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WATER BALANCE ANALYSIS AND WASTEWATER TREATMENT PLANT TIE-IN ANALYSIS BANTA-DAVIS LAND AND ADJOINING LAND AT 338 BEDFORD ROAD, CARLISLE, MA

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Contents

Figures

INTRODUCTION

The purpose of this report is to analyze the development potential of the town-owned Banta-Davis land and the adjacent parcel at 338 Bedford Road (the former Goff property) with respect to water supply and wastewater disposal. The report is divided into the following sections:

- Existing conditions
- Potential development plans
- Water demands and wastewater flows
- Water balance / water budget
- Water infrastructure and permitting
- Wastewater infrastructure and permitting
- Conclusions and recommendations

EXISTING CONDITIONS

The Banta-Davis land, located on Bedford Road (Route 225) is approximately 38 acres in area, of which approximately 6 to 7 acres are playing fields, a paved and gravel road, and gravel parking. Two of the ball fields and a small, dug pond and irrigation well are located in the middle of the property, roughly half way between Bedford Road and Baldwin Road. The third field, a Little League field, is located toward the front and eastern edge of the Banta Davis property. The wastewater treatment plant (WWTP) and leaching field that serve the Carlisle public schools are situated among the playing fields on the Banta Davis property and collectively occupy, approximately one- half acre of land. A paved road off Bedford Road, which becomes gravel after the Little League field, is used to access the parking, fields and wastewater treatment facilities.

The adjacent 338 Bedford Road property, to the east, contains approximately 5 acres and currently includes a single-family home with a private well and septic system.

The Banta-Davis and 338 Bedford Road properties are shown on Figure 1.

Except for the first 150 to 200 feet along the entry road, both sites are relatively flat, rising generally from west to east from approximately 160 to 200 feet in elevation (NGVD Billerica USGS Quadrangle map). Wetlands were flagged on the Banta Davis site in 2006 and on the 338 Bedford Road site in 2013. The Banta Davis wetlands include an isolated wetland near the irrigation pond and a wetland running along the rear, southwestern property line. According to a Report by Stamski & McNary (April, 2012), there are no rare or endangered species or habitat on the Banta Davis site nor are there any certified vernal pools. The 338 Bedford Road property adjoins wetlands on the Fox Hill Conservation Land near Bedford Road, and contains a wetland area in the back of the property.

The subsurface conditions on both the Banta Davis and the adjoining 338 Bedford Road land change from the front portion near Bedford Road to the rear. The front portion of the combined sites, an area that includes the subsurface wastewater disposal field and the Little League field on the Banta Davis property, and an area that consists of upland fields on the 338 land, has a layer of sand approximately

25 to 35 feet thick over till and bedrock. Groundwater is approximately 15 feet below the surface and generally flows toward the north (Bedford Road). Because water flows readily through the sand and the groundwater table is deep, this is a good location for the existing or a future wastewater disposal field.

The layer of sand narrows and disappears further into the site to the south where bedrock rises toward the surface. There is a thin layer of till over the bedrock and in places rock outcrops appear in the rear, undeveloped portion of the Banta Davis site, south of the multi-purpose playing field, as well as in the far westerly portion of the Banta Davis land, between the softball field and the western property line.

According to the USGS Hydrologic Atlas HA-662, crystalline bedrock underlies the site, and well yields in such crystalline bedrock are commonly 2 to 10 gallons per minute (gpm). According to the USGS Water Recourse Report 90-4144 bedrock wells in the area are typically 100 to 300 feet deep and can have yields up to 200 gpm. The water is typically low in dissolved solids (120 mg/l), moderately hard (90 mg/l as calcium carbonate), slightly alkaline (PH 7.8) and may have traces of iron.

The USGS Investigation Report 5155 (2010) evaluates the yield of bedrock wells in the Nashoba Terrane, which is the zone of bedrock underlying large portions of central and eastern Massachusetts. The data in the report suggest that the bedrock under the site is either granite or schist and gneiss and that wells in these types of materials have average yields of 10 to 12 gpm, based on over 3,000 reporting wells. (Appendix A)

POTENTIAL DEVELOPMENT PLANS

In terms of providing water and disposing of wastewater, potential development on the Banta Davis land and 338 Bedford Road property needs to account for the existing and future water consumption and wastewater disposal needs for the Carlisle Public School. Water to the existing school, on another parcel, is provided separately by a well at the school, but wastewater is treated and disposed on the Banta-Davis land. Wastewater flows from the existing school are discussed in the next section. It is anticipated that water for a future school on the Banta Davis land would come from a new water supply well on the Banta Davis site

The potential development of the Banta-Davis and 338 Bedford Road properties are subject to future public approvals, including Town Meeting votes for land use and/or funding. Accordingly, the potential development for which the water and wastewater capacities of the combined Banta Davis and 338 Bedford Road sites are analyzed includes the following, in addition to maximizing the use of the existing Carlisle Public School:

Banta-Davis Property

1. Up to 50 Units of Multi-family Rental Housing (up to 79 bedrooms)
2. New K-8 School (300 to 400 students)
3. Existing three playing fields plus, per the 2013 Carlisle Open Space and Recreation Plan, one additional multi-purpose playing field and four tennis courts

338 Bedford Road Property

1. Group homes for the adult developmentally disabled (9 or 10 bedrooms)
2. Community Center for up to 400 people (up to 10,000 sq. ft.)

We were asked to assume that use of the WWTP by the existing Carlisle school might increase in the future, if and when student enrollment increases. Available capacity in the WWTP will be allocated first to this increased enrollment in the existing school, and only then to other potential development. Accordingly, the analysis in this report contemplates that the existing school enrollment might increase to as many as 800 students, which we understand to be approximately 110% of the design population for the Carlisle Public School. Because we have robust wastewater data sets from the existing school over a number of years, we can determine expanded school population wastewater flows with a high degree of confidence.

WATER DEMANDS AND WASTEWATER FLOWS

Water demands and wastewater flows are typically reported in terms of average annual and peak day conditions, each in gallons per day (gpd). The average day flows are the total volume of water or sewage over a year divided by 365 days. The peak is the highest single day during the year. The peak condition for small wastewater treatment systems, similar to the one in Carlisle, is typically between 2 and 3 times the average. In Massachusetts, because there are State-approved published standards for wastewater flows and not for water demands, typically wastewater flows are calculated first and then water demands are estimated, rather than the other way around. So the first step in this process is to develop wastewater flows.

Wastewater Flows. The existing flows from the school are based on actual data recorded at the treatment plant. Further, for public schools, Mass DEP has modified the definition of peak flow to account for the specific nature of school operations. For Carlisle, DEP has approved a peak design flow based on the average of the maximum day flow during each month except July and August. (MassDEP letter dated April 17, 2012) Further, weekend data are not used to calculate average day conditions for school flows. Based on this definition, which includes only weekdays when school is in session, Stamski and McNary summarized, and MassDEP concurred in, the flow data for 2011. Updated data for 2012 and 2013 (less December) were obtained from David Flannery of the Carlisle Public School and the WWTP operator, Weston & Sampson. The flow data are summarized in Table 1.

Table 1. Wastewater Flows from Carlisle Schools (gpd)

	Year		
Condition (1)	2011	2012	2013
Average day	2,266	1,956	2,314
Average of max day each month	**4,324**	**3,460**	**4,103**
Max day	6,210	3,930	5,000
WWTP Capacity	13,500	13,500	13,500
Available Capacity, per DEP guidance (2)			9,397

(1) Data represents flows on weekdays and excludes July and August.

(2) WWTP capacity less the average of the max day each month, except July and August.

As the data show, the average of the max day flows decreased from 2011 to 2012, then increased in 2013, but remained below 2011 levels. The last data that DEP reviewed in April 2012 were from 2011. In its April 17, 2012 letter, DEP called for updating data prior to adding non-school flows to the WWTP. Based on the relatively consistent school flows over multiple years, the WWTP continues to have at least the excess capacity recognized by DEP in its April 2012 letter. As noted in the April 2012 DEP letter, the WWTP was constructed with a 7,000 gallon equalization tank, further reducing the impact of peak flows on the system.

To account for the potential maximum utilization of the existing school in the future, the average max day flow per pupil was calculated and applied to the potential additional enrollment. Clearly additional pupils also entail additional teachers, staff, parents and other visitors, but by using the more-readily-available pupil counts to calculate a per-pupil-flow rate, wastewater generated by adults at the school are incorporated into per-pupil flow figures. In 2012-13 there were 645 students enrolled in the Carlisle Public School. Thus the per-pupil average maximum flow in 2013 was 6.36 gpd.

We understand the current Carlisle Public School was designed for a comfortable occupancy of approximately 725 pupils. We further understand that the current physical school might be pushed to accommodate as many as 800 pupils for a limited number of years during peak student demographics, approximately 110% of the comfortable design capacity. This is approximately 155 more students than are currently enrolled in the school. Adding the flow from these additional students to the existing design flow of 4,100 gpd would increase the design flow by 985 gpd to 5,085 gpd.

The existing WWTP permitted capacity is 13,500 gpd. Thus the available capacity for other development is approximately 8,400 gpd

The wastewater flows for the potential development are summarized as follows:

Table 2. Daily Wastewater Flows for Future Development (gpd)

Use	Peak (1)		Average (2)	
	Title 5	LEED	Title 5	LEED
Banta-Davis Property				
50 Units of Multifamily Housing (79 bedrooms)	8,690	6,083	4,345	3,042
New K-8 School (400 students)	3,200	2,544	1,600	1,272
Goff Property				
Community Center for 400 people (10,000 sf)	2,400	1,680	1,200	840
Group Housing (10 bedrooms)	1,100	770	550	385
Total	15,390	11,077	7,695	5,539

1. Based on 110 gals/bedroom, 8 gals/student, and 6 gals/person per Title 5 of the State Sanitary Code. LEED flows are 70% of Title 5 based on water conservation for housing and the community center and school flows are based on 6.36 gpd per student from existing data.
2. Average flows are 50% of design flows.

Of the potential development flows, only the group homes for the developmentally disabled are reasonably foreseeable at this time. There is more than adequate capacity in the WWTP to accommodate up to 10 bedrooms of group housing and maximum occupancy of the existing Carlisle School.

At the same time, the current WWTP does not have the capacity to treat the Title 5-derived peak design flows for all the proposed development. However, as discussed below under Wastewater Infrastructure and Permitting, there are opportunities to accommodate more development in the treatment plant using a combination of the following approaches:

1. Use more realistic flows, based on LEED development principles for water conservation.
2. Schedule development in a step-wise fashion so it is clear to DEP that actual flows do not approach Title 5 peaks.
3. Utilize the suitable, sandy soils in the central portion of the 338 Bedford Road property for wastewater disposal needs for the group housing, and
4. Reduce the size of one or more development elements.

Water Demand. The water demand for the existing school is served by a separate well that is at the school. The existing school well pumped approximately 3,000 gpd on an average school day during 2013. School water withdrawals have not resulted in any reported loss of water to abutting residences or churches over many years of operation. The water demand for the potential development, including a second school, would be served by a new bedrock well located on the undeveloped land in the rear of the Banta Davis site.

Water demand is normally higher than the wastewater flows because of losses in the system, consumptive uses and outdoor uses that do not enter the sewer system. An increase in the wastewater flows of 10% is typical to account for these conditions.

Increasing wastewater flows for all potential development by 10% gives the estimated water demands as follows based on Title 5 and based on LEED building principles with water conservation:

Average day 8,465 gpd (6,093 gpd with LEED water conservation)

Peak day 16,929 gpd (12,185 gpd with LEED water conservation)

To put these numbers in perspective, the average day demand of 8,465 gpd would equal approximately 6 gpm. A garden hose typically flows at 6 to 10 gpm.

See Appendix B for wastewater and water data.

WATER BALANCE / WATER BUDGET

A water balance (sometimes referred to as a water budget analysis) is useful to understand if the annual precipitation over an area (input) is sufficient to sustain the uses that export water (output) from the same area. This can be a concern when water is drawn from one part of a watershed and transported to a distant part, or outside of the watershed, via municipal sewers. Carlisle is a largely residential community with large lots and no sewers and therefore has a highly conservative water budget in that most of the water withdrawn from wells is returned to the ground through nearby septic systems. Such

Because of the configuration of the Banta-Davis land, the likely location of the new well, the location of the wastewater disposal field and the geology, water would be moved only about 400 yards from the well location, through the treatment plant, to the soil absorption field, but would stay within the same watershed. Nonetheless, to be conservative, it is useful to look at a 'worst case' condition comparing only the localized precipitation around the well (input) with the well withdrawal (output).

The estimated average day water use for the combined potential development elements is 6,093 gpd, using the 110% of average wastewater flows method for calculating water demand and LEED water conservation. The new well will require a Zone 1 protective radius of approximately 278 feet, where no development can occur (see next section for an explanation of the Zone 1). The recharge (input) to groundwater from precipitation in the 5.6 acre Zone 1 area alone (disregarding additional recharge from precipitation falling on other portions of the Banta Davis land) averages approximately 8,311 gpd. (See Appendix C for calculations)

In short, the annual groundwater recharge from precipitation in Zone 1 alone will be greater than the amount of the water pumped from the well by about 36%. The localized recharge from precipitation within the Zone 1 is more than adequate to permanently sustain the potential well withdrawal, including water for a second school that is not likely to be built for several decades.

If water demand for only the potential community center and potential rental housing are considered (i.e. the distant-future second school water demand is not included), then the water budget / water balance analysis becomes even more favorable.

In addition, treated wastewater from on-site development, plus treated wastewater from the existing school will be returned to groundwater within a relatively short distance, and additional areas of Banta Davis also receive precipitation which adds to groundwater recharge.

WATER INFRASTRUCTURE AND PERMITTING

As noted above, a new well and an associated Zone 1 protected area would be needed in the rear of the Banta Davis property to serve the potential development. The State will classify the well as a public water supply since it would serve more than 25 year-round residents. The State Drinking Water Regulations (310 CMR 22.00) and Guidelines for Public Water Supplies (MassDEP, May 2010) cover land use, capacity, water quality, engineering, O&M and financial matters related to the well. The Guidelines describe a 25-step process for the approval of a new public water supply. Two early steps are critical and if not satisfied will end the process. These two steps are: (1) siting the well and control of surrounding land uses, and (2) proving the actual capacity or safe yield of the well after drilling and conducting a pumping test, but before the well can be used as a source of potable water. If these two issues are resolved satisfactorily, the remaining steps consist of demonstrating safe water quality, engineering the facilities, financial planning and administrative tasks. It is not uncommon for the process of permitting a public water supply well to take between 9 months and a year.

Siting and Land Uses. There is only one option in siting a potential well on the Banta Davis property and that is in the undeveloped rear portion of the site. This is due to the MassDEP requirement to protect the quality of the water drawn from the well. To insure this protection, the State will require a Zone I, undeveloped area around the well. The Zone I is a circle around the wellhead with a radius defined by the maximum, potential well use, using the peak design flow from Title 5.

As shown in Table 2 under Title 5, the peak day wastewater flows from all potential development elements, including a new school, would be 15,390 gpd (10.7 gpm). As noted above this yields a Zone I radius of approximately 278 feet, using MassDEP calculation guidelines. The Zone I land must be owned or controlled by the water supplier and the uses in Zone I must be limited to those associated with the water system and have no significant impact on water quality.

Only the rear, undeveloped portion of the Banta Davis land (land that is almost certain to remain undeveloped due to the fact that it is interspersed with ledge and wetland and has the most restricted physical access of any portion of the property) is adequate to contain the Zone I area. Based on the 278 foot required radius, the Zone I contains approximately 5.6 acres. As shown on Figure 2, a well can be sited in the rear of the Banta-Davis property and comply with Zone I requirements.

In addition to the Zone I, MassDEP regulations also create a larger, Interim Wellhead Protection Area (IWPA) around public water wells. The IWPA is a surrogate for a Zone II which is the "cone of influence" area of the aquifer that may contribute water to the well under prolonged pumping at the design rate for 180 consecutive days without precipitation. The land uses in the IWPA are less restrictive than in the Zone I, and effectively exclude hazardous and industrial uses noted in the regulations. There is also a restriction on nitrate loading rates in the IWPA, such that nitrate concentrations in the well water do not exceed 5 milligrams per liter (mg/l). Carlisle zoning already complies with the IWPA requirements both with respect to hazardous and industrial uses and nitrate loadings by virtue of the minimum 2 acre residential lot size.

Capacity or Safe Yield. The capacity of a well is often listed as the safe yield. The safe yield is the amount of water, typically given in gallons per day (gpd), that can be pumped for sustained periods and not adversely impact groundwater resources. This doesn't mean the well can't be pumped at higher rates for short periods, but these situations rarely arise or are necessary based on the conservative procedures set by the State in setting safe yield rates.

The safe yield of a well is calculated based on the results of a prolonged pumping test. The State requires that water well sources be designed based on the maximum day demand for the design year. Further, for bedrock wells, MassDEP requires that the pumping test be run at 133% of the hypothetical maximum day demand. This would require that a pumping test on a well on Banta Davis property be performed at approximately 20,469 gpd or 14.2 gpm. If the pumping test shows stable drawdown and recovery conditions in the test well over a minimum of 48 hours of pumping and projected over 180 days, this flow will be approved as the well's safe yield. It would be useful to monitor the irrigation pond well during the pumping test to provide data showing the impact of pumping at the proposed well.

Pumping at 133% of the maximum day demand is a conservative requirement, very unlikely to be exceeded during actual well use. Moreover, MassDEP has increasingly moved from a 48-hour continuous pump test to a 7-consecutive-days pump test for proving well safe yield.

It is possible that a well in the rear of the Banta-Davis property will yield 14.2 gpm based on the history of wells in similar fractured bedrock conditions. A pumping test according to DEP guidelines, as described above, will be needed to establish the safe yield of the well, early in the permitting process.

In addition to the control of Zone I and proving safe yield, the quality of the groundwater is important. Because the land uses on and in the vicinity of the Banta-Davis property are benign, water quality is anticipated to be good. As a precautionary measure there may be a need to disinfect, depending of the results of water samples taken during the pumping test. The results of the water sampling will also determine if additional treatment (e.g., water softening) is needed.

The potential water supply system would include the well and pump(s), storage tankage, standby power, distribution piping, valves and meters.

The time it takes to permit a Public Water Supply could delay the Group Housing, which is the first scheduled project. To expedite construction a separate well, below the threshold for Public Water Supplies, could be developed on the 338 Bedford Road property to serve the housing. This would only require local permitting.

WASTEWATER INFRASTRUCTURE AND PERMITTING

One of the advantages of the Banta-Davis property is the treatment plant located on-site with significant available capacity. According to DEP's letter of April 17, 2012, the treatment plant has a design capacity of 13,500 gpd and only 4,324 gpd of that capacity was being used based on an average of the maximum day flows for each month during 2011, excluding July and August. As noted above, the average of the maximum day flows have slightly decreased in 2012 and 2013 from the 2011 flows. DEP acknowledged available capacity at the WWTP of approximately 9,200 gpm as of April 2012. DEP went further to say that more recent data should be used to up-date available capacity before tying in new flows from non-school sources. Using the 2013 data give a slightly larger available capacity of 9,400 gpd, subject to approval by DEP. "Grossing up" the existing school flows to 800-pupil enrollment levels (approximately 110% of school architectural design capacity), to allow for future school population growth, yields a design flow (calculated per DEP's April 2012 letter) of 5,090 gpd. This leaves available, long-term capacity in the existing WWTP of approximately 8,400 gpd.

Using Title 5 design flows, the total potential development would generate 15,390 gpd. This is in excess of the available WWTP capacity of 8,400 gpd, after accounting for the existing school at a maximum capacity of 800 students. However, there are several options, which together can reduce this gap and accommodate the wastewater from the majority of the potential development elements.

First, the flows in Title 5 of the State Sanitary Code are conservatively high, especially considering the latest Plumbing Code requirements and available conservation measures. LEED requirements for sustainable buildings have credits for reducing water use by 30% to 40%, which is possible with available conservation measures. As an example, the school's water use was reduced by 19% from 2012 to 2013 in part with low flow fixtures and water-saving devices installed as part of a major reconstruction. Water conservation should be taken advantage of as it is an accepted industry practice acknowledged by DEP. Appendix C contains information on potential water reductions using existing proven conservation methods.

If a savings of 30% were realized in the new development, the 15,390 gpd would be reduced to 11,077 gpd. Except for schools (310 CMR 15.416) however, these savings are not accepted by DEP until after the buildings are operational and the flows measured and confirmed. But because group housing wastewater flows would be connected to the WWTP before any community center or rental housing flows, and all potential flows would be connected many years before a second school was constructed, the actual lower flow figures would exist long before second school construction was required. This would allow a more realistic wastewater flow budget for the WWTP during DEP review.

A second option would be to convince MassDEP to allow a separate leaching system for the group housing on the 338 Bedford Road property. We understand from the Trust that the Master Planning team (especially Samiotes Consulting engineers) has already raised this question with MassDEP. Subject to testing, the peak Title 5 flow of 1, 100 gpd could be accommodated in the front portion of the 338 Bedford Road property where soil conditions are similar to those under the Banta-Davis leaching field. Water to the housing could also be served by a small well dedicated to this use.

Under this option the Group Housing would be a stand-alone project and, because of its size, would keep permitting local. A Groundwater Discharge permit and Public Water Supply approval would not be needed from DEP. This would allow for an expedited permitting and construction schedule.

A third option would be to reduce the size of the community center to serve 300 people and to reduce the number of rental housing bedrooms.

Combining these three approaches (water conservation, a separate leaching system and adjustments in the size of the community center and rental housing) gives a number of development options, several of which are presented in Table 3.

Table 3 Use of Available WWTP Capacity of 8,400 gpd

Uses	Options, gpd (1)			
	1	2	3	4
New School, students				
300	1,908	1,908		
400			2,544	2,544
Group Housing, bedrooms				
10	770	on-site	770	on-site
Community Center, People				
300		1,260		1,260
400	1,680		1,680	
Rental Housing, bedrooms				
52	4,004			
67		5,159		
44			3,388	
59				4,543
Total	8,362	8,327	8,382	8,347
Remaining capacity	38	73	18	53

1. Flows are 70% of Title 5 based on water conservation.
2. The on-site option includes a separate septic tank and leaching field on the 338 Bedford Road property.

The permitting process for adding flows to the WWTP for developments that are under different ownership (School, Trust) would require legal agreements between or among the different owners

The permitting process for adding flows to the WWTP for developments that are under different ownership (School, Trust) would require legal agreements between or among the different owners that identify the basis for cost contributions (e.g. metered water use), the operation and maintenance responsibilities and easements. A new Ground Water Discharge Permit would not be needed. However, if a separate septic tank and leaching field were constructed on 338 Bedford Road, this would require a new permit from the Board of Health.

CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis described above, the following conclusions can be made:

1. Based on wastewater flow data from the school and industry standards, the peak design flows given in Title 5 of the State Sanitary Code are high and this condition has been recognized by DEP.
2. With water conservation measures there is adequate capacity in the existing WWTP, together with separate on-site disposal, to accommodate flows from a scaled down potential development provided the individual projects are scheduled over time.
3. There is adequate land on the Banta Davis property to locate a Zone 1 protective area around a new well which would provide water for the potential development.
4. A pumping test will need to be run to prove that a new well has adequate capacity to serve the potential development. If a lower safe yield is determined, then the development elements would need to be reduced in kind.

Based on these conclusions, the following development plan is recommended.

1. Schedule the individual development projects such that flow data from each can be collected and documented over at least a 2 year period.
2. Develop a wastewater plan (Table 3, Option 2) that maximizes the use of the WWTP and also uses on-site disposal on 338 Bedford Road for the Group Housing. The plan allows for the following projects to be connected to the WWTP:

    - Rental housing with 67 bedrooms
    - Community Center serving 300 people
    - New School serving 300 students

3. Begin the process for DEP approval of a public water supply on the Banta Davis property and as an early action conduct a pumping test at the proposed well site to determine safe yield.
4. Provide water for the Group Housing with a new well on 338 Bedford Road to allow for a stand-along project where permitting can be expedited.

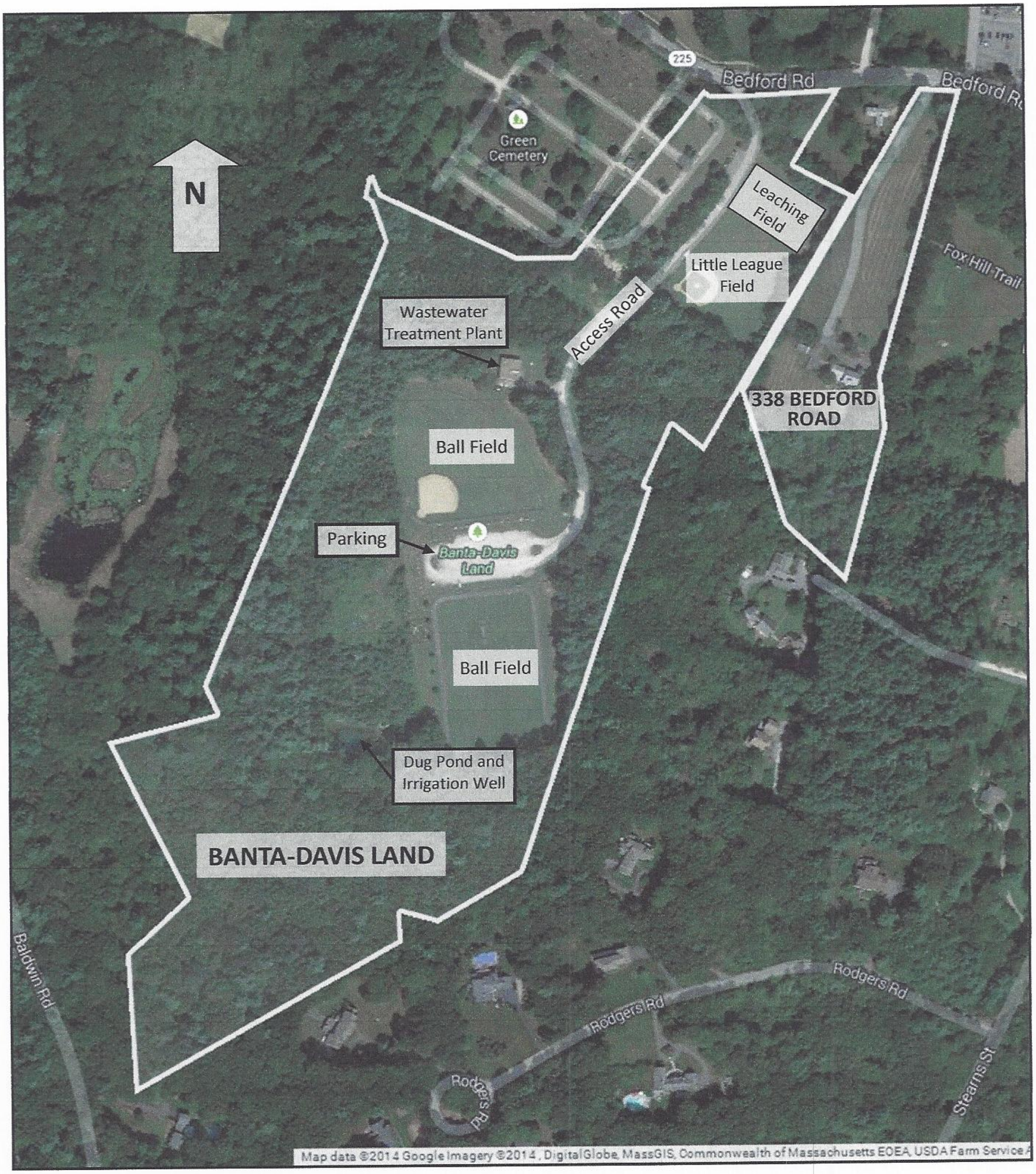


Figure 1. Existing Conditions
Banta Davis and 338 Bedford Road Properties

1in = 350 ft

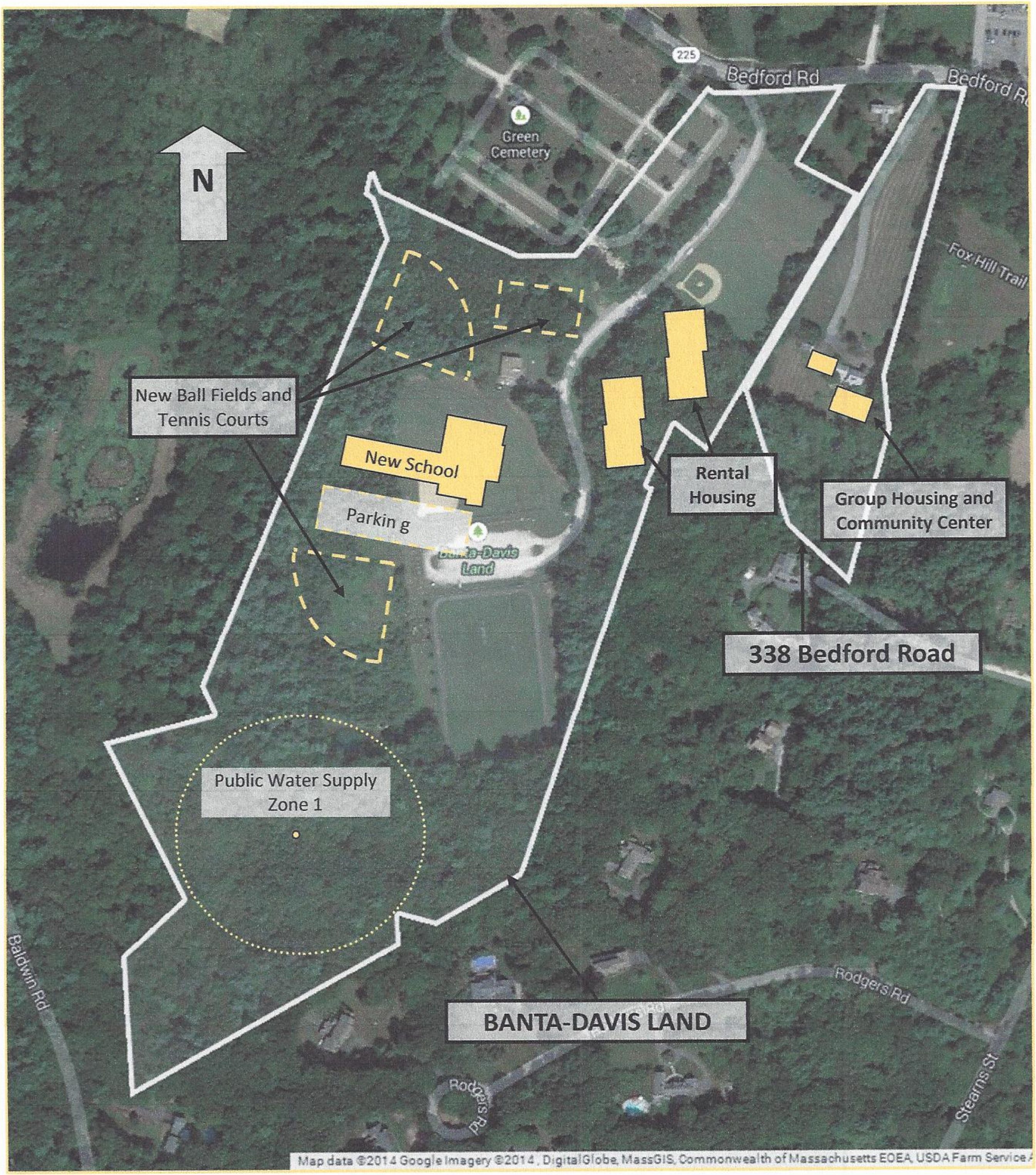


Figure 2. Proposed Development
Banta Davis and 338 Bedford Road Properties

1in = 350 ft

Appendix A

Subsurface Data

1. Report 5155, Figure 14 Page 31
2. USGS Geology Map
3. USGS Topographic Map (Billerica Quad)

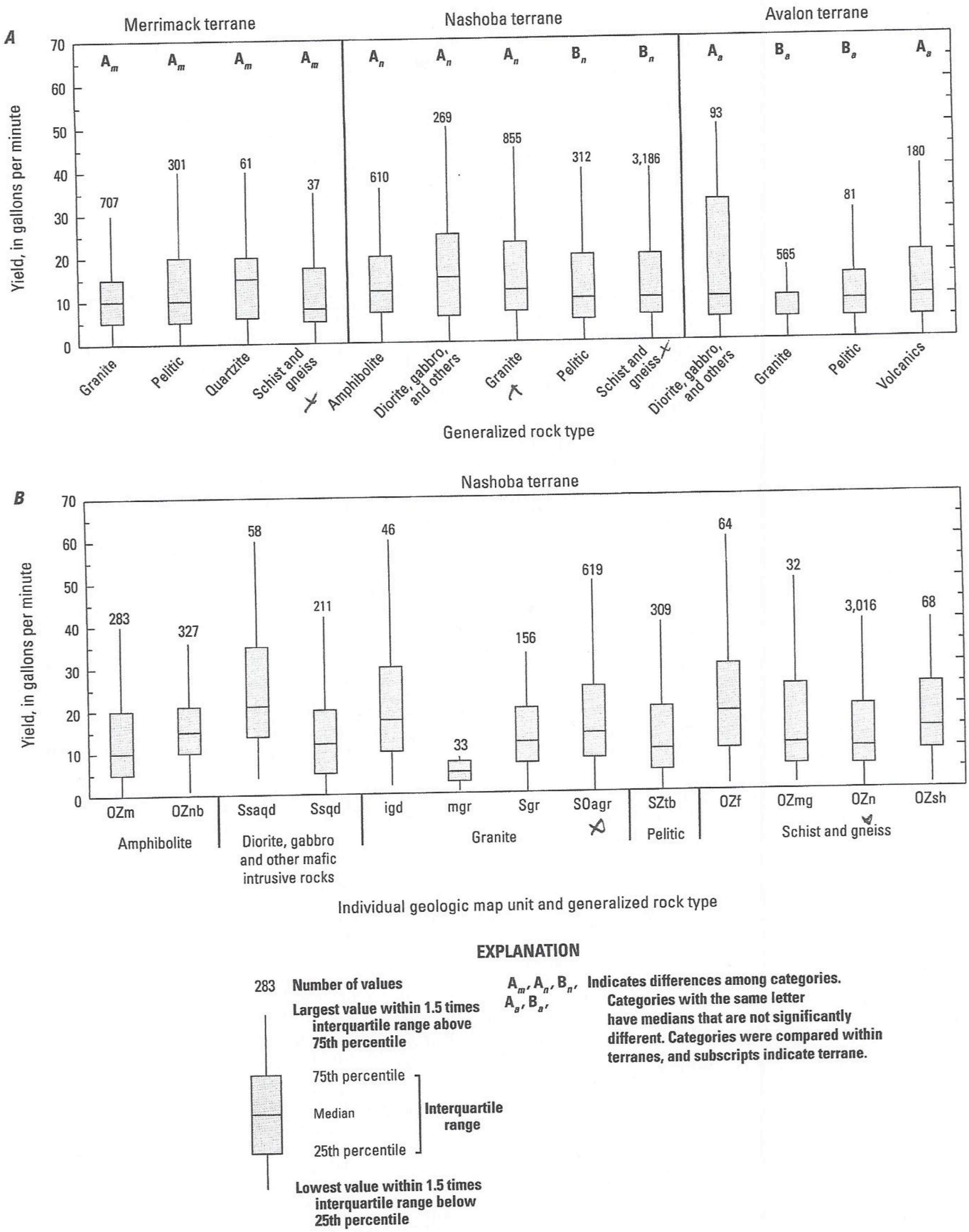
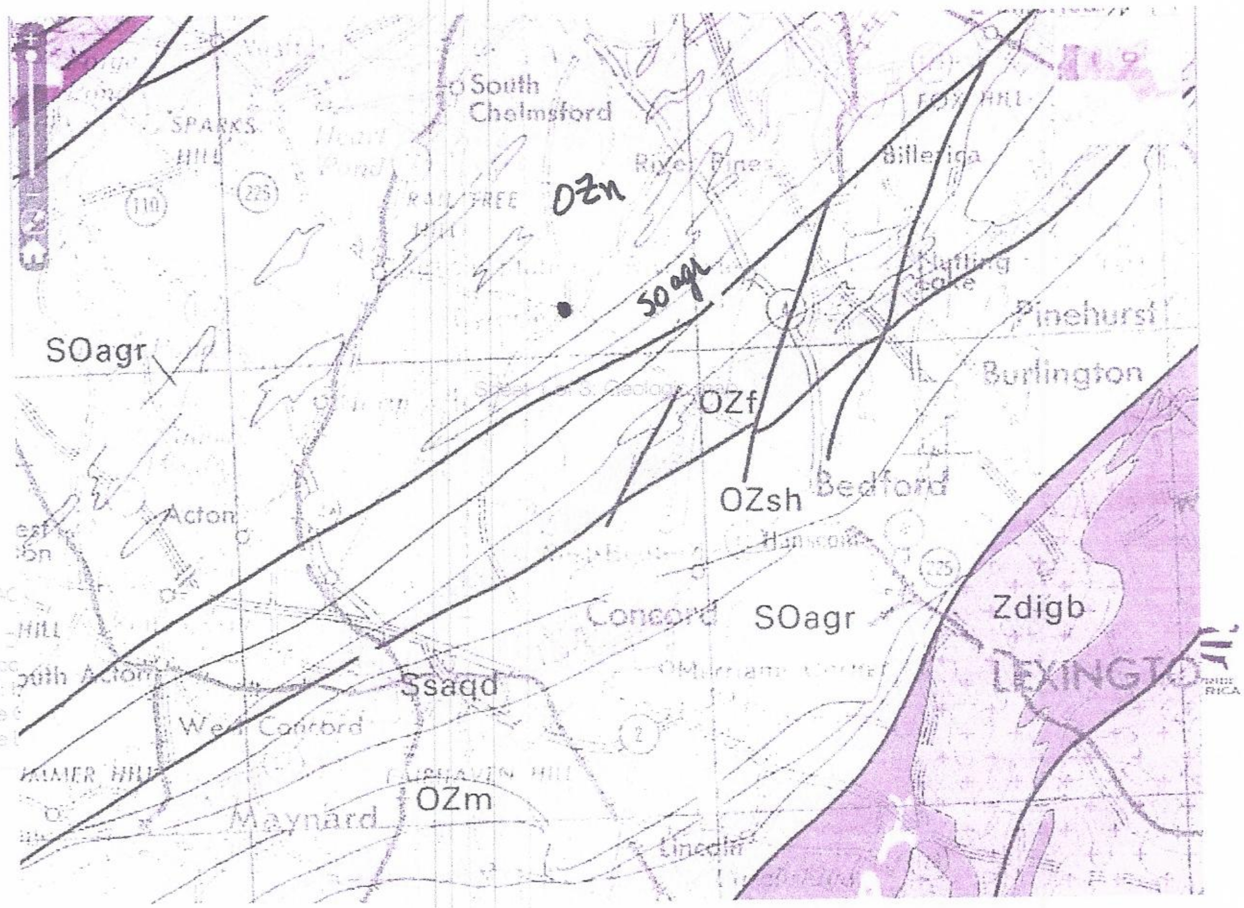


Figure 14. Well yield by bedrock geology. *(A)* Well yield by generalized rock type in the Nashoba terrane and surrounding area. *(B)* Well yield by individual geologic map unit in the Nashoba terrane. See table 1 and appendix 2 for explanation of individual geologic map unit abbreviations.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SPARKS HILL
River Pines
Billerica
FOX HILL
OZn
Soagr
Nutting Lake
Pinehurst
SOagr
Burlington
OZf
Acton
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Lincoln

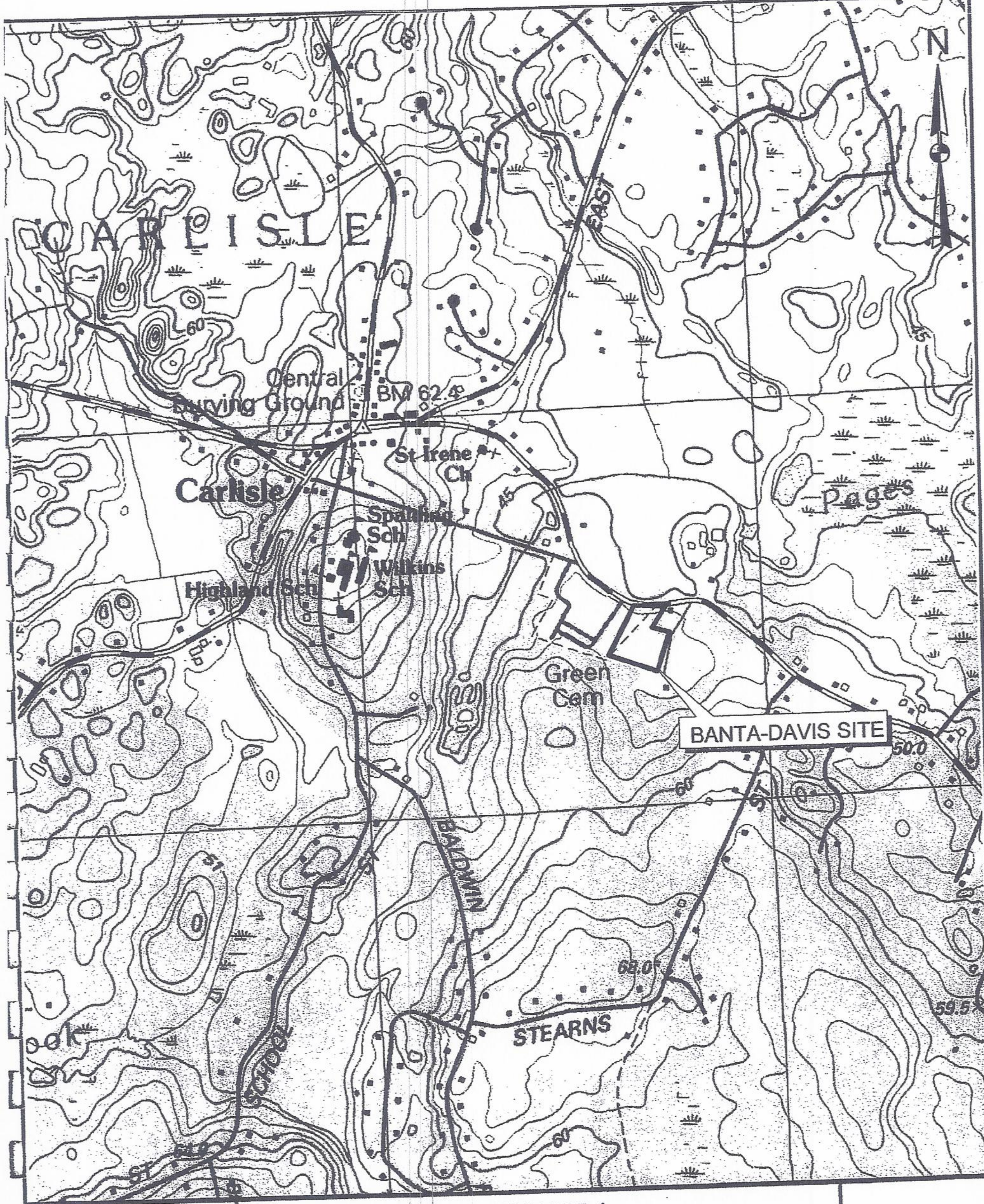


FIGURE 1.
LOCUS MAP

SCALE | SOURCE:

Appendix B

Flow Data

1. Carlisle Public School Water Withdrawals
2. Carlisle Public School Enrollment
3. Wastewater Flows (2012, 2013)

CARLISLE PUBLIC SCHOOL
83 School Street
Carlisle, MA 01741

Water Flows									
	2005	2006	2007	2008	2009	2010	2011	2012	2013
Jan	77,100	78,100	88,600	84,300	65,900	69,800	55,400	80,000	65,800
Feb	64,200	67,400	61,900	66,500	61,400	53,700	48,900	70,400	47,100
Mar	99,100	103,600	92,800	82,600	76,900	79,800	79,900	101,300	64,200
Apr	74,600	67,200	68,600	72,200	66,800	64,500	66,300	73,000	55,500
May	93,800	95,000	93,700	89,900	82,800	77,100	79,400	86,000	74,200
Jun	82,700	72,300	58,300	61,300	70,700	52,700	79,300	62,300	54,200
Jul	26,300	17,700	14,400	16,200	15,200	15,300	31,400	21,500	9,300
Aug	17,700	18,200	14,700	13,900	23,800	13,700	22,600	38,100	12,800
Sep	93,100	83,700	80,800	81,800	85,300	67,600	77,600	71,600	66,800
Oct	95,900	89,400	92,000	88,000	88,400	70,600	75,800	66,200	71,200
Nov	111,200	83,800	77,400	66,600	74,100	67,300	75,900	61,800	56,800
Dec	67,800	65,600	53,500	62,600	62,400	57,600	64,600	33,500	46,100
	903,500	**842,000**	**796,700**	**785,900**	**773,700**	**689,700**	**757,100**	**765,700**	**624,000**

Annual Water Flows	
1989	685,616
1990	560,326
1991	519,936
1992	514,623
1993	554,914
1994	352,909
1995	347,695
1996	583,100
1997	631,100
1998	620,900
1999	739,000
2000	754,500
2001	786,900
2002	829,400
2003	805,400
2004	835,400
2005	903,500
2006	842,000
2007	796,700
2008	785,900
2009	773,700
2010	689,700
2011	757,100
2012	765,700
2013	624,000
2014	

Construction on New Spalding starts
Project ends Oct, 2012

Water Flows are from Drinking Water Monthly Chlorination Reports
UOM (Gallons)

C:\Users\moorec3\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\3CAUT35M\Enrollment Projections ~water flows.xlsAnnual Water Flow

CARLISLE PUBLIC SCHOOL
83 School Street
Carlisle, MA 01741

Enrollment PreK-8	
Fiscal Year	**CPS**
2003-2004	**807**
2004-2005	**810**
2005-2006	**799**
2006-2007	**770**
2007-2008	**750**
2008-2009	**705**
2009-2010	**687**
2010-2011	**656**
2011-2012	**650**
2012-2013	**645**
2013-2014	**642**
2014-2015	**654**
2015-2016	**652**
2016-2017	**643**
2017-2018	**650**
2018-2019	**641**
2019-2020	**650**

YEAR	Actual Births*
1999	58
2000	44
2001	45
2002	46
2003	32
2004	41
2005	24
2006	24
2007	29
2008	29
2009	22
2010	33
2011	23
2012	24
2013	
2014	
2015	

** Source: Carlisle Town Clerk's Records*

Actual

NESDEC 10/10/13 Projections

Appendix B Flow Data
Wastewater, 2012

Month	Volume, gal Total	Weekdays	Flow/Weekdays gpd (days)	Max Day gpd
January	49,560	34,350	2,021 (17)	3,290
February	38,290	23,990	1845 (13)	3,310
March	56,650	38,540	2,267 (17)	3,610
April	60,450	36,130	2125 (17)	3,850
May	51,440	35,690	1,983 (18)	3,570
June	31,830	14,190	1,774 (8)	3,140
July	3,010	-	-	-
August	3,890	-	-	-
September	30,670	21,990	1,833 (12)	3,460
October	26,430	18,520	1,684 (11)	3,030
November	40,540	28,750	2,053 (14)	3,406
December	42,980	23,770	1,981 (12)	3,930
Totals	435,740		Average 1,956	3,460

Appendix B Flow Data
Wastewater, 2013

Month	Volume, gal Total	 Weekdays	Flow/Weekdays gpd (days)	Max Day gpd
January	47,250	28,810	1,801 (16)	3,540
February	43,970	26,910	2,243 (12)	4,170
March	65,210	36,270	2,267 (16)	4,220
April	55,540	36,070	2,576 (14)	4,400
May	62,770	38,290	2,252 (17)	2,790
June	59,390	33,010	2,751 (12)	4,820
July	8,510	-	-	-
August	4,640	-	-	-
September	35,550	25,900	1,619 (16)	3,980
October	71,140	51,910	2,732 (19)	5,000
November	57,280	29,419	2,451 (12)	4,150
December	-	-	2,444 (12)	3,960
Totals	511,250		Average 2,314	4,103

Appendix C

Water Budget

1. Zone 1

a. Design Flow	15,390 gpd (Based on Tille 5)
b. Radius	278 ft [(150 x log 13,390) - 350]
c. Area	242,672 ft^2 5.57 acres
d. Annual Preparation	45 inches
e. Annual Evapotranspiration & Runoff	25 inches
f. Annual Recharge	20 inches
g. Annual Recharge in Zone 1	3.03 million gallons = 8,311 gpd

   h. Average Withdrawal (6,093 gpd) based on water conservation
   i. Withdrawals will not stress water resources
   j. Annual Recharge on entire 43 acre (Banta-Davis and 338 Bedford Road) equals 64,150 gpd

2. IWPA

a. Design Flow	15,390 gpd (10.7gpm)
b. Radius	742ft [(10.7gpm)32 + 400]
c. Area	1.73 ft^2 = 40 Acres

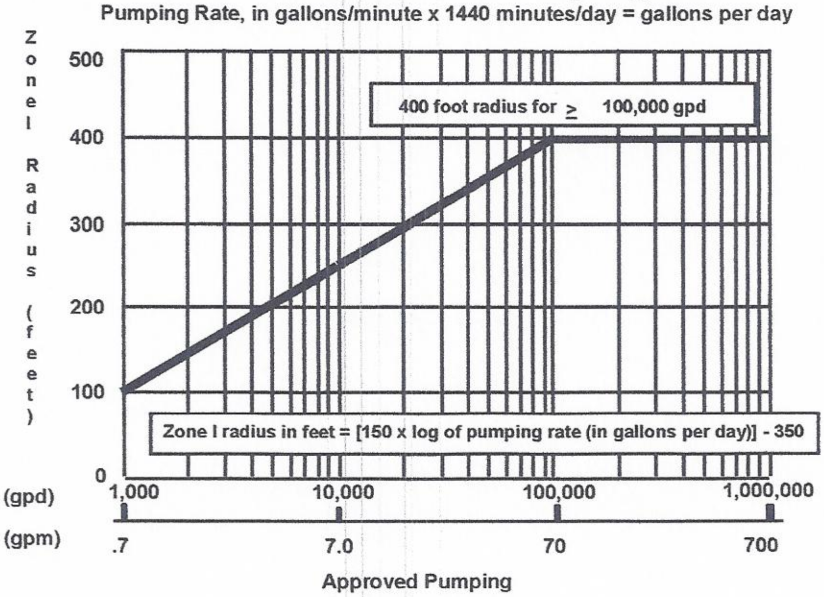
3. Water Conservation
   a. Water Efficiency Data
   b. LEED Requirements

4. Local Well Data, Rodgers Road

Appendix D

Zone I Radius vs. Pumping Rate

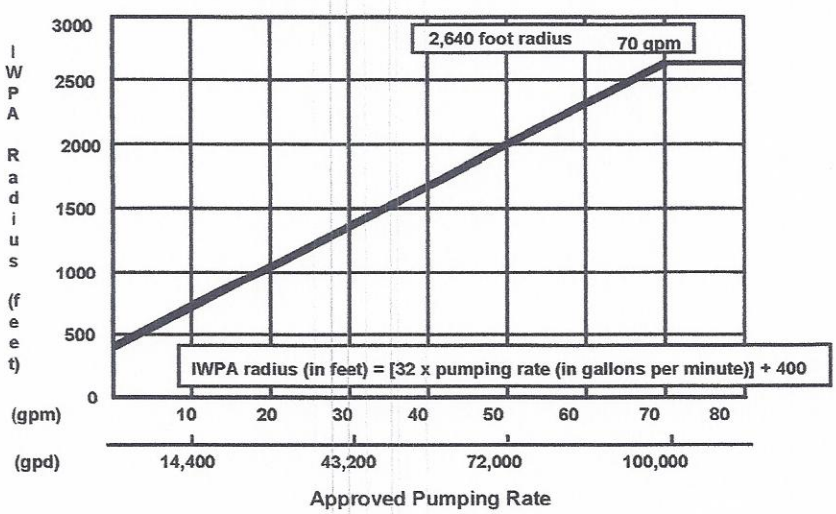
Pumping Rate, in gallons/minute x 1440 minutes/day = gallons per day

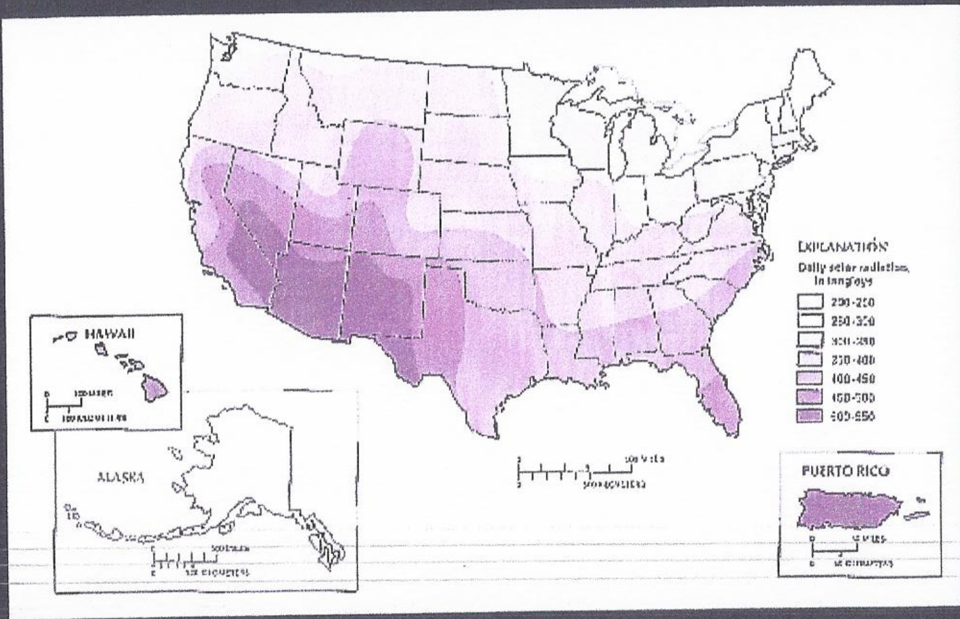


A minimum Zone I radius of 100 feet shall be applied to all groundwater sources with Approved Yields of 1,000 gallons per day or less.

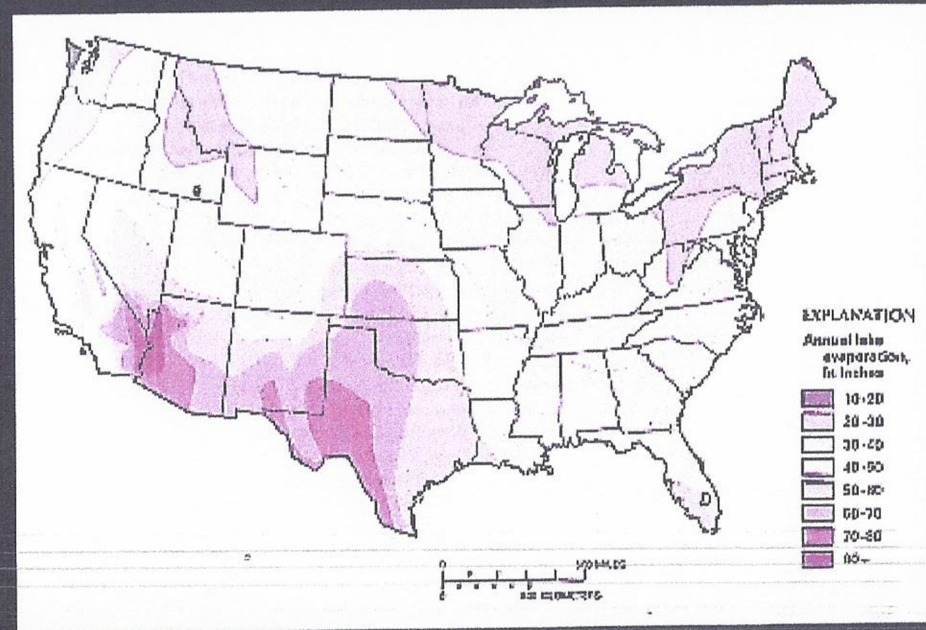
IWPA Radius vs. Pumping Rate

Pump Rate, in gallons/minute x 1440 minutes/day = gallons per day

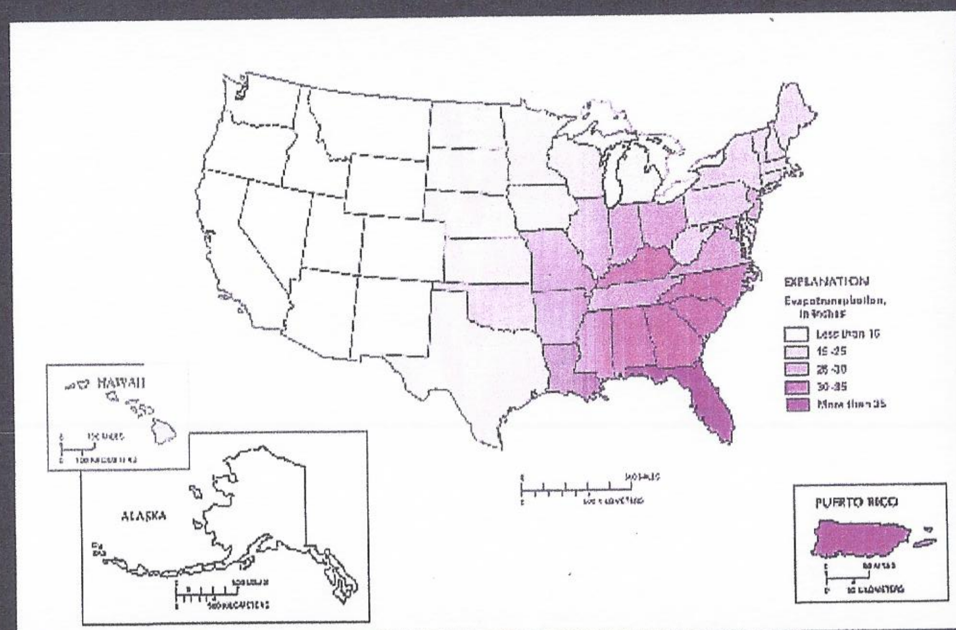




Mean daily solar radiation



Mean annual lake evaporation



Mean annual ET

the inflows, outflows, changes in storage, movement of water in the system, and possibly other important features. As a mathematical representation of the system, the model can be used to estimate the response of the system to various development options and provide insight into appropriate management strategies. However, a computer model is a simplified representation of the actual system, and the judgment of water-management professionals is required to evaluate model simulation results and plan appropriate actions. We return to the use of models in the final chapter of this report, "Meeting the Challenges of Ground-Water Sustainability."

Because any use of ground water changes the subsurface and surface environment (that is, the water must come from somewhere), the public should determine the tradeoff between ground-water use and changes to the environment and set a threshold for what level of change becomes undesirable.

Field Examples of How Ground-Water Systems Change in Response to Pumping

LONG ISLAND, NEW YORK

Long Island is bounded on the north by Long Island Sound, on the east and south by the Atlantic Ocean, and on the west by New York Bay and the East River. Long Island is divided into four counties--Kings, Queens, Nassau, and Suffolk. The two western counties, Kings and Queens, are part of New York City.

Precipitation that infiltrates and percolates to the water table is Long Island's only natural source of freshwater because the ground-water system is bounded on the bottom by relatively impermeable bedrock and on the sides by saline ground water or saline bays and the ocean (Figure 9). About one-half the precipitation becomes recharge to the ground-water system; the rest flows as surface runoff to streams or is lost through evapotranspiration (Cohen and others, 1968). Much of the precipitation that reaches the uppermost unconfined aquifer moves laterally and discharges to streams and surrounding saltwater bodies; the remainder seeps downward to recharge the deeper aquifers. Water enters these deeper aquifers very slowly in areas where confining units are present but enters freely in other areas where confining units are absent. Water in the deeper aquifers also moves seaward and eventually seeps into overlying aquifers. Predevelopment water budgets for most of Nassau and Suffolk Counties on Long Island are shown in Figure 9.

Over the past three centuries, the island's ground water has been developed through three distinct phases. In the first, which began with the arrival of European settlers in the mid-17th century, virtually every house had its own shallow well, which tapped the uppermost unconsolidated geologic deposits, and also had its own cesspool, which returned wastewater to these same deposits. Because population was sparse, this mode of operation had little effect on the quantity and quality of shallow ground water. During the next two centuries, the population increased steadily, and, by the end of the 19th century, the individual wells in some areas had been abandoned in favor of shallow public-supply wells.

The second phase began with the rapid population growth and urban development that occurred during the first half of the 20th century. The high permeability of Long Island's deposits encouraged the widespread use of domestic wastewater-disposal systems, and the contamination resulting from increased wastewater discharge led to the eventual abandonment of many domestic wells and shallow public-supply wells in favor of deeper, high-capacity wells. In general, pumping these deep wells had only a small effect on the quantity of shallow ground water and related surface-water systems because most of the water was returned to the ground-water reservoir through domestic wastewater-disposal systems.

OVERALL PREDEVELOPMENT WATER-BUDGET ANALYSIS

INFLOW TO LONG ISLAND HYDROLOGIC SYSTEM	CUBIC FEET PER SECOND
1. Precipitation	2,475
OUTFLOW FROM LONG ISLAND HYDROLOGIC SYSTEM	
2. Evapotranspiration of precipitation	1,175
3. Ground-water dischage to sea	725
4. Streamflow discharge to sea	525
5. Evapotranspiration of ground water	25
6. Spring flow	25
Total outflow	2,475

GROUND-WATER PREDEVELOPMENT WATER-BUDGET ANALYSIS

INFLOW TO LONG ISLAND GROUND-WATER SYSTEM	CUBIC FEET PER SECOND
7. Ground-water recharge	1,275
OUTFLOW FROM LONG ISLAND GROUND-WATER SYSTEM	
8. Ground-water discharge to streams	500
9. Ground-water discharge to sea	725
10. Evapotranspiration of ground water	25
11. Spring flow	25
Total outflow	1,275

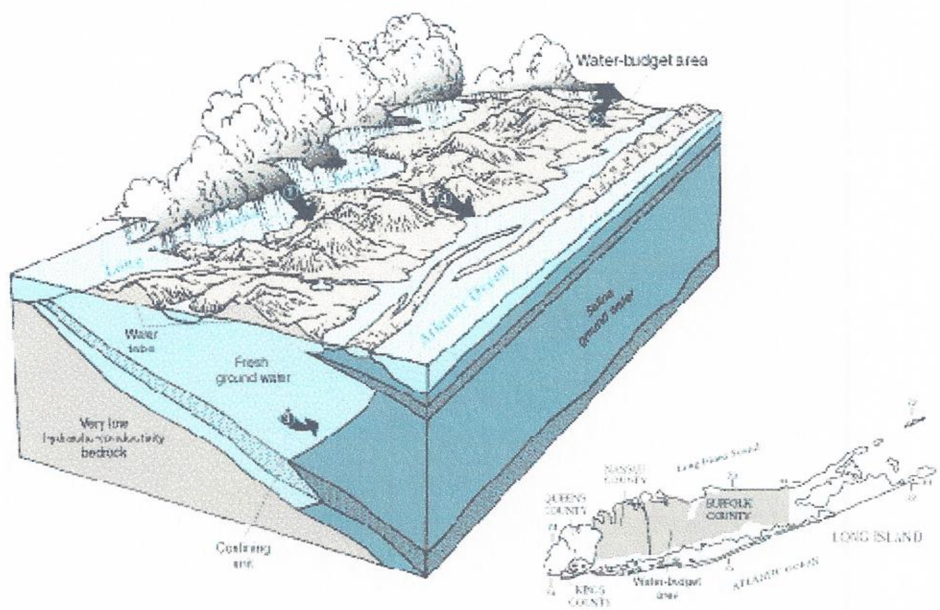


Figure 9. *Ground-water budget for part of Nassau and Suffolk Counties, Long Island, New York. (Modified from Cohen and others, 1968.)*

Block diagram of Long Island, New York, and tables listing the overall water budget and ground-water budget under predevelopment conditions. Both water budgets assume equilibrium conditions with little or no change in

A comparison of recharge rates in aquifers of the United States based on groundwater-age data

P. B. McMahon · L. N. Plummer · J. K. Böhlke ·
S. D. Shapiro · S. R. Hinkle

Abstract An overview is presented of existing groundwater-age data and their implications for assessing rates and timescales of recharge in selected unconfined aquifer systems of the United States. Apparent age distributions in aquifers determined from chlorofluorocarbon, sulfur hexafluoride, tritium/helium-3, and radiocarbon measurements from 565 wells in 45 networks were used to calculate groundwater recharge rates. Timescales of recharge were defined by 1,873 distributed tritium measurements and 102 radiocarbon measurements from 27 well networks. Recharge rates ranged from<10 to 1,200mm/yr in selected aquifers on the basis of measured vertical age distributions and assuming exponential age gradients. On a regional basis, recharge rates based on tracers of young groundwater exhibited a significant inverse correlation with mean annual air temperature and a significant positive correlation with mean annual precipitation. Comparison of recharge derived from groundwater ages with recharge derived from stream base-flow evaluation showed similar overall patterns but substantial local differences. Results from this compilation demonstrate that age-based recharge estimates can provide useful insights into spatial and temporal variability in recharge at a national scale and factors controlling that variability. Local age-based recharge estimates provide empirical data and process information that are needed for testing and improving more spatially complete model-based methods.

Keywords Groundwater age · Groundwater recharge/water budget · USA

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Introduction

Well-constrained water budgets are needed to assess groundwater availability and manage aquifers sustainably throughout the world (Healy et al. 2007; Reilly et al. 2008). Recharge is perhaps the most difficult water-budget component to quantify because of its spatial and temporal variability (Tyler et al. 1996; Wolock 2003; Scanlon et al. 2006; Crosbie et al. 2010). Several tools, including environmental tracers of groundwater age, are available for quantifying recharge and each has advantages and limitations (see review by Scanlon et al. 2002). Groundwater-age distributions giving vertical groundwater velocities provide relatively direct measures of recharge (Solomon and Sudicky 1991), whereas many other techniques for estimating recharge such as environmental and applied tracers in the unsaturated zone, numerical hydraulic modeling, water-table fluctuations, stream base-flow separation, and various other types of water-budget analyses, are relatively indirect measures of recharge. Groundwater ages also define timescales of recharge processes that could be used as relative measures of aquifer sustainability (Darling et al. 1997; Douglas et al. 2007; Bethke and Johnson 2008; Gates et al. 2008) or aquifer susceptibility (Böhlke 2002; Manning et al. 2005; Osenbrück et al. 2006; Burow et al. 2007; McMahon et al. 2008a). The interpretation of environmental-tracer data can be complicated by processes that affect tracer concentrations in recharge and groundwater along flow paths such as degradation, contamination, sorption, degassing, mixing, gas and water transport in thick unsaturated zones, rock–water interactions, and a decline or variability in atmospheric concentrations of tracers (Solomon and Cook 2000; Kalin 2000; International Atomic Energy Agency 2006). A further limitation is the lack of readily available methods for measuring groundwater ages between about 50 and

 DOI 10.1007/s10040-011-0722-5

Table 1 Recharge rates based on groundwater-age data from selected nested-well networks in unconfined aquifers. Map reference numbers refer to Fig. 1. See Table ESM1 for apparent ages and supporting information. *MAP* mean annual precipitation, 1971–2000; National Climatic Data Center 2010

Map reference number	Principal aquifer system	General land use[a]	Age tracer	Recharge rate[b] (mm/yr)	Recharge as percentage of MAP	Mean residence time (yr)	Data source
1	Alluvium	2	CFC	620	64[c]	7	McMahon and Böhlke 1996
2	Central Valley	2	CFC	580	52[c]	39	Burow et al. 1999, 2007
3	Central Valley	2	SF_6, CFC	420	28[c]	28	Green et al. 2008a, b
4	Glacial Deposits (eastern glaciated region)	1	SF_6, CFC, $^3H/^3He$	470	38	24	Böhlke et al. 2009
5	Glacial Deposits (eastern glaciated region)	3	$^3H/^3He$	690 27.2"	56	17	Solomon et al. 1995
6	Glacial Deposits (eastern glaciated region)	3	$^3H/^3He$	520 20.5"	44	13	Mullaney and Grady 1997
7	Glacial Deposits (central glaciated region)	3	$^3H/^3He$	750	75	23	Shapiro et al. 1998
8	Glacial Deposits (central glaciated region)	3	$^3H/^3He$, SF_6	170	22	62	USGS unpublished data; Thomas 2000
9	Glacial Deposits (central glaciated region)	1	CFC	95–180	14–27	40–76	Puckett et al. 2002; Puckett and Cowdery 2002
10	Glacial Deposits (central glaciated region)	1	CFC	230	34	17	Delin et al. 2000; Böhlke et al. 2002
11	Glacial Deposits (central glaciated region)	1	CFC	120	18	38	Delin et al. 2000; Böhlke et al. 2002
12	Glacial Deposits (central glaciated region)	1	SF_6, CFC	72	9.5	180	Green et al. 2008a, b
13	High Plains (northern)	3	SF_6, CFC	100–160	14–23	42–68	Landon et al. 2008
14	High Plains (northern)	5	^{14}C	20	3.9	2,700	McMahon et al. 2007
15	High Plains (northern)	2	$^3H/^3He$	380–1,200	–	6–20	Böhlke et al. 2007a
16	High Plains (central)	5	^{14}C	7	1.4	3,800	McMahon et al. 2004a
17	Northern Atlantic Coastal Plain	1	CFC	100	8.3	33	Tesoriero et al. 2005, 2007
18	Northern Atlantic Coastal Plain	1	SF_6, CFC	270	24	13	Lindsey et al. 2003
19	Northern Atlantic Coastal Plain	1,4	CFC	64	5.6	39	Böhlke et al. 2007b
20	Northern Atlantic Coastal Plain	1	CFC	300	26	31	Dunkle et al. 1993; Böhlke and Denver 1995
21	Northern Atlantic Coastal Plain	1	SF_6, CFC	270	24	22	Green et al. 2008a, b
22	Northern Atlantic Coastal Plain	3	$^3H/^3He$	400	35	31	Szabo et al. 1996; Stackelberg et al. 2000; Kauffman et al. 2001
23	Pacific Northwest basin fill	2	SF_6, CFC	200	21[c]	190	Green et al. 2008a, b
24	Pacific Northwest basin fill	6	CFC	54	18	210	Hinkle et al. 2007
25	Puget-Willamette Lowland	1	$^3H/^3He$	650	56	12	Wassenaar et al. 2006
26	Puget-Willamette Lowland	3	$^3H/^3He$	290	31	80	Hinkle 2009
27	Rio Grande (eastern mountain front, Albuquerque vicinity)	5	^{14}C	8	3.3	19,000	Plummer et al. 2004
28	Rio Grande (eastern mountain front, south of Tijeras Arroyo)	5	^{14}C	2[d]	0.3	–	Plummer et al. 2004
29	Surficial	1	CFC	150	13	26	Puckett and Hughes 2005

[a] *1* precipitation-dominated agriculture; *2* irrigation-dominated agriculture; *3* residential/commercial; *4* forest; *5* rangeland; *6* rural residential

[b] Calculated using Eq. (1), except where noted

[c] Mean annual precipitation plus applied irrigation water. Amounts of applied irrigation water from the indicated references

[d] Assumes linear age gradient

DOI 10.1007/s10040-011-0722-5

Water Conservation

WATER CONSERVATION STANDARDS

The Commonwealth of Massachusetts
EXECUTIVE OFFICE of ENVIRONMENTAL AFFAIRS
and
WATER RESOURCES COMMISSION
July 2006

D) Tables and Figures

Table 1. Average indoor water use in nonconserving and conserving North American single-family homes.

Water Use Type	Nonconserving Home*	Conserving Home 2001*	Conserving Home 2005**	Nonconserving Home	Conserving Home 2001	Conserving Home 2005
Units	*Average gpcd*	*Average gpcd*	*Average gpcd*	*Percent of total*	*Percent of total*	*Percent of total*
Dishwasher	1	0.7	0.7	1.4%	1.5%	1.9%
Baths	1.2	1.2	1.2	1.7%	2.7%	3.3%
Leaks	9.5	4	4.0	13.7%	8.8%	11.0%
Faucets	10.9	10.8	10.8	15.7%	23.9%	29.8%
Showers	11.6	8.8	7.0	16.8%	19.5%	19.4%
Clothes Washer	15	10	5.2	21.7%	22.1%	14.3%
Toilets	18.5	8.2	5.6	26.7%	18.0%	15.6%
Other Domestic	1.6	1.6	1.6	2.2%	3.4%	4.4%
TOTAL	**69.3 gpcd**	**45.2 gpcd**	**36.2 gpcd**	**100%**	**100%**	**100%**

**Source: Vickers, 2001 (Adapted from Mayer et al, 1999)*

***Substituting 1.1 gpf High Efficiency Toilets, a 14 gpl front-load washing machine, and 2.0 gpm showerheads for Vickers' 1.6 gpf toilets, 27 gpl washing machine and 2.5 gpm showerheads*
gpcd = gallons per capita daily, gpf=gallons per flush, gpl=gallons per load, and gpm=gallons per minute

Table 2. Federal and Massachusetts maximum water-use requirements for plumbing fixtures and selected appliances

Fixture or Appliance	Conservation Standard	Reference
Toilet, gravity tank	1.6 gpf	U.S. Energy Policy Act, 1992 (EPAct), MA Plumbing Code
Urinals, any type	1.0 gpf	EPAct, MA Plumbing Code
Showerheads, any type (except those used for safety reasons)	2.5 gpm (at 80 psi) or 2.2 gpm (at 60 psi)	EPAct, MA Plumbing Code
Lavatory faucets and replacement aerators	2.5 gpm (at 80 psi) or 2.2 gpm (at 60 psi)	EPAct, MA Plumbing Code
Kitchen faucets and replacement aerators		EPAct, MA Plumbing Code
Dishwashers	4.5 gpl	National Appliance Energy Conservation Act, Vickers
Clotheswashers	Water Factor of 9 or less, 27 gpl	National Appliance Energy Conservation Act, Vickers

gpf = gallons per flush
gpm = gallons per minute
psi = pounds per square inch
gpc = gallons per cycle
gpl = gallons per load
Water Factor = a measure of the gallons of water used per cycle per cubic foot
Source: Adapted from Vickers, 2001

WE Credit 3: Water Use Reduction

2–4 Points

Intent

To further increase water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.

Requirements

Employ strategies that in aggregate use less water than the water use baseline calculated for the building (not including irrigation). The minimum water savings percentage for each point threshold is as follows:

Percentage Reduction	Points
30%	2
35%	3
40%	4

Calculate the baseline according to the commercial and/or residential baselines outlined below.[1] Calculations are based on estimated occupant usage and must include only the following fixtures and fixture fittings (as applicable to the project scope): water closets, urinals, lavatory faucets, showers, kitchen sink faucets and pre-rinse spray valves.

Commercial Fixtures, Fittings, and Appliances	Current Baseline (Imperial Units)	Current Baseline (Metric units)
Commercial toilets	1.6 gallons per flush (gpf)* Except blow-out fixtures: 3.5 (gpf)	6 liters per flush (lpf) Except blow-out fixtures: 13 lpf
Commercial urinals	1.0 (gpf)	4 lpf
Commercial lavatory (restroom) faucets	2.2 gallons per minute (gpm) at 60 pounds per square inch (psi), private applications only (hotel or motel guest rooms, hospital patient rooms) 0.5 (gpm) at 60 (psi)** all others except private applications 0.25 gallons per cycle for metering faucets	8.5 liters per minute (lpm) at 4 bar (58 psi), private applications only (hotel or motel guest rooms, hospital patient rooms) 2.0 lpm at 4 bar (58 psi), all others except private applications 1 liter per cycle for metering faucets
Showerheads	2.5 (gpm) at 80 (psi) per shower stall ****	9.5 lpm at 5.5 bar (80 psi)
For projects with commercial pre-rinse spray valves, the flow rate must comply with the ASME A112.18.1 standard of 1.6 gpm (6 lpm) or less.		

Residential Fixtures, Fittings, and Appliances	Current Baseline (Imperial units)	Current Baseline (Metric units)
Residential toilets	1.6 (gpf)***	6.1 liters per flush (lpf)
Residential lavatory (bathroom) faucets	2.2 (gpm) at 60 psi	8.5 lpm at 4 bar (58 psi)
Residential kitchen faucet		
Residential showerheads	2.5 (gpm) at 80 (psi) per shower stall****	9.5 lpm at 5.5 bar (80 psi) per shower stall

1 Tables adapted from information developed and summarized by the U.S. Environmental Protection Agency (EPA) Office of Water based on requirements of the Energy Policy Act (EPAct) of 1992 and subsequent rulings by the Department of Energy, requirements of the EPAct of 2005, and the plumbing code requirements as stated in the 2006 editions of the Uniform Plumbing Code or International Plumbing Code pertaining to fixture performance.

Residential Fixtures, Fittings, and Appliances	Current Baseline (Imperial units)	Current Baseline (Metric units)

* EPAct 1992 standard for toilets applies to both commercial and residential models.

** In addition to EPAct requirements, the American Society of Mechanical Engineers standard for public lavatory faucets is 0.5 gpm at 60 psi (2.0 lpm at 4 bar (58 psi)) (ASME A112.18.1-2005). This maximum has been incorporated into the national Uniform Plumbing Code and the International Plumbing Code.

*** EPAct 1992 standard for toilets applies to both commercial and residential models.

**** Residential shower compartment (stall) in dwelling units: The total allowable flow rate from all flowing showerheads at any given time, including rain systems, waterfalls, bodysprays, bodyspas and jets, must be limited to the allowable showerhead flow rate as specified above (2.5 gpm/9.5 lpm) per shower compartment, where the floor area of the shower compartment is less than 2,500 square inches (1.5 square meters). For each increment of 2,500 square inches (1.5 square meters) of floor area thereafter or part thereof, an additional showerhead with total allowable flow rate from all flowing devices equal to or less than the allowable flow rate as specified above must be allowed. Exception: Showers that emit recirculated nonpotable water originating from within the shower compartment while operating are allowed to exceed the maximum as long as the total potable water flow does not exceed the flow rate as specified above.

The following fixtures, fittings and appliances are outside the scope of the water use reduction calculation:

- Commercial Steam Cookers
- Commercial Dishwashers
- Automatic Commercial Ice Makers
- Commercial (family-sized) Clothes Washers
- Residential Clothes Washers
- Standard and Compact Residential Dishwashers

Potential Technologies & Strategies

Use WaterSense-certified fixtures and fixture fittings where available. Use high-efficiency fixtures (e.g., water closets and urinals) and dry fixtures, such as toilets attached to composting systems, to reduce the potable water demand. Consider using alternative on-site sources of water (e.g., rainwater, stormwater, and air conditioner condensate, graywater) for nonpotable applications (e.g., toilet and urinal flushing, custodial uses). The quality of any alternative source of water being used must be taken into consideration based on its application or use.

Local Well Data

OLIVER: MassGIS's Online Mapping Tool

Rodgers Rd. Carlisle MA.

LOT LOCATION

70 Rodgers Rd

Town of Carlisle

MASSACHUSETTS 01741

Office of
BOARD OF HEALTH

PD.
CK# 10515

Permit No. 8707 70 Rogers Fee 50—

APPLICATION FOR WELL PERMIT

Application is hereby made for a permit to drill (✓) or repair ( ) a well.

Location: Address #15 ROGERS RD. Lot No. 15

Owner C+D ASSOC. BLD.

Owner's Address ROBINWOOD RD. Acton

Well Contractor E.R. SULLIVAN INC. License No. 173

Contractor's Address BOLTON MA. 01740

WELL CONTRACTOR (To be filled in at time of pump test.)

Type of Well ARTEISIAN Well Used For DOMESTIC

Diameter of Well 6" Size of Casting 6 5/8 SCHED. 40

Depth of Bed Rock 27 Ft. Depth of Casing into Bed Rock 14 Ft.

Was Seal Tested? Yes (✓) No ( ) Date of Testing 3/3/87

Depth of Well 225 Ft. Well ended in what material? LEDGE

Depth to Water 12 Ft. Delivers 20 GPM

Drawdown ______ Feet After Pumping ______ Hours at ______ GPM

Sketch a map of the well location with tie down lines from building on the back of this form.

Date of Completion 3/3/87

______ Health Inspector's Signature

E.R. Sullivan INC.
Well Company's Signature

TOWN OF CARLISLE INCORPORATED A DISTRICT APRIL 19, 1754 A TOWN FEB. 18, 1805 MASSACHUSETTS

Town of Carlisle

74 Rodgers Rd.

MASSACHUSETTS 01741

Office of

BOARD OF HEALTH

APPLICATION FOR WELL PERMIT

Permit No._________ Fee $50.00

$50. Fee Paid____________

Application is hereby made for a permit to drill ( ) or repair ( ) a well.

Location: Address LOT 14 RODGRRS RD Lot Number 14

Owner/Developer: JIM MARCHANT

Address:__________ Tel:__________

Well Driller: ER SULLIVAN

Type of Well: 6" ROCK Well used for:__________

Depth to Bedrock:__________ Cased Depth:__________

Drilled Depth: 425' Static Water Level:__________

Well Ended in What Material:__________

Grouted/Sealed:__________ Yield:__________ G.P.M.

Change of well location from that shown on an approved Septic Design Plan must have prior approval of the Board of Health or its Agent and be noted on the plan.

Date of Completion__________ Inspection Signoff:__________

Board of Health Agent

****

APPLICATION FOR PUMP PERMIT

Permit No: 1093 Fee $50.00

$50. Fee Paid: #1662

Pump Installer: NEED PUMP CO.

Size and name of pump: 3/4 HP Jacuzzi Size of Tank:__________

Depth of Pump: 300' feet.

Results of flow test: Start Meter 12378 Stop meter 14501

Drawdown 280' feet after pumping 5 hours at 7 G.P.M.

Date of Completion:__________ Inspection Signoff: James O'Dawn

Board of Health Agent

Revised 3/31/87

78 Rodgers Rd #10629

Town of Carlisle

MASSACHUSETTS 01741

Office of

BOARD OF HEALTH

√W8712

Permit No. ___ (Ellie took ck)

Fee 50 —

APPLICATION FOR WELL PERMIT

Application is hereby made for a permit to drill (✓) or repair ( ) a well.

Location: Address #13 Rogers Rd. Lot No. 13

Owner GD Assoc. Bld.

Owner's Address 3 Robinwood Rd Acton

Well Contractor E.R. Sullivan Inc License No. 473

Contractor's Address Bolton, MASS

WELL CONTRACTOR (To be filled in at time of pump test.)

Type of Well ARTEISIAN Well Used For Domestic

Diameter of Well 6" Size of Casting 6 5/8 sch 40

Depth of Bed Rock 25 Ft Depth of Casing into Bed Rock 16 Ft.

Was Seal Tested? Yes (✓) No ( ) Date of Testing MAY 4 1987

Depth of Well 145 Ft. Well ended in what material? LEDGE

Depth to Water 10 Ft. Delivers 50 GPM

Drawdown ___ Feet After Pumping ___ Hours at ___ GPM

Sketch a map of the well location with tie down lines from building on the back of this form.

Date of Completion MAY 4/87

Health Inspector's Signature ___

E.R. Sullivan INC.
Well Company's Signature

83 Rodgers Rd
3/4/87

Town of Carlisle ~~Rogers~~

MASSACHUSETTS 01741

Office of
BOARD OF HEALTH

Permit No. 8708 Fee 50 —

APPLICATION FOR WELL PERMIT

Application is hereby made for a permit to drill (✓) or repair ( ) a well.

Location: Address #12 Rogers Lot No. 12

Owner MET West Development Inc.

Owner's Address 329 Boston Post Rd. Sudbury

Well Contractor E.R. Sullivan Inc. License No. 175

Contractor's Address Bolton MA

WELL CONTRACTOR (To be filled in at time of pump test.)

Type of Well ARTESIAN Well Used For DOMESTIC

Diameter of Well 6" Size of Casting 6 5/8 SCHED. 40

Depth of Bed Rock 27 Ft. Depth of Casing into Bed Rock 14 Ft.

Was Seal Tested? Yes (✓) No ( ) Date of Testing 3/5/87

Depth of Well 125 Ft. Well ended in what material? LEDGE

Depth to Water 20 Ft. Delivers 35 GPM

Drawdown ______ Feet After Pumping ______ Hours at ______ GPM

Sketch a map of the well location with tie down lines from building on the back of this form.

Date of Completion 3/5/87

James Davis
Health Inspector's Signature

E.R. Sullivan INC.
Well Company's Signature

Nashoba Analytical, LLC Tel: 978-391-4428 Fax: 978-391-4643
31A Willow Road, Ayer MA 01432 Website: http://www.NashobaAnalytical.com

LabNumber: **114251**
Use this number with all correspondence

Client:
Carlisle Board of Health Town of Carlisle
66 Westford Street
Carlisle, MA 01741

ReportDate: 6/21/2010

RECEIVED
JUN 24 2010
BOARD OF HEALTH
CARLISLE

Certificate of Analysis

David & Sara Dolins, 83 Rodgers Rd, Carlisle MA

Parameter	Method	Result	MCL	MRL	Date of Analysis	Analyst
- Sample Tap						
Sampled: 6/5/2010 10:55:00 AM by Lab Staff						
Total Coliform Bacteria, /100ML	MF-SM9222B	0	0/Absent	0	6/5/2010 1:15:00 PM	M-MA1118
Arsenic, Total, MG/L	SM 3113B	ND	0.01	0.002	6/7/2010	M-MA1118
Calcium, MG/L	EPA 200.7	ND	Not Spec	1	6/8/2010	M-MA1118
Copper, MG/L	EPA 200.7	ND	1.3	0.01	6/8/2010	M-MA1118
Iron, MG/L	EPA 200.7	0.12	0.3	0.01	6/8/2010	M-MA1118
Lead, MG/L	SM 3113B	ND	0.015	0.002	6/8/2010	M-MA1118
Magnesium, MG/L	EPA 200.7	ND	Not Spec	1	6/8/2010	M-MA1118
Manganese, MG/L	EPA 200.7	ND	0.05	0.005	6/8/2010	M-MA1118
Potassium, MG/L	EPA 200.7	ND	Not Spec	1	6/8/2010	M-MA1118
Sodium, MG/L	EPA 200.7	44.8	See Note	1	6/8/2010	M-MA1118
Alkalinity, MG/L	SM 2320B	44	Not Spec	1	6/7/2010	M-MA1118
Ammonia, MG/L	SM 4500-NH3-D	ND	Not Spec	0.1	6/8/2010	M-MA1118
Chloride, MG/L	EPA 300.0	23.4	250	1	6/5/2010	M-MA1118
Chlorine, Free Residual, MG/L	SM 4500-CL-G	ND	Not Spec	0.02	6/5/2010	M-MA1118
Color Apparent, CU	SM 2120B	ND	15	1	6/5/2010	M-MA1118
Conductivity, UMHOS/CM	SM 2510B	263	Not Spec	1	6/5/2010	M-MA1118
Fluoride, MG/L	EPA 300.0	ND	4	0.1	6/5/2010	M-MA1118
Hardness, Total, MG/L	SM 2340B	ND	Not Spec	2	6/8/2010	M-MA1118
Nitrate as N, MG/L	EPA 300.0	ND	10	0.05	6/5/2010	M-MA1118
Nitrite as N, MG/L	EPA 300.0	ND	1	0.01	6/5/2010	M-MA1118
Odor, TON	SM 2150B	0	3	0	6/5/2010	M-MA1118
pH, PH AT 25C	SM 4500-H-B	7.5	6.5 - 8.5	NA	6/5/2010	M-MA1118
Sediment, pos/neg	-------------	NEG	-----	NEG	6/5/2010	M-MA1118
Sulfate, MG/L	EPA 300.0	17.6	250	1	6/5/2010	M-MA1118
Turbidity, NTU	EPA 180.1	2	Not Spec	0.1	6/5/2010	M-MA1118
Gross Alpha, PCI/L	EPA 900.0	0.0 +/- 0.6	15	1.5	6/21/2010	KNL
Radon, PCI/L	EPA 913.0	1900	10000	100	6/8/2010	NEHA103216

MCL=Maximum Contaminant Level (EPA Limit), MRL = Minimum Reporting Level
Sodium Guidelines- Mass 20, EPA 250, # = Result Exceeds Limit or Guideline
ND = None Detected (<MRL), * = Background Bacteria Noted

Massachusetts Certified
Laboratory #MA1118

David L. Knowlton
Laboratory Director

58 ~~[illegible]~~ Rodgers Rd

REPORT NO. 6707

The Water Works Laboratories

of MASSACHUSETTS, INC.
59 MAIN STREET, LEOMINSTER, MA 01453

(617) 534-1444
800-LAB-0094
(In Mass.)
800-LAB-0081
(Outside Mass.)

SAMPLE INFORMATION

Requested by: Need Pump Co.
Address: Stuart Rd. Sterling, Ma.

Phone No.

Sample Location: Met West Devel. Corp
Lot #16 Rogers Rd. Carlisle
Sampled by: Need Pump Co.

Time: 5:00 pm Date: Sep 18, 1987

Mass. Cert. #16251

Water Quality Test Results

	Test	Results	Limits	Brief Explanation
Bacteria	Coliform Bacteria	0/100	4/100	The # of Coliform Bacteria found in 100 milliliters
	Fecal Bacteria	NT	0/100	Bacteria from human waste
	Standard Plate Count	NT	200/100	Determines total bacteria
Minerals/Metals	Arsenic	NT	0-0.05 mg/l	Toxic metal contaminant
	Sodium	4.70	0-250 mg/l	A component of "salt" (In Mass. 20 mg/l)
	Copper	0.00	0-1 mg/l	May indicate pipe corrosion
	Iron	1.00	0-0.3 mg/l	Brown stains, bitter taste
	Lead	NT	0-0.05 mg/l	Toxic metal contaminant
	Manganese	0.00	0-0.05 mg/l	May cause laundry staining
	Magnesium	2.400	0-200 mg/l	A component of hardness
	Calcium	24.00	0-200 mg/l	A component of hardness
Chemical	Alkalinity	36.00	NO LIMIT	Ability to neutralize acids
	Chlorine	0.00	0-0.05 mg/l	A disinfectant (bleach), kills bacteria
	Chloride	1.400	0-250 mg/l	A component of "salt", salty taste
	Hardness	48.00	0-160 mg/l	Ability to form soap bubbles, 0-75 soft
	Nitrate	0.00	0-10 mg/l	Indicator of biological waste
	Corrosiveness	Corr	NO LIMIT	A calculation of water/metal interaction
	Sulfate	0.00	0-250 mg/l	A common mineral - may cause odor
	Total Solids	51.00	0-500 mg/l	Total minerals present
Physical	pH	6.70	6.5-8.5	The acidic or basic condition
	Conductivity	102.00	0-550	Resistance to electricial current (umhos/cm)
	Color	5.00	0-15 cu	Clarity (0) or discoloration (15)
	Dissolved Oxygen	5.90	0-15 mg/l	Amount of oxygen present
	Odor	0.00	0-3 TON	Odors due to contamination
	Turbidity	5.00	0-5 NTU	Presence or absence of particles

For those items tested, this sample meets the following EPA criteria for drinking water.

(X) Primary ( ) Secondary ( ) Neither

NT — Not Tested

Reported by: Eric J. Koslowski
CHEMIST

Date: Sep 22, 1987

74 Rodgers Rd

REPORT NO. 7761

The Water Works Laboratories

of MASSACHUSETTS, INC.

59 MAIN STREET, LEOMINSTER, MA 01453

(617) 534-1444
800-LAB-0094
(In Mass.)
800-LAB-0081
(Outside Mass.)

SAMPLE INFORMATION

Requested by: Need Pump Co.
Address: Stuart Rd. Sterling, Ma.

Phone No.

Sample Location: Jim Marshall
Lot #14 Rogers Rd. Carlisle

Sampled by: Need Pump Co,

Time: 5:00 pm Date: Dec 23, 1987

Mass. Cert. #16251

Water Quality Test Results

	Test	Results	Limits	Brief Explanation
Bacteria	Coliform Bacteria	0/100	4/100	The # of Coliform Bacteria found in 100 milliliters
	Fecal Bacteria	NT	0/100	Bacteria from human waste
	Standard Plate Count	NT	200/100	Determines total bacteria
Minerals/Metals	Arsenic	NT	0-0.05 mg/l	Toxic metal contaminant
	Sodium	8.50	0-250 mg/l	A component of "salt" (In Mass. 20 mg/l)
	Copper	0.00	0-1 mg/l	May indicate pipe corrosion
	Iron	2.00	0-0.3 mg/l	Brown stains, bitter taste
	Lead	NT	0-0.05 mg/l	Toxic metal contaminant
	Manganese	0.00	0-0.05 mg/l	May cause laundry staining
	Magnesium	1.00	0-200 mg/l	A component of hardness
	Calcium	10.20	0-200 mg/l	A component of hardness
Chemical	Alkalinity	28.50	NO LIMIT	Ability to neutralize acids
	Chlorine	0.00	0-0.05 mg/l	A disinfectant (bleach), kills bacteria
	Chloride	6.00	0-250 mg/l	A component of "salt", salty taste
	Hardness	20.40	0-160 mg/l	Ability to form soap bubbles, 0-75 soft
	Nitrate	0.00	0-10 mg/l	Indicator of biological waste
	Corrosiveness	Corr	NO LIMIT	A calculation of water/metal interaction
	Sulfate	0.00	0-250 mg/l	A common mineral - may cause odor
	Total Solids	42.00	0-500 mg/l	Total minerals present
Physical	pH	7.02	6.5-8.5	The acidic or basic condition
	Conductivity	84.00	0-550	Resistance to electricial current (umhos/cm)
	Color	5.00	0-15 cu	Clarity (0) or discoloration (15)
	Dissolved Oxygen	5.30	0-15 mg/l	Amount of oxygen present
	Odor	0.00	0-3 TON	Odors due to contamination
	Turbidity	8.40	0-5 NTU	Presence or absence of particles

For those items tested, this sample meets the following EPA criteria for drinking water.

( ) Primary ( ) Secondary (x) Neither

NT — Not Tested

Reported by: Eric J. Koslowski
CHEMIST

Date: Dec 28, 1987