wellsite is Hatches Creek, located approximately 2,300 feet to the north. Preliminary groundwater modeling performed by the USGS in 2004 (Masterson 2004), indicated that pumping of public water supply wells at District G could reduce baseflow to Hatches Creek. A water table and production zone well couplet, three stream gauges, and two piezometers were installed near or within Hatches Creek to evaluate hydrogeologic conditions. These locations were monitored prior to, during, and after the seven day District G pump test. The SEAWAT model was refined in the vicinity of Hatches Creek based on field observations and monitoring. The model was then used to evaluate potential impacts to streamflow in Hatches Creek from pumping at the District G wellfield. Two 100-year simulations were performed to estimate the long-term average discharge at Hatches Creek; the first under non-pumping conditions and the second under pumping conditions. The anticipated annual average pumping rate for the District G wellsite is 0.25 MGD or 250,000 gpd. SEAWAT groundwater modeling results indicate that the discharge to the Hatches Creek drain cells under non-pumping conditions is 0.63 cubic feet per second (cfs) and the discharge is reduced to 0.57 cfs, or by 9.6 percent, when G-TPW-1 is operated continuously at 250,000 gpd on an annual basis over this 100-year period.

Permit Application #X240376

Nauset Regional High School New Water Supply Source

DEP Pumping Test Report BRP WS 19

Prepared for:
Town of Eastham, Massachusetts

December 2011

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EXECUTIVE SUMMARY

The Town of Eastham has been evaluating potential water resources, with the goal of identifying and permitting sufficient water supplies to serve a town-wide municipal water system. The goal of these efforts is to secure water supplies for a Town-wide water system that Eastham is considering and that would have the following estimated demands (in million gallons per day (MGD)):

Daily demand, annual average	1.0 MGD
Daily demand, seasonal average	1.8 MGD
Peak day demand	2.6 MGD

Over the past several years, several potential sites that could potentially serve as public water supplies were evaluated and three were selected for further consideration (shown on Figure ES-1): Wellfield Protection Zoning District "H" (District H), Water Resource Protection District "G" (District G), and Nauset Regional High School (NRHS). In addition to these, an interconnection with the Town of Orleans was considered.

This report fulfills the requirements for the Massachusetts Department of Environmental Protection (DEP) required Pumping Test Report for the NRHS new water supply source. This is submitted as permit application BRP WS 19 in accordance with the requirements of the Massachusetts Drinking Water Regulations. The report describes soil boring, well installation and aquifer testing activities at NRHS, analyses of the collected hydrogeologic data to determine site-specific aquifer properties, groundwater modeling performed to determine the recommended yield and Zone II area, and an evaluation of land uses and groundwater protection measures within the proposed Zone II. On the basis of this work, a yield of 882,000 gallons per day (gpd) is recommended for the well field.

The NRHS well field site has one existing water supply well that is permitted for up to 100,000 gpd and is the current water supply to the regional high school. The site is at the northeast corner of property owned by the Nauset Regional School District, approximately 3,000 feet north-northeast of the intersection of Cable Road and Nauset Road. The test production well (NRHS TPW-1) is 80 feet west of the school's existing water supply well. The Zone I for the NRHS TPW-1 well is located on Nauset Regional School District and National Park Service (NPS) owned property.

The NRHS well field site is located in the northern region of the Nauset Lens aquifer, approximately one mile east-northeast of the high point of the freshwater mound where ground surface elevation is approximately 63 feet NAVD 88. Groundwater elevation at the NRHS site is approximately 13 feet NAVD 88 and the depth to the water table is approximately 50 feet bgs. The direction of groundwater flow at the site is towards the east.

In August 2009, Environmental Partners installed a deep boring and two observation wells at the NRHS site. The deep boring was drilled to a total depth of 400 feet bgs. The upper zone of unconsolidated material, known as the Eastham Plain Deposits, extends from the ground surface to a depth of approximately 110 feet bgs (-48 feet NAVD 88) and consists primarily of fine to coarse sand with some gravel. The Eastham Plain deposits are underlain by up to 300 feet of glacial lake deposits, consisting predominately of silts and clays. The aquifer is approximately 60 feet thick and extends from the water table to interface of the Eastham Plain deposits and the glacial lake silts and clays at 110 feet bgs. The saltwater interface was not encountered and is located within the low permeability clays or bedrock.

Between June and October 2010 long term aquifer pumping test activities were performed at the NRHS well field site. A five-day constant rate aquifer test was performed on NRHS TPW-1, and a limited aquifer test was performed at each of the observation wells. The observation well network was equipped with data loggers to record groundwater elevations before, during and after the pumping tests. Water quality sampling was also performed on the production well and observation well clusters.

The pump test was conducted on the NRHS TPW-1 well from August 25-30, 2010 at a pump rate of 613 gallons per minute (gpm) or 883,000 gpd. Available water over the well screen was 34 feet; therefore, with the required five-foot buffer above the well screen available drawdown in the production well was 29 feet. Total drawdown at the end of the five-day test was 26 feet, leaving 8 feet above the well screen. As a check of the drawdown stabilization, data from the last 24-hours of the pump test was plotted on a semi-log plot extrapolation of the time drawdown curve (time on the logarithmic scale) over a 180-day period. Based on this plot, total drawdown after 180-days was 26.75 feet, leaving seven feet of water above the well screen. The calculated Approvable Yield for NRHS TPW-1 was 684 gpm (984,960 gpd), however, because the regulations limit the yield to the rate at which the pump test was performed the maximum approvable yield for NRHS TPW-1 is 613 gpm (883,000 gpd).

The data derived from the pumping test was used to develop piezometric maps of water level drawdown conditions resulting from water withdrawals during the aquifer performance test and to develop estimates

of key aquifer parameters including, hydraulic conductivity, storativity, specific yield, vertical anisotropy, and aquifer thickness.

Groundwater modeling was performed using the SEAWAT numerical model developed by the U.S. Geological Survey (USGS). SEAWAT is a three-dimensional, variable-density, numerical model used to model groundwater flow and transport. The SEAWAT model was refined in the vicinities of the NRHS, District G, and District H sites based on site-specific data collected through field investigations.

The Zone II was defined by the SEAWAT model to simulate the conditions under no recharge (180 days) and a pumping rate of 883,000 gpd. The Zone II boundaries were determined using the particle tracking program MODPATH and takes into consideration natural hydrologic boundaries. Particles were placed at the water table and tracked for 200 years until the particles stopped at a model boundary. The Zone II and associated land use within the Zone II for the NRHS TPW-1 well field is shown on Figure ES-2. As shown on Figure ES-2, land use within the Zone II is comprised predominately of forested and residential use with some recreational and commercial uses. No potential sources of contamination were identified within the Zone II. An ongoing groundwater monitoring program is not proposed for the NRHS TPW-1 well field, because none of the land uses identified within the Zone II require the placement of monitoring wells.

[redacted]

Permit Application # X251003

Well Field Protection Zoning District H
New Water Supply Source

DEP Pumping Test Report
BRP WS 19

Prepared for:
Town of Eastham, Massachusetts

April 2013

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EXECUTIVE SUMMARY

Introduction

The Town of Eastham has been evaluating potential water resources, with the goal of identifying and permitting sufficient water supplies to serve a town-wide municipal water system. The goal of these efforts is to secure water supplies that can meet the projected water demands for the Town of Eastham, as follows:

Daily demand, annual average	1.0 MGD
Daily demand, seasonal average	1.8 MGD
Peak day demand	2.6 MGD

Over the past several years, several potential sites were identified that are municipally-owned properties for consideration as water supplies. Based on these evaluations, three water supply sites were targeted to serve the system (shown on Figure ES-1): Wellfield Protection Zoning District "H" (District H), Water Resource Protection District "G" (District G), and Nauset Regional High School (NRHS), as well as an interconnection with the Town of Orleans.

The NRHS site was permitted in 2012, with an approved pumping rate of 613 gallons per minute (gpm) and maximum daily withdrawal not to exceed 0.833 million gallons per day (MGD). The District G site was also permitted in 2012, with an approved pumping rate of 691 gpm and a maximum daily withdrawal not to exceed 0.955 MGD.

This permit application (BRP WS 19) and report fulfills the requirements for the Massachusetts Department of Environmental Protection (DEP) required Pumping Test Report for this District H new water supply to permit two water supply wells, TPW-3B and TPW-2C. The report provides the following: soil boring, well installation and aquifer testing activities; analyses of the collected hydrogeologic data to determine site-specific aquifer properties; groundwater modeling performed to determine the recommended yield and Zone II areas; groundwater modeling to evaluate vernal pool response to groundwater pumping; evaluation of land uses and groundwater protection measures within the proposed Zone IIs; and the proposed monitoring program for the well field.

District H Hydrogeology Summary

The District H well field site is owned by the Town of Eastham and is located in a heavily wooded area approximately 900 feet east of the intersection of Schoolhouse Road and Nauset Road (Figure ES-1). A Site Plan for District H is included as Figure ES-2. The Zone I for the test production wells TPW-3B and TPW-2C wells is on Eastham and National Park Service (NPS) owned property. A cluster of Certified Vernal Pools under the National Heritage & Endangered Species Program (NHESP) are located within the vicinity of the TPW-3B and TPW-2C.

The freshwater aquifer, the Nauset Lens, consists of a groundwater mound that forms along the central axis of Lower Cape Cod, generally following the alignment of Route 6. Groundwater flows radially toward the coastlines (eastward and westward) and toward streams and inlets (northward and southward). This freshwater lens is underlain by more dense saltwater. The District H well field site is located on the eastern portion of the Nauset Lens aquifer, approximately 6,200 feet southeast of the high point of the freshwater mound. The groundwater elevation at District H is between 16 to 17 feet NAVD88 (approximately 30 feet bgs) under average conditions. The direction of groundwater flow at the site is toward the east.

The upper zone of unconsolidated material, known as the Eastham Plain Deposits, extends from the ground surface to a depth of approximately 400 feet bgs (-370 feet NAVD 88) and consists primarily of fine to coarse sand with some gravel interbedded with finer grained silt and clay deposits. The freshwater – saltwater transition zone and interface occurs at a depth below 360 feet bgs (-325 feet NAVD88). To the north of District H the Eastham Plain deposits consist of fine to coarse sand with some graved to a depth of approximately 110 feet bgs, underlain by up to 300 feet of glacial lake deposits, consisting predominately of silts and clays. This thick section of fine grained glacial lake deposits were either not deposited or were removed in the District H area.

Four aquifer units are present at the District H site, designated as Zone A, Zone B, Zone C, and Zone D, each separated by leaky aquitards. Zones B and C are potential sources for public water supply. Zone A is the shallow overburden aquifer and is not considered a potential source for public water supply because of potential impacts to nearby vernal pools that would result from groundwater withdrawals in this aquifer zone. Zone D is also not considered a potential source for public water supply because of the potential for salt water intrusion that could result from groundwater withdrawals..

In 2007 District H well TPW-1B, completed in the Zone B aquifer, was permitted as a public water supply for a source less than 100,000 gallons per day.

District H Aquifer Performance Test Summary

New test production wells were installed in the Zone B (TPW-3B) and Zone C (TWP-2C) aquifers. Additional observation wells were also installed in Zone A, B, C, and D aquifers. The observation well network monitored during the APT activities consist of: 4 wells in Zone A, 5 wells in Zone B, 5 wells in Zone C, and 2 wells in Zone D. Water levels were also monitored within and beneath three nearby vernal pools VP-E1, VP-E9 and VP-E11. These wells and piezometers (shown on Figure ES-2) were equipped with data loggers to record groundwater levels before, during and after the production well pumping tests.

Individual pumping tests were performed on the TPW-3B and TPW-2C test production wells in December 2010 and a combined pumping test where both wells were pumped simultaneously was performed in March 2011, pumping both TPW-3B and TPW-2C. The individual well pump tests were performed at a rate of 910 gpm (1.31 MGD) for TPW-3B and 916 gpm (1.31 MGD) for TPW-2C. The combined pump test was performed at the rate of 1.0 MGD per well for a combined pumping rate of 2.0 MGD. On the basis of this work an overall yield of 1.31 million gallons per day (MGD) is recommended for the well field. The yield can be obtained from either the Zone B or Zone C production wells or any combination of the two wells, as long as the combined pumping rate does not exceed 1.3 MGD.

Water quality sampling was also performed each production well, and the laboratory analytical data indicate that the groundwater quality is excellent and suitable for public water supply. The pH levels in both TPW-3B and TPW-2C is slightly acidic, 6.26 and 6.15, respectively; which is consistent with other water supply wells in Eastham and the outer Cape. All other parameters are within DEP drinking water MCLs, secondary MCLs and guidelines.

Water levels in the Zone B, C, and D aquifers show diurnal tidal cycles, with tidal fluctuations of up to approximately 0.3 feet. Because of tidal influences, and as a check of the drawdown stabilization, data from the end of each pump test was plotted on a semi-log plot extrapolation of the time drawdown curve over a 180-day period. Based on these plots, the DEP criteria to have a minimum of 5 feet of water, or 10 percent of the available water column above the well screen at the end of the test, is achieved with a large safety margin.

District H Groundwater Modeling Summary

Groundwater modeling was performed to determine appropriate pumping rates at each production well that a) are protective of the vernal pool and surface water resources of the area, and that b) did not result

in adverse salt water upconing affects into the freshwater aquifer. The groundwater modeling activities consisted of the following elements:

A. Removing the diurnal tidal effects from the groundwater elevation data so that the model reflects "true" groundwater elevations.

B. Developing appropriate hydrologic properties of the four aquifers and intervening aquitards underlying District H. This was achieved through the use of a Mulit-Layer Unsteady (MLU) aquifer analysis.

C. Modeling of the vernal pools in the vicinity of the test production wells so that water elevations in the ponds and their response to pumping conditions could be evaluated.

D. Modeling of the salt water transition zone in response to pumping.

Together, these modeling efforts and their results were used as the basis of the recommended pumping rates for TPW-3B and TPW-2C and the monitoring program. These modeling activities are described in more detail below.

Corrections to Water Level Data to Remove Effects of Tidal Fluctuations

Prior to the use of monitoring well water elevation data for the District H aquifer test analyses and SEAWAT model calibrating, the influence of the tidal fluctuation was removed or "filtered" from the data to separate this extraneous effect from that of the pumping well. The method used for filtering tidal effects from District H water level data was developed by Erskine (1991) for removing tidal effects from wells in a highly permeable aquifer located between 160 to 1,300 feet from the shore, which are conditions comparable to those at District H. These filtered water levels were then used for Multi-Layer Unsteady (MLU) aquifer analysis and SEAWAT model calibration.

Multi-Layer Unsteady (MLU) Aquifer Analysis

MLU software was used to analyze data from the two December 2010 pumping tests to estimate hydraulic properties of aquifers and aquitards in the vicinity of the test site and to evaluate the test data for use in parameterizing a SEAWAT model for the site and surrounding aquifer. MLU was selected to perform the data analysis for the District H tests, because it possesses the ability to calculate drawdown for, and estimate properties for, multiple aquifer and aquitard layers in a single model simulation. District H exhibits complex geology that can be generally represented by four higher-permeability units (aquifers)

separated by three intervening lower permeability units (aquitards). MLU modeling was used to determine horizontal and vertical hydraulic conductivity and storage coefficient values for the four aquifer and four aquitard units.

Vernal Pool Monitoring

A cluster of NHESP certified vernal pools exist in the area between the Nauset Light Beach and the District H wellfield. Water levels within and beneath three vernal pools (VP-E1, VP-E9 and VP-E11) located within 1,000 feet of test production wells TPW-3B and TPW-2C were monitored prior to, during and after the aquifer tests with dedicated pressure transducers and manual gauging. A staff gauge was installed within each vernal pool and piezometers installed within the peat layer underlying the vernal pool and in the aquifer (Zone A) beneath the peat layer.

A predictive model of vernal pool behavior in response to changes in groundwater levels, such as those that might accompany pump in District H was developed based on: (a) water levels collected as part of the District H testing from December 2010 to December 2011, (b) information from previous vernal pool studies by the National Park Service, USGS, and Cape Cod Commission, and (c) equations from the scientific literature describing vernal pool hydrologic processes.

Vernal pool VP-E11 exhibited the greatest response to production well pumping and was used to develop the vernal pool model. The vernal pool model produced a good match to measured pool VP-E11 water elevations during the 2010-2011 period. The model was then used to predict water level changes within VP-E11 under pumping conditions of 500,000 gpd, which is greater than the anticipated long term average pumping rate for District H.

The model showed that seepage from the vernal pool to groundwater is more rapid when the pool stage is high and inundation overlies the areas of thinner peat mat near the edges of the vernal pools. The model also demonstrated that vernal pool VP-E11 is fed by precipitation and that the vernal pool is most likely not replenished by groundwater. Therefore, a decline in water-table level due to pumping is not anticipated to transmit a similar decline to the vernal pool. As a corollary, while pumping and water level declines do not significantly affect pool water levels, a period with no rainfall would have a much larger impact on pool levels, regardless of pumping.

The vernal pool VP-E11 model results indicate that groundwater level declines in the vicinity of the pool caused by future District H pumping is not anticipated to cause a significant change in the seasonal water elevations in the pool. In addition, because vernal pools VP-E1 and VP-E9 exhibited no apparent

responses during the District H aquifer test, it is anticipated that long term District H pumping will have less of an effect on these vernal pools than the very small long-term effect calculated for vernal pool VP-E11.

SEAWAT Modeling

Groundwater modeling was performed using the SEAWAT numerical model developed by the U.S. Geological Survey (USGS) to model freshwater lens conditions of Lower Cape Cod. SEAWAT is a three-dimensional, variable-density, numerical model used to model groundwater flow and transport. The Nauset Lens model was developed by McLane Environmental for analyses of Eastham proposed wellfields and uses SEAWAT (version 4). Under the Nauset Lens model, the SEAWAT model was refined in the vicinities of the NRHS, District G, and District H sites based on site-specific data collected through field investigations. The SEAWAT model was used to:

A. Examine the response of the higher-density saltwater zone beneath the District H well field, and possible total dissolve solids (TDS) concentration impacts in discharged water, and

B. Evaluate the drawdown during no-recharge conditions and the resulting area of contribution to the wells that serves as the basis for the Zone IIs for TPW-3B and TPW-2C.

The Nauset Lens SEAWAT model was used to model changes in TDS concentrations in the aquifer zone beneath the TPW-3B and TPW-2C wells with a constant pumping rate of 1.31 MGD in each well. TDS concentrations were modeled to simulate 100 years of pumping. The modeled TDS concentrations in TPW-3B and TPW-2C after 100 years of pumping each well at 1.31 MGD were 42 mg/L and 148 mg/L, respectively. These simulations do not represent actual anticipated pumping conditions, but demonstrate that pumping at the approvable yield rate for a very long time will not result in TDS concentrations above the drinking water guideline for TDS of 500 mg/L. Dilution from the abundant freshwater contribution to the wells is sufficient to keep the TDS concentrations from deteriorating water quality in the pumping wells.

For the purposes of generating a zone of contribution at the land surface for Zone II delineation using water levels from the 180-day, constant-pumping at 1.31 MGD simulation, particles were placed at the water table and tracked for 5,000 years until the particles stopped at a model boundary (e.g. a groundwater divide or coastal discharge location) or were extracted at the pumping well. Land use within the Zone IIs for the District H TPW-3B and TPW-2C wellfield is shown on Figure ES-3 and is comprised predominately of forested and residential use with some recreational and commercial uses. Other minor

land uses within the Zone II include: portions of the NRHS building and parking lots and the northeastern corner of the Eastham Closed Landfill. Particle tracking of groundwater flow from the landfill area shows that groundwater flow is predominantly to the southeast of the landfill toward Salt Pond Bay area of Nauset Marsh, and most importantly it shows that District H is outside the predicted groundwater discharge zone for the landfill.

The landfill has been identified to be, at least in part, the source of impacts to groundwater by vinyl chloride and 1,4-dioxane. Vinyl chloride was first detected in a private well at 325 Schoolhouse Road at concentrations that exceed the MCL for vinyl chloride (VC) of 2 µg/L. An Immediate Response Action (IRA) under the Massachusetts Contingency Plan (MCP) was completed and properties with measurable concentrations of VC and DCE were provided bottled water, where authorized by the homeowner, by the Town. A point of entry granular activated activated carbon filtration water treatment system was installed at the 325 Schoolhouse Road property. A Class A-2 Response Action Outcome (RAO) for the 325 Schoolhouse Road site was completed by the Town after the vinyl chloride concentrations at the influent to activated carbon system were reported as less than the GW-1 standard of 2.0 ppb for ten consecutive quarterly rounds of sampling. The 325 Schoolhouse Road property and 5 nearby properties where VOCs were detected in their private wells are all located outside and to the south-southwest of the Zone IIs for TPW-3B and TPW-2C..

As part of the fall 2012 post-closure monitoring of the landfill 1,4-dioxane was detected in one of the landfill monitoring wells at a concentration that exceeds the Massachusetts Contingency Plan RCGW-1 Standard of 3 µg/L. (MW-3D – 4.3 µg/L). The Town prepared an IRA Plan in January 2013, approved by DEP, that consists of sampling residential drinking water wells in the downgradient area of the landfill. These IRA activities are ongoing. The most recent Immediate Response Action Status Report and Quarterly Landfill Monitoring Report, dated March 29, 2013, summarizes the status of these IRA activities and consists of sampling over 200 residential wells. The results of this sampling program are to be provided to DEP in the next quarterly progress report, to be submitted to DEP before the end of June 2013.

In response to these detections of 1,4-dioxane in groundwater in the vicinity of the landfill, the public water supply wells proposed to be developed by the Town, consisting of District G, Nauset Regional High School, and District H were sampled on January 17, 2013 and analyzed for 1,4-dioxane in accordance with EPA Method 522.1, which has a method reporting limit of 0.2 ppb and a method detection limit of 0.041 ppb. The wells at District G and the Nauset Regional High School had no detections of 1,4-Dioxane. At District H, the well screened in the Zone B aquifer had trace concentrations

(below the method reporting limit and therefore are estimated concentrations) below 0.081 ppb, two orders of magnitude below the GW-1 standard of 3.0 ppb for 1,4-dioxane under the Massachusetts Contingency Plan (GW-1) is 3.0 ppb. This GW-1 cleanup standard is to be lowered by DEP in the near future to 0.3 ppb. The analytical results of sampling at each of the proposed public water supply locations are either non-detect or a minimum of an order of magnitude lower than the potentially revised standard of 0.3 ppb, and therefore the wells are suitable for public water supply purposes.

Particle tracking generated by the MODFLOW groundwater model shows that groundwater emanating from the landfill area flows generally to the southeast and does not intersect the District H property. For this reason the source of the trace concentrations of 1,4-dioxane detected at the Zone B and Zone C wells from samples collected in the January 2013 sampling event is not known at this time. The objective of the ongoing IRA investigations by the Town will provide definition on the horizontal and vertical extent of the 1,4-dioxane in groundwater and what the likely sources are.

Groundwater Monitoring Program

Three monitoring programs are proposed for the District H well field:

1 Monitoring to confirm the water quality conditions related to movement of the saltwater transition zone transition zone under actual operating conditions of the well field. The goal of the water quality monitoring plan is to ensure that behavior of the salt water transition zone is consistent with SEAWAT modeling predictions. This monitoring program includes long term water level monitoring in the Zone B, C and D aquifers and water quality monitoring in the Zone C and Zone D aquifers.

2 Monitoring of water levels in select vernal pools and monitoring wells to confirm the vernal pool modeling predictions under actual operating conditions of the well field. This monitoring program includes monitoring of water levels within and beneath in four vernal pools located within 1,000 feet of the District H production wells.

3 Monitoring of water quality in sentinel wells located at the western perimeter of the District H property. Water quality parameters of nitrate, VOCs and 1,4-dioxane will be monitored in the Zone B and Zone C aquifers.

The monitoring programs will begin after the permit is issued and before pumping begins to allow for the comparison of baseline data (i.e., pre-pumping conditions) to wellfield pumping conditions.

Water System Parcels and Mass. DOR Property Type Classification Codes

Classification Code	Land Use	Category	Parcels
0	Multiple-Use Property		
		Mixed Residential/Commercial	14
		Mixed Commercial/Residential	26
			40
1	Residential		
		Single Family	1495
		Condominium	30
		Two- and Three-Family	49
		Accessory Land with Improvement	6
		Multiple Houses on One Parcel, Apartments, Group Homes	3
		Developable Land	109
		Undevelopable Land	37
			1789
3	Commercial		
		Transient Group Quarters (Hotels, Motels)	9
		Retail, Auto Service, Office Buildings, Recreation Facilities, Warehouse	39
		Commercial Developable Land	11
		Commercial Undevelopable Land	1
			60
4	Industrial		18
8	Recreational Land		2
9	Tax Exempt Property		
		United States Government	26
		Commonwealth of Massachusetts	7
		Town-Owned	62
		Charitable and Religious Groups, Housing Authorities	17
			112
TOTAL PROPERTIES			2021

Massachusetts Department of Revenue Division of Local Services
Amy A. Pitter, Commissioner Robert G. Nunes, Deputy Commissioner & Director of Municipal Affairs

PROPERTY TYPE CLASSIFICATION CODES,
Non-arm's Length Codes and
Sales Report Spreadsheet Specifications

Prepared by the Bureau of Local Assessment
Revised March 2014

CHANGES

- Revised Personal Property Section

Post Office Box 9569, Boston, MA 02114-9569, Tel: 617-626-2300; Fax: 617-626-2330 http://www.mass.gov/dor

MULTIPLE-USE PROPERTY

CODE 0

Real property used or held for use for more than one purpose, including parcels with multiple detached or attached buildings, are considered multiple-use property for classification purposes. Any necessary related land on a multiple-use property must be allocated among the classes of property within the building.

The first digit of multiple-use property is always a zero (0). The second and third digits are the major classification of the property represented. The digits following zero (0) are listed in the order of major importance.

Examples

Since the guidelines for coding multiple-use property are unique, several specific examples of how to identify such property with these codes are listed here. These are only examples and do not represent all possible multiple use codes.

013 Multiple-Use, primarily Residential

A building with a retail store on the first floor, apartments on the upper floors, and a major portion of the related land is reserved for tenant parking.

031 Multiple-Use, primarily Commercial

A building with retail use on the first floor, office space on the second and third floors, apartments on the fourth floor and a major portion of the related land is allocated for commercial use.

037 Multiple-Use, primarily Commercial with part of land designated under Chapter 61A use

A farm property with land and buildings predominantly used for commercial farming with part of land (at least 5 acres) designated horticulture/agricultural under Chapter 61A.

021 Multiple-Use, primarily Open Space

A single-family house with substantial acreage designated open space by the assessors.

RESIDENTIAL

CODE 1

M.G.L. Chapter 59 §2A: All real property used or held for human habitation containing one or more dwelling units including rooming houses with facilities assigned and used for living, sleeping, cooking and eating on a non-transient basis, and including a bed and breakfast home with no more than three rooms for rent. Such property includes accessory land, buildings or improvements incidental to such habitation and used exclusively by the residents of the property or their guests. Such property shall include: (i) land that is situated in a residential zone and has been subdivided into residential lots, and (ii) land used for the purpose of a manufactured housing community, as defined in Chapter 140, §32F. Such property shall not include a hotel or motel.

Incidental accessory land, buildings or improvements would include garages, sheds, in-ground swimming pools, tennis courts, etc. Non-incidental accessory land, classified and coded differently, would include mixed use properties, such as a variety store, machine shop, etc. on a residential parcel.

10 Residences

101 .....Single Family
102 .....Condominium
103 .....Mobile Home (includes land used for purpose of a mobile home park)
104 .....Two-Family
105 .....Three-Family
106 .....Accessory Land with Improvement - garage, etc.
107 .....(Intentionally left blank)
108 .....(Intentionally left blank)
109 .....Multiple Houses on one parcel (for example, a single and a two-family on one parcel)

11 Apartments

111 .....Four to Eight Units
112 .....More than Eight Units

12 Non-Transient Group Quarters

121..... Rooming and Boarding Houses
122..... Fraternity and Sorority Houses
123..... Residence Halls or Dormitories
124..... Rectories, Convents, Monasteries
125..... Other Congregate Housing which includes non-transient shared living arrangements

13 Vacant Land in a Residential Zone or Accessory to Residential Parcel

130..... Developable Land
131..... Potentially Developable Land
132..... Undevelopable Land

14 Other

140..... Child Care Facility (M.G.L. Chapters 59 §3F; 40A §9C) (see also Code 352)

OPEN SPACE

CODE 2

M.G.L. Chapter 59 §2A: Land which is not otherwise classified and which is not taxable under the provisions of Chapter 61, 61A or 61B, or taxable under a permanent conservation restriction, and which land is not held for the production of income but is maintained in an open or natural condition and which contributes significantly to the benefit and enjoyment of the public.

For land designated as Forest, Agricultural/Horticultural and Recreational under Chapters 61, 61A, 61B, see Codes 6, 7, 8.
Land placed under conservation restriction according to Chapter 184, §31 is to be classified according to its use as residential, commercial or industrial property.

20 Open Land in a Residential Area

201 .....Residential Open Land
202 .....Underwater Land or Marshes not under public ownership located in residential area (typically, privately owned ponds, lakes, salt marshes or other wetlands of non-commercial use)

21 Open Land in Rural Area

210 .....Non-Productive Agricultural Land (that part of an operating farm not classified as Chapter 61A Agricultural/Horticultural or Chapter 61 Forest Land)
211 .....Non-Productive Vacant Land

22 Open Land in a Commercial Area

220 .....Commercial Vacant Land (acreage without site improvements and not in commercial use)
221 .....Underwater Land or Marshes not under public ownership located in commercially zoned area

23 Open Land in an Industrial Area

230..... Industrial Vacant Land (acreage without site improvements and not in commercial or industrial use)
231..... Underwater Land or Marshes not under public ownership located in industrial area

Chapter 61, 61A, 61B Property Being Classified as Open Space

Forest, Agricultural/Horticultural and Recreational lands valued according to M.G.L. Chapters 61, 61A 61B and is being classified as open space. (Without an Open Space Classification they must be placed in Codes 6, 7 or, see page 8.)

26 Forest Land

261..... All land designated under Chapter 61
262..... Christmas Trees

27 Agricultural/Horticultural

All land that designated under Chapter 61A. (Land devoted to this use must be in excess of 5 acres and meet other requirements of the law and is being classified as open space.) Note Non-Productive land is being coded as 29.

Productive Land

270..... Cranberry Bog
271..... Tobacco, Sod
272..... Truck Crops - vegetables
273..... Field Crops - hay, wheat, tillable forage cropland etc.
274..... Orchards - pears, apples, grape vineyards etc.
275..... Christmas Trees
276..... Necessary related land-farm roads, ponds, land under farm buildings
277..... Productive Woodland - woodlots
278..... Pasture
279..... Nurseries

Non-Productive Land

290..... Wet land, scrub land, rock land

28 Recreational Land

All property designated under Chapter 61B. (If an area has more than one use according to the codes below, use the code which represents the primary use of the land and is being classified as open space.).

280 .....Productive woodland -woodlots
281 .....Hiking - trails or paths, Camping - areas with sites for overnight camping, Nature Study - areas specifically for nature study or observation
282 .....Boating - areas for recreational boating and supporting land facilities
283 .....Golfing - areas of land arranged as a golf course
284 .....Horseback Riding - trails or areas
285 .....Hunting - areas for the hunting of wildlife and Fishing Areas
286 .....Alpine Skiing - areas for "downhill" skiing and Nordic Skiing - areas for "cross-country" skiing
287 .....Swimming Areas and Picnicking Areas
288 .....Public Non-Commercial Flying - areas for gliding or hand-gliding
289 .....Target Shooting - areas for target shooting such as archery, skeet or approved fire-arms

COMMERCIAL

CODE 3

M.G.L. Chapter 59 §2A: All real property used or held for use for business purposes and not specifically included in another class, including but not limited to any commercial, business, retail, trade, service, recreational, agricultural, artistic, sporting, fraternal, governmental, educational, medical or religious enterprise for non-profit purposes.

30 Transient Group Quarters

300..... Hotels
301..... Motels
302..... Inns, Resorts or Tourist Homes
303..... (Intentionally left blank)
304..... Nursing Homes - includes property designed for minimal care with or without medical facilities
305..... Private Hospitals
306..... Care and Treatment Facilities - designed and used on a transient basis, including half-way houses or other types of facilities that service the needs of people

31 Storage Warehouses and Distribution Facilities

310..... Tanks Holding Fuel and Oil Products for Retail Distribution, either Above Ground or Underground (Underground tanks of service stations would be real estate; however, above ground tanks that rest on concrete saddles or steel frames that can be separated without damage are personal property.)
311..... Bottled Gas and Propane Gas Tanks
312..... Grain and Feed Elevators
313..... Lumber Yards
314..... Trucking Terminals
315..... Piers, Wharves, Docks and related facilities that are used for storage and transit of goods
316..... Other Storage, Warehouse and Distribution facilities (see also Industrial Code 401)
317..... Farm Buildings - barns, silo, utility shed, etc.
318..... Commercial Greenhouses

32 Retail Trade

321 .....Facilities providing building materials, hardware and farm equipment, heating, hardware, plumbing, lumber supplies and equipment
322 .....Discount Stores, Junior Department Stores, Department Stores
323 .....Shopping Centers/Malls
324 .....Supermarkets (in excess of 10,000 sq. ft.)
325 .....Small Retail and Services stores (under 10,000 sq. ft.)
326 .....Eating and Drinking Establishments - restaurants, diners, fast food establishments, bars, nightclubs

33 Retail Trade - Automotive, Marine Craft and Other Engine Propelled Vehicles, Sales and Service

330 .....Automotive Vehicles Sales and Service
331 .....Automotive Supplies Sales and Service
332 .....Auto Repair Facilities
333 .....Fuel Service Areas - providing only fuel products
334 .....Gasoline Service Stations - providing engine repair or maintenance services, and fuel products
335 .....Car Wash Facilities
336 .....Parking Garages
337 .....Parking Lots - a commercial open parking lot for motor vehicles
338 .....Other Motor Vehicles Sales and Services

34 Office Building

340 .....General Office Buildings
341 .....Bank Buildings
342 .....Medical Office Buildings

35 Public Service Properties (see Code 9 for Exempt Public Service Properties)

350..... Property Used for Postal Services
351..... Educational Properties
352..... Day Care Centers, Adult (see also Code 140)
353..... Fraternal Organizations
354..... Bus Transportation Facilities and Related Properties
355..... Funeral Homes
356..... Miscellaneous Public Services - professional membership organizations, business associations, etc.

36 Cultural and Entertainment Properties

360..... Museums
361..... Art Galleries
362..... Motion Picture Theaters
363..... Drive-In Movies
364..... Legitimate Theaters
365..... Stadiums
366..... Arenas and Field Houses
367..... Race Tracks
368..... Fairgrounds and Amusement Parks
369..... Other Cultural and Entertainment Properties

37 Indoor Recreational Facilities

370..... Bowling
371..... Ice Skating
372..... Roller Skating
373..... Swimming Pools
374..... Health Spas
375..... Tennis and/or Racquetball Clubs
376..... Gymnasiums and Athletic Clubs
377..... Archery, Billiards, other indoor facilities

38 Outdoor Recreational Properties (excluding those classified under General Laws 61B)

380 .....Golf Courses
381 .....Tennis Courts
382 .....Riding Stables
383 .....Beaches or Swimming Pools
384 .....Marinas - including marine terminals & associated areas primarily for recreational marine craft
385 .....Fish and Game Clubs
386 .....Camping Facilities - accommodations for tents, campers or travel trailers
387 .....Summer Camps - children's camps
388 .....Other Outdoor facilities - e.g., driving ranges, miniature golf, baseball batting ranges, etc.
389 .....Structures on land classified under Chapter 61B Recreational Land

39 Vacant Land - Accessory to Commercial parcel or not specifically included in another class

390 .....Developable Land
391 .....Potentially developable Land
392 .....Undevelopable Land
393 .....Agricultural/Horticultural Land not included in Chapter 61A

INDUSTRIAL

CODE 4

M.G.L. Chapter 59 §2A: All real property used or held for use for manufacturing, milling, converting, producing, processing, extracting or fabricating materials unserviceable in their natural state to create commercial products or materials; the mechanical, chemical or electronic transformation of property into new products and any use that is identical to or an integral part of such use, whether for profit or non-profit purposes; property used or held for uses for the storage, transmitting and generating of utilities.

40 Manufacturing and Processing

400..... Buildings for manufacturing operations
401..... Warehouses for storage of manufactured products
402..... Office Building - part of manufacturing operation
403..... Land - integral part of manufacturing operation
404..... Research and Development facilities

41 Mining and Quarrying

410..... Sand and Gravel
411..... Gypsum
412..... Rock
413..... Other

42 Utility Properties

420..... Tanks
421..... Liquid Natural Gas Tanks
423..... Electric Transmission Right-of-Way
424..... Electricity Regulating Substations
425..... Gas Production Plants
426..... Gas Pipeline Right-of Way
427..... Natural or Manufactured Gas Storage
428..... Gas Pressure Control Stations

43 Utility Properties - Communication

430 .....Telephone Exchange Stations
431 .....Telephone Relay Towers
432 .....Cable TV Transmitting Facilities
433 .....Radio, Television Transmission Facilities

44 Vacant Land - Accessory to Industrial Property

440 .....Developable Land
441 .....Potentially Developable Land
442 .....Undevelopable Land

45 Electric Generation Plants

450 .....Electric Generation Plants
451 .....Electric Generation Plants, Transition Value
452 .....Electric Generation Plants, Agreement Value

PERSONAL PROPERTY

CODE 5

M.G.L. Chapter 59 §2: All personal property...wherever situated, unless expressly exempt, shall be subject to taxation...

501..... Individuals, Partnerships, Associations, Trusts, Limited Liability Companies and other non-incorporated entities filing for federal income tax purposes as non-incorporated entities

All personal property is taxable and includes: stock in trade, machinery used in the conduct of the business, personal property used in connection with any cleaning or laundry processes, machinery used in the refrigeration of goods or in the air conditioning of premises, and all furnishings and effects not kept at an individual's domicile.

502..... Business Corporations, as defined in Chapter 63 §30 and taxable under Chapter 63§39, including unincorporated entities treated as corporations for federal income tax purposes.

Taxable personal property includes only: underground conduits, poles, wires and pipes, whether on public or private property; and machinery used in the conduct of the business, except stock in trade or machinery directly used in connection with dry cleaning or laundering processes, refrigeration of goods, air conditioning of premises or in any purchasing, selling, accounting or administrative function.

503..... Classified Manufacturing Corporations*, as defined in Ch. 63 §42B, including unincorporated entities treated as corporations for federal income tax purposes.

Taxable personal property includes only: underground conduits, poles, wires and pipes whether on public or private property.

*Includes Classified Research & Development Corporations in communities accepting local option R & D exemptions and Classified Manufacturing and Research & Development LLCs with single member disregarded entities in communities accepting that local option exemption.

504 .....Utility Corporations, other than Telephone & Telegraph and Pipeline Corporation, taxed as business corporations, including unincorporated entities treated as corporations for federal income tax purposes.

Taxable personal property includes only: underground conduits, poles, wires and pipes whether on public or private property; and machinery used in the conduct of business, except stock in trade or machinery directly used in connection with dry cleaning or laundering processes, refrigeration of goods, air conditioning of premises or in any purchasing, selling, accounting or administrative function.

505 .....Machinery, Poles, Wires and Underground Conduits, Wires and Pipes of all Telephone and Telegraph Companies, as determined by the Commissioner of Revenue.

506 .....Pipelines of 25 Miles or More in Length for Transmitting Natural Gas or Petroleum, as determined by the Commissioner of Revenue.

508 .....Cellular/Mobile Wireless Telecommunications Companies

550 .....Electric Generation Plants Personal Property

551 .....Electric Generation Plant P.P., Transition Value

552 .....Electric Generation P. P., Agreement Value

CHAPTER 61, 61A, 61B PROPERTY

Forest, Agricultural/Horticultural and Recreational lands valued according to M.G.L. Chapters 61, 61A 61B are not specifically included in any of the four major classifications. The commercial property tax rate, however, is the applicable rate for land under these chapters.

CODE 6

Forest Land

601..... All land designated under Chapter 61
602..... Christmas Trees

CODE 7

Agricultural/Horticultural

All land that has been designated under Chapter 61A. (Land devoted to this use must be in excess of 5 acres and meet other requirements of the law.)

71 Productive Land (Including Necessary and Related Land)

710..... Cranberry Bog
711..... Tobacco, Sod
712..... Truck Crops - vegetables
713..... Field Crops - hay, wheat, tillable forage cropland etc.
714..... Orchards - pears, apples, grape vineyards etc.
715..... Christmas Trees
716..... Necessary Related Land-farm roads, ponds, Land under farm buildings
717..... Productive Woodland - woodlots
718..... Pasture
719..... Nurseries

72 Non-Productive Land

720..... Wet land, scrub land, rock land

CODE 8

Recreational Land

All property that has been designated under Chapter 61B. (If an area has more than one use according to the codes below, use the code which represents the primary use of the land).

801 .....Hiking - trails or paths
802 .....Camping - areas with sites for overnight camping
803 .....Nature Study - areas specifically for nature study or observation
804 .....Boating - areas for recreational boating and supporting land facilities
805 .....Golfing - areas of land arranged as a golf course
806 .....Horseback Riding - trails or areas
807 .....Hunting - areas for the hunting of wildlife
808 .....Fishing Areas
809 .....Alpine Skiing - areas for "downhill" skiing
810 .....Nordic Skiing - areas for "cross-country" skiing
811 .....Swimming Areas
812 .....Picnicking Areas
813 .....Public Non-Commercial Flying - areas for gliding or hand-gliding
814 .....Target Shooting - areas for target shooting such as archery, skeet or approved fire-arms
815 .....Productive Woodland - woodlots

EXEMPT PROPERTY

CODE 9

All property which is totally exempt from taxation under various provisions of the law and owned by:

90 Public Service Properties

900..... United States Government
901..... (Intentionally left blank)

91 Commonwealth of Massachusetts – Reimbursable Land

910..... Department of Conservation and Recreation, Division of State Parks and Recreation
911..... Division of Fisheries and Wildlife, Environmental Law Enforcement
912..... Department of Corrections, Division of Youth Services
913..... Department of Public Health, Soldiers' Homes
914..... Department of Mental Health, Department of Mental Retardation
915..... Department of Conservation and Recreation, Division of Water Supply Protection
916..... Military Division – Campgrounds
917..... Education – Univ. of Mass, State Colleges, Community Colleges
918..... Department of Environmental Protection, Low-level Radioactive Waste Management Board
919..... Other

92 Commonwealth of Massachusetts – Non Reimbursable

920..... Department of Conservation and Recreation, Division of Urban Parks and Recreation
921..... Division of Fisheries and Wildlife, DFW Environmental Law Enforcement, Department of Environmental Protection
922..... Department of Corrections, Division of Youth Services, Mass Military, State Police, Sheriffs' Departments
923..... Department of Public Health, Soldiers' Homes, Department of Mental Health, Department of Mental Retardation
924..... Mass Highway Department
925..... Department of Conservation and Recreation Division of Water Supply Protection, conservation restrictions and sewer easements), Urban Parks
926 .....Judiciary
927 .....Education – Univ. of Mass, State Colleges, Community Colleges
928 .....Division of Capital Asset Management, Bureau of State Office Buildings
929 .....Other

GASB 34 Codes

93 Municipal or County Codes

930 .....Vacant, Selectmen or City Council
931 .....Improved, Selectmen or City Council
932 .....Vacant, Conservation
933 .....Vacant, Education
934 .....Improved, Education
935 .....Improved, Municipal Public Safety
936 .....Vacant, Tax Title/ Treasurer
937 .....Improved, Tax Title/ Treasurer
938 .....Vacant, District
939 .....Improved, District

Educational Private

940 .....Elementary Level
941 .....Secondary Level
942 .....College or University
943 .....Other Educational
944 .....Auxiliary Athletic
945 .....Affiliated Housing
946 .....Vacant
947 .....Other

94 Charitable

950 .....Vacant, Conservation Organizations
951 .....Other
952 .....Auxiliary Use (Storage, Barns, etc.)
953 .....Cemeteries
954 .....Function Halls, Community Centers, Fraternal Organizations
955 .....Hospitals
956 .....Libraries, Museums
957 .....Charitable Services
958 .....Recreation, Active Use
959 .....Housing, Other

95 Religious Groups

960 .....Church, Mosque, Synagogue, Temple, etc.
961 .....Rectory or Parsonage, etc.
962 .....Other

96 Authorities

970..... Housing Authority
971..... Utility Authority, Electric, Light, Sewer, Water
972..... Transportation Authority
973..... Vacant, Housing Authority
974..... Vacant, Utility Authority
975..... Vacant, Transportation Authority

97 Land Held by other Towns, Cities or Districts

980..... Vacant, Selectmen or City Council, Other City or Town
981..... Improved, Selectmen or City Council, Other City or Town
982..... Vacant, Conservation, Other City or Town
985..... Improved Municipal or Public Safety, Other City or Town
988..... Vacant, Other District
989..... Improved, Other District

98 Other

990 .....121A Corporations
991 .....Vacant, County or Regional
992 .....Improved, County or Regional, Deeds or Administration
993 .....Improved Count or Regional Correctional
994 .....Improved County or Regional Association Commission
995 .....Other, Open Space
996 .....Other, Non-Taxable Condominium Common Land
997 .....Other

Table D-1.2. Estimate of Existing and Future Average Daily Water Demands of the Eastham Water System.

Classification Code	Land Use	Category	Parcels	Water Demand (gpd, average day)				
				Existing	%	Future	Total Future	%
0	Multiple-Use Property							
		Mixed Residential/Commercial	14	1,745		-	1,745	
		Mixed Commercial/Residential	26	7,265		-	7,265	
			40	9,009	2.8%	-	9,009	2.6%
1	Residential							
		Single Family	1495	202,124		-	202,124	
		Condominium	30	4,056		-	4,056	
		Two- and Three-Family	49	13,655		-	13,655	
		Accessory Land with Improvement	6	-		135	135	
		Multiple Houses on One Parcel, Apartments, Group Homes	63	8,518		-	8,518	
		Developable Land	109	-		14,737	14,737	
		Undevelopable Land	37	-		-	-	
			1789	228,353	71.4%	14,872	243,225	69.2%
3	Commercial							
		Transient Group Quarters (Hotels, Motels)	9	25,850		-	25,850	
		Retail, Auto Service, Office Buildings, Recreation Facilities, Warehouse	39	36,620		-	36,620	
		Commercial Developable Land	11	-		9,806	9,806	
		Commercial Undevelopable Land	1	-		-	-	
			60	62,470	19.5%	9,806	72,276	20.6%
4	Industrial	Warehouse, Sand/Gravel, Electric Transmission	14	318	0.1%		318	0.1%
		Industrial Developable Land	3	-		411	411	
		Industrial Undevelopable Land	1	-		-	-	
			18	318		411	729	
8	Recreational Land		2	4,334	1.4%	-	4,334	1.2%
9	Tax Exempt Property							
		United States Government	26	1,604		-	1,604	
		Commonwealth of Massachusetts	7	-		-	-	
		Town-Owned	62	7,851		7,304	15,155	
		Charitable and Religious Groups, Housing Authorities	17	5,757		-	5,757	
			112	15,213	4.8%	7,304	22,517	6.4%
	Subtotal		**2021**	**319,696**	**100.0%**	**32,393**	**351,679**	**100.0%**
Additional Water Uses								
	Confidentaly Estimated Municipal Water Use (3%)			9,591		972	10,550	
	Unacounted for Water (10%)			31,970		3,239	35,168	
Buffer/Contingency (5%)				15,985		1,620	17,584	
TOTAL PARCELS			**2021**					
TOTAL WATER DEMAND, AVERAGE DAY (gpd)				**377,242**		**38,224**	**414,981**	
TOTAL WATER DEMAND, AVERAGE DAY (Rounded to nearest 1,000 gpd)				**378,000**		**39,000**	**415,000**	

Eastham Assessors Data - 2014

Mixed - Residential/Commercial and Commercial/Residential Properties (State Class Codes 130 and 310)

Water Demand Calculation

1. Residential/Commercial (Class 130)

Assumptions: These parcels are primarily residential.
Equivalent number of households = 3.1 bedrooms/household
Water demand is based on average of 2.08 residents/household; 3.1 bedrooms/household
Water demand i= 65 rgpcd

Number of parcels	14 parcels
Number of bedrooms	40 bedrooms
Equivalent single family households	13 households
Equivalent residents	27 residents
Water demand (gpd)	**1745** gpd

2. Commercial/Residential (Class 310)

Assumptions: Calculated on basis of individual property characteristics and Title 5 flow criteria (see above)
Title 5 flow represents peak day flow (2.0 times average day)
Title 5 flow represents 85% of water demand

Title 5 flow (calculation from above)	12,350 gpd
Water demand, peak day (Title 5 Q/0.85)	14,529 gpd
Water demand, average day (0.5* water demand)	**7,265 gpd**

Eastham Assessors Data - 2014
Residential - Single Family Homes (State Class Code 101)

Water Demand Calculation		
Total Parcels (Households)	1495	parcels
Average number of bedrooms/household	3.1	per household
Average household size	2.08	residents/household
Equivalent Population	3110	residents
Water usage rate	65	rgcpd
Water Demand, Single Family Residence (gpd, average day)	**202,124**	**gallons per day**

Eastham Assessors Data - 2014
Residential - Condominiums (State Class Code 102)

Water Demand Calculation

Total Number of Condominium Units (Households)	30	units
Residents/household	2.08	residents/household
Equivalent Population (2.08 residents/unit)	62.4	residents
Water usage rate	65	rgcpd
Water Demand, Residential Condominiums	**4,056**	**gallons per day**

Eastham Assessors Data - 2014

Residential - Two and Three Family (State Class Codes 104 and 105)

Water Demand Calculation

Total Number of Units		
Two-Family Units	46	
Three-Family Units	3	
Total Units	49	units
Equivalent Number of Single Family Households	101	Households
Residents/Household	2.08	residents/household
Equivalent Population (2.08 residents/unit)	210	residents
Water usage rate	65	rgcpd
Water Demand, 2 and 3 Family Parcels	**13,655**	**gallons per day**

Eastham Assessors Data - 2014

Residential - Accessory Land with Improvement - Garage, etc. (State Class Code 106)

Water Demand Calculation

Assumption:

All properties less than 1 acre in size are undevelopable (consistent with current zoning in Eastham).
Building on a smaller lot would require a variance.

Properties < 1 acre (Undevelopable)	5	Properties
Properties > 1 Acre (Developable)	1	Property
Total number of ALI Properties	6	Properties
Number of household units	1	household
Equivalent population (2.08 residents/unit)	2.08	residents
Water demand (65 rgcpd)	135	gpd

Eastham Assessors Data - 2014
Residential - Multiple Houses, Apartments (4-8 Units) and Group Home (State Class Codes 109, 111 and 125)

Water Demand Calculation

Parcel Count		
Multiple Houses	59	parcels
4-8 Units	3	parcels
Group Home	1	parcel
Total Parcels	63	parcels
Bedroom Count		
Total Bedrooms	195	bedrooms
Bedrooms/household	3.1	bedrooms/household
Equivalent households	63.0	
Equivalent Population (2.08 residents/parcel)	131	residents
Water usage rate	65	rgcpd
Water Demand	**8,518**	**gallons per day**

Eastham Assessors Data - 2014
Residential - Vacant Land, Developable (State Class Code 130)

Water Demand Calculation

Assumptions:

Vacant land that is developable is a future water demand.
Residential developable lots are assumed to represent a future buildout of a single family home.
Future water use rate under this category is assumed at the same rate as a single family home.

Total Parcels	109 parcels
Equivalent Population (2.08 residents/parcel)	227 residents
Water usage rate	65 rgcpd
Water Demand, Residential Developable Lots	**14,737 gallons per day**

Eastham Assessors Data - 2014
Commercial - Motels and Inns (State Class Codes 301 and 301)

Water Demand Calculation

Assumptions:

Water demand calculated on basis of Title 5 criteria (110 gpd/bedroom)
Title 5 flow = 85% of water demand
Title 5 flow is a peak day flow; average day flow = 0.5 times peak day

Water Demand, based on Title 5 calclulation:

Total number of properties	9	properties
Total number of bedrooms	57	bedrooms
Title 5 flow (equivalent to peak day)	6270	gpd
Water demand		
Peak day (gpd)	7,376	gpd
Average day (gpd) (0.5*peak day)	3,688	gpd

Water Demand (average day (gpd)), based on DEP Community Water System data

Sheraton Hotel	16,359	gpd
Captains Quarters	5,353	gpd
Overlook Inn (Oaks of Cape Cod)	449	gpd
	22,162	gpd

Total Water Demand (Title 5 estimate + Community System data)	**25,850**	**gpd**

Eastham Assessors Data - 2014
Commercial - Warehouse, Small Retail, Restaurants, Auto Repair & Service Stations, Office Buildings, Etc. (State Class Codes 316 - 351)

Water Demand Calculation

Assumptions:

Water demand calculated on basis of Title 5 criteria
Title 5 criteria listed for each use and property shown on table, next page.
Title 5 flow = 85% of water demand
Title 5 flow is a peak day flow; average day flow = 0.5 times peak day

Total number of properties	39	properties
Water Demand:		
Title 5 flow (equivalent to peak day)	40,359	gpd
Water demand		
Peak day (gpd)	47,481	gpd
Average day (gpd)	23,740	gpd
Community Systems Data - average day		
Fairway/Hole in One	7,825	gpd
Arnolds (3580 State Highway)	1,282	gpd
Willys World	3,773	gpd
	12,879	gpd
Total, Average Day Demand	36,620	gpd

Eastham Assessors Data - 2014
Commercial - Warehouse, Small Retail, Restaurants, Auto Repair & Service Stations, Office Buildings, Etc. (State Class Codes 316 - 351)

Map	Parcel	Extension	StateClassNonChpt	StateClassDesc	LocNumbe	Location	Acres	ZoneDesc	StyleDesc	Title 5 Flow Criteria		
8	169	0	3160	WAREHOUSE	150	HOLMES RD	1.028	INDUSTRIAL	LIGHT MANUF.	15 gpd/person	90	Assume 6 employees
7	366	A	3250	SMALL RETAIL	491	CAMPGROUND RD	0.476	RESIDENTIAL	STORE(SM. RET)	50 gall/1000 sf	87	
15	70	0	3250	SMALL RETAIL	2390	STATE HWY	2.248	RES & LTD COMM	COMM < 1200 SF	50 gall/1000 sf	44	
8	163	A	3250	SMALL RETAIL	50	BRACKETT RD	1.778	RETAIL/SERVICE	STORE(SM. RET)	50 gall/1000 sf	525.05	
8	165	0	3250	SMALL RETAIL	100	BRACKETT RD	0.5	RETAIL/SERVICE	STORE(SM. RET)	50 gall/1000 sf	153.1	
8	193	B	3250	SMALL RETAIL	4550	STATE HWY	3.536	RETAIL/SERVICE	OFFICE BUILDING	75 gal/1000 sf	50.4	
8	146	A	3250	SMALL RETAIL	4360	STATE HWY	0.691	RETAIL/SERVICE	COMM < 1200 SF	50 gall/1000 sf	38.4	
5	129	A	3250	SMALL RETAIL	4715	STATE HWY	0.988	RETAIL/SERVICE	<Null>	50 gall/1000 sf	0	
8	187	0	3250	SMALL RETAIL	200	BRACKETT RD	0.5	RETAIL/SERVICE	STORE(SM. RET)	50 gall/1000 sf	200	Assume:
8	142	C	3260	RESTAURANTS	4295	STATE HWY	1.078	RETAIL/SERVICE	RESTAURANT	35/seat	DEP NC System data available	
8	194	0	3260	RESTAURANTS	4580	STATE HWY	1.098	RETAIL/SERVICE	RESTAURANT	35/seat	2413.6	4 seats/100 sf
8	146	B	3260	RESTAURANTS	4380	STATE HWY	1.028	RETAIL/SERVICE	RESTAURANT	35/seat	7019.6	4 seats/100 sf
8	202	0	3260	RESTAURANTS	4680	STATE HWY	0.88	RETAIL/SERVICE	RANCH	35/seat	1075.2	4 seats/100 sf
8	133	0	3260	RESTAURANTS	4100	STATE HWY	3.397	RETAIL/SERVICE	RESTAURANT	35/seat	11907	4 seats/100 sf
5	121	A	3260	RESTAURANTS	4940	STATE HWY	1.018	RES & LTD COMM	RESTAURANT	35/seat	7072.8	4 seats/100 sf
5	12	0	3260	RESTAURANTS	5270	STATE HWY	0.948	RES & LTD COMM	FAST FOOD	20/seat	1430.8	4 seats/100 sf
11	4	0	3260	RESTAURANTS	3580	STATE HWY	1.468	RETAIL/SERVICE	RESTAURANT	35/seat	DEP NC System data available	
15	87	0	3320	AUTO REPAIR	2355	STATE HWY	1.008	RES & LTD COMM	SERVICE GARAGE	125 gpd/bay	250	
8	166	0	3320	AUTO REPAIR	100	HOLMES RD	0.55	INDUSTRIAL	LIGHT MANUF.	15 gpd/person	60	
8	286	A	3340	SERVICE STATION	4565	STATE HWY	1.138	RETAIL/SERVICE	SERVICE STATION	125 gpd/bay	250	
8	192	0	3340	SERVICE STATION	4460	STATE HWY	0.89	RETAIL/SERVICE	SERVICE STATION	125 gpd/bay	250	
8	160	0	3340	SERVICE STATION	4515	STATE HWY	0.73	RETAIL/SERVICE	SERVICE STATION	125 gpd/bay	250	
5	125	0	3400	GEN OFFICE BLDG	4760	STATE HWY	0.49	RES & LTD COMM	OFFICE BUILDING	75 gal/1000 sf	87.6	
5	115	0	3400	GEN OFFICE BLDG	5150	STATE HWY	1.098	RES & LTD COMM	OFFICE BUILDING	75 gal/1000 sf	169.05	
8	172	0	3400	GEN OFFICE BLDG	275	HOLMES RD	0.5	INDUSTRIAL	OFFICE BUILDING	75 gal/1000 sf	155.7	
8	145	A	3410	BANK BLDG	4355	STATE HWY	0.968	RETAIL/SERVICE	BANK	75 gal/1000 sf	235.35	
8	193	A	3410	BANK BLDG	75	BRACKETT RD	0.921	RETAIL/SERVICE	BANK	75 gal/1000 sf	150.75	
21	28	J	3420	MED OFFICE	725	STATE HWY	1.388	RESIDENTIAL	OFFICE BUILDING	75 gal/1000 sf	285.6	
8	129	A	3430	CI CONDO	3960	STATE HWY	0	<Null>	OFFICE CONDO	75 gal/1000 sf	59.85	
8	140	L	3430	CI CONDO	3	MAIN ST	0	<Null>	MM CONDO	75 gal/1000 sf	61.5	
8	188	A	3430	CI CONDO	180	BRACKETT RD	0	RETAIL/SERVICE	RETAIL CONDO	50 gall/1000 sf	60.8	
8	136	P	3430	CI CONDO	3	MAIN ST	0	<Null>	MM CONDO	50 gall/1000 sf	39.2	
15	73	0	3500	POSTAL SERVICE	2365	STATE HWY	0.6	RES & LTD COMM	STORE(SM. RET)	50 gall/1000 sf	84	
5	176	A	3510	EDUC PROP	930	MASSASOIT RD	2.938	RESIDENTIAL	CHURCHES	6 gpd/seat	1800	Assume 300 seats
8	304	0	3530	FRATERNAL ORG	60	MCKOY RD	4.425	RESIDENTIAL	CLUB/LODGE/HALL	15 gpd/seast	3750	Assume 250 seats
5	128	B	3760	ATHLETIC CLUB	4730	STATE HWY	5.391	RETAIL/SERVICE	HEALTH CLUB	25 gpd/participant	DEP NC System data available	
11	1	0	3860	Mixed-Comm/Chpt 61B	3700	STATE HWY	7.175	RETAIL/SERVICE	STORE(SM. RET)	50 gall/1000 sf	65.45	
5	124	0	3880	OUTDOOR REC PROP	4790	STATE HWY	10.86	RES & LTD COMM	STORE(SM. RET)	50 gall/1000 sf	111.75	
15	65	P	3400	GEN OFFICE BLDG	2470	STATE HWY	1	RES & LTD COMM	RES CONDO	75 gal/1000 sf	75	
							64.73			Title 5 flow	40,359	

Eastham Assessors Data - 2014
Commercial and Industrial - Developable and Undevelopable Land (State Class Codes 390, 392, 440, 442)

Water Demand Calculation

Commercial

Total developable parcels	11	properties
Total undevelopable parcels	1	property
Average water demand/acre of existing commercial property		
Motels & Inns	785	gpd/acre
Miscellaneous Commercial	566	gpd/acre
Average	675	gpd/acre
Estimated water demand of developable commercial property		
Acres of developable property	14.5	acres
Estimated water demand (675 gpd/acre)	**9,806**	**gpd**

Industrial

Total developable parcels	3	properties
Total undevelopable parcels	1	property
Average water demand/acre of existing industrial property		
Existing acres of industrial property	25.60	acres
Water Demand	318	gpd
Water demand/acre	12.41	gpd/acre
Estimated water demand of developable industrial property		
Acres of developable property	33.11	acres
Estimated water demand	**411**	**gpd**

Eastham Assessors Data - 2014

Industrial - Miscellaneous (Warehouse, Sand/Gravel, Electric Transmission ROW (State Class Codes 401,410 and 423)

Water Demand Calculation

Assumptions:

- Water demand applied only to properties with structures and in active use
- Water demand calculated on basis of Title 5 criteria for warehouses (15 gpd/employee)
- Number of employees for each property were assumed on basis of existing businesses
- Title 5 flow = 85% of water demand
- Title 5 flow is a peak day flow; average day flow = 0.5 times peak day

Property count:

Properties with structures and that are in use, classified as warehouses	10 properties
Sand and gravel operation	1 property
Electrical right-of-way or substation	3 properties
Total properties	14 properties

Water Demand:

Title 5 flow (equivalent to peak day)	540 gpd
Water demand	
Peak day (gpd)	635 gpd
Average day (gpd)	**318** gpd

PROPERTY DETAIL:

Map	Parcel	Extension	StateClassNonChpt	StateClassDesc	Location	NAME1	Acres	StyleDesc	Title 5 Criteria	Assume # of people	Title 5 Flow
8	168	0	4010	WAREHOUSE	HOLMES RD	FARRELL ELECTRIC INC	2.298	WAREHOUSE	15 gpd/person	8	120
8	170	0	4010	WAREHOUSE	HOLMES RD	ANDERSON E STEVEN	0.84	WAREHOUSE	15 gpd/person	4	60
8	177	0	4010	WAREHOUSE	HOLMES RD	SHEA SHAWN E & KATHLEEN E	0.53	WAREHOUSE	15 gpd/person	2	30
8	171	0	4010	WAREHOUSE	HOLMES RD	ANDERSON E STEVEN	0.6	WAREHOUSE	15 gpd/person	2	30
8	186	0	4010	WAREHOUSE	HOLMES RD	HOLMES ROAD REALTY TRUST	0.919	WAREHOUSE	15 gpd/person	4	60
8	183	B	4010	WAREHOUSE	HOLMES RD	NERAK WAY LLC	0.54	WAREHOUSE	15 gpd/person	2	30
8	183	A	4010	WAREHOUSE	HOLMES RD	FARRELL GUY A & TIMOTHY M	0.51	WAREHOUSE	15 gpd/person	2	30
8	180	0	4010	WAREHOUSE	HOLMES RD	TJM EASTHAM REALTY TRUST	1.158	WAREHOUSE	15 gpd/person	4	60
8	176	0	4010	WAREHOUSE	HOLMES RD	TOWN LINE NOMINEE TRUST	0.46	WAREHOUSE	15 gpd/person	2	30
8	179	0	4010	WAREHOUSE	HOLMES RD	TOWN LINE NOMINEE TRUST	0.46	STORAGE GARAGE	15 gpd/person	2	30
5	32	A	4100	SAND/GRAVEL	NAUSET RD	CHAVES JOHN F SR & JOHN F JR	12.398	COMM < 1200 SF	15 gpd/person	4	60
8	125	0	4230	ELEC TRANS ROW	HOLMES RD OFF	NSTAR ELECTRIC CO	2.23	<Null>	No flow	0	0
8	182	0	4230	ELEC TRANS ROW	BRACKETT RD OFF	NSTAR ELECTRIC CO	0.3	<Null>	No flow	0	0
8	190	A	4240	ELEC SUBSTATION	BRACKETT RD	NSTAR ELECTRIC CO	2.356		No flow	0	0
											540

Eastham Assessors Data - 2014
Chapter 61 Property - Recreational Land (State Class Code 802 and 803)

Water Demand Calculation

Assumptions:

Water demand calculated on basis of Title 5 criteria
Title 5 criteria for camping is equal to public park with bathhose, showers and toilets = 10 gpd/person
Assume that Atlantic Oaks has capacity for 300 campers; the nature study has capacity for 150 visitors/day

Title 5 flow = 85% of water demand
Title 5 flow is a peak day flow; average day flow = 0.5 times peak day

Water Demand:

Title 5 flow (equivalent to peak day)	-	
Atlantic Oaks	-	DEP data available (below)
Nature Study	1,500	
Title 5 flow	1,500	
Water demand		
Peak day (gpd)	1,765	
Average day (gpd)		882

Based on DEP Community Water System data:

	Annual (MGY)	Ave Day
Atlantic Oaks Campground	1.26	3,452

TOTAL, Average Day demand 4,334

PROPERTY DETAIL:

Map	Parcel	Extension	StateClassNonChpt	StateClassDesc	LocNumbe	Location	NAME1	Acres	ZoneDesc
8	126	0	8020	CAMPING	0	STATE HWY BY RR	ATLANTIC OAKS REALTY LLC	9.93	RETAIL/SERVICE
13	78	C	8030	NATURE STUDY	1175	HERRING BROOK RD	THOMAS FREDERICK W TTEE	5.447	RESIDENTIAL

Eastham Assessors Data - 2014
Exempt Property - US Govt, State Properties (State Class Codes 900, 911, 921, 924)

Water Demand Calculation

Summary:

All but two properties are undevelopable

Developable properties are: 1) CCNS Salt Pond Visitors Center and 2) CCNS-owned house

Assumptions:

CCNS Visitors Center has average of 500 visitors/day

For Visitor Center, apply Title 5 criteria for public park with toilets = 5 pgd/person

For single family residence, assume same criteria for a single family home

Water Demand:

CCNS Visitor Centger

Title 5 Flow (represents peak day)	2500	gpd
Equivalent water demand (peak day)	2,941	gpd
Average day (0.5 Qpk)	1,471	gpd
Single family home	134	gpd
Total Water Demand (Ave Day)	1,604	gpd

Eastham Assessors Data - 2014

Public (Exempt) Property - Vacant, Improved (State Class Codes 930, 931, 932, 934, 935, 936, 950)

Water Demand Calculation

EXISTING WATER DEMAND

Approach:

A. Community water system data used where available.

B. Residential home calculated on basis of single family home criteria.

C. Title 5 criteria used for all remaining properties, adjusted to average daily water usage

1. Based on Community Water System data

Location	Annual Demand (MGY)	Ave Day (gpd)	Source:
Eastham Elementary School, 200 Schoolhouse	0.21	563	2013 ASR
Nauset Regional High School, 100 Cable Rd	1.01	2,754	2013 ASR
Eastham Town Hall	0.69	1,890	2005 ASR
		5,208 gpd	

2. Based on Title 5 Criteria

Location	*Assumptions*	
1425 Nauset Road - Single Family Home		
	2.06 residents; 65 rgcpd	134 gpd
10 Balwic Road - Day Care Center		
	Title 5 = 10 gall/person; 50 people	294 gpd
Library - based in DEP wellpermit		900 gpd
Council on Aging		
	Title 5 for function hall = 15 gal/seat; 100 seats	882 gpd
Police and Fire Station		
	Title 5 for office bldg = 75 gpd/1000sf; 7000 sf	309 gpd
Eastham DPW and Natural Resources		
	Title 5 for office bldg = 75 gpd/1000sf; 2800 sf	124 gpd
Subtotal		2,643 gpd

Total, Existing Water Demand (Community System data + Title 5 estimates) **7,851**

POTENTIALLY DEVELOPABLE PROPERTIES

1. Roach Property	43.4 acres; 1 house/acre		
2. Purcell #1	10.4 acres; 1 house /acre		
3. Purcell #3	0.81 acres; 1 house/acre		
	Total acres	54.6	acres
	Number of single family residences	55	residences
	Equivalent population (2.06/residence)	112	residents
	Water demand (65 rgpcd)	**7,304**	**gpd**

Eastham Assessors Data - 2014
Public (Exempt) Property - Charitable, Religious, Authorities (State Class Codes 953 - 970)

Approach:

A. Community water system data used where available.

B. Housing authority property demands based on residential use criteria (2.08 residents/unit; 65 rgpcd).

C. Title 5 criteria applied to all other properties, adjusted to average daily water usage.

Property summary:

Developed and in use (libraries, place of worship, housing authority)	15 properties
Undevelopable land (cemetaries)	2 properties
	17 properties

Water Demand Calculation

1. Based on water demands

			Water Demand (gpd)
10	Smith Lane	1 residence	
220	ELDIA WAY	1 residence	
9	MASSASOIT RD	1 residence	
1195	STATE HWY	1 residence	
5960	STATE HWY	2 residences	
5970	STATE HWY	2 residences	
5965	BALLWIC RD	2 residences	
15	STATE HWY	1 residence	
5975	STATE HWY	2 residences	
5985	STATE HWY	2 residences	
		15 residences	2,028 gpd

2. Based on Title 5 Criteria

		Title 5 Category	Title 5 Flow (gpd)	
2375	STATE HWY	Office building	99	58 gpd
25	SCHOOLHOUSE RD	Office building	241	142 gpd
1050	GREAT POND RD	Place of Worship	3,000	1,765 gpd
3200	STATE HWY	Place of Worship	3,000	1,765 gpd
				3,729 gpd

TOTAL WATER DEMAND **5,757 gpd**

Eastham Water System
Form WMA-D2: Withdrawals with Seasonal Variation

Table D.2.1 Monthly Water Withdrawals of Outer Cape Communities as % of Annual Total.

Month	*Orleans*	*Orleans*	*Brewster*	*Provincetown*	*AVERAGE*
ASR	*2013*	*2012*	*2012*	*2012*	
January	5%	4%	5%	4%	**5%**
February	4%	4%	4%	4%	**4%**
March	4%	4%	5%	4%	**4%**
April	5%	7%	6%	7%	**6%**
May	9%	8%	9%	8%	**8%**
June	11%	12%	10%	12%	**11%**
July	17%	19%	17%	19%	**18%**
August	16%	16%	16%	16%	**16%**
September	10%	10%	10%	10%	**10%**
October	8%	6%	8%	6%	**7%**
November	6%	5%	5%	5%	**5%**
December	5%	5%	5%	5%	**5%**

Orleans - 2013 Annual Statistical Report

	Water Withdrawals (Gallons)		
Month	*Volume*	*Total*	*% of Annual*
January	16,077,500	325,909,900	5%
February	14,104,700	325,909,900	4%
March	14,485,000	325,909,900	4%
April	17,717,800	325,909,900	5%
May	27,967,400	325,909,900	9%
June	34,856,400	325,909,900	11%
July	54,579,300	325,909,900	17%
August	51,913,000	325,909,900	16%
September	34,008,800	325,909,900	10%
October	25,624,600	325,909,900	8%
November	18,451,000	325,909,900	6%
December	16,124,400	325,909,900	5%
	325,909,900		100%

Orleans - 2012 Annual Statistical Report

	Water Withdrawals (Gallons)		
Month	*Volume*	*Total*	*% of Annual*
January	15,165,300	342,154,500	4%
February	13,499,100	342,154,500	4%
March	14,124,900	342,154,500	4%
April	22,989,700	342,154,500	7%
May	28,244,900	342,154,500	8%
June	40,078,900	342,154,500	12%
July	66,202,800	342,154,500	19%
August	53,136,500	342,154,500	16%
September	34,051,000	342,154,500	10%
October	21,639,300	342,154,500	6%
November	15,585,500	342,154,500	5%
December	17,436,600	342,154,500	5%
	342,154,500		100%

Brewster - 2013 Annual Statistical Report

	Water Withdrawals (Gallons)		
Month	*Volume*	*Total*	*% of Annual*
January	20,700,000.0	453,837,000	5%
February	18,570,000.0	453,837,000	4%
March	21,372,000.0	453,837,000	5%
April	25,267,000.0	453,837,000	6%
May	39,641,000.0	453,837,000	9%
June	47,623,000.0	453,837,000	10%
July	77,923,000.0	453,837,000	17%
August	74,523,000.0	453,837,000	16%
September	46,660,000.0	453,837,000	10%
October	36,312,000.0	453,837,000	8%
November	23,259,000.0	453,837,000	5%
December	21,987,000.0	453,837,000	5%
	453,837,000		100%

Provincetown - 2013 Annual Statistical Report

	Water Withdrawals (Gallons)		
Month	*Volume*	*Total*	*% of Annual*
January	12,182,546	228,089,068	5%
February	11,365,560	228,089,068	5%
March	13,257,002	228,089,068	6%
April	13,951,257	228,089,068	6%
May	21,215,276	228,089,068	9%
June	24,228,088	228,089,068	11%
July	34,595,991	228,089,068	15%
August	36,306,425	228,089,068	16%
September	23,266,696	228,089,068	10%
October	17,026,758	228,089,068	7%
November	10,923,330	228,089,068	5%
December	9,770,139	228,089,068	4%
	228,089,068		100%

2013 Public Water Supply Verification

Please verify the information below and then click the Continue button.

PWS ID:	**4224000**
PWS Name:	**ORLEANS WATER DEPARTMENT**
PWS Street Address Line 1:	**292 RTE 28**
PWS Street Address Line 2:	
City/Town:	**ORLEANS**
State:	**MA**
Zip Code:	**02653-0000**
Class:	**COM**

Massachusetts Department of Environmental Protection
Bureau of Resource Protection – Drinking Water Program
Public Water Supply Annual Statistical Report
Reporting Year 2013

PWSID#: 4224000
Name: ORLEANS WATER DEPARTMENT
City: ORLEANS
PWS Class: COM

RAW Water Production and Consumption Summary for Reporting Year :

Raw Water means water in its natural state, prior to treatment and is usually the water entering the first treatment process of a water treatment plant.

☐ Same as finished water (it is not necessary to complete Table if same volume as above)

Month	(1) Amount of raw water pumped from own sources (GAL)	(2) Amount of raw water purchased from other systems (GAL)	(3) Amount of raw water sold to other systems (GAL)	(4) Net raw Water Consumption (1) + (2) - (3) = (4) (GAL)
January	16,077,500	0	0	16,077,500
February	14,104,700	0	0	14,104,700
March	14,485,000	0	0	14,485,000
April	17,717,800	0	0	17,717,800
May	27,967,400	0	0	27,967,400
June	34,856,400	0	0	34,856,400
July	54,579,300	0	0	54,579,300
August	51,913,000	0	0	51,913,000
September	34,008,800	0	0	34,008,800
October	25,624,600	0	0	25,624,600
November	18,451,000	0	0	18,451,000
December	16,124,400	0	0	16,124,400
TOTAL	325,909,900	0	0	325,909,900

Maximum Daily Raw Water Pumping:	Volume (GAL): 2,372,800	Date: 7/17/2013

Summary of Water Sold

Sold Water

System Name	PWS ID#	Total Volume Sold (GAL)	Water type
GLACIER WATER VEND @ ORLEANS	4224005	3,574	Finished

2012 Public Water Supply Verification

Please verify the information below and then click the Continue button.

PWS Name:	**ORLEANS WATER DEPARTMENT**
PWS Street Address Line 1:	**292 RTE 28**
PWS Street Address Line 2:	
City/Town:	**ORLEANS**
State:	**MA**
Zip Code:	**02653-0000**
Class:	**COM**

Massachusetts Department of Environmental Protection
Bureau of Resource Protection – Drinking Water Program
Public Water Supply Annual Statistical Report
Reporting Year 2012

PWSID#: 4224000
Name: ORLEANS WATER DEPARTMENT
City: ORLEANS
PWS Class: COM

RAW Water Production and Consumption Summary for Reporting Year :

Raw Water means water in its natural state, prior to treatment and is usually the water entering the first treatment process of a water treatment plant.

☐ Same as finished water (it is not necessary to complete Table if same volume as above)

Month	(1) Amount of **raw** water pumped from own sources (GAL)	(2) Amount of **raw** water purchased from other systems (GAL)	(3) Amount of **raw** water sold to other systems (GAL)	(4) Net **raw** Water Consumption (1) + (2) - (3) = (4) (GAL)
January	15,165,300	0	0	15,165,300
February	13,499,100	0	0	13,499,100
March	14,124,900	0	0	14,124,900
April	22,989,700	0	0	22,989,700
May	28,244,900	0	0	28,244,900
June	40,078,900	0	0	40,078,900
July	66,202,800	0	0	66,202,800
August	53,136,500	0	0	53,136,500
September	34,051,000	0	0	34,051,000
October	21,639,300	0	0	21,639,300
November	15,585,500	0	0	15,585,500
December	17,436,600	0	0	17,436,600
TOTAL	342,154,500	0	0	342,154,500

Maximum Daily Raw Water Pumping:	Volume (GAL): 2,693,100	Date: 7/21/2012

Summary of Water Sold

Sold Water

System Name	PWS ID#	Total Volume Sold	Water type

2013 Public Water Supply Verification

Please verify the information below and then click the Continue button.

PWS ID:	**4041000**
PWS Name:	**BREWSTER WATER DEPARTMENT**
PWS Street Address Line 1:	**165 COMMERCE PARK RD**
PWS Street Address Line 2:	
City/Town:	**BREWSTER**
State:	**MA**
Zip Code:	**02631-0000**
Class:	**COM**

Massachusetts Department of Environmental Protection
Bureau of Resource Protection – Drinking Water Program
Public Water Supply Annual Statistical Report
Reporting Year 2013

PWSID#: 4041000
Name: BREWSTER WATER DEPARTMENT
City: BREWSTER
PWS Class: COM

Water Production & Consumption Information

How to report in Gallons vs. Million Gallons
When Converting gallons to Million gallons, decimal point moves 6 places to the left.

	If Reporting in Gallons (Gal)	If Reporting in Million Gallons (MG)
Example 1	45,562,100	45.5621
Example 2	340,212	0.340212
Example 3	631,020,000	631.02
Example 4	96,543	0.096543

Volume Units ○ Gallons (GAL) ◉ Million Gallons (MG) ○ No Meter

FINISHED Water Production and Consumption Summary for Reporting Year :

Finished Water means water that is introduced into the distribution system of a public water system and is intended for distribution and consumption without further treatment, except as treatment necessary to maintain water quality in the distribution system (e.g. booster disinfection, addition of corrosion control chemicals).

Month	(1) Amount of **finished** water from own sources (MG)	(2) Amount of **finished** water purchased from other systems (MG)	(3) Amount of **finished** water sold to other systems (MG)	(4) Net **finished** Water that entered your distribution system (1) + (2) - (3)= (4) (MG)
January	20.700	0.000	0.000	20.700
February	18.570	0.000	0.000	18.570
March	21.372	0.000	0.000	21.372
April	25.267	0.000	0.000	25.267
May	39.641	0.000	0.000	39.641
June	47.623	0.000	0.000	47.623
July	77.923	0.000	0.000	77.923
August	74.523	0.000	0.000	74.523
September	46.660	0.000	0.000	46.660
October	36.312	0.000	0.000	36.312
November	23.259	0.000	0.000	23.259
December	21.987	0.000	0.000	21.987
TOTAL	453.837	0.000	0.000	453.837

Maximum Daily Finished Water Consumption: Volume (MG): 3.651 Date: 7/6/2013

2013 Public Water Supply Verification

Please verify the information below and then click the Continue button.

PWS ID:	**4242000**
PWS Name:	**PROVINCETOWN WATER DEPARTMENT**
PWS Street Address Line 1:	**26 ALDEN ST**
PWS Street Address Line 2:	
City/Town:	**PROVINCETOWN**
State:	**MA**
Zip Code:	**02657-0000**
Class:	**COM**

Massachusetts Department of Environmental Protection
Bureau of Resource Protection – Drinking Water Program
Public Water Supply Annual Statistical Report
Reporting Year 2013

PWSID#: 4242000
Name: PROVINCETOWN WATER DEPARTMENT
City: PROVINCETOWN
PWS Class: COM

Water Production & Consumption Information

How to report in Gallons vs. Million Gallons
When Converting gallons to Million gallons, decimal point moves 6 places to the left.

	If Reporting in Gallons (Gal)	If Reporting in Million Gallons (MG)
Example 1	45,562,100	45.5621
Example 2	340,212	0.340212
Example 3	631,020,000	631.02
Example 4	96,543	0.096543

Volume Units (•) Gallons (GAL) ( ) Million Gallons (MG) ( ) No Meter

FINISHED Water Production and Consumption Summary for Reporting Year :

Finished Water means water that is introduced into the distribution system of a public water system and is intended for distribution and consumption without further treatment, except as treatment necessary to maintain water quality in the distribution system (e.g. booster disinfection, addition of corrosion control chemicals).

Month	(1) Amount of **finished** water from own sources (GAL)	(2) Amount of **finished** water purchased from other systems (GAL)	(3) Amount of **finished** water sold to other systems (GAL)	(4) Net **finished** Water that entered your distribution system (1) + (2) - (3)= (4) (GAL)
January	12,182,546	0	0	12,182,546
February	11,365,560	0	0	11,365,560
March	13,257,002	0	0	13,257,002
April	13,951,257	0	0	13,951,257
May	21,215,276	0	0	21,215,276
June	24,228,088	0	0	24,228,088
July	34,595,991	0	0	34,595,991
August	36,306,425	0	0	36,306,425
September	23,266,696	0	0	23,266,696
October	17,026,758	0	0	17,026,758
November	10,923,330	0	0	10,923,330
December	9,770,139	0	0	9,770,139
TOTAL	228,089,068	0	0	228,089,068

Maximum Daily Finished Water Consumption: Volume (GAL): 1,799,550 Date: 7/27/2013

A3. Characterization of Groundwater and Vernal Pool Interactions in District H

Previous studies (e.g. Sobczak et al. 2003) have identified a cluster of vernal pools in the area between the Nauset Light Beach and the proposed District H well field site. This assemblage of pools in the eastern portion of Eastham is associated with a number of kettle ponds in the same area. Kettle ponds and vernal pools are surface-water features that are typically without any surface-water inlets or outlets. Kettle ponds are 15-70 ft deep and extend 300-6,600 ft from shore to shore. They hold standing water throughout all seasons of the year and are often referred to as "windows into the aquifer" because they are considered to be surface expressions of the groundwater aquifer. Vernal pools are smaller and shallower than kettle ponds. They have been given the prefix "vernal" because they generally fill up with 3-7 ft of water during the spring and dry down in the fall. Over time a distinct biotic community has adapted to the semi-annual flooding and drying regime (Sobczak et al. 2003).

Three of the vernal pools at the District H well site (E1, E9, and E11) are located within approximately 1,000 feet from the test production wells TPW-3B and TPW-2C (Figure A3-1). These pools were investigated extensively during a study (referred to herein as the Sobczak et al. 2003 study) that was sponsored by Cape Cod Commission, Water Resources Office of the National Park Service, University of Rhode Island, and the Lower Cape Water Management Task Force. These pools were also monitored by EPG during and after the December 2010 aquifer tests.

Vernal pool aquifer test data were analyzed in the context of previous pool study data to investigate the potential effects of future pumping in District H on water levels in the vernal pools. Vernal pool data from previous studies and from the aquifer test program were combined with equations from the scientific literature describing vernal pool hydrologic processes to form a simple predictive model of pool behavior in response to changes in groundwater levels such as those that might accompany pumping in District H.

A brief summary of vernal pool formation and hydrology along with a statement of study objectives for the current investigation is presented in Section A3.1. Key findings and data from the Sobczak et al. 2003 study regarding the vernal pools in the vicinity of the District H site are summarized in Section A3.2. The site-specific data collected for the vernal pools during and after the December 2010 aquifer tests is presented in Section A3.3. The model equations that establish the relationship between surface water elevation in vernal pool E11 and groundwater levels in the vicinity of the pool are described in Section A3.4. Application of the model to investigate changes in vernal pool E11 water levels in response to anticipated future pumping at the District H site is presented in Section A3.5.

A3.1 Vernal Pool Hydrology and Current Study Objectives

Vernal pools on Cape Cod are formed within topographic depressions that were likely formed by melting of buried ice-blocks during deglaciation (Oldale 1992). Over time, organic material accumulated in the vernal pools, forming a peat mat. The peat mat forms a layer of bed material, thicker near the pond center and thinner toward the pond outer edges, that exhibits lower permeability than the surrounding and underlying soil

and aquifer materials. There are typically no distinct surface water features that enter and exit a vernal pool. Vernal pools receive their water primarily from precipitation runoff via diffuse overland flow from a catchment area that supplies the pool. Surface flow into the pool raises pool water levels, which initiate and maintain a process of slow drainage into underlying groundwater.

The vernal pool/groundwater interaction in District H is complex because the water level of the vernal pools in District H are not steady but fluctuate depending on the amount of rainfall, the level of the water table, the pool seepage rate, and the rate of evapotranspiration (Sobczak et al. 2003; Liebowitz and Brooks 2008). In addition, the vernal pool dimension and lithologic characteristics (width, depth, and peat thickness) also play a roll in the fluctuation of the pool water levels.

The objectives of the current investigation are to (1) use site-specific data on pool inputs and fluctuations to develop a quantitative relationship that describes pool leakage for given pool and groundwater levels, and (2) apply the derived relationship to examine likely long-term declines in pool level that may be associated with groundwater level declines near the pools due to pumping at the District H site. Because the previous study by Sobczak et al. (2003) was crucial in this investigation, a brief summary of the Sobczak et al. (2003) study is presented below in section A3.2.

The current investigation takes the previous study a step further by estimating the amount of induced infiltration that will occur for a range of water table elevations. This is important because the proposed pumping wells in District H have the potential to lower the water table at a withdrawal rate of 1.31 million gallons per day (MGD). Because the vernal pool levels are also heavily dependent upon the amount of precipitation, the future pool levels cannot be predicted, but the response of the vernal pools to pumping can be estimated as described below.

A3.2 Previous Vernal Pool Study

From the late 1990's through the early 2000's, the vernal pools in District H were the subject of a study with the objectives of 1) characterizing the nature of groundwater and surface water relationships and 2) predicting the vernal pool levels response to groundwater withdrawals in District H and the Cape Cod National Sea Shore (Sobczak et al. 2003). While the study collected and analyzed a large quantity of data to characterize vernal pool area, volume, and stage elevation changes in response to natural hydrologic factors over a period of several years, it did not derive a quantitative model to predict pool level response to pumping. The Sobczak study data, described in this section and in Section A3.3 below, form the basis for the predictive model developed in the current study (Section A3.4) that was applied to proposed future District H pumping (Section A3.5).

The Sobczak investigation included a field survey to characterize wetland topography and peat thickness for vernal pools E1, E2, E3, E4, E5, E6, E7, E8, E9, E10, and E11 in Eastham, Massachusetts. The locations of these pools are shown on Figure A3-1. The characterization of the wetland topography included the development of vernal pool stage/volume and vernal pool stage/surface area rating curves. The peat mats that compose the bottom sediments of the vernal pools were found to be thickest in the centers of the vernal pools, ranging from 3-10 feet-thick and thinnest toward the edges of

the pools that are bordered by shrubs. Figure A3-2 is a conceptual cross section of vernal pool E11 showing the lateral extent and thickness of the peat mat. Materials below the peat mat and surrounding the edges of the pools where the peat mat pinches out are composed of mineral sediments (sand, silts, and clays). It was demonstrated under a falling-head permeameter test that the groundwater/surface water flows more readily through the mineral sediments surrounding the pool than it does through the peat mats (Sobczak et al. 2003).

Sobczak et al. (2003) concluded that:

- natural water level fluctuations in the pools and at the water table parallel each other;
- the vernal pool stage and water table elevation were more similar during high-water conditions than during low-water conditions;
- the infiltration of vernal pool water occurs more readily when the level of the vernal pool overtops the peat mat and is in contact with the mineral sediments;
- the infiltration of vernal pool water is impeded by the peat mat; and
- the recession rate of the water table and pool stage is not constant but depends on the frequency and intensity of seasonal precipitation.

A3.3 Monitoring and Interpretation of the 2010-2011 Vernal Pool Monitoring Data

Groundwater and surface water levels at vernal pools E1, E9, and E11 were collected from December 2010 to December 2011. A staff gage/piezometer monitoring pair was installed at each vernal pool at a location where the pools are closest to the pumping wells. The monitoring pair VP-E1A/VP-E1C was installed in the center of vernal pool E1; VP-E9A/VP-E9C was installed on the northern edge of vernal pool E9; and VP-11A/VP-11C was installed on the western edge of vernal pool E11 (see Figure A3-1). The piezometers were used to determine the water table elevation directly below the vernal pools and the staff gages were used to determine the vernal pool stage. Each monitoring pair was instrumented with pressure tranducers/dataloggers, which provided water level measurements every 10 minutes during non-pumping conditions and at one-minute intervals during the three pumping tests. The three aquifer test schedules are shown on Table A3-1).

Table A3-1 Aquifer Test Schedule

Aquifer Test	Test Production Well(s)	Pump On	Pump Off	Duration	Pump Rate (gpm)
1	TPW-3B	12/6/2010 9:02	12/11/2010 9:04	5 days	910
2	TPW-2C	12/16/2010 9:02	12/21/2010 9:04	5 days	916
3	TPW-3B	3/22/2011 10:02	3/28/2011 2:35	5 days 16.5 hours	738
3	TPW-2C	3/22/2011 10:02	3/28/2011 2:35	5 days 16.5 hours	738

The physical dimensions of the pools and their distances from the pumping wells are listed in Table A3-2.

Table A3-2 Vernal Pool Dimensions

Vernal Pool	Maximum Area (ft^2)	Maximum Peat Mat Thickness (ft)	Approximate Pool Bottom Elevation (ft NAVD88)	Distance from TPW-3B (ft)	Distance from TPW-2C (ft)
E1	7,300	3.44	9.80	870	970
E9	31,655	8.50	8.20	700	840
E11	14,264	7.71	8.20	670	720

A rain gauge was installed at a location 0.85 miles west of the District H well field. The precipitation data were used for the interpretation of water-level response to precipitation prior to, during, and after the aquifer tests. Although precipitation monitoring was continuous, the individual precipitation events from December 2nd to December 28th 2010 and from March 17th to April 1st 2011 are summarized in Table A3-3 below:

Table A3-3 Precipitation Events in District H during Aquifer Tests 1, 2, and 3

Date(s)	Precipitation (in)
December 12th – 13th	1.50
December 19th – 20th	0.11
December 21st – 22nd	1.23
December 22nd – 23rd	0.57
December 26th – 27th	1.19
March 21st – 22nd	0.25
March 24th	0.19
March 31st	0.06

An analysis of the water-level trends during the December 2010 District H pumping tests indicated that the water-table response to pumping was more pronounced at vernal pool E11 than at pools E1 and E9, where the response of water levels to pumping was not apparent due to the effects of precipitation and regional/local water-level trends. However, the water table and the pools appear to respond to precipitation events in a similar way. Because there is an obvious parity between the pool levels and the water table levels under non-pumping conditions and an obvious disparity under pumping conditions (as described below), it appears that the pumping effects on the pools is far smaller than pumping effects on the water table. Therefore, a decline in water table level due to pumping is not anticipated to transmit a similar decline to the vernal pool, as demonstrated by the aquifer test hydrograph data discussed in this section and by the vernal pool response-to-pumping model discussed in Section A3.5.

Hydrographs of water table and vernal pool stage for E11, E1, and E9 during the District H aquifer tests are presented in Figures A3-3 through A3-7. Figure A3-3, the hydrograph of monitoring at E11 during aquifer test 1 (TPW-3B pumping 910 gpm) and

aquifer test 2 (TPW-2C pumping 916 gpm) shows that the water table declines 0.38 feet during aquifer test 1, recovers 0.57 feet from December 11th to December 16th after the pump is shut off, and then declines 0.28 feet during aquifer test 2. The pool stage at E11 during this period (December 2nd to December 28th) appears to respond mainly to precipitation events. In addition, the recovery of the water table at E11 after both aquifer tests is somewhat obscured/enhanced by the precipitation events on December 13th and December 21st through the 23rd. For example, the E11 water table level and vernal pool stage begin to rise on December 20 in response to precipitation, before TPW-2C is even shut off.

The hydrograph (Figure A3-4) of E11 monitoring locations during aquifer test 3 (TPW-3B pumping 738 gpm and TPW-2C pumping 738 gpm) shows the water table declines 0.54 feet in response to pumping, recovers 0.45 feet after the pumps are shut off, but also shows there is no apparent response to pumping in the vernal pool. The vernal pool level appears to be declining steadily from 9.98 feet NAV88 on March 17th to 9.80 feet NAV88 on March 31st 2011. Note that in March 2011, the vernal pool stage and water table are approximately 0.5 feet higher than in December 2010. This means that more of the pool area is inundated and that the water table is well above the bottom of the pool.

The bottom elevation of vernal pool E11 (i.e. the average top of the peat layer in the pool) is approximately 8.20 feet NAV88 (converted from feet msl reported by Sobczak et al. (2003)) and is shown on the hydrographs (Figures A3-3 and A3-4). The hydrographs show that the water table level at E11 drops below the bottom of the pool from December 7th to December 12th but is otherwise above the bottom of the pool. Furthermore, it does not appear from Figure A3-3 that the vernal pool level responds differently when the water table drops below the pool bottom than it does when the water table is above the pool bottom.

Figure A3-5 shows long-term water levels measured in EGW-36 and H-OW-1A for the period between April 16th 2010 and May 1st 2011, which are used for comparison with the water table elevations measured at E11C. Water levels in EGW-36 are higher because that well is located closer to the center of the lens. Water levels in H-OW-1A are higher than in E11C because H-OW-1A is upgradient to E11C. The long-term trends in the water table appear to be similar in all three locations. Furthermore, water levels in monitoring well H-OW-1A indicate that the water table elevation in District H was highest at 12.38 feet NAVD88 on April 17th, 2010 (prior to monitoring at E11C) and was lowest at 9.36 feet NAVD88 on December 12th, 2010 (Figure A3-5). Based on these observations, it appears that during the December 2010 aquifer test, water table levels were at their lowest point, providing the optimal time for observing the effects of a low water table on pool levels.

Figures A3-6 and A3-7 show groundwater and pool stage levels for vernal pools E1 and E9 during December 2010 aquifer tests 1 and 2. The water table levels in both graphs do not show an apparent response to pumping and, therefore, the vernal pool levels also show no obvious response. However, these graphs do show that at the end of test 2, water levels rise in response to precipitation. This same rainfall event obscures the water level response near vernal pool E11 (Figure A3-3). The water table elevation does not fall below the bottoms of these pools even when water levels are lowest on December 12th, 2010.

By comparing the vernal pool and water table responses to pumping, it was determined that vernal pool E11 is the most susceptible to induced infiltration under pumping test conditions (see Figures A3-3, A3-4, A3-6, and A3-7). In order to evaluate the extent of induced infiltration under pumping test conditions for vernal pool E11, a quantitative, empirical hydrologic model was developed for predicting vernal pool response to pumping at TPW-3B.

A3.4 Modeling Vernal Pool Stage Elevation

A3.4.1 Vernal Pool Water Budget

For the purpose of understanding the fluctuation of pool level, a water budget model was created using the data collected from vernal pool E11. The factors affecting the water budget are simplified here, but are the elements of a typical climate–water balance equation where the sum of precipitation (+), evapotranspiration (-), groundwater seepage (±), and surface water exchange (±) is equal to the change in the vernal pool's storage over time (Liebowitz and Brooks 2008; Kadlec and Wallace 2009):

$$\frac{dV}{dt} = (P \times A_c) - (ET \times A) \pm GW \pm SW \qquad \text{[A3-1]}$$

where dV is change in the volume of the vernal pool in cubic feet, dt is time in hours, P is precipitation in feet per hour, A_c is vernal pool catchment area in square feet, ET is evapotranspiration in feet per hour, A is vernal pool surface area in square feet, GW is groundwater-vernal pool seepage rate in cubic feet per hour, and SW is surface water influx in cubic feet per hour.

Because the model in this initial stage is intended to simulate pool hydrologic response during the District H aquifer tests, the equation was further simplified by eliminating ET and SW. There is little to no ET in December and March in the northeastern United States (Brooks 2004) and there is no surface water influx (i.e., streams) into the pools from outside the immediate vicinity of the pool (Sobczak et al. 2003). Thus the equation becomes (see Figure A3-8):

$$\frac{dV}{dt} = (P \times A_c) \pm GW \qquad \text{[A3-2]}$$

[Note: Evapotranspiration was later added to form an enhanced model based on hydrologic data from December 2010 through December 2011 that was used to simulate longer-term vernal pool hydrologic response to precipitation and groundwater fluctuations (see Section A3.5 below).]

A3.4.2 Relationship between Vernal Pool Stage and Volume

To apply Equation A3-2 to vernal pool E11, the relation between the vernal pool stage and the volume of water in the pool was needed. The vernal pool stage/volume rating curve was developed by Sobczak et al. (2003) and is shown in (Figure A3-9).

A3.4.3 Precipitation Input to Vernal Pool

The precipitation volume (P x A_c) into vernal pool E11 was estimated by multiplying rainfall by catchment surface area. The precipitation was measured hourly

from August 2010 to December 2011 at a rain gauge located 0.85 miles from District H. The catchment area (A_c) of vernal pool E11 is approximately 14,300 square feet (Sobczak et al. 2003).

A3.4.4 Seepage to Groundwater as a Function of Vernal Pool Stage

The groundwater seepage rate (*GW*) was estimated by evaluating the relative difference between vernal pool stage and groundwater elevation. The hydrographs on Figures A3-3 and A3-4 show that during all three aquifer tests, the vernal pool stage is always greater than the water table elevation, indicating that vernal pool E11 discharges to groundwater. The rate of seepage from vernal pool E11 was estimated using the following equation from Kadlec and Wallace (2009):

$$GW = \lambda L_b \left(H_v - H_g \right) \qquad \text{[A3-3]}$$

and

$$L_b = 2\pi \sqrt{\frac{A_s}{\pi}} \qquad \text{[A3-4]}$$

where λ is an empirical coefficient representing the effect that the pool stage has on the seepage rate in feet per hour, L_b is the flooded circumference of the vernal pool in feet, H_v is the vernal pool stage elevation in feet NAVD88, H_g is the groundwater elevation in feet NAVD88, and A_s is the vernal pool surface area based on the vernal pool stage elevation in square feet. The vernal pool's flooded circumference (L_b) (see Equation A3-4) was estimated based on the vernal pool stage/surface area rating curve developed by Sobczak et al. (2003) (Figure A3-10) and based on the simplifying assumption, for the purpose of the calculation, that the shape of the vernal pool is circular.

An empirical coefficient (λ) was developed to account for how the vernal pool stage affects the seepage rate. The study by Sobczak et al. (2003) determined that the seepage rate was higher when the vernal pool stage is high and that this was due to seepage through the mineral sediments and thinner peat mat at the perimeter of the pools. However, due the variability in effective peat thickness the coefficient (λ) is non-linear. As the pool stage rises, areas of the pool with much thinner peat mat become inundated and the areas with thinner to no peat-mat will control the seepage rate. Conversely, at low pool stages, a thicker peat mat controls the seepage rate of the pool. Figure A3-11 shows the relation between peat mat thickness and the vernal pool stage elevation. The peat thickness relation in Figure A3-11 was approximated by a 6th order polynomial and is referred to as the peat thickness equation (α).

The empirical coefficient (λ) equation was based on the inverse of the relation between peat mat thickness and pool stage elevation (see Figure A3-11). Calibration of the empirical coefficient (λ) equation was performed by plotting the modeled vernal pool stage elevation with the measured vernal pool stage data for aquifer tests 1 and 2. The empirical coefficient (λ) equation was multiplied by a scaling factor to adjust the seepage rate (*GW*) so that the estimated pool stage matched the hydrographs for aquifer test 1 and 2. A graph of the empirical coefficient (λ) versus vernal pool stage is shown in Figure A3-12. Figure A3-13 shows the water levels for vernal pool E11 monitoring locations (as plotted in Figure A3-3) as well as the vernal pool stage calculated using the method

described above. The modeled stage elevations tracked quite well with the measured data. A graph of measured versus calculated pool stage is shown on Figure A3-14. The measured and modeled stages plotted on top of the diagonal line (1:1 line) indicating that the model matches well with the measured data. A linear least squares fit was applied to the plot resulting in a slope (m) that was slightly less than 1 (m = 0.98). Additionally, the Root Mean Square Error (RMSE), the square root of the sum of the residual values squared, was calculated and found to be reasonably small (RMSE = 0.02 feet).

A3.4.5 Validation of Vernal Pool Stage / Leakage Model

Given water table elevation, vernal pool stage elevation, precipitation, rating curves, and the empirical coefficient (λ) function, Equation A3-2 can model vernal pool stage elevation through time. The model for vernal pool E11 was then validated by plotting the modeled vernal pool stage elevation with the measured vernal pool stage data for aquifer test 3 (Figure A3-15). Again, the modeled stage elevations match the measured data very well. A second plot between the modeled vernal pool stage elevation and the measured vernal pool stage data from March 2011 further shows that the model provides a close approximation to the measured vernal pool stage elevation (Figure A3-16). The slope (m) of the March 2011 plot was found to be slightly more than 1 (m = 1.04). The RMSE was calculated and found again to be quite small (RMSE = 0.01 feet). Based on the calibration and validation results, the model developed for vernal pool E11 is capable of estimating the vernal pool stage when groundwater elevations are above the bottom of the peat mat.

A3.5 Estimating Pumping Effects on Vernal Pools

A3.5.1 Effect of Pumping and Groundwater Elevation Decline on Vernal Pool Leakage Rate

The model was used to estimate the influence of pumping on the stage of vernal pool E11 because, as discussed in Section A3.3 above, the influence of pumping is small compared to the influence of precipitation. Therefore, drawdown from pumping (H_g) was removed from the model to show the influence from precipitation only. The adjusted water table elevation was applied to the vernal pool model (in Equation A3-2) to estimate the pool stage elevations. Figure A3-17 is a graph showing two modeled vernal pool stages, one using precipitation-only and the other using precipitation and pumping. Without pumping, the seepage rate of the pool is approximately 706 gallons per day over the period from December 6th to December 21st. Based on the calibrated model, it is estimated that pumping resulted in an increased seepage rate of 110 gallons per day (16%) and in a 0.04 foot difference in pool level by the end of test 2.

A3.5.2 Test of Model Using Long-Term Data Set

A long-term hydrograph for vernal pool stage was created using Equation A3-2 with the addition of evapotranspiration resulting into Equation A3-5:

$$\frac{dV}{dt} = (P \times A_c) - (ET \times A) - GW \qquad \text{[A3-5]}$$

Evapotranspiration in this enhanced version of the vernal pool model was based on Brooks (2004), who calculated potential evapotranspiration using the Thornthwaite method for a thirty-year period for Quabbin Reservation, Massachusetts (Figure A3-18). Application of Brooks (2004) evapotranspiration rates to vernal pool E11 resulted in an underestimation of vernal pool stage. Utilizing half of Brooks (2004) evapotranspiration rates (see Figure A3-18) resulted in modeled vernal pool stage elevations that track quite well with the measured data (Figure A3-19). A graph of measured versus calculated pool stage is shown on Figure A3-20. The measured and modeled stages plotted on top of the diagonal line (1:1 line) indicating that the model matches well with the measured data. A linear least squares fit was applied to the plot resulting in a slope (m) that was slightly less than 1 (m = 0.98). Additionally, the RMSE was calculated and found to be reasonably small (RMSE = 0.01 feet).

A3.5.3 Analysis of Effect of District H Well Pumping on Vernal Pool Stage

The calibrated Nauset lens SEAWAT model was used to predict drawdown at the water table beneath vernal pool E11 under pumping conditions in District H of 0.5 MGD at well TPW-3B. This withdrawal rate is greater than the anticipated long term average withdrawal rate for the District H Site. The Nauset lens model indicates that the stabilized water table drawdown is 0.62 feet at vernal pool E11 after 100 years of pumping. Figure A3-21 is a graph showing two modeled vernal pool stages, one using precipitation and evapotranspiration and the other using precipitation, evapotranspiration, and pumping. With pumping, the water table drawdown is 7.4 inches (0.62 ft) and the average drop in the vernal pool stage is 2.5 inches (Figure A3-22).

A3.6 Conclusions

Data describing aquifer (groundwater elevation) and vernal pool response to pumping of test production wells TPW-3B and TPW-2C were collected during the December 2010 District H proposed well site aquifer test. Evaluation of those data indicated that, of the three vernal pools (E1, E9, and E11) located within 1,000 feet of the test production wells, water-table response to pumping was more pronounced at vernal pool E11 than at pools E1 and E9, where the response of water levels to pumping was not apparent due to the effects of precipitation and regional/local water-level trends. By comparing the vernal pool and water table responses to pumping, it was determined that vernal pool E11 is the most susceptible to induced infiltration under pumping at TPW-3B and TPW-2C.

To examine potential long-term effects of District H pumping on water levels in pool E11, an empirical model relating pool water levels to surrounding groundwater levels for average climatologic and hydrologic conditions in the Eastham area was developed. Model equations were formulated based on the District H aquifer test data and data from previous study of vernal pools near the District H site (Sobczak et al. 2003, and specifically the pool E11 data). The model incorporates the effects of precipitation input to the pool and pool losses due to leakage to groundwater. The model, which was calibrated to measured vernal pool stage data collected during the December 2010 District H pumping tests, produced a very good fit to measured vernal pool water elevations. The calibrated model was then used to simulate vernal pool E11 response to

pumping during the District H combined pumping test conducted in March 2011. The ability of the model to accurately reproduce measured pool E11 water elevations verified the accuracy of the model. In addition, an enhanced version of the model that included evapotranspiration losses was used to simulate vernal pool E11 stage elevations under longer-term natural precipitation, evapotranspiration, and groundwater fluctuation conditions from December 2010 to December 2011. The vernal pool model produced a good match to measured pool E11 water elevations during the one-year period.

The calibrated vernal pool E11 model was applied to examine the potential response of pond water levels to declines in groundwater elevations that are anticipated to accompany normal pumping conditions in District H (see Section A3.5 of this report). The model shows that the pumping would have had a very small effect on the vernal pool stage (an average drop of 2.5 inches) from December 2010 to December 2011. This conclusion is based on a SEAWAT calculated groundwater level decline of approximately 7.4 inches (0.62 ft) in the vicinity of pool E11, in response to a withdrawal rate of 0.5 MGD in TPW-3B. The geometry and hydrologic processes (see Figure A3-8) of vernal pool E11 interact to mitigate pool stage declines in response to declines in surrounding groundwater elevations. Groundwater elevation declines in the range anticipated to be caused by District H pumping result in only a relatively small increase in pool bottom seepage rate. As this slightly increased seepage acts to reduce pond water levels, the pool area contracts. This (1) causes a reduction in average evapotranspiration rate, and (2) places pond water over the thickest portion of the peat layer, thereby reducing the rate of seepage loss to groundwater.

The vernal pool model developed in this study provides valuable insight into pool hydrologic processes. The model demonstrates that seepage is more rapid when the pool stage is high and inundation overlies the areas of thinner peat mat. The model also demonstrates that vernal pool E11 is fed by precipitation and that the vernal pool is most likely not significantly replenished by groundwater. Therefore, as indicated above, a decline in water table level due to pumping is not anticipated to cause a similar decline in the vernal pool stage. As a corollary, while pumping and water level declines do not significantly affect pool water levels, a period with no rainfall would have a much larger impact, regardless of pumping.

The vernal pool E11 model results indicate that groundwater level declines in the vicinity of the pool caused by future District H pumping are not anticipated to cause a significant change in the seasonal water elevations in the pool. In addition, because vernal pools E1 and E9 exhibited no apparent responses to pumping of the District H test, it is anticipated that long term District H pumping will have an effect on these pools that is even smaller than the very small long-term effect calculated for pool E11. Monitoring of groundwater and vernal pool water elevations, along with collection of data including precipitation and temperature, would provide a check on the model's results regarding potential pumping effects, and would provide input data that would allow the model to be applied, and modified as necessary, for use as a hydrologic management tool for the vernal pool area surrounding the District H well field.

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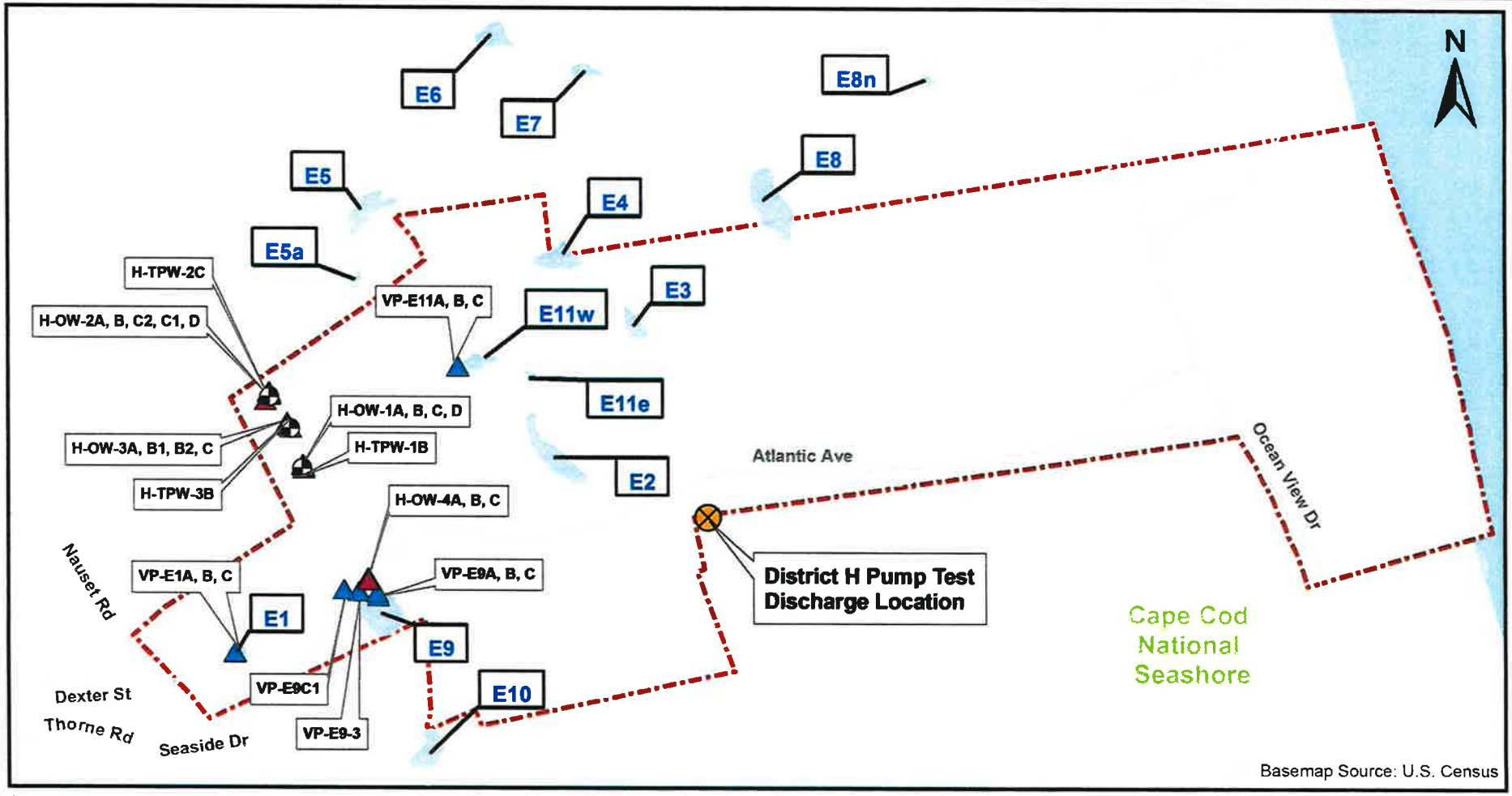

Legend

- Pumping Wells
- Observation Wells
- Vernal Pool Staff Gages/ Piezometers
- Discharge Location
- E2 Vernal Pools
- Site Boundaries
- B-B' Cross Section Transect
- Roads

0 250 500 1,000 Feet

Location of Vernal Pools, Monitoring Wells, and Test Production Wells at District H

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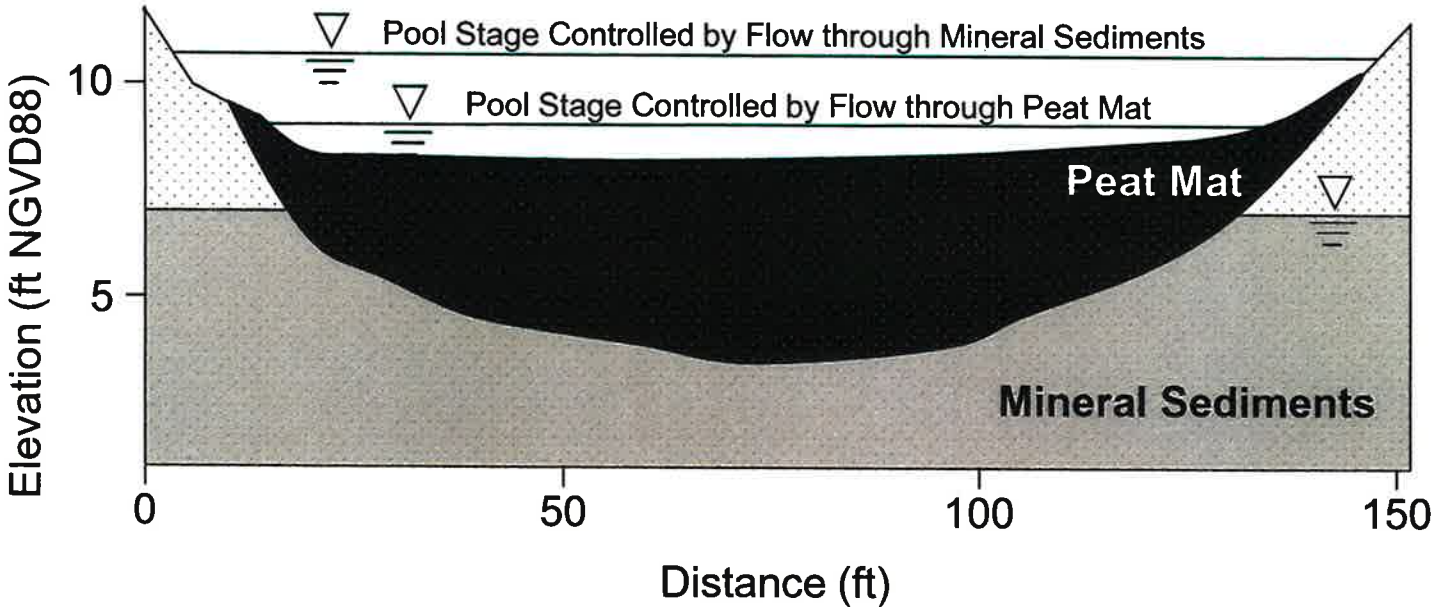
Figure A3-1



Conceptual Cross section of Vernal Pool E11

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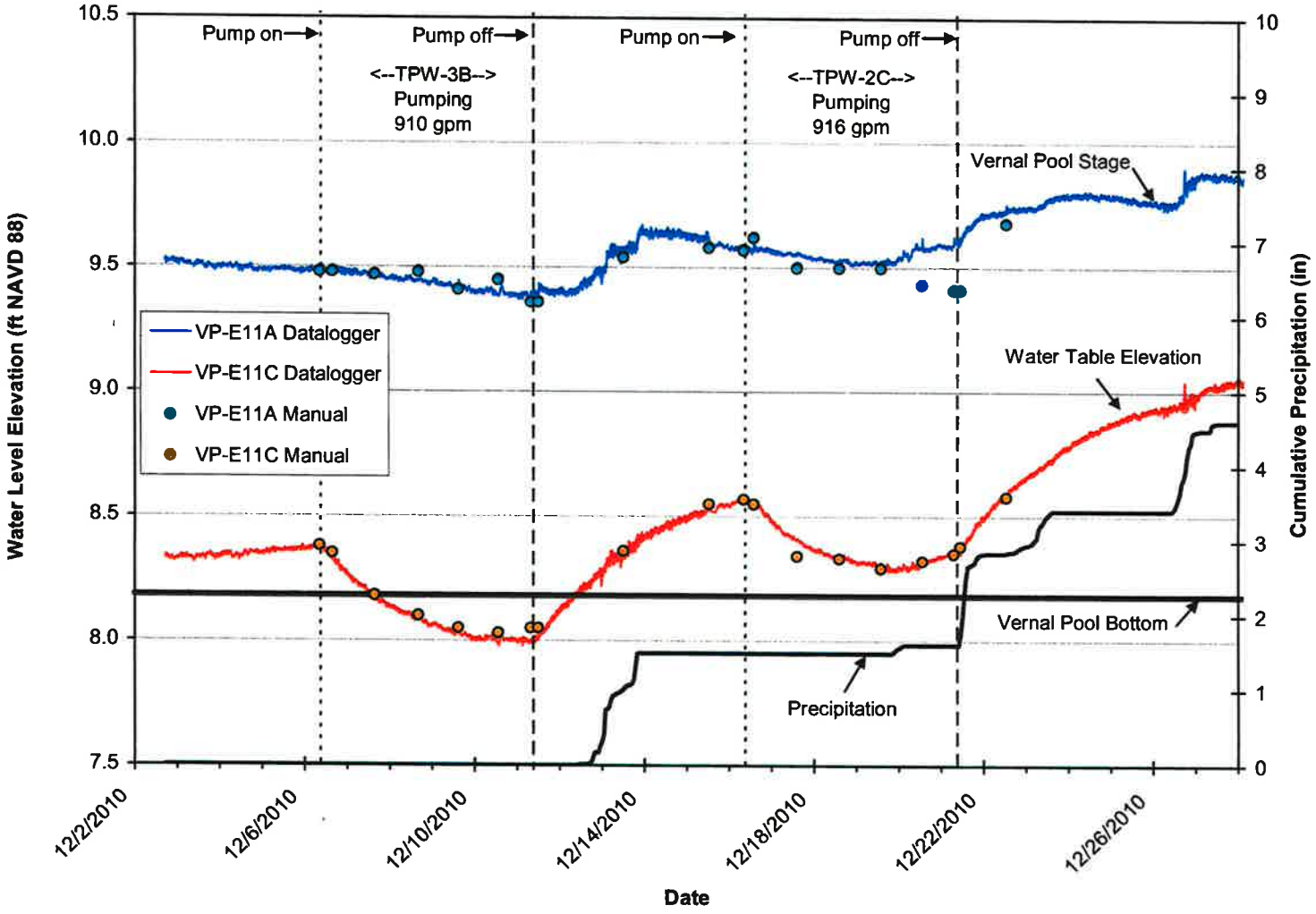
Figure A3-2



Groundwater and Stage Levels for Vernal Pool E11 during Aquifer Test 1 (TPW-3B) and Aquifer Test 2 (TPW-2C)

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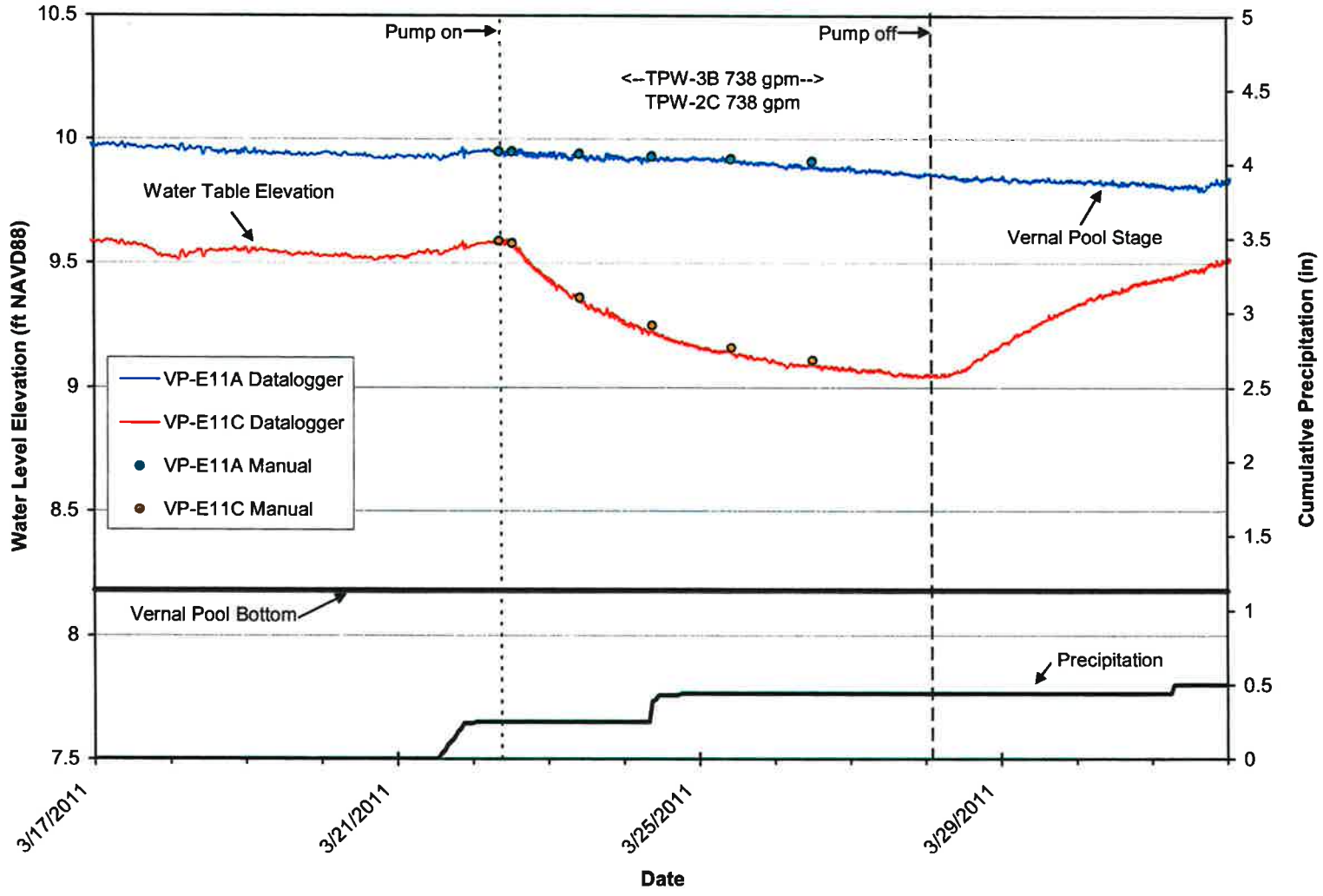
Figure A3-3



Groundwater and Stage Levels for Vernal Pool E11 during Aquifer Test 3 (TPW-3B & TPW-2C)

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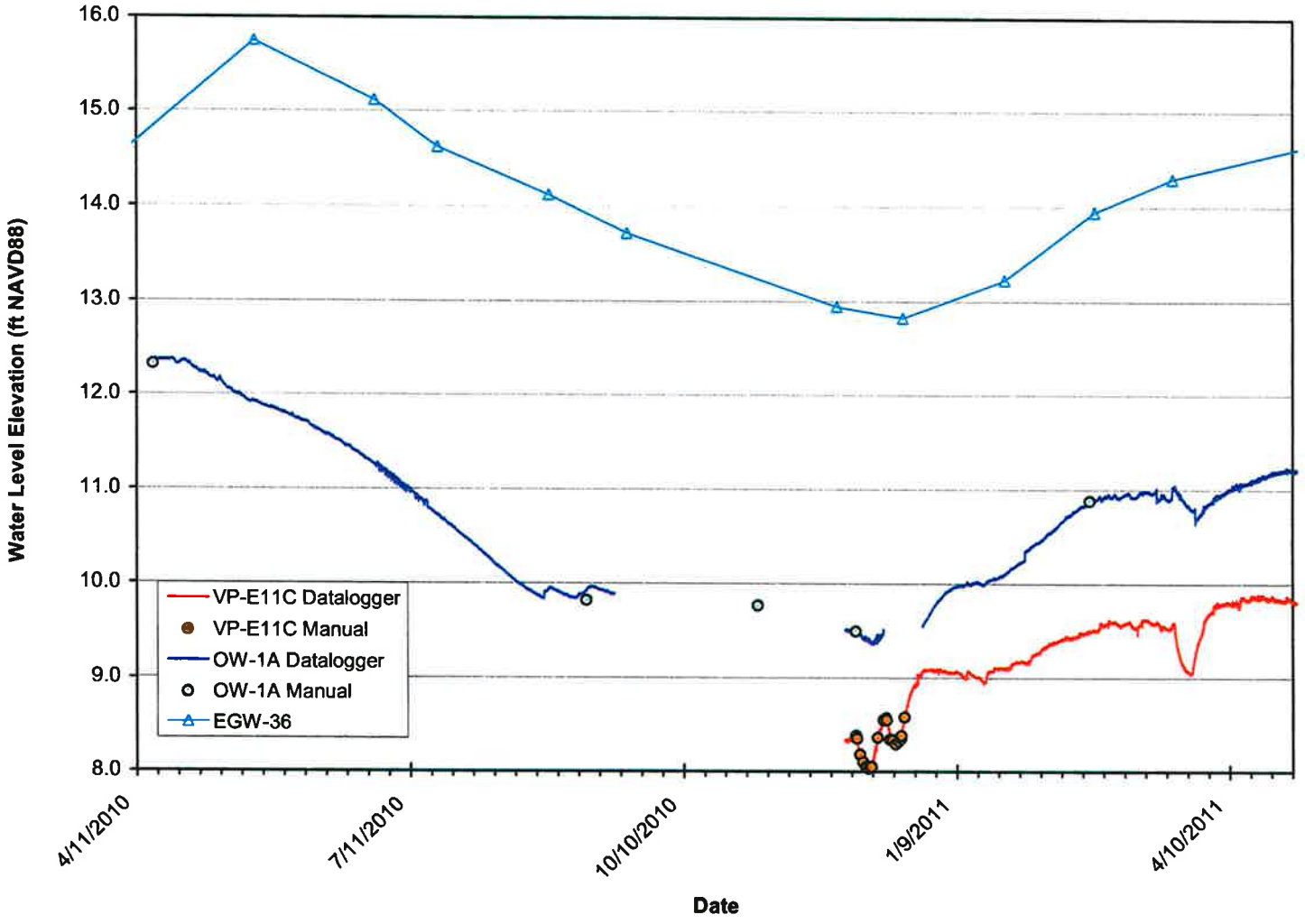
Figure A3-4



Long-term Water Levels in H-OW-1A, E11C, and EGW-36

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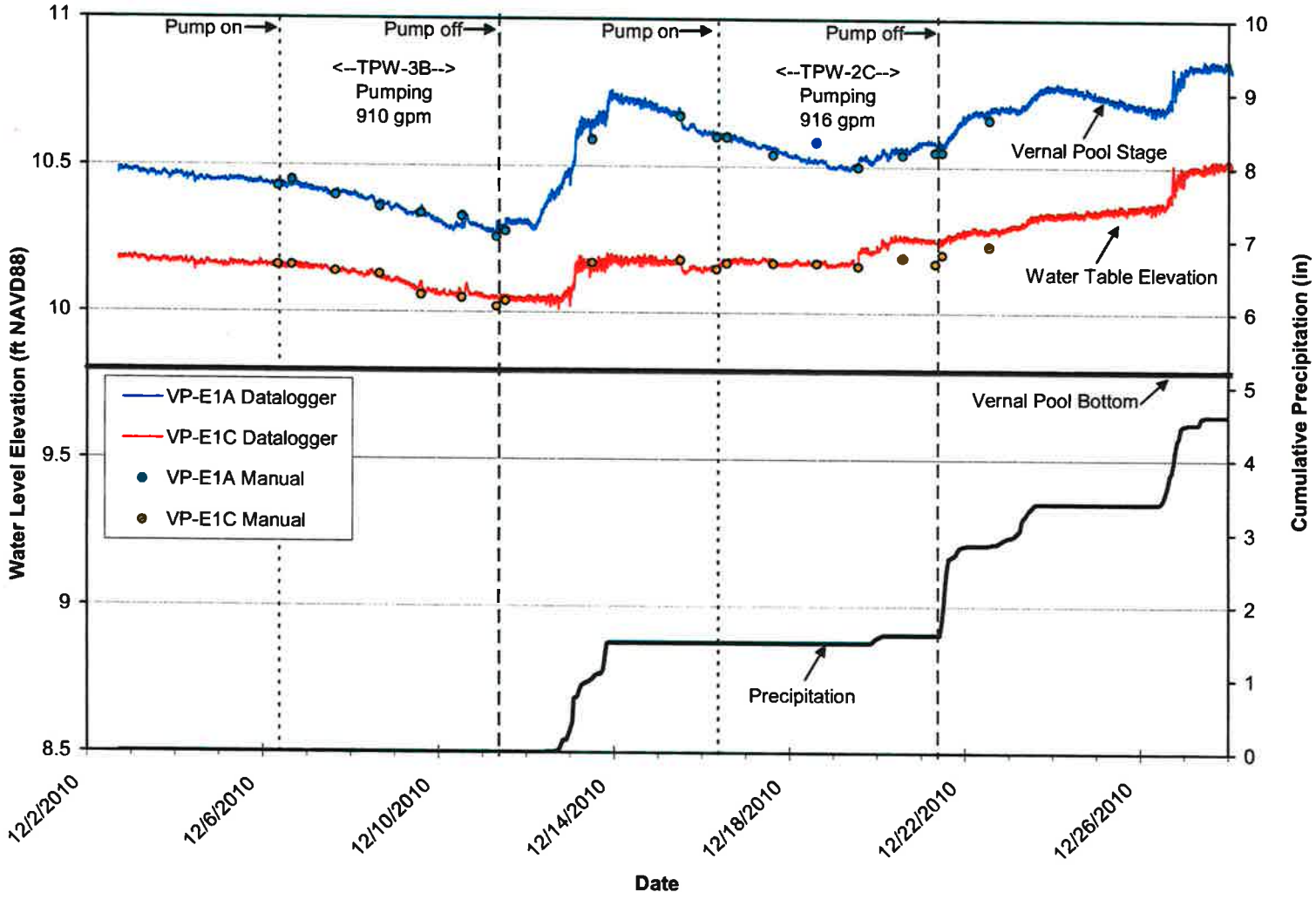
Figure A3-5



Groundwater and Stage Levels for Vernal Pool E1 during Aquifer Test 1 (TPW-3B) and Aquifer Test 2 (TPW-2C)

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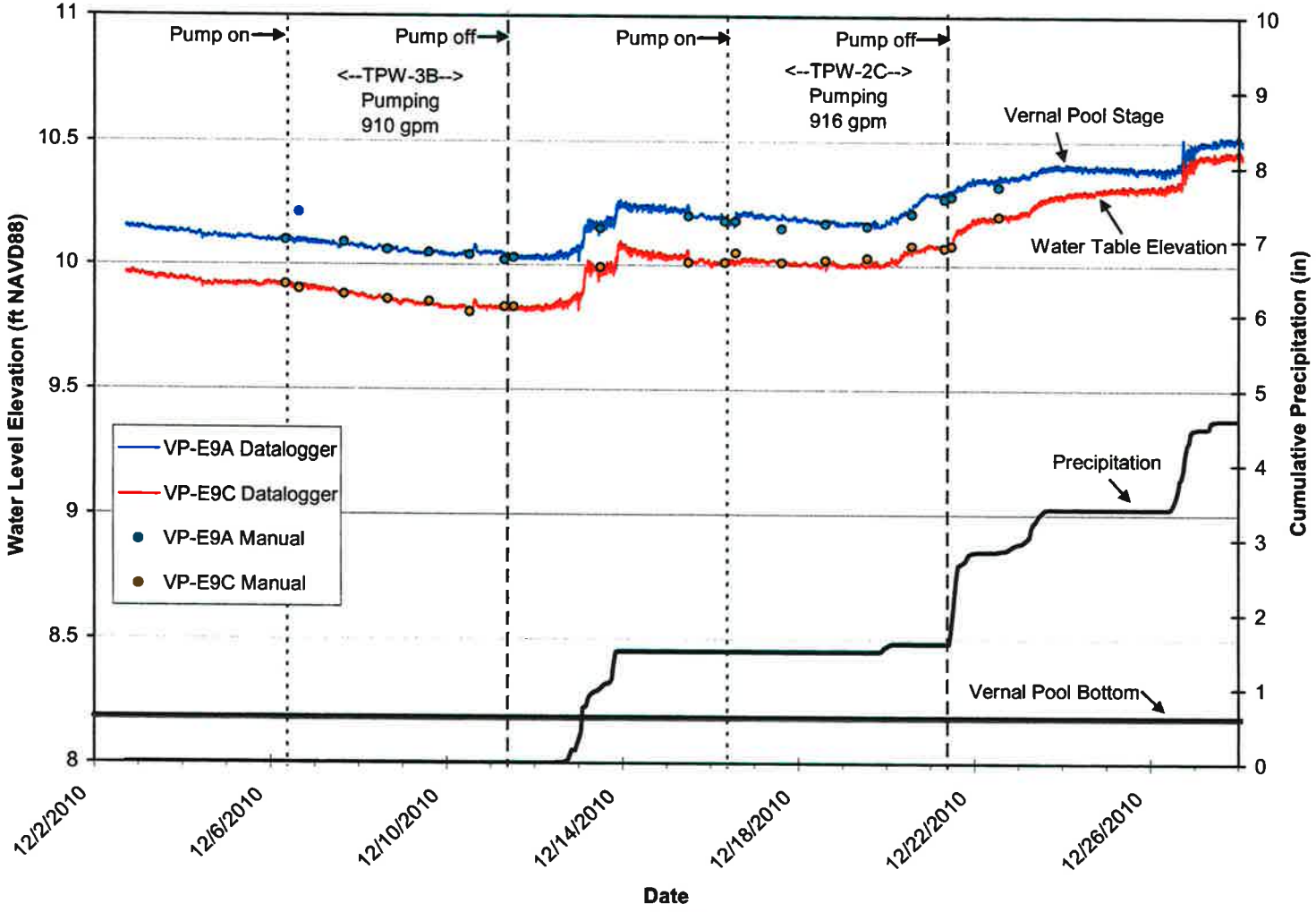
Figure A3-6



Groundwater and Stage Levels for Vernal Pool E9 during Aquifer Test 1 (TPW-3B) and Aquifer Test 2 (TPW-2C)

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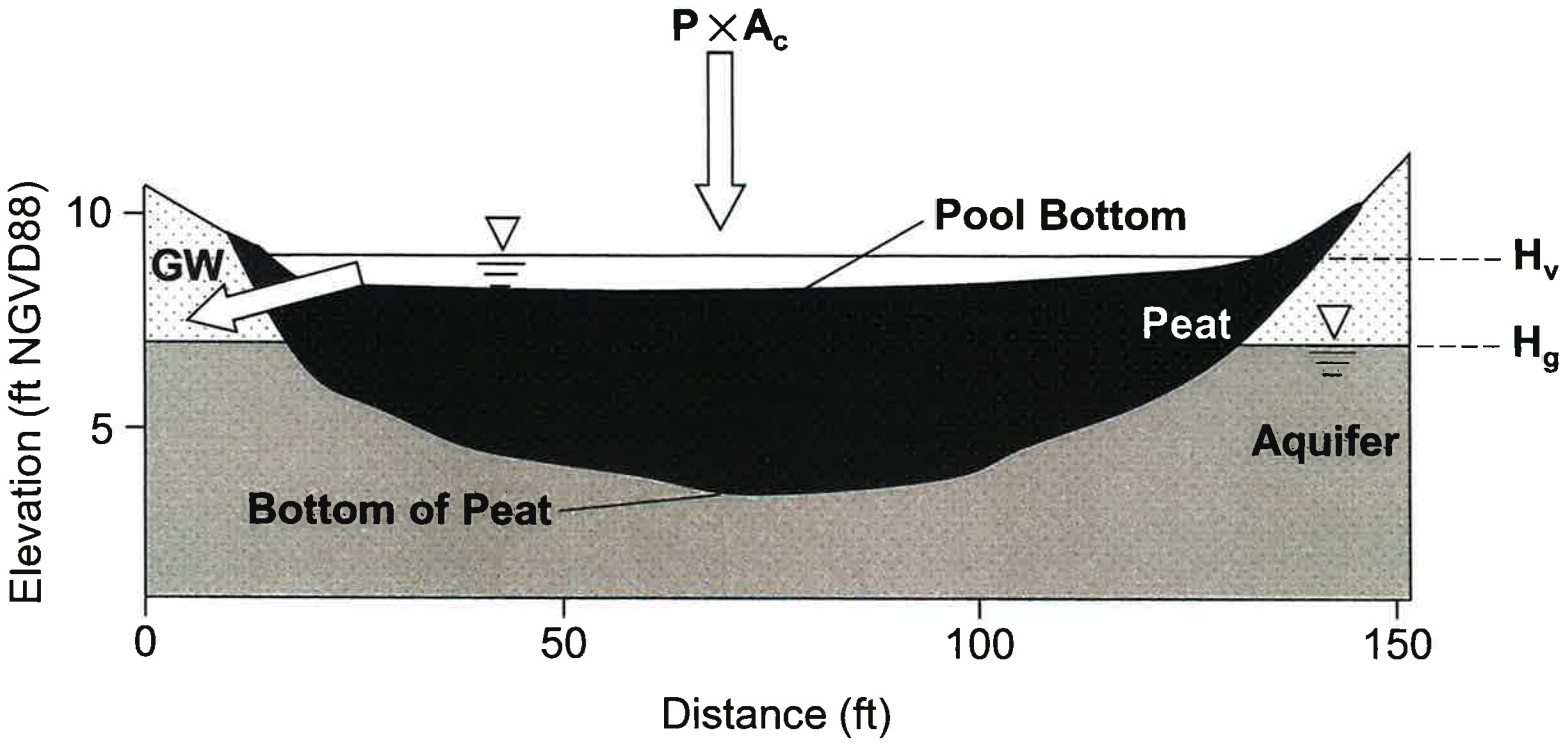
Figure A3-7



P = precipitation
GW = discharge to groundwater
H_v = vernal pool water elevation
H_g = groundwater elevation
A_c = vernal pool catchment area

Components of the Water Budget for Vernal Pool E11

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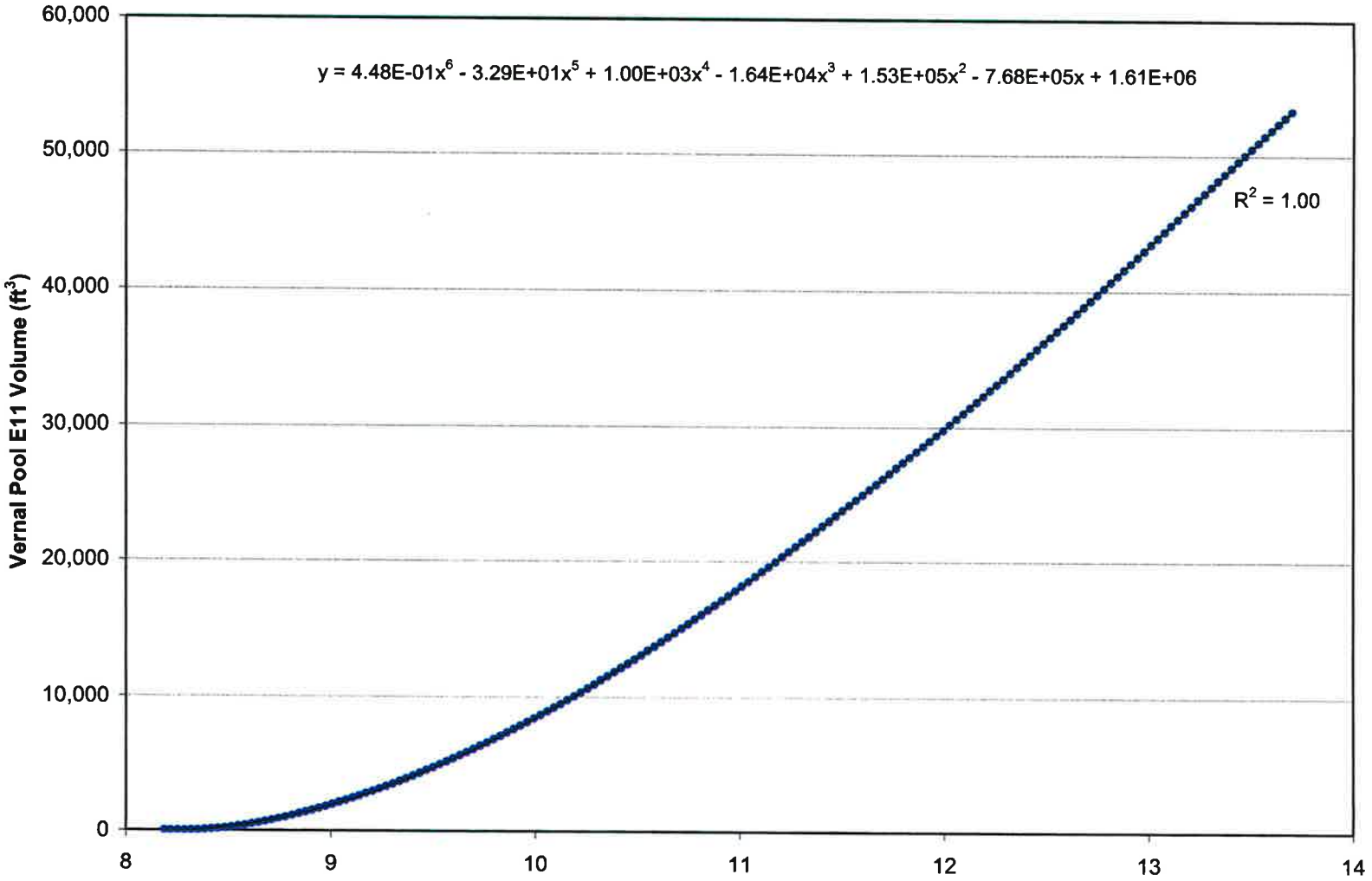
Figure A3-8



(Data from Sobczak et al. 2003)

Stage Elevation and Volume Rating Curve for Vernal Pool E11

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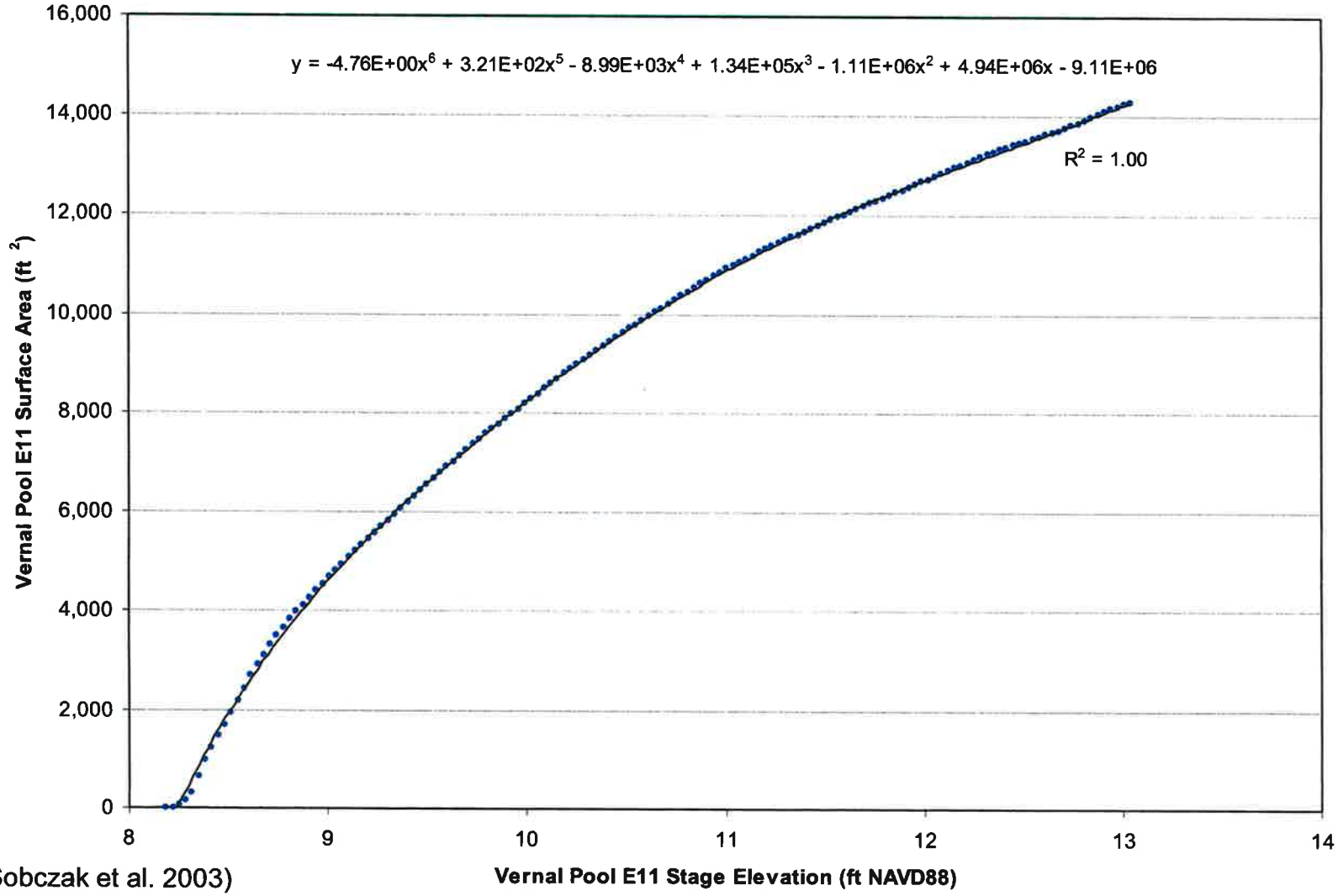
Figure A3-9



(Data from Sobczak et al. 2003)

Stage Elevation and Surface Area Rating Curve for Vernal Pool E11

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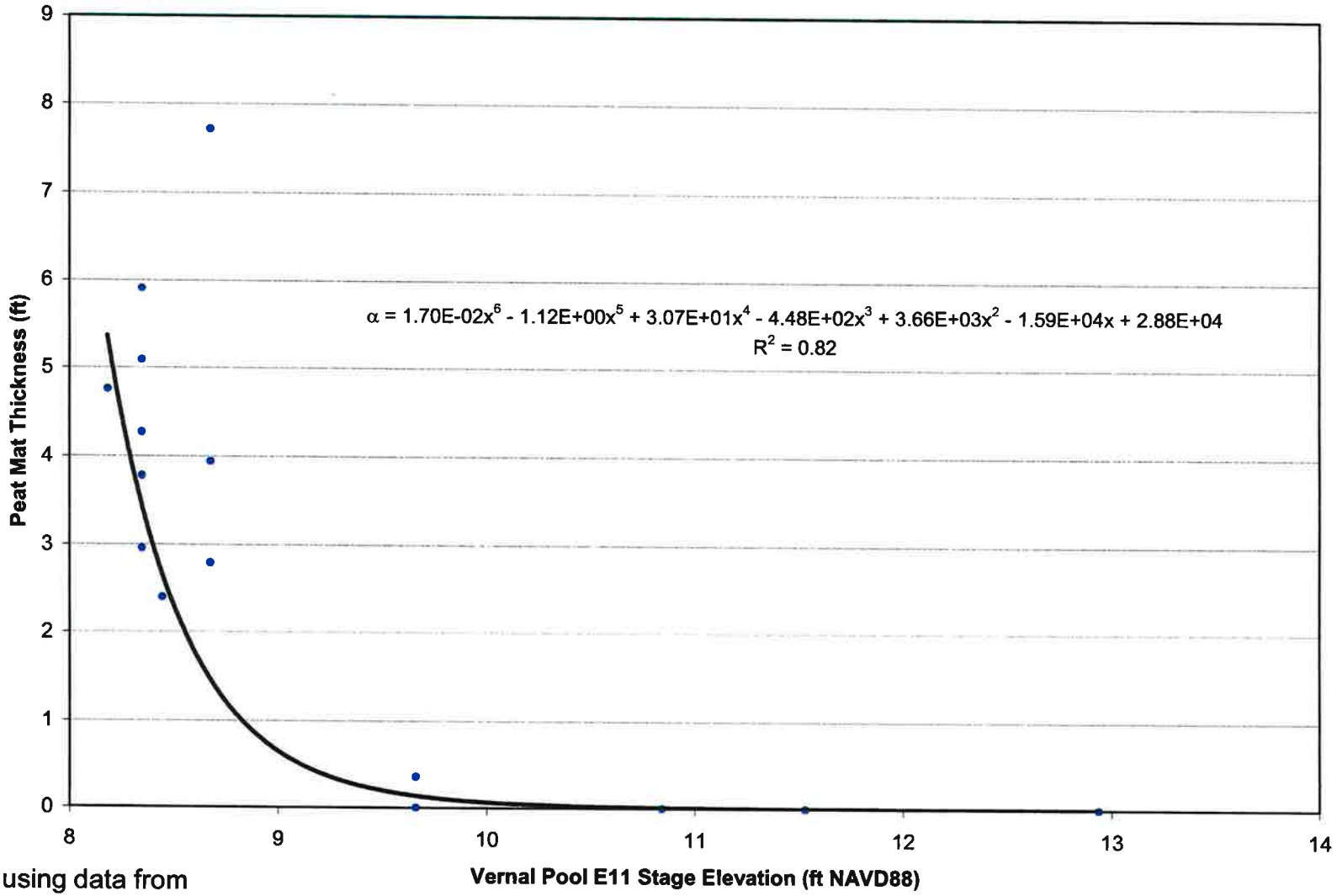
Figure A3-10



(Created using data from Sobczak et al. 2003)

Relation between the Upper Peat Mat Surface and Peat Mat Thickness

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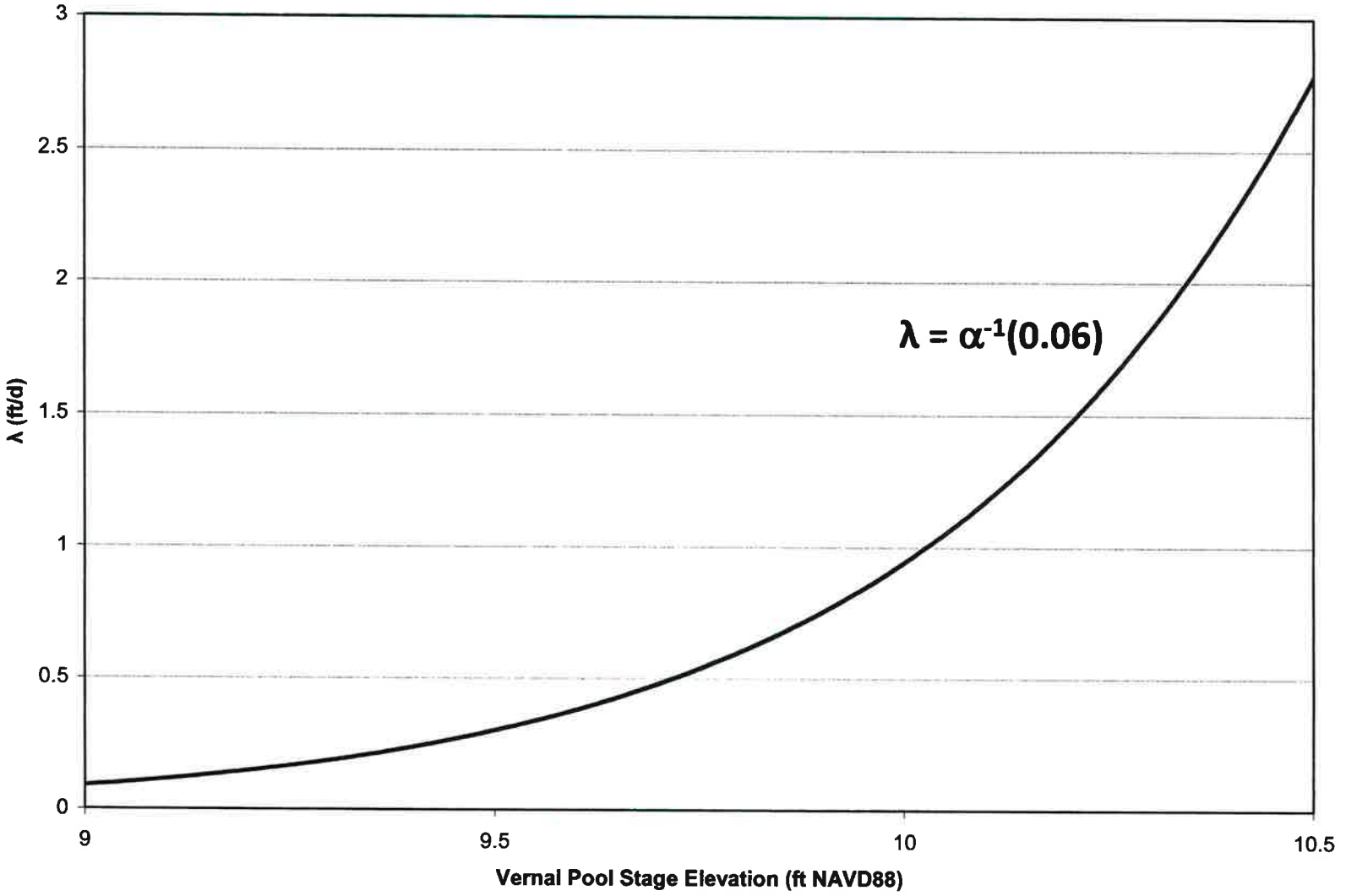
Figure A3-11



Relation between the Empirical Coefficient (λ) and Vernal Pool Stage

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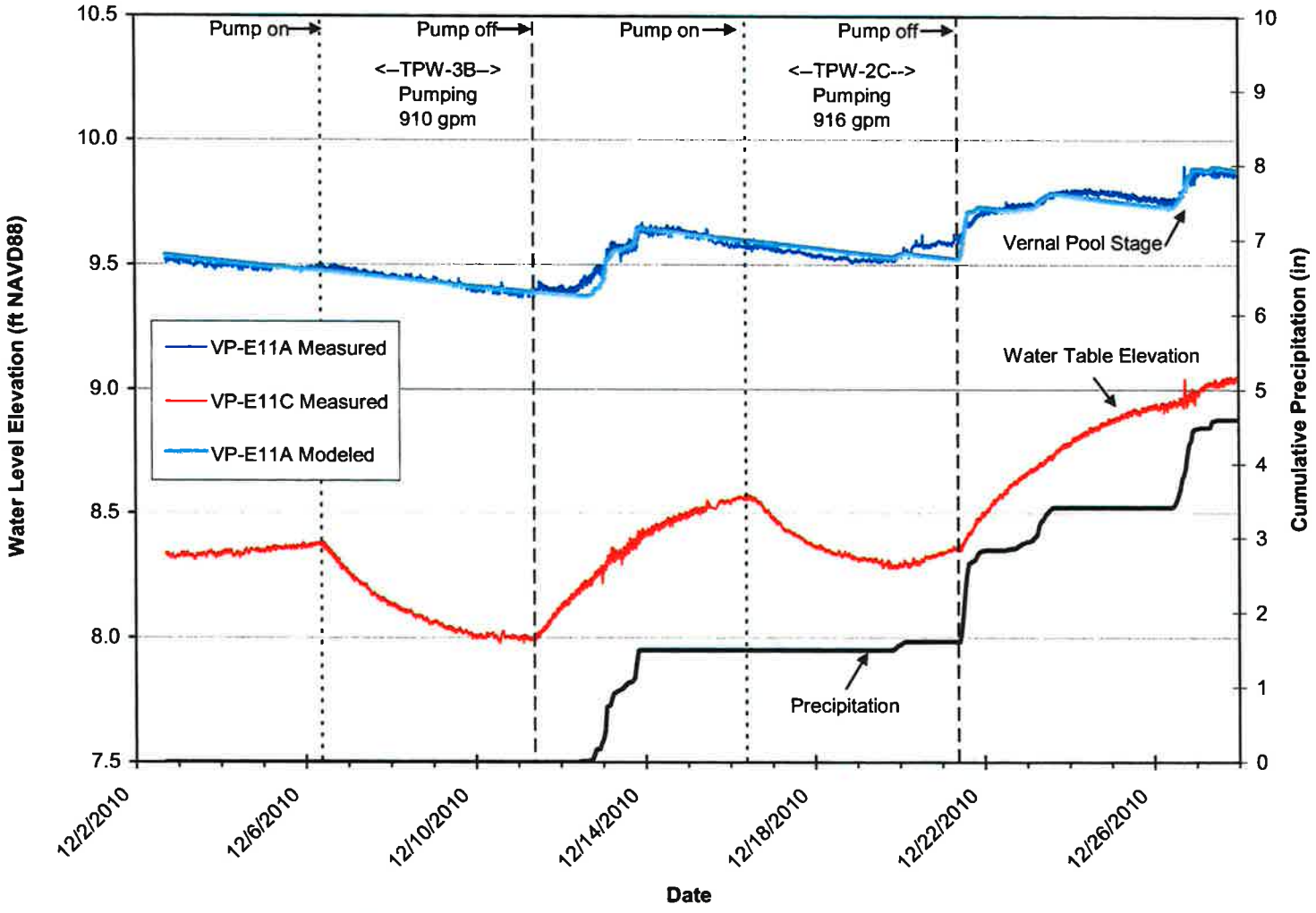
Figure A3-12



Calibration Results for TPW-3B & TPW-2C Constant Rate Aquifer Tests

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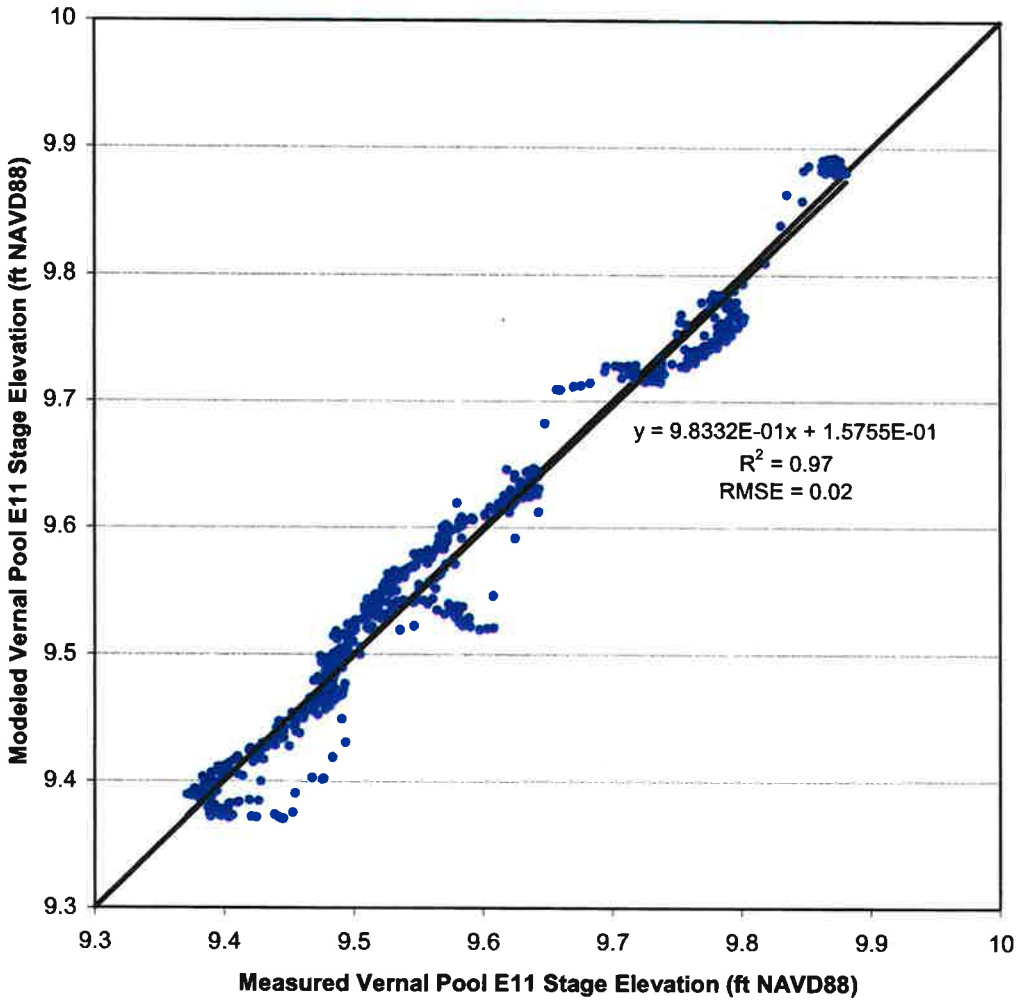
Figure A3-13



Measured vs. Calculated Vernal Pool E11 Stage Elevation for TPW-3B & TPW-2C Single Well Aquifer Tests 1 and 2

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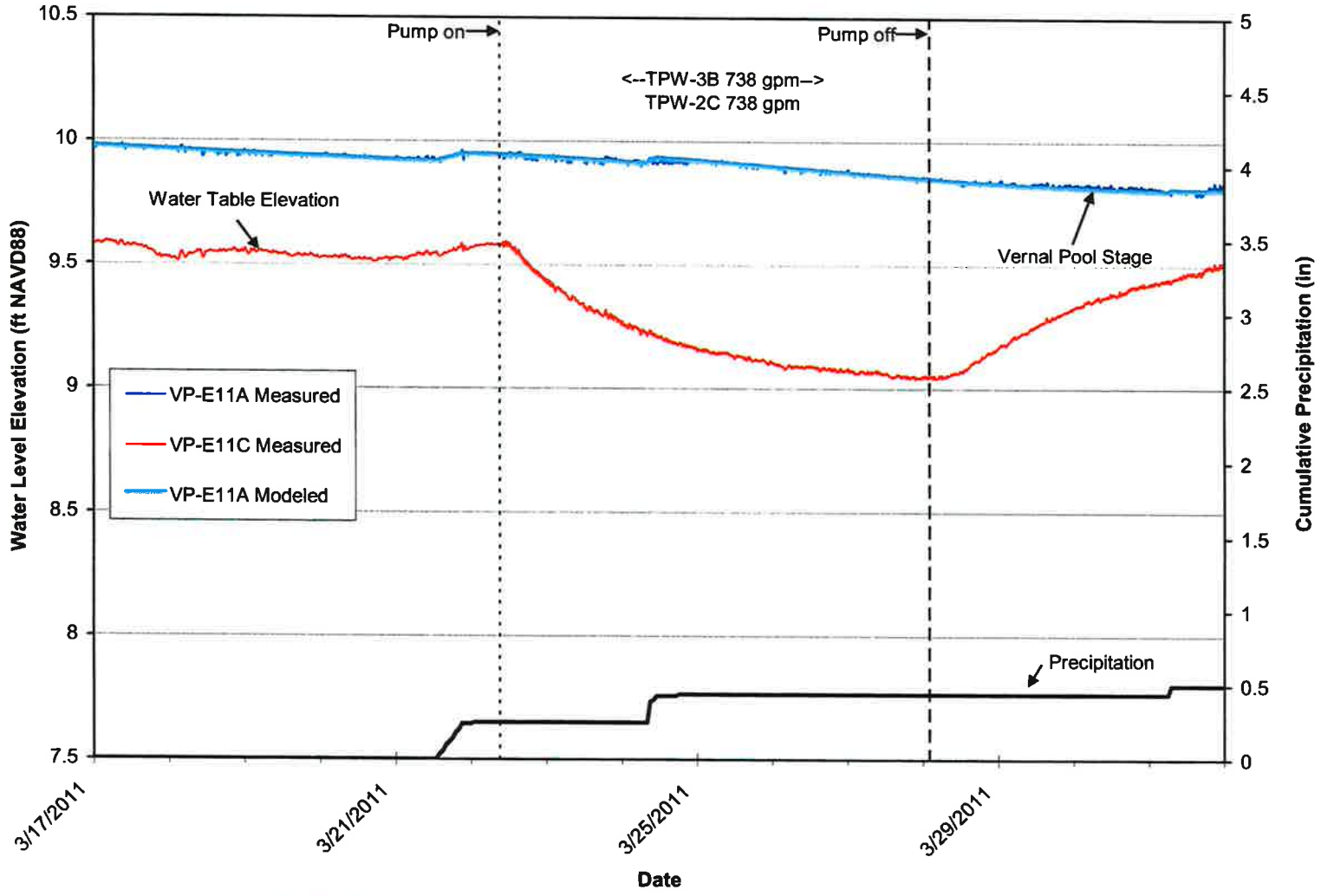
Figure A3-14



Model Validation Using Multiple Well Aquifer Test 3

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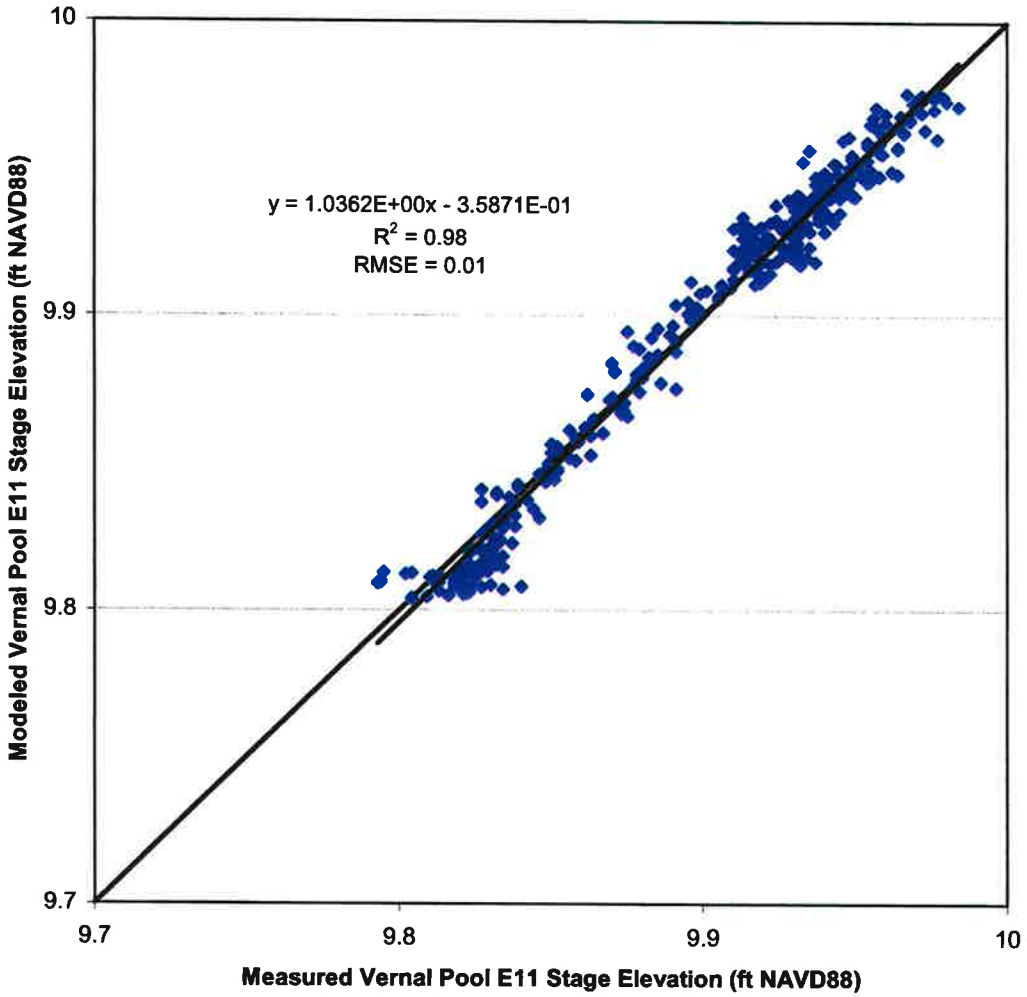
Figure A3-15



Measured vs. Calculated Vernal Pool E11 Stage Elevation for Multiple Well Aquifer Test 3

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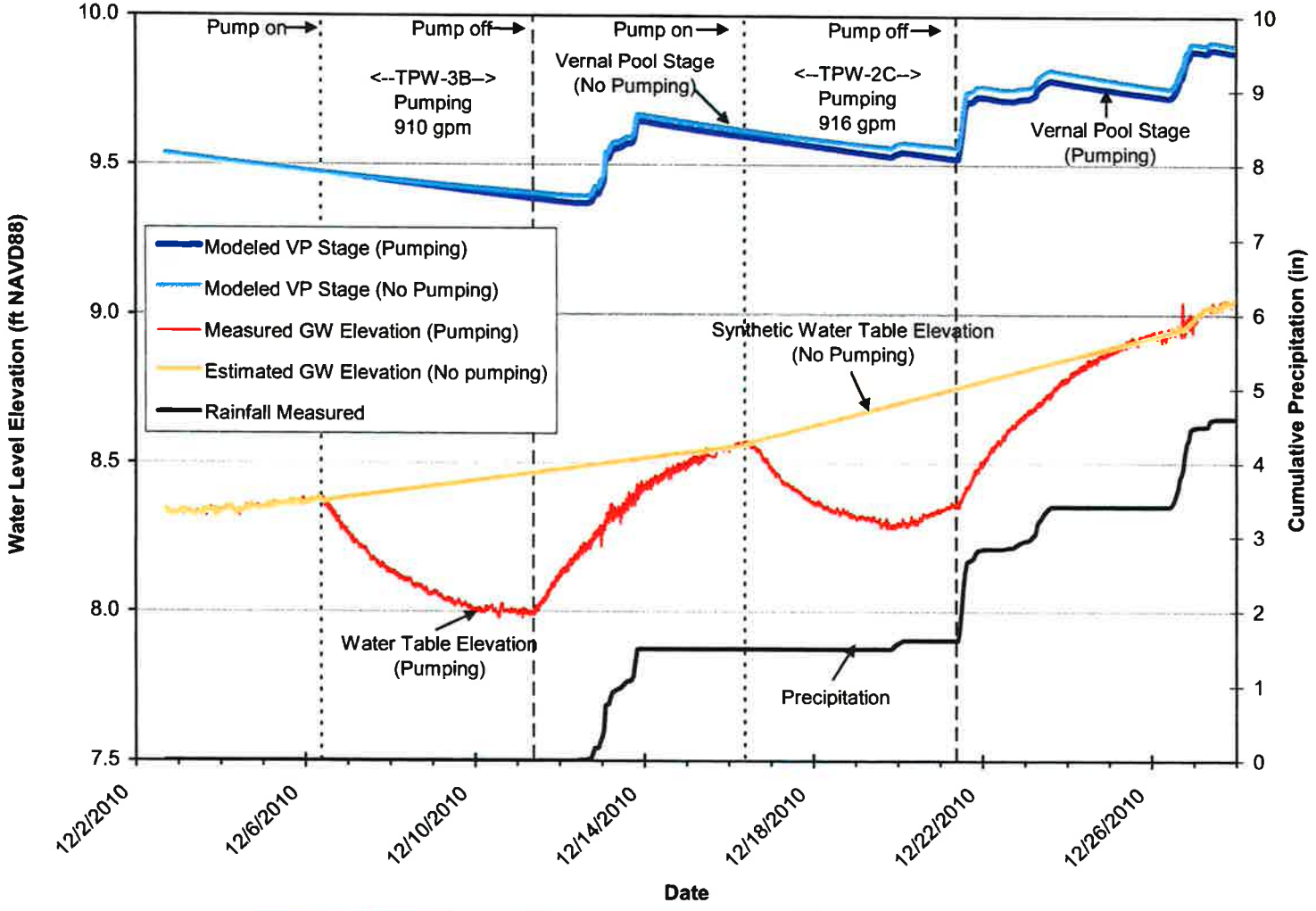
Figure A3-16



Predicted Vernal Pool Stage with and without Wells Pumping during TPW-3B & TPW-2C Single Well Aquifer Tests 1 & 2

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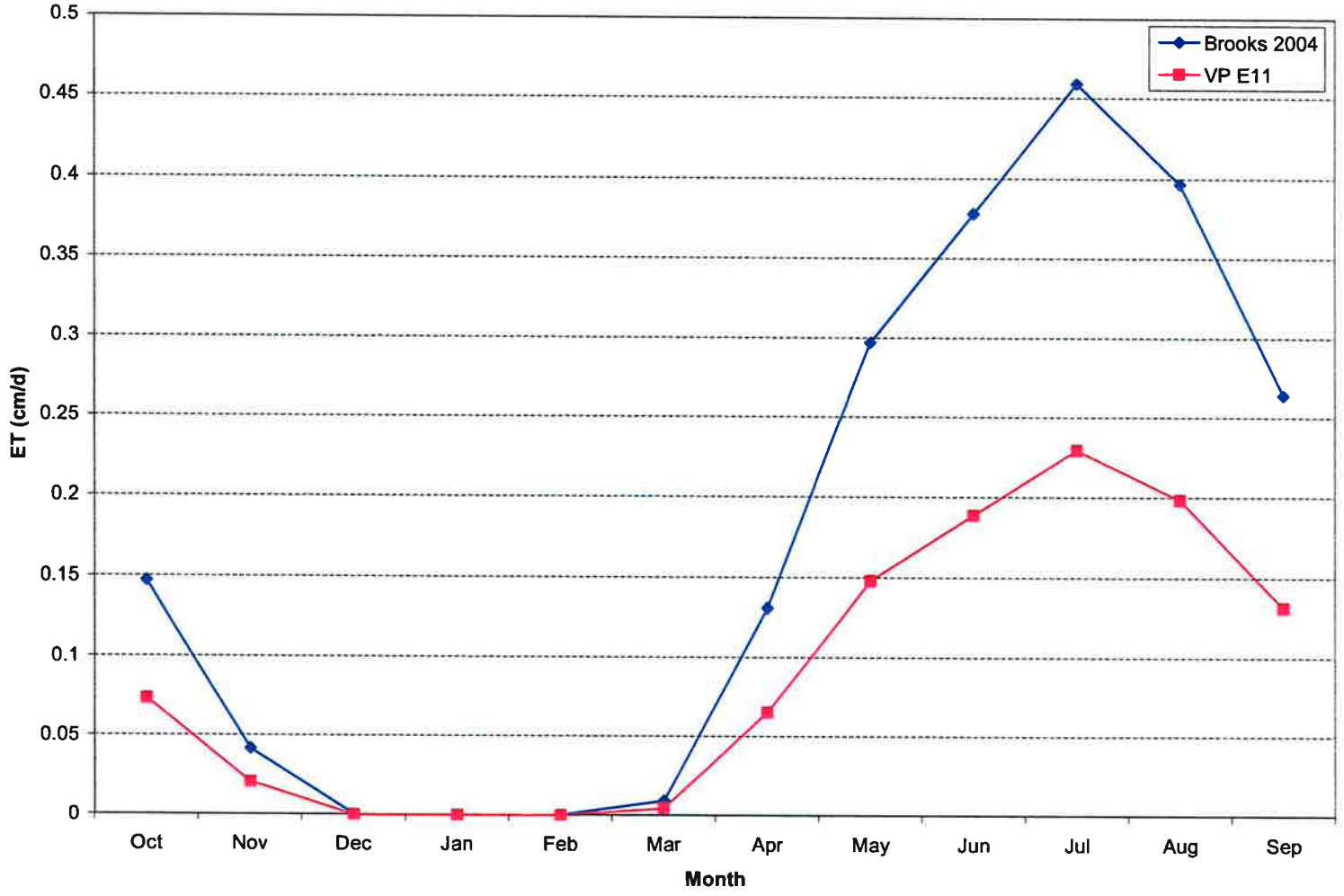
Figure A3-17



Seasonal Evapotranspiration Rates for Quabbin Reservation, Massachusetts and Vernal Pool E11

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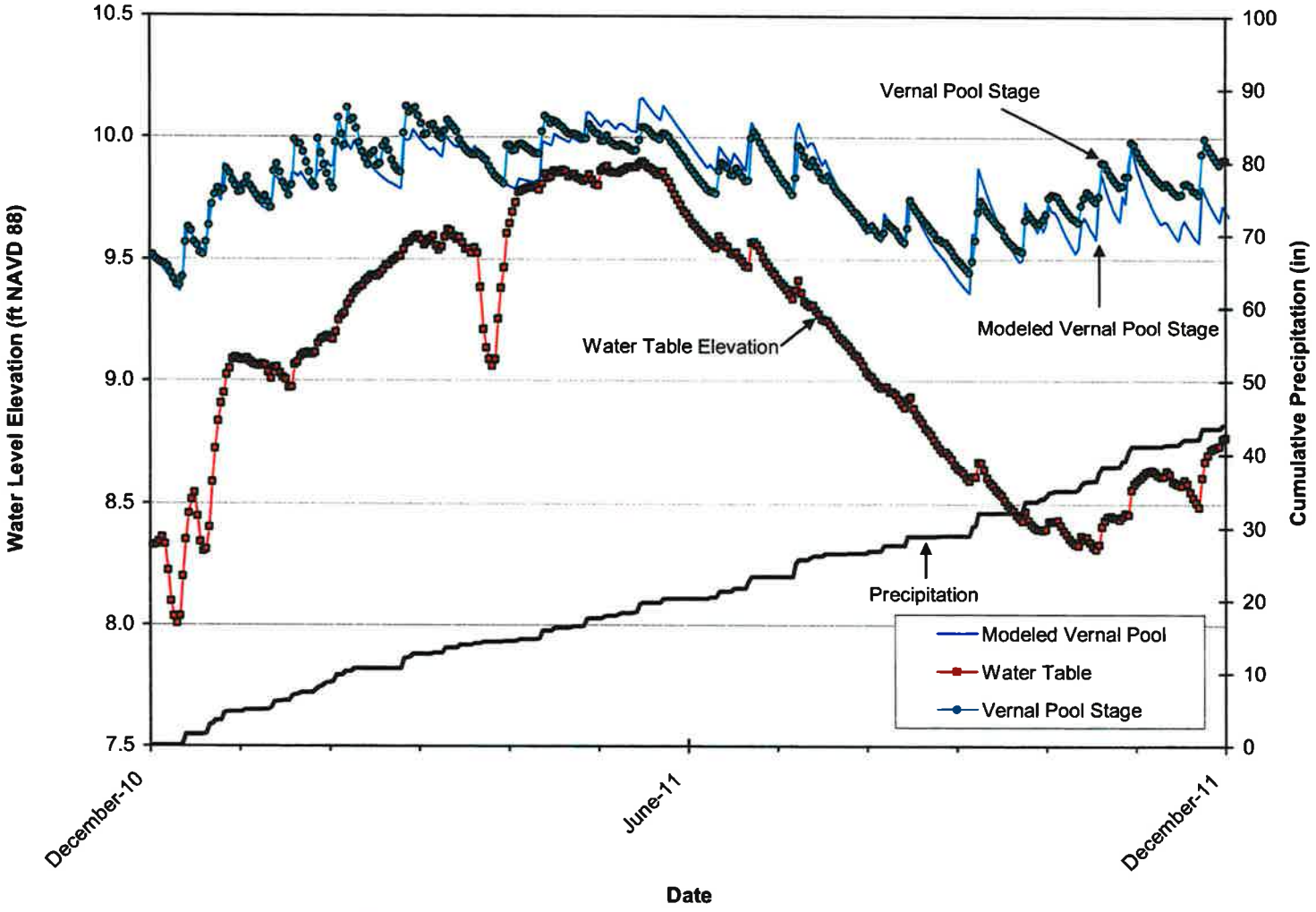
Figure A3-18



Modeled Vernal Pool Stage for E11 from December 2010 to December 2011

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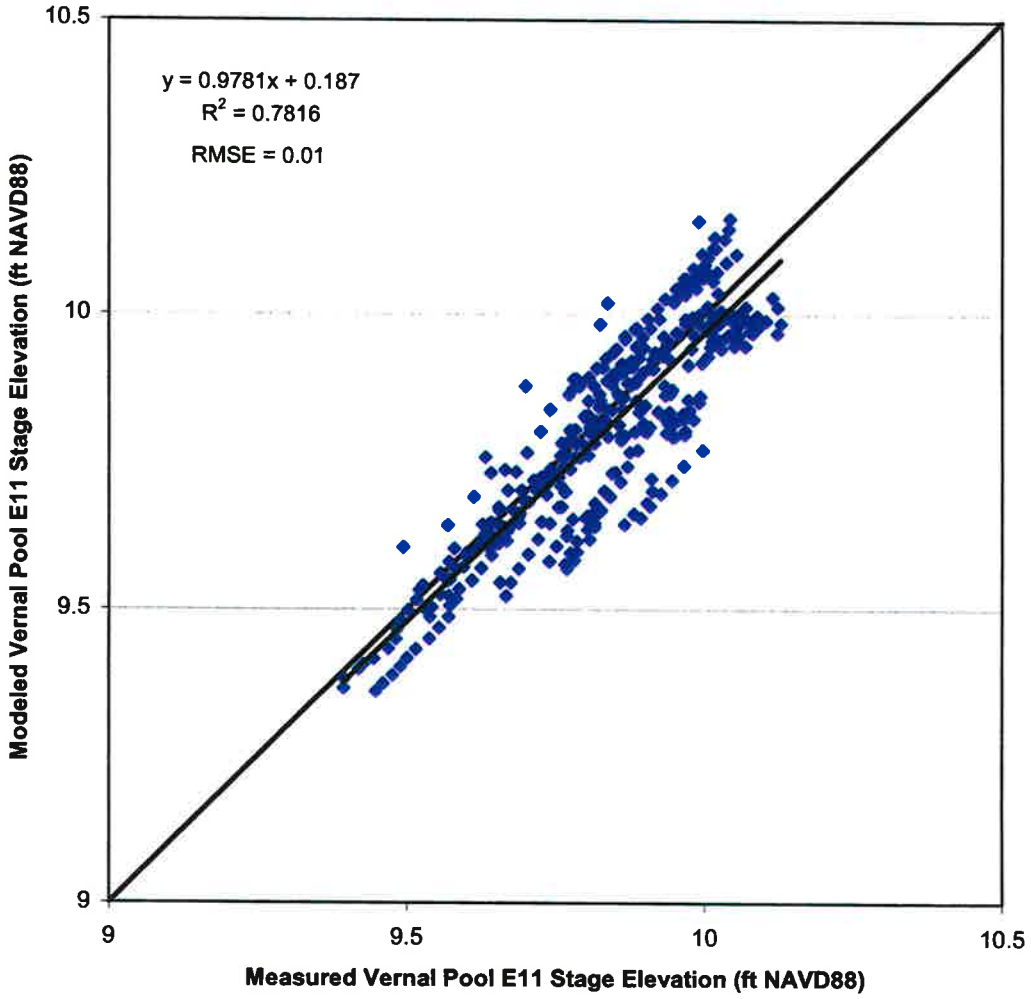
Figure A3-19



Measured vs. Estimated Vernal Pool Stage from December 2010 to December 2011

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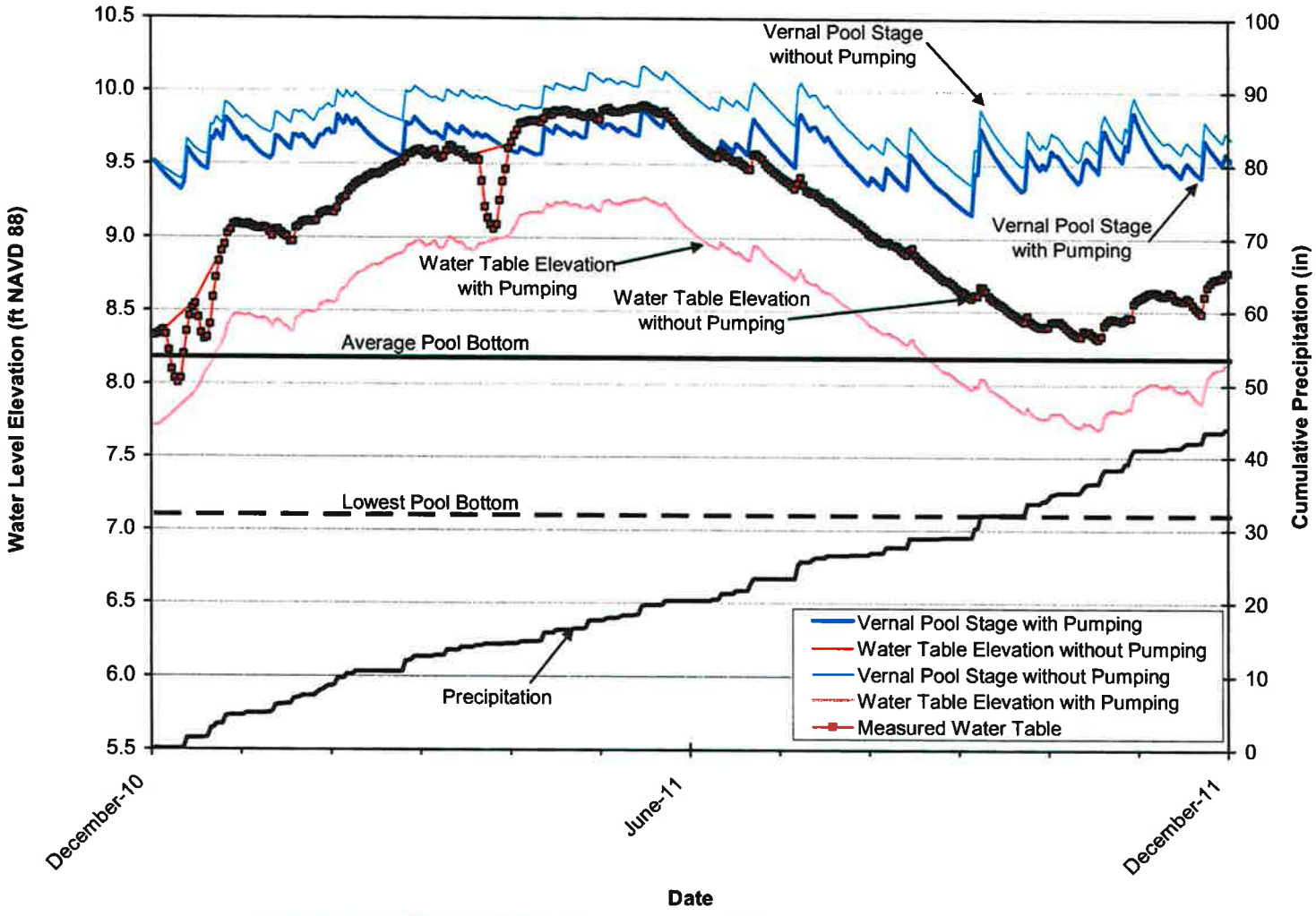
Figure A3-20



Predicted Vernal Pool Stage with and without TPW-3B Pumping at 0.5 MGD from December 2010 to December 2011

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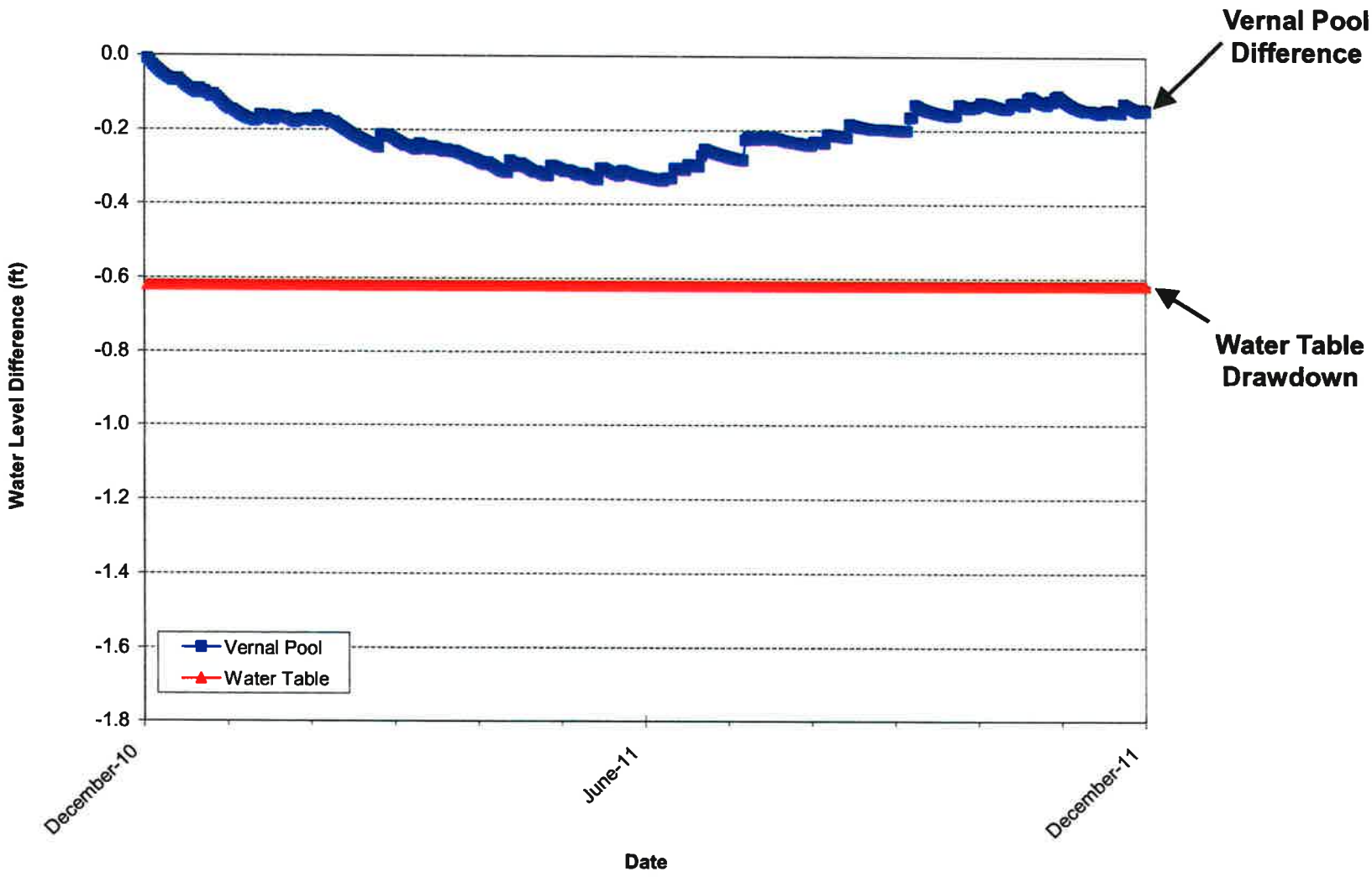
Figure A3-21



Difference between Predicted Vernal Pool Stage with and without Pumping at 0.5 MGD

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Figure A3-22

THE COMMONWEALTH OF MASSACHUSETTS

WATER RESOURCES COMMISSION

Water Conservation Questionnaire for Public Water Suppliers

Effective date: July 13, 2000
Revised: March 12, 2008

This questionnaire is based on the *Water Conservation Standards* for the Commonwealth of Massachusetts, which were approved by the Water Resources Commission (July 2006, or latest version; see Reference No. 10). The water conservation standards outline key components of a successful water conservation and demand management program, and are intended to assist communities and public water suppliers in protecting and maintaining their water supplies. Each section of this form corresponds to one of the standards, and begins with a statement of the standard, followed by a series of questions. As part of the water needs forecasting and Water Management Act permitting processes, technical staff in the Office of Water Resources (Department of Conservation and Recreation) and the Department of Environmental Protection will review this questionnaire to assess success in meeting the Water Conservation Standards and opportunities for improving water system efficiencies.

Who should complete this questionnaire?

- Public Water Suppliers applying for a Water Management Act permit, permit amendment or permit transfer from the Department of Environmental Protection
- Permittees undergoing a five-year review of their existing Water Management Act permit by the Department of Environmental Protection
- Public Water Suppliers requesting new or updated water needs forecasts from the Department of Conservation and Recreation, Office of Water Resources[1]
- Entities applying for Interbasin Transfer Approval with the Massachusetts Water Resources Commission
- Water suppliers interested in planning for demand management
- Water suppliers planning a new water source

When completing this form please note:

- See list of references at the end of this document.
- For specific information and background on the water conservation standards, see the latest version at http://www.mass.gov/envir/mwrc/pdf/Conservation_Standards.pdf (Reference No. 10).
- If necessary, expand responses beyond the space provided and/or reference or attach appropriate plans or responses.
- Projects requiring an Interbasin Transfer (IBT) approval are subject to specific water conservation performance standards that must be met prior to approval. IBT performance standards are available at http://www.mass.gov/dcr/waterSupply/intbasin/download.htm (Reference No. 13).

Questions? Contact:

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Office of Water Resources
Department of Conservation and Recreation
251 Causeway Street, Suite 600
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(617) 626-1395

Duane LeVangie, Director
Water Management Program
Department of Environmental Protection
1 Winter Street
Boston MA 02108
Duane.Levangie@state.ma.us
(617) 292-5706

[1] See *Policy for Developing Water Needs Forecasts for Public Water Suppliers and Communities and Methodology for Implementation*, December 13, 2007, at http://www.mass.gov/envir/mwrc/pdf/121307_waterneedsforcast.pdf

WATER CONSERVATION QUESTIONNAIRE

GENERAL INFORMATION ON THE PUBLIC WATER SUPPLY SYSTEM

Water Supplier: Town of Eastham PWS ID#: _____

Street Address: 2500 State Highway

City/Town: Eastham Zip Code: 02642

Contact Person: Sheila Vanderhoef Title: Town Administrator

Tel.: (508) 240-5900 E-mail: svanderhoef@eastham0ma.gov

1. Total volume of DEP Water Management-authorized water withdrawals (mgd):
   (a) Registered volume: N/A mgd
   (b) Permitted volume during each 5-year permit period:

   Volume N/A mgd From: _____ To: _____
   Volume N/A mgd From: _____ To: _____
   Volume N/A mgd From: _____ To: _____
   Volume N/A mgd From: _____ To: _____

   Total authorized withdrawal volume (a + b) for the current year: _____

   Permit expiration date (if applicable): _____

2. If not registered or permitted, state total volume of water withdrawals (mgd) from the most recent Annual Statistical Report: Eastham does not have a municipal water system. At their 2014 Annual Town Meeting the Town authorized construction of a limited water system. The annual water demand, and therefore annual withdrawal volume, is estimated to be 132 Million Gallons per Year (MPY), increasing to 145 MGY in the future.

3. Is your Residential Gallons per Capita Day below 65?
   ☐ Yes ☐ No
   RGPCD reported on the most recent ASR (date: 20_____) is _____ gallons per capita day.

4. Is your Unaccounted-for-Water below 10%?
   ☐ Yes ☐ No
   UAW reported on the most recent ASR (date: 20_____) is _____ %.

5. Please attach a map of the municipalities served by your water supply system and outline the area served by your system.

Note: Citations and links can be found in the list of references at the end of this document.

STANDARD 1.0: COMPREHENSIVE PLANNING

Develop a written drought management plan that follows American Water Works Association drought management planning guidance (AWWA 2002 or latest version; Reference No. 2). Develop strategies appropriate to the system to reduce daily and seasonal peak demands and develop contingency plans to ameliorate the impacts of drought, seasonal shortages, and other non-emergency water supply shortfalls

Develop emergency management plans.

Develop a written water conservation program to comply with the Water Conservation Standards (July 2006 or latest version, Reference No. 10) and, where possible, with the recommendations outlined in that document, in the operation and management of the water supply. MassDEP Water Management permit conservation requirements are based on the state Water Conservation Standards.

Make the above documents readily available to personnel from all municipal departments to facilitate compliance and, if necessary, enforcement.

1. Do you have a Drought Management Plan that follows AWWA planning guidance (Reference No. 2)?

   ☐ Yes ☒ No

   If Yes, provide a copy of the cover, table of contents, and date of the plan: _____

   If No, do you have a schedule and timetable for developing a Drought Management Plan? By January 2016. The water system operation is scheduled to start during the Spring of 2016.

2. Do you have an Emergency Management Plan describing procedures for handling water emergencies?

   ☐ Yes ☒ No

   If Yes, provide a copy of the cover, table of contents, and date of the plan: _____

   If No, do you have a schedule and timetable for developing an Emergency Management Plan? _____

3. Do the plans include written procedures outlining which users will be cut back, what emergency measures will be implemented which trigger points require action, and how much will be cut back in the event of a water emergency or drought?

   ☐ Yes ☐ No

   If yes, please attach a summary or copy of the written procedures: _____

4. Do you have a written Conservation Program that meets the conditions of your Water Management Act permit (where applicable) or Massachusetts Water Conservation Standards (July 2006 or latest version, Reference No. 10)?

   ☐ Yes ☒ No

   What is the approximate cost per year of your conservation efforts, including personnel costs: $_____

   What is the funding source(s) for these efforts? _____

   If No, do you have a schedule and timetable for developing a written Conservation Program? By January 2016. The water system operation is scheduled to start during the Spring of 2016.

5. Are the above documents readily available to facilitate compliance and, if necessary, enforcement of restrictions in your plans?

☐ Yes ☐ No

STANDARD 2.0: SYSTEM WATER AUDITS AND LEAK DETECTION

Conduct a water audit on an annual basis using the MassDEP Water Audit Guidance Document (http://www.mass.gov/dep/water/approvals/wmgforms.htm#audit or latest version, Reference No. 9).

Conduct complete system-wide leak detection every two years (unless leakage constitutes a small portion of the system's unaccounted-for water; or the most current leak detection survey (conducted within the previous two years) indicates insignificant leakage (see Reference No. 3 for guidance).

Meet or demonstrate steady progress towards meeting 10% unaccounted-for water (UAW) as soon as practicable.

Conduct field surveys for leaks and repair programs in accordance with the AWWA Manual 36 (Reference No. 3 or latest version) and any MassDEP guidance documents (Reference No. 7 and other guidance documents available on DEP's web site, http://www.mass.gov/dep/water/laws/policies.htm#dwguid).

Repair all leaks found as expeditiously as possible. Establish a priority system to implement leak repairs. See specific guidance on timelines for repairing leaks in:

- MassDEP guidance (http://www.mass.gov/dep/water/approvals/wmgforms.htm#audit) (Reference Nos. 7 and 9)
- MWRA regulations, 360 CMR 12.09: Leak Repairs (Reference No. 16)
- MassDEP Water Management permits.

1. Do you conduct an annual water audit of your system?

☐ Yes. ☐ No

Water audit last performed by Leak detection surveys are anticipated to be performed every two years.

Begin date: _____ End date: _____

Describe the tasks and results of your most recent audit (attach additional information if necessary):

_____

_____

_____

2. Do you conduct a full leak detection program for your distribution system every two years?

☐ Yes. ☐ No

If Yes, leak detection last performed by _____ on _____

Please attach Table G3 from your 2007 ASR OR list summary results of that survey which includes: miles of main surveyed, # of leaks found, estimated water loss for each leak, date the leak was (or is scheduled to be) repaired. Attach additional information as necessary.

_____

_____

_____

If No, when was the last time you performed system-wide leak detection? _____

How often is a 100% leak detection survey of the distribution system completed? _____

_____

3. Estimate how much is spent on leak detection and repairs annually or per survey: $_____

☐ Yes ☐ No Do you include leak detection/repair as an expense of the water system?

☐ Yes ☐ No Do you have funds set aside for regular maintenance?

☐ Yes ☐ No Do you have funds set aside for emergency repairs?

STANDARD 3.0: METERING

Ensure 100% metering of all water uses, including water use at all municipal facilities (schools, school athletic fields, etc.). Properly size the service lines and meters for all water distribution system users to meet AWWA performance standards (Reference No. 5).

Increase billing frequency. For domestic accounts, bill customers on actual, not estimated, meter readings. If billing frequency is less than quarterly (i.e. annual or biannual) move to quarterly billing as soon as possible.

Implement a water meter repair/replacement policy and program. Replace meters by size and time based on AWWA standards and guidelines (Reference Nos. 1 and 5) available on the MassDEP website (Reference No. 8 or latest version). Establish an annual budget line item for the calibration, replacement, and repair of all sources of supply and distribution network water metering systems.

Seal all water account metering systems against tampering and periodically inspect to ensure water works system integrity.

Calibrate any meter used to record quantity, according to its type and specification.

Properly size water service lines and meters to handle required water volumes and ensure a high level of metering accuracy.

Water Suppliers: Establish the necessary regulations and controls to **ensure that owners of large meters (1.5 inches or greater) calibrate the meters annually** and provide the results as part of an annual reporting requirement.

1. Is your system 100% metered?

☒ Yes ☐ No

If No, what is not metered? _____

What steps are you taking to complete metering of your system? _____

_____

2. Do you use an automatic or radio-read meter reading system?

☒ Yes ☐ No

If No, do you plan to install one?

☐ Yes ☐ No When? _____ Projected cost? _____

3. Are all public-sector facilities billed for their water use?

☒ Yes ☐ No

4. Are any accounts not billed?

☐ Yes ☒ No

If Yes, what types of accounts are not billed? _____

5. Do you bill based on actual meter readings, not estimated use?

☒ Yes ☐ No

If No, what steps are you taking to bill based on actual meter readings? _____

_____

6. Do you bill residential customers at least quarterly?

☐ Yes ☐ No

7. How often do you bill large users (1.5-inch meter or larger)?

☐ Annually ☐ Biannually

☐ Quarterly ☐ Monthly ☐ Other _____

8. Do the bills compare current use with use during the previous period?

☐ Yes ☐ No

9. Do the bills compare current use with use during the same period last year?

☐ Yes ☐ No

10. Is the volume of water used stated in gallons on the bill?

☐ Yes ☐ No

11. Do you have a meter repair/replacement program that services meters based on the AWWA standards (Reference Nos. 1 and 5)?

☐ Yes ☐ No

12. Is your meter repair/replacement program funded through an annual budget appropriation?

☐ Yes ☐ No

If Yes, what is your annual budget for meter calibration, replacement, and repair?

$ _____

Provide program details or attach policy/program or other supporting documentation: _____

_____

If No, what steps are you taking to improve and fund your meter repair/replacement program? _____

_____

13. Do you have the necessary regulations and controls to ensure that owners of large meters (1.5 inches or greater) calibrate the meters annually and provide the results as part of an annual reporting requirement.

☐ Yes ☒ No

14. How often do you calibrate your master meters (annually recommended)? Master meters will be calibrated annually.

_____

STANDARD 4.0: PRICING

Use Full-Cost Pricing. Establish a water pricing structure that includes the full cost of operating, maintaining, and protecting the water supply system. Full-cost pricing factors all costs, including operations, maintenance, capital, and indirect costs (such as environmental impacts and watershed protection) into prices. Perform a rate evaluation every three to five years to adjust costs as needed.

Prohibit decreasing block rates. Decreasing block rates, which charge lower prices as water use increases during the billing period, are not allowed by M.G.L. Chapter 40, Section 39L.

1. Are water supply system operations fully funded by water supply system revenues?

   ☐ Yes ☐ No

2. Is this an Enterprise Account?

   ☐ Yes ☐ No

3. When was your most recent rate evaluation? _____

4. Which of the following items are covered by the price of water charged to customers?

a. ☐	Watershed purchase/protection	l. ☐	Emergency repairs
b. ☐	Well site purchase/protection	m. ☐	Capital depreciation account
c. ☐	Aquifer land acquisition	n. ☐	Capital replacement/depreciation fund
d. ☐	Distribution system operation	o. ☐	Debt service
e. ☐	Leak detection	p. ☐	Staff training/professional development
f. ☐	Pumping	q. ☐	Staff benefits package
g. ☐	Maintenance	r. ☐	Hiring of staff
h. ☐	Treatment and associated treatment plant costs	s. ☐	Purchase/installation of water conservation devices
i. ☐	Leak repairs	t. ☐	Water conservation program, including staff
j. ☐	Meter repair and replacement	u. ☐	All aspects of the education program
k. ☐	Electricity/fuel	v. ☐	All of the above

5. Please check the type of rate structure(s) your system uses:

   ☐ Increasing block rate ☐ Flat rate

   ☐ Seasonal rate ☐ (Other rate (please explain) _____

   Describe or attach a copy of your current pricing levels(s) for water and sewer:

WATER		SEWER	
Amount per	Volume	Amount per	Volume
$		$	
$		$	
$		$	
$		$	

☐ Decreasing block rate

Decreasing block rates are prohibited by law. What steps are you taking to revise your rate structure?

_____

_____

6. Is your rate structure regularly evaluated?

☐ Yes ☐ No

How often? _____

When was your rate structure last changed? _____

7. Was your rate structure developed to promote water conservation and/or control demand (that is, do you charge more for water when demand is higher – for example, in the summer)?

☐ Yes ☐ No

If Yes, describe its effectiveness _____

_____

8. Do any of your customers have a second meter for outdoor water use?

☐ Yes ☐ No

If Yes, do you have a different rate structure for these meters?

☐ Yes ☐ No

If Yes, describe this rate structure _____

(Note: rate structures that encourage reduction of nonessential outdoor water use are preferable. See *Water Conservation Standards* (Reference No. 10, Sec. 4.0) Pricing Recommendations.)

STANDARD 5.0: RESIDENTIAL WATER USE

Install Water-Efficient Plumbing Fixtures. Meet the standards set forth in the Federal Energy Policy Act, 1992 (Reference No. 12 or most recent version) and the latest version of the Massachusetts Plumbing Code (Reference No. 15). Provide and/or promote toilet leak detection kits or services, and educational literature about installation of water-saving devices and water conservation savings (in gallons and dollars) in retrofit programs.

Use Residential Water Efficiently. Meet or demonstrate steady progress toward meeting residential water use of 65 gallons per capita per day (gpcd), including both indoor and outdoor use, as soon as practicable.

Implement a comprehensive residential water conservation program that seeks to reduce residential water use by implementing some or all of the applicable recommendations listed in Sections 5.0 and 9.0 of the *Water Conservation Standards* (Reference No. 10).

1. Do you provide educational literature about installation of water-saving devices and water conservation savings (in gallons and dollars)?

☐ Yes ☐ No

2. Do you provide retrofit or rebate services to your customers?

☐ Yes ☐ No

What does your program include?

☐ Toilet retrofit ☐ Toilet replacement rebates ☐ Faucet aerators retrofit ☐ Low-flow showerheads

☐ Clothes Washer rebates ☐ Dishwasher rebates ☐ Other _____

If Yes, describe your program for assisting residential customers in converting to more efficient plumbing fixtures:_____

_____

If No, and your system's residential water use exceeds 65 gpcd, describe any plans for implementation of such a residential retrofit or rebate program. (See Ref. No. 10, Sections 5.0 and 9.0.) The plan should include dates for implementation and the expected cost per year of the program: _____

_____

STANDARD 6.0: PUBLIC SECTOR WATER USE

For all municipal and state buildings:

- Conduct indoor and outdoor audits and account for full use of water, based on full metering of public buildings, parks, irrigated playing fields, and other facilities.
- Analyze existing water-use data to spot trends, patterns, and unexplained increases that could indicate leaks or inefficient use of water.
- Identify measures where the greatest efficiencies and potential savings can be realized.
- In addition to complying with the plumbing code (Reference No. 15), build new public buildings with equipment that reduces water use. Water-saving devices and measures should be well identified to users of public buildings and facilities.
- Focus on replacing/retrofitting water-consuming equipment in buildings (e.g., bathrooms, boilers, chillers).
- Practice efficient lawn and landscape water-use techniques and meet the standards described in Section 9.0 of the *Water Conservation Standards* (Reference No. 10).

Meter or estimate use of water from fire hydrants for pipe flushing, construction, and other uses not related to fire fighting.

Strictly apply plumbing codes and incorporate other conservation measures in new and renovated buildings.

1. Does your water supply system provide assistance to your public-sector users in conducting water-use audits?

   ☐ Yes ☐ No

   If Yes, describe how you provide assistance: _____

   _____

   _____

2. Have water-saving devices been installed in all public buildings?

   ☐ Yes ☐ No

   If No, describe in detail a plan and schedule for installing such devices including the dates proposed for each facility. Attach additional sheets if necessary.

   _____

   _____

3. Do you meter water from hydrants used by contractors for pipe flushing and/or construction?

   ☐ Yes ☐ No

   Do you bill for hydrant use?

   ☐ Yes ☐ No

4. Do you inspect, or coordinate with your municipality's building inspector, to ensure the plumbing codes are strictly applied in new and renovated buildings?

☐ Yes ☐ No

STANDARD 7.0: INDUSTRIAL, COMMERCIAL AND INSTITUTIONAL (ICI) WATER USE

Carry out a water audit to determine the location and amount of water used for heating, cooling, processing, sanitary use, and outdoor use. Use the findings from the audit as the basis for actions to conserve water.[2]

Significant users (i.e., those using greater than 50,000 gpd) **install separate meters for process water** so that water can be accounted for and appreciated as a raw material in production, and for sanitary use.

Develop and implement a water-savings strategy, addressing, among other items, demand management, leak detection and repair, a program of preventive maintenance, and a program of employee education.

In new and renovated buildings, **comply with plumbing codes, use the best available technologies for water conservation, and reuse treated wastewater** within the facility to the extent possible.

Practice good lawn and landscape water-use techniques and meet the standards described in Section 9.0 of the *Water Conservation Standards* (Reference No. 10).

1. Does your water supply system assist ICI users in complying with the standards (above) of Section 7.0, Industrial, Commercial, and Institutional (ICI) water use?

☐ Yes ☐ No

If Yes, describe how you provide assistance _____

_____

If No, what steps are you taking to provide assistance in the future? _____

_____

_____

STANDARD 8.0: AGRICULTURAL WATER USE

As part of the management of an agricultural operation, adopt a water conservation approach through which water is used in a planned and efficient manner with appropriate amounts and frequency to meet needs without excessive water loss.

1. Does your water supply system provide water to significant agricultural users?

☐ Yes ☒ No

If Yes, do you have a program to assist agricultural users in conserving water? _____

_____

[2] See Appendix H of the *Water Conservation Standards* (Reference No. 10) for sample ICI water audit.

STANDARD 9.0: LAWN AND LANDSCAPE

Minimize watering of lawns or landscapes, especially in water-short communities and where the water source is in a stressed basin or sub-basin.

Develop and implement seasonal demand management plans as part of the drought management plan. These plans must identify water supply and environmental indicators (such as streamflow triggers) to serve as water-use restriction triggers and outline a set of increasingly stringent and effective water-use restrictions that are designed to protect public health and the environment.

Adopt and implement (as appropriate) a water-use-restriction bylaw, ordinance or regulation, which applies to both municipal and private wells.[3]

Fully enforce water-use restrictions. Empower authorities to issue warnings to first-time offenders and citations to repeat offenders

1. Do you assist those responsible for maintenance of municipal parks and athletic fields to minimize water use?

   ☐ Yes ☐ No

   If Yes, provide details. _____

   _____

2. Do you have a written Seasonal Demand Management Plan?

   ☐ Yes ☐ No

   If Yes, when was the plan approved? _____

   Please provide either a copy of the plan, or a copy of the cover, table of contents and date of the plan.

3. Does the municipality served by your water system have a water-use-restriction bylaw, ordinance, or regulation?

   ☐ Yes ☐ No

   If Yes, when was the bylaw, ordinance, or regulation adopted? _____

   When was the bylaw, ordinance, or regulation last implemented? From: _____ To: _____

4. Please check type of restrictions:

   ☐ ban on all non-essential outdoor water use
   ☐ hand-held hose only
   ☐ one day per week only
   ☐ two days per week only
   ☐ odd/even day wateringly only
   ☐ restricted hours (provide details): _____
   ☐ other (provide details): _____

5. Are your water-use restrictions triggered by:

   ☐ the calendar (e.g., May 1 – September 30 each year)
   ☐ Streamflow measured at a stream gage
   ☐ Drought Advisory declared by the Massachusetts Drought Task Force
   ☐ other (provide details): _____

6. Do you fully enforce water use restrictions?

   ☐ Yes ☐ No

[3] See Appendix B of the *Water Conservation Standards* (Reference No. 10) for model water use restriction bylaws.

7. Do you have a bylaw or ordinance that restricts installation or operation of automatic sprinkler systems (for example, requiring a controller that prevents system operation during rainfall)?

   ☐ Yes ☐ No

   If Yes, describe restriction _____

8. Do you have a bylaw or ordinance regulating the use of private wells for outdoor water use, particularly for landscape irrigation?

   ☐ Yes ☐ No

9. Do you have a conservation outreach program for private well owners?

   ☐ Yes ☐ No

STANDARD 10.0: PUBLIC EDUCATION AND OUTREACH

Develop and implement an education plan, which includes most, if not all, items listed in the *Water Conservation Standards*, page 29 (Reference no. 10).

Provide education and outreach to self-supplied water users (e.g., home or businesses on their own private wells) on their responsibility to conserve water.

1. Do you have a public education plan?

   ☐ Yes ☒ No

   If Yes, check which items are included in your outreach program.

   ☐ Targeted outreach to the largest water users
   ☐ Bill stuffers. How often mailed?_____.

Does your program include:

- ☐ Information enabling customers to calculate their water use and compare it to the standard of 65 gpcd
- ☐ Usage history
- ☐ Free water audits
- ☐ Rebates on water-efficient plumbing fixtures and appliances
- ☐ Information on water-wise landscaping, gardening, efficient irrigation, and lawn care practices
- ☐ Targeted outreach to industrial, commercial, and institutional users
- ☐ Water conservation curriculum for schools
- ☐ Water conservation workshops for the general public
- ☐ Special events, such as Conservation Fairs, contests, and recognition programs
- ☐ Speakers for community organizations
- ☐ Water conservation information center
- ☐ Public service announcements or announcements in other media
- ☐ Multilingual materials
- ☐ Education and outreach to self-supplied users (i.e., home or businesses on their own private wells)

What public outreach and education efforts have you found most effective and why? _____

_____

_____

_____

If No, what steps are you taking to develop a public education program? _____

_____

_____

_____

Certification:

I certify, under penalty of law, that the responses provided and all attachments were prepared under my supervision, in accordance with a system designed to ensure that qualified personnel properly gathered and evaluated the information submitted. The information submitted is, to the best of my knowledge and belief, true, accurate, and complete.

Signature: _____ Date: _____

Title: Eastham Town Administrator

REFERENCES

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16. 360 CMR 12.00. Leak Detection Regulations. See Section 12.09, Leak Repairs.

Note: References from The American Water Works Association can be ordered through the AWWA web site: http://www.awwa.org/index.cfm.

Limited Municipal Water System

Task 1 - Project Definition and Feasibility Study

August 2005

Town of Eastham

TOWN OF EASTHAM
INCORPORATED 1651

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FINAL REPORT

Limited Municipal Water System

Task 1 – Project Definition and Feasibility Study

Prepared for:
Town of Eastham

August 2005

Paul F. Gabriel
Principal

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Environmental Partners GROUP
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EXECUTIVE SUMMARY

The Town of Eastham (Town) contracted Environmental Partners Group (EPG) to provide engineering services related to development of a limited municipal water system near the Town's capped landfill. Historic and recent findings of an on-going groundwater monitoring program have shown elevated volatile organic compound (VOC) concentrations in areas South and East of the closed landfill. It is suspected that the landfill has affected drinking water supply wells on nearby private properties, thereby forcing the Town to provide bottled water or on-site water treatment to those home owners "reporting measurable concentrations of vinyl chloride-related impact" (Bennett and O'Reilly 2005 15). Given that the Town of Eastham does not have a municipal water system, and as a result of findings of VOC in drinking water wells around the landfill, the Town has proposed a limited municipal water system for the affected area adjacent to the landfill.

The proposed limited municipal water supply area will be enclosed by Glacier Hills to the North, Old Orchard Road to the West, Nauset Road to the East, and Route 6 to the South. Based on an estimated 300 homes within the proposed service area and an average daily water demand of 200 gallons per connection, the estimated initial water requirement is 60,000 gallons per day (42 gallons per minute). The water supply area includes mainly single family homes, and therefore a peak day demand factor of two was utilized to develop an initial maximum day estimate of 120,000 gallons. Potential water supply sources were identified including existing and new groundwater withdrawal locations, and connection to the Town of Orleans water system was also given consideration. The possible water supply sources documented will be further researched and evaluated in EPG's next phase of work, *Task 2 – Water Supply Source Identification.*

Utilizing a 25% contingency for conceptual level water system planning, the proposed limited water supply system will be on the order of $4.8 million dollars including engineering, legal, and initial capital. Based on 300 existing homes within the limited municipal water supply system, the opinion of probable cost per homeowner equates to approximately $16,000. It is estimated that operation and maintenance costs for the proposed limited municipal water supply system would be on the order of approximately $150,000 to $200,000 per year. Based on 300 existing homes, the initial yearly cost per homeowner would equate to approximately $580. The "No Action" alternative in which the Town continues to provide one point of entry water treatment system at 325 Schoolhouse Road and bottled drinking water to seven other residents in the affected area in lieu of the proposed water system would cost approximately $150,000 per year. Depending on grant eligibility, the annual capital costs for the proposed limited municipal water system with operation and maintenance costs would range between $250,00 to $470,000.

1. INTRODUCTION/BACKGROUND

The Town of Eastham (Town) contracted Environmental Partners Group (EPG) to provide engineering services related to development of a limited municipal water system near the Town's capped landfill. The Town is a municipality located on Cape Cod, Massachusetts with a year-round population of approximately 5,646 and a land area of roughly 27 square miles. The Town is surrounded by the Atlantic Ocean and Cape Cod National Sea Shore to the East, Cape Cod Bay to the West, Town of Wellfleet to the North, and Town of Orleans to the South.

Historic and recent findings of an on-going groundwater monitoring program have shown elevated volatile organic compound (VOC) concentrations in areas South and East of the closed landfill. It is suspected that the landfill has affected drinking water supply wells on nearby private properties, thereby forcing the Town to provide bottled water or on-site water treatment to those home owners "reporting measurable concentrations of vinyl chloride-related impact" (Bennett and O'Reilly 2005 15). Well water of home owners within the estimated impact area was sampled in order to gauge the influence of the suspected landfill plume(s) on the local drinking water supply, as shown in *Appendix A – Water Quality Investigation Area Map* prepared by Bennett & O'Reilly, Inc.

Given that the Town of Eastham does not have a municipal water system, and as a result of findings of VOC in drinking water wells around the landfill, the Town has proposed a limited municipal water system for the affected area adjacent to the landfill. An initial water supply feasibility report was completed by ATP Environmental circa 1996 to address Massachusetts Department of Environmental Protection (DEP) comments generated from the Eastham Landfill Comprehensive Site Assessment.

As part of EPG's scope of work, this report provides the Town with a feasibility study to evaluate the practicality of a limited water supply for the area of Eastham affected by elevated VOC groundwater concentrations. The assessment for the water supply system was made in terms of water needs, potential groundwater supply sources, opinion of probable program costs, funding alternatives, and review of regulatory and institutional issues. The product of this work task provides the Town with a conceptual plan to implement a limited water supply system in the area that appears to have been affected by the capped landfill. The demands and requirements of a possible future town-wide municipal water system were also considered during the preparation of this report and through the evaluation of the current proposed limited municipal water system. Once consensus has been reached on the conclusions and recommendations of this Task 1 report, EPG will continue work associated with developing a water supply system by identifying the most viable and cost effective potable water supply sources for the Town to pursue.

2. EVALUATION OF EXISITING CONDITIONS

2.1 Current Methods of Water Supply

With the exception of a small number of lots along the Town of Orleans and Eastham border, all home owners and businesses within the Town of Eastham currently utilize private groundwater wells for drinking water. The northern portions of the Town sit above the Nauset Lens aquifer, whereas southern Eastham rests above the Monomoy Lens. Both flow cells provide the Town with a potable freshwater source. The Town does not currently own or operate a municipal water system. The *Town of Eastham – Local Comprehensive Plan, Second Edition 2002* notes:

> Eastham's water delivery system consists entirely of private wells. Most of these are on-site domestic water supply wells drawing about 200 gallons per day (gpd). Some are Small Volume Wells, serving various businesses, condominiums, and office buildings for which the withdrawal volumes can be substantially larger. Currently, there are known to be 50 such wells of which seven (7) are non-transient/non-community public water supply systems, and 43 are transient/non-community public water supply systems. Only a few services near the Orleans town line are connected to the Orleans public water supply (30).

2.2 Landfill Contamination Threats

In 1997, the Town's sanitary landfill was capped and a groundwater monitoring program was instituted in accordance with regulatory requirements. Recently, elevated VOC concentrations in private groundwater drinking wells East and Southeast of the landfill have raised concerns with the possible contamination of drinking water wells by a landfill contamination plume. More specifically, it appears that "the presence of a low-level dissolved-phase chlorinated solvent plume which appears to have emanated from the Eastham Landfill prior to its capping in 1997" is affecting deep water wells (Bennett and O'Reilly 2005 15). Deep groundwater wells were installed for some properties around the landfill due to performance issues with shallow depth wells, such as fouling by iron bacteria. From recent private well sampling, "chlorinated solvents have been reported in isolated wells set below 150' bgs (-100' +/- NGVD)" (Bennett and O'Reilly 2005 4).

Drinking water quality has been affected for residents down gradient from the landfill, as shown in *Appendix A – Water Quality Investigation Area Map* prepared by Bennett & O'Reilly, Inc. To date, one point of entry water treatment system has been installed at 325 Schoolhouse Road and seven other residents in the area have been offered and/or provided bottled drinking water. From the current site investigation of the area down-gradient from the landfill, "based on the spacial occurrence of vinyl chloride and/or its parent contaminants…, the primary axis of the contaminant plume extends from the Eastham Landfill some 2,000' south-southeast to the area of the Residence at 325 Schoolhouse Road, while a secondary area of impact has been identified to the northwest of the subject Residence in a cross-gradient location" (Bennett and O'Reilly 2005 5).

Given that the Town of Eastham does not have a municipal water system, and as a result of findings of VOCs in drinking water wells around the landfill, the Town has proposed a limited municipal water system for the affected area adjacent to the landfill. An initial limited water supply feasibility report was completed by ATP Environmental circa 1996 to address Massachusetts Department of Environmental Protection (DEP) comments generated from the Eastham Landfill Comprehensive Site Assessment. Additionally, the Bennett and O'Reilly *Immediate Response Action Status Report II – Tier Classification/Numerical Ranking February 14, 2005* states:

> Based on the technical feasibility and practicality of treatment as such low-level concentrations and depth within the aquifer, it appears that containment of chlorinated solvents through isolation is the most practical and cost effective remedial alternative at this time. Such isolation will likely come in the form of Board of Health and/or Zoning Regulations as previously discussed wherein they would be utilized as an interim measure until an alternate municipal water supply could be provided (15).

Based on this documentation between the Town and DEP, Eastham is considering construction of an alternate municipal water supply in the area East and South of the landfill to provide residents with safe, protected drinking water.

3. DEFINITION OF SERVICE AREA

As described in *Section 2.2 Landfill Contamination Threats*, a suspected contamination plume from the capped municipal landfill in the Town of Eastham has caused elevated VOC concentrations in nearby drinking water wells. The intent of the current project was to investigate a limited municipal water supply system to services areas South and East of the existing landfill to accommodate those properties affected by the suspected landfill plume. In the past, the Town has considered the possibility of a town-wide system to provide potable water to the residents and businesses of Eastham. The demands and requirements of a possible future town-wide municipal water system were considered during the preparation of this report and through the evaluation of the limited municipal water system as currently proposed by the Town.

3.1 Water Usage Estimates

Previous reports and studies completed for Eastham and lower Cape Cod have proposed a variety of water usage estimates. A summary of these estimates is provided in *Table 3.1 Water Usage Estimates*.

Table 3.1
Water Usage Estimates

Report	Date	Average Day Usage	Max Day Usage
Report on Proposed Water System Eastham, MA by Whitman & Howard	1970	–	600 gpd/connection (150 gpd/person)
Water Resources of Outer Cape Cod by Lower Cape Water Management Task Force	1998	244 gpd/connection[1] 300 gpd/connection[2]	–
Town of Eastham – Local Comprehensive Plan	2002	200 gpd/domestic water supply well	–
Water System Master Plan Town of Wellfleet, MA by Environmental Partners Group	2003	155 gpd/connection	–
Massachusetts Department of Environmental Protection Guidelines	-	85 gpd/person	–

gpd – gallons per day
mgal – million gallons per day
1 – Cape Cod average use
2 – Projected usage for Wellfleet Center and the Rt. 6 corridor and landfill area in Eastham

To maintain consistency with the Town's existing Local Comprehensive Plan, an average day usage of 200 gallons per connection was utilized in calculating water demands for the proposed limited municipal water supply system.

3.2 Near-Term Service Area Demands

Studies completed by the Town and their consultant for the landfill monitoring, Bennett & O'Reilly, Inc., have identified the contamination plume in an elliptical shape bounded by Elda Lane to the North, the capped landfill to the West, Schoolhouse Road to the East, and Surrey Street to the South. As discussed with Town representatives in a Working Group Meeting July 11th, 2005, the proposed limited municipal water supply area will be enclosed by Glacier Hills to the North, Old Orchard Road to the West, Nauset Road to the East, and Route 6 to the South, as shown in *Appendix B – Proposed Limited Municipal Water Supply Service Area*. The proposed project area was larger than the elliptical shaped plume proposed by Bennet & O'Reilly to conservatively include all home owners that could be affected by the contaminated groundwater. Additionally, the proposed project area includes those private groundwater wells, approximately 30% of the homes sampled, where "trace levels of VOCs, primarily associated with BTEX and MtBE were detected" (Bennett and O'Reilly 2005 6).

Based on an estimated 300 homes within the proposed service area and an average daily water demand of 200 gallons per connection, the estimated initial water requirement is 60,000 gallons per day (42 gallons per minute). Full build-out of the proposed limited service area with an estimated 450 parcels would equate to a future water requirement of 90,000 gallons per day (63 gallons per minute). The water supply area includes mainly single family homes, and therefore a peak day demand factor of two was utilized to develop an initial maximum day estimate of 120,000 gallons. Fire flow requirements and any peak domestic demands would be satisfied by water storage facilities.

3.3 Potential Long-Term Demands

To estimate water demands for a municipal water supply system that serviced all areas of the Town, previous studies and reports were reviewed to gauge population projections, expected water requirements, and capital costs. After review of the Town's Local Comprehensive Plan, the year round 2000 population was estimated at 5,453 with a summer population of 27,500 (4). The Local Comprehensive Plan documents a 600,000 gallon per day water requirement at 100% build-out of 5,600 households (18). Applying a peak day demand factor of two, it is estimated that a Town wide water supply system should be capable of providing approximately 1.2 million gallons per day +/-.

4. INVESTIGATION OF POSSIBLE WATER SOURCES

The Town of Eastham has long considered the implementation of a town-wide municipal water system. During research conducted by the Town, consultants, and other agencies, many potential water sources have been suggested and evaluated as a permanent water source. Initially, these investigations centered around water yield with little to no consideration of environmental consequences. Efforts have been made by the Cape Cod Commission, U.S. Geological Survey, and others to identify and assess the potential impacts of groundwater withdrawal in terms of lowering the water table; influence on ponds, wetlands, and vernal pools; and salt water intrusion.

After review of existing Town documentation and reports and from discussions with Town representatives at Working Group Meetings, *Table 4.1 Water Supply Investigation Summary* provides a brief review of investigations into possible water sources for the Town of Eastham. Existing groundwater wells identified by the Town as a possible water supply source include the nursery school/day care center located on Nauset Road, the senior center located at 1405 Nauset Road, and the Nauset Regional High School located near the intersection of Nauset Road and Cable Road. Connecting to the Town of Orleans existing water system was also considered an option by the Town's Working Group. Table 4.1 below lists the well location; documented potential yield, if available; documented water quality, if available; source of information; and site identification. The general location of the identified wells are shown in *Appendix C – Possible Water Supply Well Locations.*

Table 4.1
Water Supply Investigation Summary

Site ID	Well Location	Potential Yield	Expected Water Quality	Report Name
Well-field Protection Zoning District "H"	Test Well No. 1 – East of Nauset Rd. & South of Cable Rd.	400 gpm	Good	Report on Proposed Water System Eastham, MA by Whitman & Howard
	Test Well No. 2 – West of Nauset Rd. & South of Bracket Rd.	500 gpm	Good	
	Test Well No. 3 – East of Nauset Rd. & South of Cable Rd.	300 gpm	Good	
	Test Well No. 4 – East of Nauset Rd. & South of Cable Rd.	700 gpm	Good	
	Northeast Eastham	0.65 mgd	Unknown	Water Resources of Outer Cape Cod by Lower Cape Water Management Task Force
	Marconi Beach (Wellfleet)	Unknown	Unknown	
Eastham Water Protection District "G"	Eastham Water Protection District (EWPD)	0.65 mgd	Unknown	
	Roach Property	0.22 mgd	Unknown	
	Little Creek (Nauset Road)	Unknown	Unknown	Water Resource Management Plan by Cape Cod National Seashore Massachusetts
	Eastham Elementary School	<70 gpm	Poor	–
	Nauset Regional High School	Unknown	Unknown	
	Eastham Senior Center	Unknown	Unknown	
	Nursery School/Day Care	<70 gpm	Unknown	
	Town of Orleans Water Supply System	Unknown	Good	

gpd – gallons per day
mgal – million gallons per day
Note that references to identical well locations/sites in multiple reports were only identified once.

The potential water supply sources listed in *Table 4.1 Water Supply Investigation Summary* will be further researched and evaluated in EPG's next phase of work, *Task 2 – Water Supply Source Identification*. The Task 2 study will provide the Town with recommended appropriate water supply sites for supplemental investigations leading to a DEP Site Examination and Pump Test.

5. PROJECT OPINION OF PROBABLE COSTS AND FUNDING

Using estimated water demands and the water supply service area developed in previous sections of this report, the following text provides an opinion of probable costs for a limited water supply system for the landfill area. General funding alternatives such as grants and low interest rate loans were also researched and described in the text below.

5.1 Near-Term Service Area

As described in *Section 3.2 Near-Term Service Area Demands*, the proposed limited municipal water supply area will be bounded by Glacier Hills to the North, Old Orchard Road to the West, Nauset Road to the East, and Route 6 to the South. The proposed service area is shown in *Appendix B – Proposed Limited Municipal Water Supply Service Area*. With an estimated water demand of 60,000 gallons per day, an opinion of probable cost for the proposed limited municipal water supply system was broken down into capital costs for well supply, distribution system, and storage. Additionally, water system operational costs were developed and is described in the text below.

5.1.1 Well Supply

As noted in *Section 4 – Investigation of Possible Water Sources*, a number of potential groundwater well sites have been identified as a potable water source for the proposed limited municipal water supply system. EPG's next phase of work to be completed in Task 2 will include further assessment of groundwater sources, including Zone I availability, Zone II issues, environmental considerations, and property ownership. For the purposes of estimating project costs, it was assumed that a groundwater well would be installed on Town owned property within the Cape Cod National Seashore Boundary, as identified in the Whitman and Howard, Inc. report completed in 1970. It was anticipated that the well supply would include a gravel packed well (10"x6") drilled to a depth of 150', a redundant well similar in construction to the main duty well, submersible centrifugal well pump, pump house, stand-by power, process instrumentation, and associated appurtenances. An opinion of probable costs for the well supply is detailed below.

Table 5.1
Well Supply Opinion of Probable Costs

Item Description	Unit	Quantity	Unit Price	Total
Gravel Packed Well	LF	300	$750	$225,000
Centrifugal Pump	LS	2	$25,000	$50,000
Pump House	SQ FT	400	$200	$80,000
Valves, Pipe, and Fittings	LS	1	$10,000	$10,000
Process Instrumentation	LS	1	$50,000	$50,000
Security Fencing	LF	200	$25	$5,000
Site Grading	LS	1	$15,000	$15,000
Access Road	SQ YD	300	$20	$6,000
Power	LS	1	$75,000	$75,000
Stand-by Power	LS	1	$50,000	$50,000
Electrical	LS	1	$84,900	$84,900
			Well Supply Total	**$650,900**

5.1.2 Distribution System

Based on the limited service area and water demand requirements, it is anticipated that the distribution system will consist primarily of 8" and 12" ductile iron pipe mains. Looping of the distribution system is recommended for fire flow protection and to minimize "stale" water conditions. Fire hydrants were assumed for every 300 feet of pipe length, and gate valve quantities were estimated at one valve per 500 feet of pipe length. Opinion of probable costs for the proposed limited distribution system, as shown in *Appendix B – Proposed Limited Municipal Water Supply Service Area*, were tabulated below.

Table 5.2
Distribution System Opinion of Probable Costs

Item Description	Unit	Quantity	Unit Price	Total
8" Ductile Iron Pipe	LF	14,600	$90	$1,314,000
12" Ductile Iron Pipe	LF	2,700	$135	$364,500
Fire Hydrants	EA	58	$2250	$116,000
Gate Valves	EA	35	$1000	$35,000
			Distribution System Total	**$1,829,500**

5.1.3 Water Storage

Water storage facilities are a typical means of providing peak day and fire flow capacity while equalizing demands on water source supply and potable water distribution. Usually storage is provided in an elevated structure such as a stand-pipe or elevated water tank. Preliminary sizing of a water storage tank for the proposed limited municipal water system was based on a fire flow requirement of 540,000 gallons (3,000 gallons per minute for 3 hours), per American Water Works Association guidance manuals.

Table 5.3
Water Storage Opinion of Probable Costs

Item Description	Unit	Quantity	Unit Price	Total
Steel Water Storage Tank	GAL	540,000	$1.25	$675,000
Security Fencing	LF	200	$25	$5,000
Site Grading	LS	1	$20,000	$20,000
			Water Storage Total	**$700,000**

5.1.4 Total Program Opinion of Probable Costs

Utilizing the developed opinion of probable costs for the anticipated well supply, distribution system, and water storage facilities, additional costs including engineering, legal, and contingencies were applied to develop a total program opinion of probable cost for the limited municipal water supply system. As shown in *Table 5.4 Total Program Opinion of Probable Costs*, with an appropriate 25% contingency for conceptual level water system planning, the proposed limited water supply system will be on the order of $4.8 million dollars including engineering, legal, and initial capital. Based on 300 existing homes within the limited municipal water supply system, the opinion of probable cost per homeowner equates to approximately $16,000+/-.

Table 5.4
Total Program Opinion of Probable Costs

Item Description	Total
Well Supply	$651,000
Distribution System	$1,830,000
Water Storage	$700,000
Engineering @ 20%	$636,000
Legal @ 1%	$32,000
Sub-Total	**$3,849,000**
Contingency @ 25%	$962,000
Total Program	**$4,811,000 +/-**

5.2 Operation and Maintenance Costs

The ability to supply and distribute a safe and reliable source of water for public consumption requires a full complement of qualified individuals to perform the administrative, management, operational, maintenance, and laboratory functions. Water system personnel must possess qualifications and skills to fulfill regulatory requirements, administrative functions, and ensure proper operating and maintenance procedures.

General administrative/managerial responsibilities for the water system to be provided by the Town would include:

- Assume the ultimate responsibility for the entire operation and maintenance of the water system.
- Be aware of all regulations and laws governing the operation of water supply, treatment, distribution, and storage facilities and oversee the completion of all operational duties so as to maintain regulatory compliance.
- Prepare daily, monthly, and annual reports for process control monitoring and compliance with regulations.
- Coordinate regular meter readings and submit bills to customers.
- Prepare budgets and reports that accurately reflect the system's fiscal and personnel needs for efficient operation and maintenance.

Operation and maintenance personnel include foreman, laborers, and treatment system operators. A summary of typical duties and responsibilities for operation and maintenance staff is listed below:

- Repair and maintain pumps, electric motors, pipes, process equipment, miscellaneous machinery, and distribution piping. Monitor, maintain and calibrate meters, gauges, analytical equipment, and other instrumentation and control equipment.
- Perform tasks required in the general upkeep of all water system facilities and grounds including cleaning, painting, snow removal, and landscaping.
- Maintain vehicles, machinery, hand tools, auxiliary equipment, and safety equipment in good working order.
- Operate water supply, treatment, and distribution system equipment including, emergency generators, well pumps, chemical feed systems, laboratory equipment, water meters, valves, hydrants, etc.
- Maintain distribution system by flushing and cleaning water lines to prevent the buildup of films, sediment, and debris.
- Respond to water system alarms and emergencies.

Based on similar potable water systems on the lower Cape, it is estimated that operation and maintenance costs for the proposed limited municipal water supply system would be on the order of approximately $150,000 to $200,000 per year. This would generally include administrative, operational, and maintenance expenses. Based on 300 existing homes, the initial yearly cost per homeowner would equate to $580 +/-. Assuming all 450 parcels were built out in the limited service area, the yearly cost per home would be on the order of $380 +/-. Literature indicates that "annual water bills on Cape Cod range from $150 to $248 with an average of $187 per connection", however due to the limited system and economies of scale the proposed per connection costs are appropriate for the anticipated water system (*Water Resources of Outer Cape Cod* by Lower Cape Water Management Task Force 21).

5.3 Funding Alternatives

"The capital expenses of adding a public water supply system are often subsidized by grants and low interest loans" (*Water Resources of Outer Cape Cod* by Lower Cape Water Management Task Force 19). A description of potential funding opportunities for the proposed limited water supply system is detailed below.

- The United States Department of Agriculture (USDA) Rural Development Utilities Program. The USDA (http://www.usda.gov/rus/) provides "loan and grant funds for water and wastewater projects serving the most financially needy communities" including rural areas of less than 10,000 people (*RUS Instruction 1780* 2). Loans and grants can be utilized "to construct, enlarge, extend, or otherwise improve rural water, sanitary sewage, solid waste disposal, and storm wastewater disposal facilities" (*RUS Instruction 1780* 6). Though there are specific limitations and requirements to the USDA Rural Development program, the Town of Eastham should purse possible grant eligibility with the USDA program for financing the proposed limited water supply system.

- Massachusetts Drinking Water State Revolving Fund Program (DWSRF). The Division of Municipal Services of DEP (www.mass.gov/dep/) and the Massachusetts Water Pollution Abatement Trust mutually oversee a financing program which includes low interest rate loans. "Financial assistance is available for the engineering, design, and construction of drinking water projects that protect public health and strengthen compliance with federal and state drinking water regulations" such as the proposed limited water supply system (MA *DEP Grant and Loans Program 2005* 10). Applicants for the low interest rate loans are ranked based on need, and projects assigned to the Intended Use Plan Project Listing (IUP) are "eligible to apply for financing in the current year" (MA *DEP Grant and Loans Program 2005* 11). It is anticipated that the Town of Eastham could secure a DWSRF low interest loan for the proposed limited municipal water supply project.

The Town has conducted preliminary discussions with Eastham's grant writer to explore grant and funding opportunities prior to detailed project work for the limited water supply system.

5.4 Financial Analysis

The following section details various financial scenarios to gauge fiscal liability for the proposed limited municipal water supply system. Opinion of probable costs developed in previous sections of this report were utilized in the financial analysis, specifically the total program opinion of probable cost of $4.8 million dollars. All amortized costs were based on a 20-year repayment period at a 2% interest rate. A "No Action" alternative was also presented in which the Town continues to provide one point of entry water treatment system at 325 Schoolhouse Road and bottled drinking water to seven other residents in the affected area in lieu of the proposed water system. The "No Action" alternative would include continued environmental monitoring and compliance with DEP mandates.

Table 5.5
Financial Analysis –Annualized Cost for Limited Municipal Water System

Item	Alternatives		
	No Action	75% Grants/ 25% Loans	100% Loans
Environmental Monitoring/Point of Entry System/ Bottled Water	$150,000[1]	–	–
Annualized Total Program Opinion of Probable Costs	–	$73,008	$292,056
Water System Operation and Maintenance Opinion of Probable Costs	–	$175,000	$175,000
Total Annual Opinion of Probable Cost (2005 Dollars)[2]	**$150,000**	**$248,008**	**$467,056**

1 – Information provided at Eastham Water Resources Advisory Committee Meeting July 12, 2005
2 – Annual cost per life of loan repayment period of 20 years

5.5 Long-Term Service Area

As documented in *Section 3.3 Potential Long-Term Demands*, the Local Comprehensive Plan documents a 600,000 gallon per day water requirement at 100% build-out of 5,600 households (18). Applying a peak day demand factor of two, it is estimated that a Town wide water supply system should be capable of providing approximately 1.2 million gallons per day +/-. At this stage of project planning, it is difficult to accurately quantify capital costs associated with a Town wide water system. However, the proposed conceptual limited water system in terms well supply, distribution, and water storage could be tied into a future Town wide water supply system. The *Report on Proposed Water System Eastham, MA* by Whitman & Howard circa 1970 estimated a cost of approximately $3.5 million dollars to construct and implement a water system for the Town of Eastham. The $3.5 million dollar cost was based on two gravel packed wells, approximately 25 miles of water main, and a 750,000 gallon elevated water storage tank. Utilizing the Engineering News Record Cost Index, the 1970 estimate in 2005 dollars would equate to approximately $18.8 million dollars. Utilizing an appropriate 25% contingency for conceptual level water system planning, the costs for a Town wide system would be on the order of $23.5 million dollars.

6. REGULATORY AND INSTITUTIONAL ISSUES

Prior to construction and implementation of the proposed limited municipal water supply system, the Town will have the responsibility to meet regulatory and institutional requirements related to the project. Regulatory issues include coordination and submission of project documentation with environmental protection organizations, whereas institutional issues would pertain to funding strategies and public support for a potable water system.

6.1 Regulatory Issues

In general a project of this scope and type could require regulatory coordination with the following,:

- Massachusetts DEP 310 CMR 22.00 Drinking Water Regulations
- Massachusetts DEP 310 CMR 36.00 Water Management Act Regulations
- Massachusetts Environmental Policy Act (MEPA) 301 CMR 11.00
- Massachusetts Endangered Species Act 321 CMR 10.00
- Massachusetts Wetland Protection Act 310 CMR 10.00 and 310 CMR 13.00
- Massachusetts Highway Department
- Army Corps of Engineers
- Eastham Conservation Commission
- Cape Cod Commission

Pursuit of a new groundwater well for the proposed limited water supply system would follow DEP's requirements for New Source Approval for groundwater sources less than 70 gallons per minute. The initial phase of work would include completing DEP application BRP WS 13 – Approval to Site a Source and Conduct Pumping Tests for Sources Under 70 Gallons Per Minute and required support information, including:

- Site map identifying existing public water supply wells, property boundaries, local zoning information, existing and potential future sources of contamination, and environmentally sensitive receptors
- Site exam
- Test well drilling for water quality sampling, estimate of well yield, and well log profile
- Test well prolonged pump test

Once the prolonged pump test was completed, the next phase of work would consist of completing DEP application BRP WS 15 – Approval Application to Construct a Source Less Than 70 Gallons per Minute. Supplemental information to BRP WS 15 required by DEP would include:

- Pump test report summarizing results, conclusions, and recommendations from the prolonged pump test
- Detailed engineering plans
- Plot plan showing necessary Zone 1 protective radius
- Construction opinion of probable costs

For scheduling purposes, it is estimated that testing, permitting, regulatory review, and design would take approximately 12 to 18 months.

6.2 *Institutional Issues*

Institutional issues important to the proposed limited water supply to be resolved within the Town include which entity(ies) will bear the capital and operation and maintenance costs; what will the future scope and magnitude of environmental monitoring will be required by DEP; and will the residents of Eastham support a limited and/or Town-wide municipal water system. The key factors for the proposed limited municipal water supply system project to be successful include public support and project funding. Public support of the proposed water system through out-reach and educational programs will be essential. Through discussions with the Working Group, it appears that the Town will investigate possible grant and funding opportunities in advance of detailed project work to gauge potential cost burden. These institutional issues and others will need to be addressed to successfully implement a potable water system in the Town of Eastham.

7. CONCLUSIONS

This report provides the Town of Eastham with a feasibility study and conceptual plan for a limited water supply for the area of Eastham affected by elevated VOC groundwater concentrations. The assessment for the water supply system was made in terms of water needs, potential groundwater supply sources, opinion of probable program costs, funding alternatives, and review of regulatory and institutional issues. The following conclusions can be drawn from this Task 1 report:

- Drinking water quality has been affected for residents down gradient from the landfill. To date, one point of entry water treatment system has been installed and seven other residents in the area have been offered and/or provided bottled drinking water. From the current site investigation of the area down-gradient from the landfill completed by Bennet and O'Reilly, "based on the spacial occurrence of vinyl chloride and/or its parent contaminants..., the primary axis of the contaminant plume extends from the Eastham Landfill some 2,000' south-southeast to the area of the Residence at 325 Schoolhouse Road, while a secondary area of impact has been identified to the northwest of the subject Residence in a cross-gradient location" (Bennett and O'Reilly 2005 5).

- Given that the Town of Eastham does not have a municipal water system, and as a result of findings of VOC in drinking water wells around the landfill, the Town has proposed a limited municipal water system for the affected area adjacent to the landfill.

- To maintain consistency with the Town's existing Local Comprehensive Plan, an average day usage of 200 gallons per connection was utilized in calculating water demands for the proposed limited municipal water supply system. Based on an estimated 300 homes within the proposed service area, the estimated initial water requirement is 60,000 gallons per day (42 gallons per minute). Full build-out of the proposed limited service area with an estimated 450 parcels would equate to a future water requirement of 90,000 gallons per day (63 gallons per minute). A peak day demand factor of two was utilized to develop an initial maximum day estimate of 120,000 gallons.

- Potential water supply sources were identified including existing and new groundwater withdrawal locations, and connection to the Town of Orleans water system was also given consideration. The possible water supply sources documented in Section 4 will be further researched and evaluated in EPG's next phase of work, *Task 2 – Water Supply Source Identification*.

- With a 25% contingency for conceptual level water system planning, the proposed limited water supply system will be on the order of $4.8 million dollars including engineering, legal, and initial capital. Based on 300 existing homes within the limited municipal water supply system, the opinion of probable cost per homeowner equates to approximately $16,000.
- It is estimated that operation and maintenance costs for the proposed limited municipal water supply system would be on the order of approximately $150,000 to $200,000 per year. This would generally include administrative, operational, and maintenance expenses. Based on 300 existing homes, the initial yearly cost per homeowner would equate to approximately $580.
- The "No Action" alternative in which the Town continues to provide one point of entry water treatment system at 325 Schoolhouse Road and bottled drinking water to seven other residents in the affected area in lieu of the proposed water system would cost approximately $150,000 per year. Depending on grant eligibility, the capital costs for the proposed limited municipal water system with operation and maintenance costs would range between $250,00 to $470,000 per year (assuming a 20 year loan @ 2%).
- The Town will have to satisfy regulatory and institutional issues before implementation of the proposed limited water supply system.

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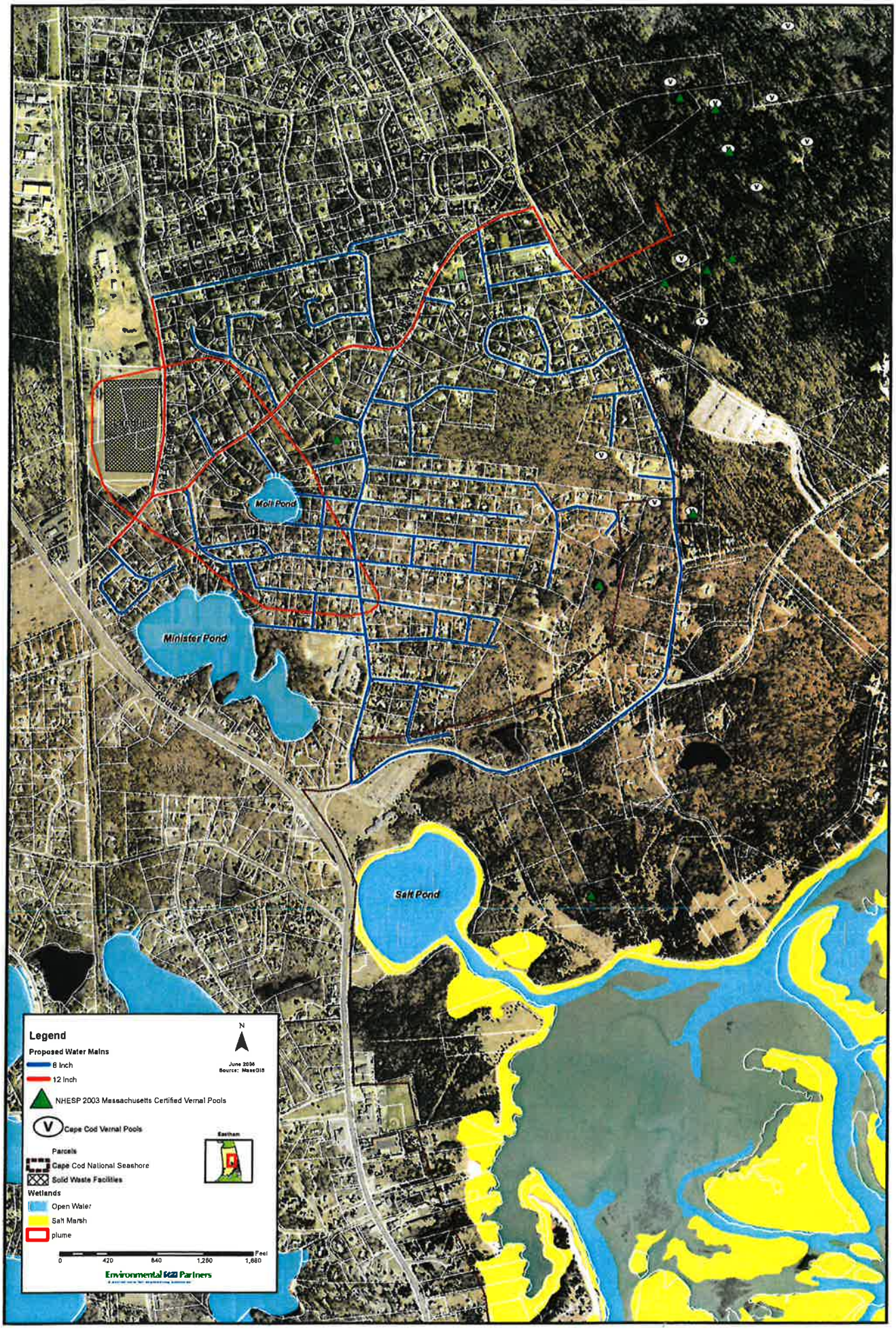
WELLFLEET
Marconi Beach
Northeast Eastham
Roach Property
Nauset Regional High School
EWPD - Water Resources Protection Zoning District "G"
Eastham Senior Center
Well-field Protection Zoning District "H"
Nursery School/Day Care
Little Creek
Eastham Elementary School
EASTHAM
ORLEANS
Great Pond
Salt Pond
Salt Pond Bay
Minister Pond
Depot Pond
Mill Pond
Herring Pond
Nauset Bay
NAUSET BEACH
Campground Landing
Kingsbury Beach
First Encounter Beach
Legend
400' Radius
NHESP Certified Vernal Pools
Parcels
Potential Well Site
1 inch equals 2,500 feet
Environmental Partners
A partnership for engineering solutions


Moll Pond
Minister Pond
Route 6
Salt Pond
Legend
Proposed Water Mains
8 Inch
12 Inch
NHESP 2003 Massachusetts Certified Vernal Pools
Cape Cod Vernal Pools
Parcels
Cape Cod National Seashore
Solid Waste Facilities
Wetlands
Open Water
Salt Marsh
plume
N
June 2006
Source: MassGIS
Eastham
0
420
840
1,260
1,680
Feet
Environmental Partners

Environmental Partners

A partnership for engineering solutions.

350 Lincoln St.
Suite 216
Hingham, MA 02043

Phone: 781 749 6771
Fax: 781 749 6607
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Municipal Water Distribution System Master Plan

Town of Eastham

May 2006

Environmental Partners GROUP
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1. INTRODUCTION/BACKGROUND

The Town of Eastham (Town) engaged Environmental Partners Group (EPG) to provide engineering services related to development of a Town-wide water distribution system Master Plan. The specific goals of this report were to establish town-wide water usage rates, prepare conceptual town-wide water system maps, and develop conceptual plan level cost estimates.

The Town is a municipality located on Cape Cod, Massachusetts with a year-round population of approximately 5,646 and a land area of roughly 27 square miles. The Town is surrounded by the Atlantic Ocean and Cape Cod National Sea Shore to the East, Cape Cod Bay to the West, Town of Wellfleet to the North, and Town of Orleans to the South.

Eastham's water delivery system consists almost entirely of private wells. Most of these are on-site domestic water supply wells for single family homes. Most private wells in the area provide good quality drinking water, but increasing development density and several larger point-sources of contamination (town owned landfill, gasoline stations) negatively influence the quality. Cross-contamination, whereby effluents from nearby contamination sources intercept wells, can cause problems (Eastham, 2002).

For these reasons, the Town of Eastham has long considered the implementation of a town-wide municipal water system. In the late 1960's, the Town hired the engineering firm of Whitman and Howard to conduct a feasibility study for this purpose (W&H, 1970). The resulting report estimated a cost of approximately $3.5 million dollars to construct and implement a water system for the Town of Eastham. Updated to 2005 costs using industry indices, the Whitman & Howard project would cost approximately $23.5 million. Unfortunately however, the cost estimate was based on only 25 miles of water main. Eastham actually has approximately 53 miles of town-owned roads and 63.8 miles of private roads for a total of 116.8 miles (Fitzback, 2006).

In 1996, the Town hired ATP Environmental to conduct an initial limited water supply feasibility report to evaluate the practicality of a limited water supply for the area of Eastham affected by elevated volatile organic compound (VOC) concentrations suspected to be originating from the Town-owned landfill. The resulting report (ATP, 1996) estimated a cost of approximately $1.1 - $3.1 million dollars to construct and implement the limited water system south and east of the Landfill. The variability in costs to implement this system was due to the extent of coverage provided by the limited system (1 mile – 2.4 miles) and the location of the potable source area (.5 mile – 4 miles) from the area affected by the landfill.

In August, 2005, Environmental Partners Group completed a feasibility study (EPG, 2005), which evaluated the implementation of a limited water supply system in the area affected by the landfill. The estimated cost of $4.1 million dollars was based on an expanded distribution system with 3.3 miles of distribution mains. As part of the follow-on to that task, a separate study (EPG, 2005a) conducted by Environmental Partners Group examined potential drinking water sources within Eastham. Results of both of these 2005 studies are incorporated into this town-wide plan.

This assessment for the town-wide water system included an assessment of water needs, potential groundwater supply sources, opinion of probable program costs, funding alternatives, and review of regulatory and institutional issues. The product of this work task provides the Town with a conceptual plan to implement a town-wide water supply system. Once consensus has been reached on the conclusions and recommendations of this report, EPG will continue work associated with developing a water supply system by identifying the most viable and cost effective potable water supply sources for the Town to pursue.

2. EVALUATION OF EXISTING CONDITIONS

2.1 Current Methods of Water Supply

With the exception of a small number of lots along the border between the Towns of Orleans and Eastham, all home owners and businesses within the Town of Eastham currently utilize private groundwater wells for drinking water. The northern portions of the Town sit above the Nauset Lens aquifer, whereas southern Eastham rests above the Monomoy Lens. Both flow cells provide the Town with a potable freshwater source. The Town does not currently own or operate a municipal water system. The *Town of Eastham – Local Comprehensive Plan (LCP), Second Edition 2002* notes:

> Eastham's water delivery system consists entirely of private wells. Most of these are on-site domestic water supply wells drawing about 200 gallons per day (gpd). Some are small volume wells, serving various businesses, condominiums, and office buildings for which the withdrawal volumes can be substantially larger. Currently, there are known to be 50 such wells of which seven (7) are non-transient/non-community public water supply systems, and 43 are transient/non-community public water supply systems. Only a few services near the Orleans town line are connected to the Orleans public water supply (page 30).

As part of this current planning effort, the LCP figures were compared to current MASSGIS mapping of non-transient/non-community and transient/non-community public water supply systems. Currently MASSGIS lists 8 non-transient/non-community wells and 63 transient/non-community public water supply systems (71 total) within the Town (see attached figures in Appendix C).

2.2 Potential Sources of Contamination

2.2.1 Landfill

In 1997, the Town's sanitary landfill was capped and a groundwater monitoring program was instituted in accordance with regulatory requirements. Recently, elevated VOC concentrations in private groundwater drinking wells east and southeast of the landfill have raised concerns with the possible contamination of drinking water wells by a landfill contamination plume. More specifically,

it appears that "the presence of a low-level dissolved-phase chlorinated solvent plume which appears to have emanated from the Eastham Landfill prior to its capping in 1997" is affecting deep water wells (Bennett and O'Reilly 2005 pg. 15). Deep groundwater wells were installed for some properties around the landfill due to performance issues with shallow depth wells, such as fouling by iron bacteria. From recent private well sampling, "chlorinated solvents have been reported in isolated wells set below 150' bgs (-100' +/- NGVD)" (Bennett and O'Reilly 2005 4).

Drinking water quality has been affected for residents down gradient from the landfill. To date, one point of entry water treatment system has been installed at 325 Schoolhouse Road and seven other residents in the area have been offered and/or provided bottled drinking water (Bennett and O'Reilly 2005).

A recent report concerning the landfill contamination (Bennett and O'Reilly 2005) stated:

> Based on the technical feasibility and practicality of treatment at such low-level concentrations and depth within the aquifer, it appears that containment of chlorinated solvents through isolation is the most practical and cost effective remedial alternative at this time. Such isolation will likely come in the form of Board of Health and/or Zoning Regulations as previously discussed wherein they would be utilized as an interim measure *until an alternate municipal water supply could be provided* (page 15).

2.2.2 Route 6

The *Town of Eastham – Local Comprehensive Plan, Second Edition 2002* noted:

> Route 6 traverses the crest of the Monomoy/Nauset lenses, which have a maximum water table elevation of 17 feet above mean sea level. With groundwater flows that are generally perpendicular to the lens' contour lines, this location makes the Route 6 corridor particularly hazardous with respect to the wide dissemination of contamination. That a large number of small volume wells are located within this corridor may have significant implications for economic sustainability if contamination from a variety of potential sources leads to their failure. (page 30)

2.2.3 Nitrate/Sodium

The *Town of Eastham – Local Comprehensive Plan, Second Edition 2002* noted:

As part of the Lower Cape Water Management Task Force study, the nitrate and sodium levels were measured between 1985 and 1994 for a large number of wells (more than 6,500) in Eastham, Wellfleet and Truro. The increasing nitrate levels observed during this period gave early indications of the continuing decline in water quality. To further explore this trend and its implications, the Eastham Water Resources Advisory Board initiated an annual program of voluntary nitrate screening of Eastham's well water in 1999. The results for about 7% of the Town's wells in the first two years and 20% in 2001 confirmed the continuing, gradual increase in nitrate loading of the water. These data provide evidence that the distribution of nitrate levels is not uniform across the Town, and that elevated levels are clustered in North Eastham. The primary factors that sustain this trend appear to be further development, intensive use of properties in the summer, and an increasing year-round population. (page 34)

2.2.4 MtBE/Fuel

The *Town of Eastham – Local Comprehensive Plan, Second Edition 2002* noted:

Other existing and potential contamination sources include underground gasoline storage tanks located mostly along Route 6 and buried on-site domestic fuel tanks. In recent years, the gasoline additive methyl tertiary-butyl ether (MTBE) has been found in Eastham's drinking water. Currently three MTBE contamination sources have been identified in Eastham and are being managed under the Massachusetts Contingency Plan (310 CMR 40.0000). This experience indicates that Volatile Organic Compounds (VOCs), of which MTBE is an example, are contaminants that need to be carefully monitored once their presence has been established. From a public health perspective, it reinforces the need to monitor the quality of water on a Town-wide basis (page 32).

3. DEFINITION OF SERVICE AREA

As requested by the Town, the intent of this study is to develop a town-wide, public water distribution system plan that all Eastham residents could connect to. For planning and cost estimating purposes, those limited number of residents currently tied into the Orleans water system would continue to be so.

3.1 Water Usage Estimates

Previous reports and studies completed for Eastham and lower Cape Cod have proposed a variety of water usage estimates. A summary of these estimates is provided in *Table 3.1 Water Usage Estimates*.

Table 3.1
Water Usage Estimates

Report	Date	Average Day Usage	Max Day Usage
Report on Proposed Water System Eastham, MA by Whitman & Howard	1970	–	600 gpd/connection (150 gpd/person)
Water Resources of Outer Cape Cod by Lower Cape Water Management Task Force	1998	244 gpd/connection[1] 300 gpd/connection[2]	–
Town of Eastham – Local Comprehensive Plan	2002	200 gpd/domestic water supply well	–
Water System Master Plan Town of Wellfleet, MA by Environmental Partners Group	2003	155 gpd/connection	–
Massachusetts Department of Environmental Protection Guidelines	-	85 gpd/person	–

gpd – gallons per day
mgal – million gallons per day
1 – Cape Cod average use
2 – Projected usage for Wellfleet Center and the Rt. 6 corridor and landfill area in Eastham

3.2 Potential Long-Term Demands

Future projection of long term demand was conducted to answer the fundamental questions: (1) What will be the water demand in Eastham following the full build-out of the Town, (2) Will the water resources within the Town be sufficient to support this full build-out, and (3) If the water resources are not sufficient, where should the Town turn to tap other sources?

To estimate future long-term demand, a few methods were used: (a) future population x assumed fixed consumption rate (200 gpd/connection), (b) future population x consumption rates established by Title V (310 CMR 15.203), and (c) comparison with other communities on the Lower Cape.

As part of the town-wide water master plan, the Town's assessor's maps were overlaid onto aerial photos of the Town. A total of 5,311 parcels were identified (Appendix C). Local officials indicate a total of 5,527 currently developed parcels, and approximately 400 parcels that could be conceivably developed in the future given current zoning by-laws (Fitzback, 2006). Using the first method to estimate daily town-wide water consumption for 6000 connections yields a daily consumption of 1.2 million gallons (6,000 connections x 200 gallons/connection). This is a simplistic model that does not differentiate between lot size or type (residential, commercial, institutional), yet does provide a rough estimate of potential water demand, especially considering the predominance of residential lots in the overall count.

In the second method, Title V data was used to estimate future demand. The regulations implementing Title V break down sewage flow by use of the property, then assign flow projections that reflect a peak day condition for specific use. This peak day flow is used for designing on-site wastewater disposal systems, which must have a conservative basis for design. Title V flow projections typically use a peaking factor of 2, more or less. Given the projected wastewater flow, approximate water consumption can be roughly estimated by back-calculation.

As an example, for a typical three-bedroom, single family dwelling, prescribed Title V wastewater flows would be set at 110 gallons per day per bedroom, with a total design flow of 330 gallons per day. Back calculation, using a peaking factor of 2 would result in an average water consumption estimate of 165 gallons per day for that typical home, or 55 gallons per bedroom. Assuming a demographic average of three people per household, this also equates to an average per capita water consumption of 55 gallons/day. Using this methodology with Town-wide Title V data provided by the Town of Eastham, an average daily water demand of approximately 1.09 million gallons is estimated (Appendix B, Table 1). Although this methodology is somewhat more sophisticated than the first, it still does not recognize area-specific demographic or water use patterns.

In the third method, well-documented water consumption by other communities on the Lower Cape was used to estimate both average and peak town-wide water demands for Eastham. This has been demonstrated to be the most reliable method of estimating water use when planning new water systems. Eastham is similar to other towns on the Lower Cape where the average summertime population exceeds the wintertime population by over 4:1. Despite this surge, water consumption doesn't increase by 4-fold. In Provincetown, where the population increases from approximately 3,200 to an estimated 27,500,

average daily water consumption ranges from 554,000 gpd in winter to 1.36 million gpd in summer, with a summer-time peak day demand of 1.6 million gallons. The annualized average daily water consumption is approximately 841,000 gpd, so the average summer to average annual demand ratio is 1.6:1. The peak day (1.6 million gallons) to average day ratio is 1.9:1 (Appendix B, Table 2).

In Orleans, the population increases from approximately 6,341 to an estimated 25,000. Average daily water consumption ranges from approximately 575,000 gpd in the winter months to 1.52 million gpd in the summer months. The annualized daily water consumption in Orleans is approximately 837,000 gpd, leading to an average summer to average annual consumption ratio of 1.82:1. The peak day has been measured at 2.19 million gallons, thus resulting in a peak day to average annual consumption ratio of 2.6:1 (Appendix B, Table 2).

The full spectrum of water consumption and demographic nature of services for both Provincetown and Orleans is shown in Table 2 within Appendix B. Given the high degree of reliability of the available data in those communities, and given the similar nature of the communities of Eastham and Orleans (residential to commercial splits), we believe comparison with Orleans is the most reliable gauge for projecting water needs in Eastham.

Orleans currently has 5063 connections with an average daily water consumption of 165.4 gallons/connection. This figure compares very well with the average consumption per residential connection estimated under Method 2 (Title V) – 165 gallons. Under the future build-out of Eastham's water system, a total of 6,000 connections are estimated. Based on 165.4 gallons/connection (from Orleans), a town-wide future average water consumption of 992,267 gallons per day is estimated (165.4 x 6000). Using Orleans peak factor of 1.82, based on the average peak daily consumption in the Summer (July/August), a future town-wide water system should provide for a total daily demand of 1.806 million gallons per day (average daily demand x peak factor). Using Orleans Peak Day factor of 2.6, the future Eastham water system should be able to provide 2.594 million gallons of water on its peak day.

4. INVESTIGATION OF POSSIBLE WATER SOURCES

During historical research conducted by the Town, consultants, and other agencies, many potential water sources have been suggested and evaluated as a permanent water source. Initially, these investigations centered on water yield with little to no consideration of environmental consequences. Efforts have been made by the Cape Cod Commission, U.S. Geological Survey, and others to identify and assess the potential impacts of groundwater withdrawal in terms of lowering the water table; influence on ponds, wetlands, and vernal pools; and salt water intrusion.

4.1 Limited System Water Source Investigation (EPG, 2005)

Following review of existing Town documentation and discussions with Town representatives at Working Group Meetings, Environmental Partners Group evaluated several Town-owned properties for their potential as appropriate water supply sites (see Figures, Appendix A). For purposes of this 2005 study, the primary service area was the area south and east of the Town-owned landfill.

Existing groundwater wells identified by the Town as possible water supply sources included the nursery school/day care center located on Nauset Road, the senior center located at 1405 Nauset Road, and the Nauset Regional High School located near the intersection of Nauset Road and Cable Road. Connecting to the Town of Orleans existing water system was also considered an option by the Town's Working Group.

This 2005 report also provided the Town of Eastham with an evaluation and screening study of potential (currently undeveloped) groundwater well sites for the proposed limited water system in the landfill area. With consideration to the project needs and industry design criteria, and from evaluation of the identified possible water supply sources, the following conclusions were drawn from the report:

- Of the eleven potential water supply sites screened under this evaluation, the highly favorable and most advantageous sites for a water supply source for the proposed limited water system include:
    - Well-field Protection Zoning District "H" located east of Nauset Road and within the National Seashore
    - Existing Nauset Regional High School well.
- Well-field Protection Zoning District "H" was given a highly favorable rating because the property is Town owned, and therefore requires no land taking or purchases, a 400 foot Zone I

radius is available, the well-field is in close proximity to the proposed limited service area, and previous studies have demonstrated high potential water yield and good expected water quality. Based on initial hydrogeological investigations in the District "H" area, this potential well site could possibly provide the Town with a larger supply source for a Town-wide water supply system.

- The Nauset Regional High School's existing groundwater well was identified as a highly favorable water supply source. The existing 4" well has a full 400 foot Zone I radius and the initial 48-hour pump test was conducted at the water system design requirement of 70 gallons per minute. Since the well and well site are not owned by Eastham, the Town would need to negotiate a water use agreement with the High School. Capital cost savings realized from utilizing the existing well will be off-set by construction of a 1.5 mile +/- water supply main to feed the proposed service area south and east of the landfill.

- The Town has reserved the Eastham Water Protection District (EWPD), also known as the Water Resources Protection Zoning District "G", as a site for potential development of a municipal water supply. The potential well site is Town owned and a 400 foot Zone I radius is available. However, because of the distance to the proposed service area and potential water quality issues south of the well site, EWPD was rated as less favorable.

- Little Creek, North Eastham, and Marconi Beach in Wellfleet were identified as unfavorable water supply sources. The properties are not Town owned, and therefore would be a major obstacle for development as a groundwater supply.

- The Town of Eastham owns a 64-acre plot of land known as the Roach Property, and has reserved a third of the property for potential development of a municipal water supply. The Roach Property was ranked as unfavorable because of the distance to the proposed service area and potential environmental effects that pumping would have on Hatch's Creek.

- The Eastham Elementary School, Eastham Senior Center, and Nursery School/Day Care were identified as unfavorable water supply sources. A 400 foot Zone I radius is not available at these potential well sites, and therefore a groundwater well in these locations could not meet the 70 gallons per minute water capacity design criteria.

- The Town of Orleans water system does have excess safe yield capacity to provide potable water to Eastham's proposed limited water supply service area. The three major issues with connecting to the Town of Orleans include: political issues and water service agreements between the two Towns, environmental issues related to interbasin transfer of water, and construction costs related

to installation of a transmission main along Route 6 to service the landfill area water system. At the time this report was prepared, the Town of Eastham preferred to develop its own water supply source for the proposed limited supply service area in order to eliminate dependence on the Town of Orleans for water, and therefore this option was not the preferred approach.

- Environmental Partners Group recommended the following as a parallel approach in securing a water supply source for the proposed limited water system:
    - The feasibility of connecting to the Nauset Regional High School as a permanent water supply source should be further evaluated. The Town should meet with High School administrators to discuss the integration of the existing groundwater well into a water supply source for the Town's proposed limited water system. If a water use agreement between the Town and the High School can be reached, the Town should investigate permitting requirements with DEP for utilizing the existing well as a groundwater source.
    - Pump tests should be conducted at Well-field Protection Zoning District "H" in order to gather critical field information necessary for permitting and designing a groundwater supply source. The Town should seek a meeting with the staff of the National Seashore to begin discussions on the Town's programmatic plans for water supply investigation, and to seek input from the Seashore on their needs and concerns.

4.2 Town-Wide System Water Sources

In accordance with the recommendations of the limited system water source report (EPG, 2005a), a pump test was conducted on the District H property on March 6-8, 2006, following discussions/permits from the DEP and National Park Service. A 70 gpm pumping rate was achieved, with excellent water quality and no significant groundwater drawdown in the area of the pump test. For purposes of utilizing this source under a Town-wide water system, its rating remains highly favorable.

Environmental Partners Group also held discussions with the DEP (Quink, 2006) which indicate that the permitted safe yield from the Nauset Regional High School well could be raised from 35.7 gpm to 70 gpm simply through a request from representatives of the Nauset Regional High School. The School Board voted on April 6, 2006, to allow the use of this well for public water supply purposes in Eastham; a letter to increase the pumping rate from the School Board to the DEP is forthcoming. Recent discussions with the water supply operator also indicate that the water quality from this well remains excellent (McKenzie, 2006). For purposes of utilizing this well source under a Town-wide water system, its rating remains highly favorable.

Eastham Water Protection District "G" (EWPD) was designated as "less than favorable" as a site for potential development of a limited municipal water supply, primarily due to its distance from the proposed limited water system. From Working Group discussions, residential supply wells south of EWPD, Oak Leaf Road area, have been identified with contamination by TCE (trichloroethylene). The Lower Cape Management Task Force lists the potential yield of EWPD at 450 gallons per minute (LCWMTF, pg. 31). The potential well field's close proximity to the gravel pit to the South and Route 6 to the West were a consideration in the screening evaluation. Borings advanced by the Cape Cod Commission in 2002 demonstrate that the geology down to a depth of over one hundred feet below ground surface were largely medium coarse sands. Assuming a pump test at the property shows the lack of influence of the potential contaminant sources listed above, this rating/designation could be changed to "favorable" as a water source for a Town-wide water system.

The Roach property was designated as "unfavorable" as a site for potential development of a limited municipal water supply, due to its (1) distance from the proposed limited water system, and (2) its potential impact on Hatch's Creek. Groundwater modeling by the United States Geological Survey (USGS) concluded that pumping of the Roach Property at 380 gallons per minute would affect streamflow at Hatch's Creek located north of the proposed well site. Development of the Roach site for a limited municipal water supply of less than 70 gallons per minute would require further groundwater modeling to assess the potential affects on Hatch's Creek. A boring advanced by the Cape Cod Commission at the center of the gravel pit in 2002 demonstrate that the geology down to a depth of approximate 20 feet below ground surface consisted largely of medium coarse sands; below this depth, silty sand and clay was observed for the remainder of the boring (44 feet below ground surface). Assuming this reduced pumping rate showed no significant impacts to Hatch's Creek, and the specific capacity of the well could achieve 70 gpm, this rating/designation could be changed to "favorable" as a water source for a Town-wide water system.

5. CONCEPTUAL DESIGN

Using estimated water demands and the town-wide water supply service area developed in previous sections of this report, this section of the report provides an opinion of probable costs for a town-wide water system.

5.1 Service Area

As described in Section 3, the town-wide system would service every parcel in Eastham, including those currently tied into the Orleans water system. With an estimated peak water demand of 1.8 million gallons per day, an opinion of probable cost for the proposed limited municipal water supply system was broken down into capital costs for well supply, distribution system, and storage. Additionally, water system operational costs were developed and are described in the text below.

5.1.1 Well Supply

As noted in Section 4, of the eleven sites identified as potential sources for a limited municipal water system, four are potentially viable to support a town-wide water system (see Appendix A for location map showing potential sources). The potential yield and groundwater quality from each of these four areas would need to be further evaluated. Given the heterogeneity of the geology within the groundwater lenses within Eastham, and the proximity to sensitive receptors, it is anticipated that the water to meet the 1.8 million gallons (peak demand) would come from multiple wells installed at all four sources – a multi-straw approach which has worked successfully at other Towns on the Cape. Assuming no other sources are located and that the Town will not use sources outside of Town, the average draw at each of the four locations would be 450,000 gallons per day. In addition the town should plan for additional capacity equal to 450,000 gpd should one well be taken off-line (total capacity needed: 2.25 million gpd). This additional source, together with the Town's storage capacity (1.4 million gallons (section 5.1.3)) could also be used to accommodate demand on the Town's peak day (2.6 million gallons). If the total specific capacity of these sources does not meet the estimated peak demand, other non-Town owned sources (i.e., Town of Orleans water system, Marconi Well Site) would need to be re-examined for use by the Town.

For the purposes of estimating project costs, it was assumed that two groundwater wells would be installed on each of the four properties (District H, District G, Roach, and Nauset Regional High School). It was anticipated that the well supply at each source area would include a gravel-packed well (10"x6") drilled to a depth of 150', a redundant well similar in construction to the main duty well, submersible centrifugal well pump, pump house, stand-by power, process instrumentation, and associated

appurtenances. Following tests of all four locations, the supply of water may not be evenly distributed. For example, results from the limited pump test (100 gpm) on District H show a potential pumping capacity of 1860 gpm (2.7 MGD).

An opinion of probable costs for the well supply system is summarized below.

Table 5.1
Well Supply Opinion of Probable Costs

Item Description	Unit	Quantity	Unit Price	Total
Gravel Packed Well	LS	8	$112,500	$900,000
Centrifugal Pump	LS	8	$25,000	$200,000
400 Square-foot Pump House	LS	4	$80,000	$320,000
Valves, Pipe, and Fittings	LS	4	$10,000	$40,000
Process Instrumentation	LS	4	$50,000	$200,000
Security Fencing	LS	4	$5,000	$20,000
Site Grading	LS	4	$15,000	$60,000
Access Road	LS	4	$6,000	$24,000
Power	LS	4	$75,000	$300,000
Stand-by Power	LS	4	$50,000	$200,000
Electrical	15%	1	-	$339,600
			Well Supply Total	**$2,603,600**

5.1.2 Distribution System

Based on the Town-wide service area and water demand requirements, it is anticipated that the distribution system will consist primarily of 8" and 12" ductile iron mains. Looping of the distribution system is recommended for fire flow protection and to minimize "stale" water conditions. Fire hydrants were assumed for every 300 feet of pipe length, and gate valve quantities were estimated at one valve per 500 feet of pipe length. A town-wide distribution system is shown in Appendix C. Our opinion of probable costs for the proposed town-wide distribution system, are summarized below.

Table 5.2
Distribution System Opinion of Probable Costs

Item Description	Unit	Quantity	Unit Price	Total
8" Ductile Iron Pipe	LF	503,299	$59	$29,694,694
12" Ductile Iron Pipe	LF	100,924	$69	$6,963,756
1/2" Service Tap	EA	6000	$640	$3,840,000
Fire Hydrants	EA	2,014	$1500	$3,021,115
Gate Valves	EA	1,208	$850	$1,027,179
			Distribution System Total	**$44,546,691**

5.1.3 Water Storage

Water storage facilities are a typical means of providing peak day and fire flow capacity while equalizing demands on water source supply and potable water distribution. Storage is typically provided in an elevated structure such as a stand-pipe or elevated water tank. Preliminary sizing of a water storage tank for the proposed town-wide municipal water system was based on a fire flow requirement of 540,000 gallons (3,000 gallons per minute for 3 hours), per American Water Works Association guidance manuals. For purposes of a town-wide system, and to provide proper pressure throughout the distribution system two storage tanks are proposed. Those specific locations have not been designated, but due to potential local resistance would likely be installed in wooded areas (i.e., within District H, District G) not directly abutting residences.

Table 5.3
Water Storage Opinion of Probable Costs

Item Description	Unit	Quantity	Unit Price	Total
Steel Water Storage Tank	GAL	1,080,000	$1.25	$1,350,000
Security Fencing	LS	2	$5000	$10,000
Site Grading	LS	2	$20,000	$40,000
			Water Storage Total	**$1,400,000**

5.1.4 Total Program Opinion of Probable Costs

Utilizing the developed opinion of probable costs for the anticipated well supply, distribution system, and water storage facilities, additional costs including engineering, legal, and contingencies were applied to develop a total program opinion of probable cost for the limited municipal water supply system. As shown in *Table 5.4 Total Program Opinion of Probable Costs*, with an appropriate 25% contingency for conceptual level water system planning, the proposed town-wide water supply system will be on the order of $73.4 million dollars including engineering, legal, and initial capital. Based on 6000 connections within the town-wide municipal water supply system, the opinion of probable cost per homeowner equates to approximately $12,240+/-.

Table 5.4
Total Program Opinion of Probable Costs

Item Description	Total
Well Supply	$2,603,600
Distribution System	$44,546,691
Water Storage	$1,400,000
Engineering @ 20%	$9,710,058
Legal @ 1%	$485,502

Sub-Total	**$58,745,851**
Contingency @ 25%	$14,686,463
Total Program	**$73,432,314 +/-**

5.2 Operation and Maintenance Costs

The ability to supply and distribute a safe and reliable source of water for public consumption requires a full complement of qualified individuals to perform the administrative, management, operational, maintenance, and laboratory functions. Water system personnel must possess qualifications and skills to fulfill regulatory requirements, administrative functions, and ensure proper operating and maintenance procedures. General administrative/managerial responsibilities for the water system to be provided by the Town would include:

- Assume the ultimate responsibility for the entire operation and maintenance of the water system.
- Be aware of all regulations and laws governing the operation of water supply, treatment, distribution, and storage facilities and oversee the completion of all operational duties so as to maintain regulatory compliance.
- Prepare daily, monthly, and annual reports for process control monitoring and compliance with regulations.
- Coordinate regular meter readings and submit bills to customers.
- Prepare budgets and reports that accurately reflect the system's fiscal and personnel needs for efficient operation and maintenance.

Operation and maintenance personnel include foreman, laborers, and treatment system operators. A summary of typical duties and responsibilities for operation and maintenance staff is listed below:

- Repair and maintain pumps, electric motors, pipes, process equipment, miscellaneous machinery, and distribution piping. Monitor, maintain and calibrate meters, gauges, analytical equipment, and other instrumentation and control equipment.
- Perform tasks required in the general upkeep of all water system facilities and grounds including cleaning, painting, snow removal, and landscaping.
- Maintain vehicles, machinery, hand tools, auxiliary equipment, and safety equipment in good working order.
- Operate water supply, treatment, and distribution system equipment including, emergency generators, well pumps, chemical feed systems, laboratory equipment, water meters, valves, hydrants, etc.

- Maintain distribution system by flushing and cleaning water lines to prevent the buildup of films, sediment, and debris.
- Respond to water system alarms and emergencies.

Literature (CCC, 1998) indicates that "annual water bills on Cape Cod range from $150 to $248 with an average of $187 per connection. Based on similar potable water systems on the lower Cape, it is estimated that operation and maintenance costs for the proposed town-wide municipal water supply system (6000 connections) would be on the order of approximately $1.6 million per year. The Town's water division would likely include 8-10 employees who would handle the system's administrative, operational, and maintenance duties. With no available space at the Town Hall, these individuals and their supplies/equipment would likely be housed in the DPW/Natural Resources office building on Old Orchard Road, following a remodeling effort of the interior spaces.

5.3 Funding Alternatives

"The capital expenses of adding a public water supply system are often subsidized by grants and low interest loans" (*Water Resources of Outer Cape Cod* by Lower Cape Water Management Task Force 19). A description of potential funding opportunities for the proposed limited water supply system is detailed below.

- The United States Department of Agriculture (USDA) Rural Development Utilities Program. The USDA (http://www.usda.gov/rus/) provides "loan and grant funds for water and wastewater projects serving the most financially needy communities" including rural areas of less than 10,000 people (*RUS Instruction 1780* 2). Loans and grants can be utilized "to construct, enlarge, extend, or otherwise improve rural water, sanitary sewage, solid waste disposal, and storm wastewater disposal facilities" (*RUS Instruction 1780* 6). Though there are specific limitations and requirements to the USDA Rural Development program, the Town of Eastham should purse possible grant eligibility with the USDA program for financing the municipal water supply system.
- Massachusetts Drinking Water State Revolving Fund Program (DWSRF). The Division of Municipal Services of DEP (www.mass.gov/dep/) and the Massachusetts Water Pollution Abatement Trust mutually oversee a financing program which includes low interest rate loans. "Financial assistance is available for the engineering, design, and construction of drinking water projects that protect public health and strengthen compliance with federal and state drinking water regulations" such as the proposed limited water supply system (MA *DEP Grant and Loans Program 2005* 10). Applicants for the low interest rate loans are ranked based on need, and

projects assigned to the Intended Use Plan Project Listing (IUP) are "eligible to apply for financing in the current year" (MA *DEP Grant and Loans Program 2005* 11). It is anticipated that the Town of Eastham could secure a DWSRF low interest loan for the municipal water supply system.

The Town has conducted preliminary discussions with Eastham's grant writer to explore grant and funding opportunities prior to detailed project work for the limited water supply system.

5.4 Financial Analysis

The following section details various financial scenarios to gauge fiscal liability for the proposed limited municipal water supply system. Opinions of probable costs developed in previous sections of this report were utilized in the financial analysis, specifically the total program opinion of probable cost of $73.4 million dollars. All amortized costs were based on a 20-year repayment period at a 2% interest rate.

Table 5.5
Financial Analysis –Annualized Cost for Limited Municipal Water System

Item	Alternatives	
	75% Grants/ 25% Loans	100% Loans
Annualized Total Program Opinion of Probable Costs	$1,112,591	$4,450,365
Water System Operation and Maintenance Opinion of Probable Costs	$1,600,000	$1,600,000
Total Annual Opinion of Probable Cost (2006 Dollars)[1]	**$2,712,591**	**$6,050,365**

1 – Annual cost per life of loan repayment period of 20 years

6. REGULATORY AND INSTITUTIONAL ISSUES

Prior to construction and implementation of the proposed town-wide municipal water supply system, the Town will have the responsibility to meet regulatory and institutional requirements related to the project. Regulatory issues include coordination and submission of project documentation with state and regional agencies, whereas institutional issues would pertain to funding strategies and public support for a potable water system.

6.1 Regulatory Issues

In general a project of this scope and type could require regulatory coordination with the following,:

- Massachusetts DEP 310 CMR 22.00 Drinking Water Regulations
- Massachusetts DEP 310 CMR 36.00 Water Management Act Regulations
- Massachusetts Environmental Policy Act (MEPA) 301 CMR 11.00
- Massachusetts Endangered Species Act 321 CMR 10.00
- Massachusetts Wetland Protection Act 310 CMR 10.00 and 310 CMR 13.00
- Massachusetts Highway Department
- Army Corps of Engineers
- Eastham Conservation Commission
- Cape Cod Commission

Pursuit of new groundwater wells for the proposed town-wide water supply system would follow DEP's requirements for New Source Approvals for groundwater and would require support information, including:

- Site map identifying existing public water supply wells, property boundaries, local zoning information, existing and potential future sources of contamination, and environmentally sensitive receptors
- Site exam
- Test well drilling for water quality sampling, estimate of well yield, and well log profile
- Test well prolonged pump test

Once the prolonged pump test was completed, the next phase of work would consist of:

- Pump test report summarizing results, conclusions, and recommendations from the prolonged pump test
- Detailed engineering plans
- Plot plan showing necessary Zone I/Zone II protective radius
- Construction opinion of probable costs

For scheduling purposes, it is estimated that testing, permitting, regulatory review, and design would take approximately 12 to 18 months. From a DEP-permitting perspective, each of these sources can be permitted to pump under 70 gpm. When these sources are combined, however, to serve the Town, and the average consumption exceeds 70 gpm (100,000 gallons per day), the Town will need to acquire a Water Management Act withdrawal permit (310 CMR 36.17).

6.2 Institutional Issues

Institutional issues important to the proposed town-wide water supply to be resolved within the Town include:

- Which entity(ies) will bear the capital and operation and maintenance costs
- What will the future scope and magnitude of environmental monitoring will be required by DEP
- Will the residents of Eastham support a Town-wide municipal water system

The key factors for the town-wide municipal water supply system project to be successful include public support and project funding. Public support of the proposed water system through outreach and educational programs will be essential. Through discussions with the Working Group, it appears that the Town will investigate possible grant and funding opportunities in advance of detailed project work to gauge potential cost burden. These institutional issues and others will need to be addressed to successfully implement a potable water system in the Town of Eastham. Customer demand for this system will likely manifest itself in three primary ways:

- Demand by customers that are in need due to threats to public health from existing well water quality;
- Demand resulting from future Town public health regulations or by-laws that require connection by homeowners, commercial establishments, or institutions;
- Demand that derives from abutters, who would have the right to connect if capacity is available.

7. INITIAL PLAN IMPLEMENTATION

With an annual budget of less than $20 million, and the large upfront capital and annual operational expenses, a Town-wide water system would not be installed all at once. How should the Town phase the *initial* implementation of this water master plan?

First and foremost, the Town needs to determine whether sufficient water is available to support a Town-wide system. Activities in the past 6 months (i.e., Nauset High, District H) have taken significant steps in answering that question. Additionally, the Roach property and District G are currently being surveyed as the next sites on which to conduct pump tests. Groundwater modeling based on these pump tests would be conducted using the regional MODFLOW groundwater model constructed by the USGS in order to determine the yield from town-wide sources.

In the event that town-wide sources are insufficient to provide the requested yield, alternative sources should be identified and compared (e.g., Orleans/Wellfleet). Additionally, alternative management structures for a regional water entity should be explored. This could take the form of one Town serving as the "host community" that manages and operates the system, or it could be a water District comprised of multiple towns.

Construction of the limited water supply distribution system southeast of the Town-owned landfill utilizing either the Nauset High School well, or the District H well would be the likely next step. This would target the Town's water system to the area where it is most needed. Additionally, the Town's water division would be much smaller, where organizational structures and protocols would be ironed out prior to construction of a larger system.

The next logical step would be to expand the limited water system where it could reach the most residents for the least cost – Route 6. As shown in Table 5.2, over 75% of the capital costs associated with building the Town-wide system is associated with building the distribution system. Due to the high density of residents on both sides of Route 6, and the threat that this main artery presents to the sole source aquifer (e.g., salt application, vehicle discharges/accidents, and commercial development) the Route 6 corridor in Eastham would be next expansion of the water system.

According to the Lower Cape Water Management Task Force, construction of a water system along the Route 6 corridor and the landfill area would reach an estimated 2,000 connections (9 miles of water main including connection to wells). This represents approximately 33% of the anticipated 6,000 future Town-wide connections (LCWMTF, pg. 22). Costs would be substantially lower on a per-resident basis as the distribution system, which represents the most significant capital cost of a Town-wide system, is only 8% (9 of 116.8 miles) of the Town-wide road system.

8. CONCLUSIONS

This report provides the Town of Eastham with a preliminary master plan for a town-wide water supply system. The assessment for the water supply system addressed water needs, potential groundwater supply sources, opinion of probable program costs, funding alternatives, and review of regulatory and institutional issues. The following conclusions can be drawn from this report:

- The drinking water quality of the residents of Eastham has become increasingly vulnerable due to increased development/residential density within the Town, and contamination from point sources such as the Town-owned landfill.
- After using three models for estimating future water needs for Eastham, the one model that utilized accurate historic data for the Orleans system was selected as the most reliable. Based on that model, the future average annual water demand was estimated at 0.992 million gallons per day. Summer average demand is estimated to reach 1.805 million gallons per day, with a peak day demand as high as 2.6 million gallons per day.
- Four Sites were identified as potential water supply sources for the Town-wide system: Well-field Protection Zoning District "H", Nauset Regional High School, Eastham Water Protection District "G" (EWPD), and the Roach property. In addition, the Town of Orleans water system does have excess safe yield capacity to provide potable water to Eastham, should the need be there.
- Based on the historic data and reports available on the hydrogeology of Eastham, we believe it is possible that adequate groundwater resources would not be accessible within Town for full water system build-out. Therefore, it would be prudent to thoroughly explore regional options for water supply while more definitive data is gathered on the capacity of in-town sources.
- With a 25% contingency for conceptual level water system planning, the proposed limited water supply system would cost on the order of $73.4 million dollars including engineering, legal, and initial capital. Based on 6000 existing future connections within the municipal water supply system, the opinion of probable cost per connection equates to approximately $12,240.
- It is estimated that operation and maintenance costs for the proposed limited municipal water supply system would be on the order of approximately $1.6 million per year. This would generally include administrative, operational, and maintenance expenses ($266/connection/year).
- Depending on grant eligibility, the costs for the proposed municipal water system with annual operation and maintenance costs would range between $2.7 million and $6.05 million per year (assuming a 20 year loan @ 2%).

- The Town will need to meet a host of regulatory and institutional requirements before implementation of the town-wide water supply system.
- As part of the longer term planning effort, additional data should be gathered on available water supplies in Eastham to serve a town-wide water system. The data needed includes well logs, pump test results, and groundwater modeling analysis.
- Implementation of a town-wide water system would take place in phases. Considering the time requirements for Town Meeting actions, planning, design, permitting and construction, we recommend that the Town allow for a minimum of five years, and as long as ten years.

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