Bel Air Reservoir Feasibility Study

MARYLAND
AMERICAN WATER

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DRAFT

Gannett Fleming

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Executive Summary

Maryland American Water (MDAW) owns and operates the water system that serves the Town of Bel Air and some adjacent areas that are not supplied by the Harford County water system. The primary water source for the Maryland American system is a surface water withdrawal from Winters Run which is treated at the Winters Run Water Treatment Plant. The system has two groundwater wells, the Bynum Well and the Winters Run Well, that can be used to supplement the stream withdrawal. Also, there are several interconnections with the Harford County system where treated water can be purchased. Under normal system operations, the stream withdrawal accounts for over 90% of the system supply, the Bynum Well around 8%, and the County connections less than 2%. The Winters Run Well has been used infrequently, and is currently out of service.

The stream withdrawal is permitted for an annual average supply of 1.4 MGD with a peak withdrawal of up to 1.7 MGD, but the withdrawal is subject to a minimum in-stream flow (a flowby or passby requirement) of 6.07 MGD. Thus, when stream flow is low, the primary raw water supply available to MDAW may be restricted or prohibited. During such times, the MDAW system must rely on other sources to meet system demands. Historically, the need has been met by a combination of the groundwater supplies and treated water purchased from Harford County. However, this has required the County to supply water in excess of the 0.5 MGD capacity that MDAW has purchased. In the past, the County system has been able to supply the MDAW system needs, but as future water supply shortfalls are recognized in the region, obtaining the supplemental supply from the County is not a reliable alternative. Thus, MDAW is investigating alternatives for a reliable water supply during those low stream flow conditions.

One of the alternatives under consideration is off-stream storage (also known as pumped storage) of water from Winters Run. With this concept, water is pumped from Winters Run into a reservoir when stream flows are sufficient and then during low in-stream flow conditions, water from the reservoir is used to replace or supplement the stream withdrawal to meet the system needs. Two tracts of land owned by Harford County adjacent to the south side of Winters Run and just upstream of the Winter Run Plant have been identified as potential sites for a reservoir. Site A is the Edgeley Grove site on the west side of Route 1 Bypass and Site B is the Soma Site between Route 1 and Route 1 Bypass. The purpose of this study is to evaluate the feasibility of the off-stream storage alternative by constructing a reservoir on one of these two sites.

This general scope of this study is to establish the required volume of the reservoir to meet the system need, determine the additional facilities necessary to make the system function, and finally evaluate the cost, schedule, and risks associated with the concept so that MDAW can assess the feasibility of the concept. If deemed feasible, a subsequent preliminary engineering study must be performed to refine the evaluations, determine the regulatory requirements, and establish the detailed design parameters.

When stream withdrawals are restricted by low flow conditions, the reservoir storage volume must be sufficient to supply the difference between the system demand and the supply from other sources. Water demands and demand projections were recently evaluated by MDAW and summarized in the 2012 Comprehensive Planning Study Report. These data were used to evaluate volume of water that would be required to meet system needs during the design outage. The 2012 Study projected water demands to generally decrease slightly in the MDAW system over the next 15 years, and system records subsequent to the study have shown that trend. From the 2012 report the highest demand was in 2017. The 15-year demand projections are short term projections relative to the project life for a reservoir. Therefore, the projected demand decrease was not considered and the 2017 demands were used as the basis for the evaluation in this study. Additionally, as drought outages generally occur during periods of higher water usage, the potential peak demands during a 3-month outage were evaluated. The demand evaluations recommended using a system demand of 1.50 MGD as the basis for the reservoir sizing models.

The required reservoir volume depends primarily on the duration of the 'design outage' (the period of stream withdrawal restriction or prohibition established as the design criterion), the water demand during the outage, the supply available from other sources, the minimum flowby requirement, and the peak withdrawal rate permitted for reservoir refill. A comprehensive stream flow model was developed for Winters Run that incorporates all of these factors as well as other minor factors (evaporation, precipitation, leakage, dead storage). Stream flow data for the model were developed using available records for the Winters Run and Deer Creek stream gages from 1926 to present. The record period showed the two most severe drought conditions occurred in 1966 and in 2002. For most simulations, the 2002 drought, where stream withdrawal was impacted for 132 nearly consecutive days, resulted in the largest required storage volume.

Model simulations were performed to determine the reservoir volume necessary to meet system demands during all droughts in the recorded period. Simulations were repeated using a range of model parameters to evaluate the impact on needed storage volume if regulatory or other parameters change. To establish a recommended reservoir volume for the feasibility study, however, assumptions must be made to fix the simulation parameters.

The design simulations were based on the current flowby restriction of 6.07 MGD and a system demand of 1.5 MGD. The simulations also assumed that the existing well supplies would be available and used at their reported safe yield for the duration of the outage. The Bynum Well and the Winters Run Well have reported safe yields of 0.144 MGD and 0.115 MGD, respectively. Contractually, MDAW can obtain up to 0.5 MGD of treated water from Harford County, but for these evaluations, it was assumed that the County supply was not available.

Further, the off-stream storage concept requires that the maximum daily permitted withdrawal from Winters Run be increased in order to refill the reservoir. This increase does not affect the permitted annual withdrawal, however. For this study, a raw water pumping capacity of at least 4 MGD was used in the simulations and it was assumed that stream flows in excess of the flowby plus the system demands will be used to recharge the reservoir.

Under these simulation conditions, the modelling showed that a reservoir volume of 360 acre-feet would be sufficient to meet the system needs under drought conditions similar to those that have occurred over the past 80 years of recorded data.

This study performed a comparative evaluation of the two potential reservoir sites. A field review of the mapped environmental features was performed to minimize impacts to environmental resources with the reservoir siting. Surface models were developed to site the reservoirs and estimate earthwork quantities. Because both sites are sloped, the reservoirs will be excavated to obtain the needed volume, and the excavated material will be used to construct the embankment on the downslope perimeter. For Site A the reservoir requires a perimeter embankment approximately 1900 feet in length and up to 56 feet in height. Excavation depth is up to 50 feet. The reservoir on Site B required excavations of up to 30 feet, with an embankment approximately 2,300 feet long and up to 58 feet high.

To consider conditions that would affect the reservoir design and construction, a comprehensive review of available geotechnical reports and data was performed, well completion logs were reviewed for wells constructed in the area were reviewed, and several test excavations were performed on each site. Soil samples were obtained from the excavations for lab testing and infiltration tests were performed at several excavations. The evaluations indicate that there is no clear difference between the two sites from a geotechnical perspective. The soils are sandy with high permeability such that a lining will be required for the reservoir bottom and sides in order to use on-site material for the embankment construction. The soils are underlain by decomposed rock and bed rock. Depth to bedrock is unknown from the information available, and more extensive geotechnical investigations will be required to establish the depth and character of the bedrock and its impact on the reservoir design.

The reservoir design was based on using a manufactured lining material due because of the existing soil permeability. Additionally the liner allows the excavated material to be used for the embankment construction, minimizing site spoils and material import. The lining will be earth covered on the reservoir bottom and exposed in the interior slopes. The conceptual reservoir layouts were designed to minimize the surface area of the liner material. A control tower will be required in the reservoir for the fill and withdrawal piping connection, and to provide a spillway for overflow control. The overflow will be piped to a stabilized discharge along Winters Run.

Additional facilities required for the off-stream storage system include the raw water pump station, stream intake, and piping. The raw water pump station is required to refill the reservoir when stream flow is available. Although a 4 MGD pumping capacity is the minimum required, a pumping capacity of 8 MGD is recommended. The pump station should be constructed on the Winters Run Plant site. A new stream intake is recommended to provide the required peak withdrawal capacity and should include a mechanical screen. With the new intake, it is recommended that the new raw water pump station also include new pumps for the water treatment plant withdrawal.

A pipeline from the pump station to the reservoir control tower must be constructed which will require a crossing of Winters Run. With the new pump station located on the WTP site, the same pipeline can be used for reservoir withdrawal when stream flows are low. The pipeline is one of the significant differentiators between Site A and Site B. The pipeline from the plant site to the Site A reservoir is substantially longer than for Site B, will require a trenchless crossing of Route 1 Bypass, and will have a greater impact on environmental resources.

An estimated project cost was prepared for two reservoir sites. The estimate includes the cost of design, construction, construction management, and inspection as well a 30% contingency due to unknowns. The estimate for Site A is approximately $22.4 Million and Site B is $18.1 Million.

Due to several reasons including proximity to the water plant, less environmental impacts, as well as a lower capital cost, Site B is recommended as the proposed reservoir site. Assuming a 2015 design start date for the reservoir, the reservoir could be operational by the fall of 2019.

1. Purpose and Scope of Work

1.1 Purpose

Gannett Fleming was retained by American Water Company to provide a feasibility evaluation of one alternative for addressing water supply reliability for the existing water system serving the Town of Bel Air, Maryland. The concept to be evaluated consists of an off-stream storage reservoir along Winters Run to ensure a reliable source of raw water supply for the system.

1.2 Background

The Bel Air water system serves primarily the town of Bel Air in Harford County, Maryland. The system is operated by the Maryland American Water Company (MDAW). The water system consists of the Winters Run Water Treatment Plant (WTP) on the south west side of the Town that primarily treats raw water from Winters Run. Finished water is pumped into the distribution system that serves the Town and some areas beyond the Town limits that are not served by the Harford County Department of Public Works. The Town has additional sources of raw water from two existing groundwater wells, the Winters Run Well and the Bynum Well.

In addition to the raw water supply, the Bel Air system has a finished water supply available from the Harford County water system. MDAW constructed a metered connection to the County system on MacPhail Road and has purchased a supply capacity for up to 0.5 MGD. The County bills the Town for the actual water used at a bulk water rate. This supply is used to supplement the supply from the WTP and the Bynum Well.

The primary water supply for the system is Winters Run, which is permitted for a 1.4 MGD annual average withdrawal. The current withdrawal permit also includes a restriction that only allows MDAW to withdraw from the stream as long as the passing flow is 6.07 MGD or greater. Thus, during periods of low stream flow, the primary raw water supply to the system is either restricted or prohibited.

During such periods, the Town has historically relied on their well supply and the Harford County supply to meet the system demand. This has required the Town to take more than the permitted 0.5 MGD of supply from the County. With recent changes in water supply planning for the region, Harford County has identified long term water supply shortfalls, and so the availability of County water in excess of the contract supply is not a reliable supply option for the Bel Air system.

To address the water supply reliability aspects, MDAW is evaluating the option of constructing an off-stream raw water storage reservoir, which would provide a raw water supply when the water cannot be withdrawn from the stream. When stream flows exceed the pass-by requirement, stream flow in excess of the pass-by plus the system needs can be pumped to refill the reservoir. The reservoir must be sized to provide the water volume necessary to meet the system needs for the duration of the stream restrictions.

Two possible sites for an off-stream reservoir have been suggested by Harford County. Both sites are currently owned by Harford County and are adjacent to Winters Run, just upstream of the existing WTP.

1.3 Study Objectives

Gannett Fleming, Inc. was retained by Maryland American Water to evaluate the feasibility of the off-stream storage alternative for supply reliability. A study was performed to determine the supply volume required to meet the supply needs and develop concept facility plans for a reservoir on each of the potential sites and to prepare estimated project costs based on the conceptual facilities.

To determine the storage volume needed in the impoundments, the study first evaluated historic stream flow data to establish the design duration of the withdraw restrictions period. Using demand projections from the 2012 Comprehensive Planning Study and data on other water supplies, stream flow modeling was used to establish the volume of raw water required to meet the system needs during the worst drought of record.

Once the design storage volume was established, site surface modeling was performed to evaluate reservoir siting and earthwork estimates for the two potential sites. Published geotechnical information and local well drilling records were reviewed and field test excavations were performed to evaluate local soil characteristics to establish parameters for the reservoir design. A surface model of the reservoir sites was developed to aid in the reservoir siting alternatives and earthwork calculations. A concept layout of the support facilities (intake, pump station, reservoir outlet) was developed to a sufficient level to estimate the cost and identify potential operational issues.

Gannett Fleming performed a desktop review of the known environmental and cultural resources in the area of the two potential reservoir sites and a field review of the sites to assess the potential impacts and permitting issues. Planning-level cost estimates were prepared for the project to determine its feasibility.

1.4 Study Limitations

The study was performed to establish the feasibility of the concept based on cost and risks. Detailed evaluations were performed using available information, but many assumptions were made due to time and cost limitations. These factors will need to be refined under a preliminary design contract and following coordination with the appropriate regulatory agencies. The evaluations considered the impacts on the facility design resulting from a variation of certain parameters, but assumptions had to be made to allow the costs to be estimated.

Geotechnical evaluation of existing soils and geology was based on available documents and several test pits; soil borings were not performed. One of the most significant potential cost impacts is the depth to existing rock at the reservoir site. Although the reservoir configuration can be modified to minimize rock excavation, there would be cost impacts from additional earthwork and material costs associated with reconfiguring the reservoir. Assumptions were made on system operation and availability of groundwater supplies during the outages. These assumptions will need to be reiterated with regulatory agencies.

2. Description of Water Supply System

2.1 Introduction

The Bel Air water system serves primarily the town of Bel Air in Harford County, Maryland. The system is operated by the Maryland American Water (MDAW). The water system consists of the Winters Run Water Treatment Plant (WTP) south west of the Town that primarily treats raw water from Winters Run. The plant has a nominal treatment capacity of 2.0 MGD. Finished water is pumped into the distribution system that serves the Town and some areas beyond the Town limits that are not served by the Harford County Department of Public Works.

The Town has an additional source of raw water from two existing groundwater wells, the Winters Run Well and the Bynum Well. The Winters Run Well is located on the Winters Run WTP site and water from the well is treated at the plant before pumping to the distribution system. The Bynum Well is located on the north side of the Town near the Town's municipal Public Works facility. This well is treated at the source and pumped directly to the distribution system and thus is independent of the WTP.

Harford County provides public water and sewer service to a large portion of the county outside of three incorporated municipal systems, one of which is the Town of Bel Air. The Bel Air distribution system has several interconnections with the Harford County system.

2.2 Surface Water Supply

The primary water supply for the system is the Winters Run stream withdrawal. MDAW is permitted to withdraw an annual average supply from the stream of 1.4 MGD and up to 1.7 MGD on any one day. This withdrawal is also subject to a minimum passing stream flow regulation of 6.07 MGD. Under low stream flow conditions the plant may be restricted or prohibited from using the stream for water supply. The minimum passing flow requirement is based on the Q7-10 flow, which is the lowest 7-day average flow with a 10-year recurrence frequency. The current permit is valid through 2015.

During the periods of stream withdrawal restrictions, the MDAW system must rely on its groundwater supplies and purchasing treated water from Harford County. However, this requires the County to supply water in excess of the contracted 0.5 MGD.

2.3 Groundwater Supply

The MDAW system has two permitted groundwater supplies. The Bynum Well is located on the north side of the Town near the Town's Public Works offices. The supply from the Bynum Well is treated at the source by chemical addition before pumping directly into the distributions system. This well is operated on a regular basis.

The Bynum Well has a permitted appropriation of 0.230 MGD annual average, with up to 0.271 MGD for a maximum month withdrawal. As reported in the 2012 Comprehensive Planning Study (American Water), the system has limited the withdrawal from this well to around 0.144 MGD (100 gpm) due to increased drawdown at higher pumping rates. This appropriation permit expires in 2015.

The Winters Run Well is located on the Winters Run WTP site and has a permitted appropriation of 0.132 MGD annually, with a maximum month usage of 0.246 MGD. This well also has been found to have a reduced safe yield of around 0.140 MGD (100 gpm) and, when used, is operated at around 0.115 MGD (80 gpm). Because the supply from this well is treated at the WTP, it has been typically used only when raw water withdrawal from the stream is reduced or restricted. The Winters Run Well is currently out of service due to a failure of the well casing.

2.4 Interconnections

As the two water systems were developed, several interconnections were made between the MDAW system and the Harford County distribution system. Most of these interconnections are used infrequently under emergency conditions. One connection, the MacPhail connection, was constructed to be the primary point of supply from the Harford County system. MDAW has an agreement with the County to purchase up to 0.5 MGD of finished water at the MacPhail connection at a bulk supply rate. Supplies exceeding the 0.5 MGD contract rate are not guaranteed to be available and are billed at an increased rate. Water through other connections is available on an emergency basis and is also billed at the increased rate.

2.5 System Operation

Under normal conditions, the Winters Run WTP and the Bynum Well are used to supply the system needs. Occasionally, water is purchased from Harford County at the MacPhail connection, and less frequently from other county connection. For the 2009 to 2013 period, the records show the Winters Run Well being operated for only three days in September of 2010.

Figure 2.1 and Table 2.1 show the water supplied by the available sources for the review period. It is evident that the surface water supply from Winters Run is the primary source for the system. The Bynum Well accounts for less than 10% of the total system supply, and water purchased from Harford County was less than 2% of the total.

Figure 2.2 graphically shows the monthly water supply by source for 2009-2013. It may be noted that the Bynum Well was not used for approximately six months beginning in late 2012. This was due to a detection of methyl tertiary butyl ether (MTBE), a gasoline additive, in the water supply. During this time water from the well was pumped to waste and monitored until the MTBE concentration returned to acceptable levels. In June 2013 the well was returned to use for water supply and the MTBE concentrations are monitored.

One of the most significant droughts to impact this system occurred during 2002, so the system records for that year were also reviewed to evaluate how MDAW operated the system during an extended interruption in the surface water supply. The Winters Run plant was taken offline in early July and was not returned to operation until mid-October. During that outage, the system relied almost exclusively on the purchased water supply from Harford County, using all of the metered connections. The Bynum Well was used only for several days during July and the Winters Run Well was not used at all.

***Table 2.1** - Annual Water Supply by Source*

Year	Winters Run WTP (MG)	Bynum Well (MG)	Hartford County (MG)	Total Flow (MG)
2009	482.04	48.18	12.11	542.34
2010	486.03	49.76	12.27	548.06
2011	475.40	49.18	3.58	528.15
2012	470.89	33.53	1.20	506.61
2013	483.85	18.85	8.33	511.03

***Figure 2.1** - Historical Water Supply by Source*

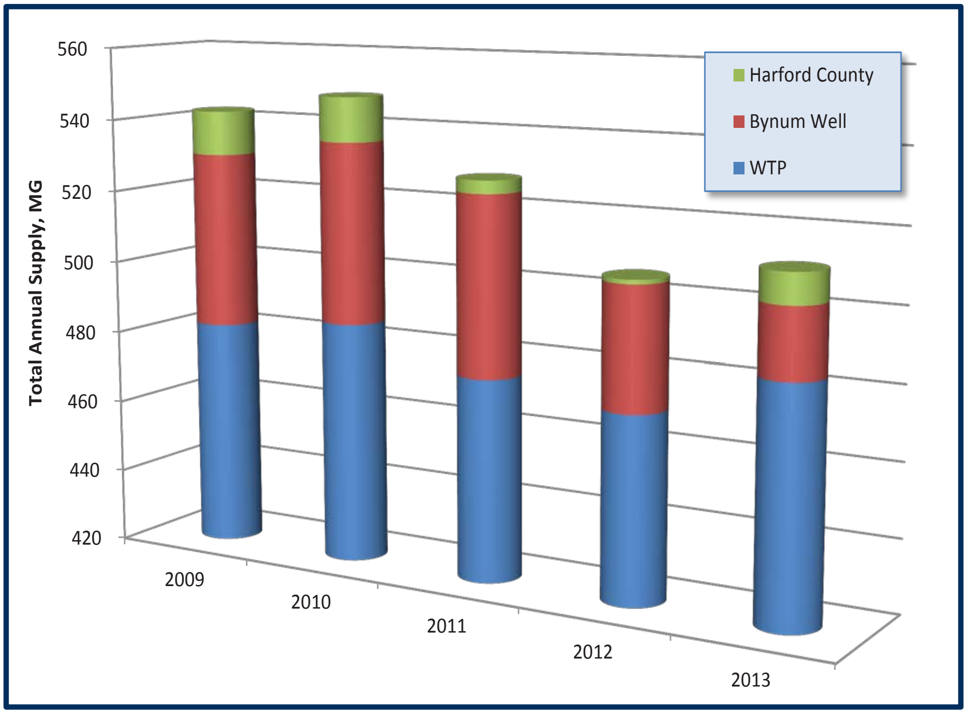
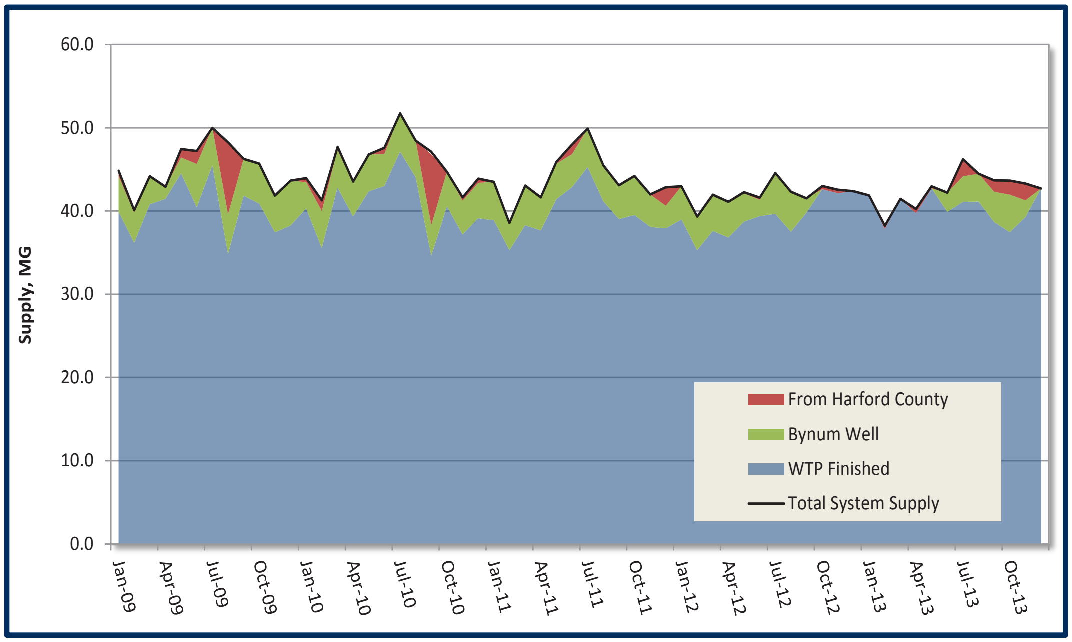


***Figure 2.2** - Monthly Water Supply by Source*



3. Demand Projections

3.1 Background

Water system demands must be evaluated in order to size the water storage reservoir. The reservoir volume must be sufficient to provide the raw water needs of the system during the design 'outage'. The raw water needs are slightly greater than the projected system demands due to the water consumption at the treatment plant for backwash and other functions.

American Water completed Bel Air Service Area Comprehensive Planning Study – 2012 (2012 CPS) which reviewed historic system demands and developed demand projections therefore, the conclusions and projections from that report were used in this study. The historical water use from the stream, wells, and purchased from the County was reviewed, however, to evaluate the raw water needs and the system demand potential during the design period of withdrawal restrictions.

3.2 Water Demand Projections

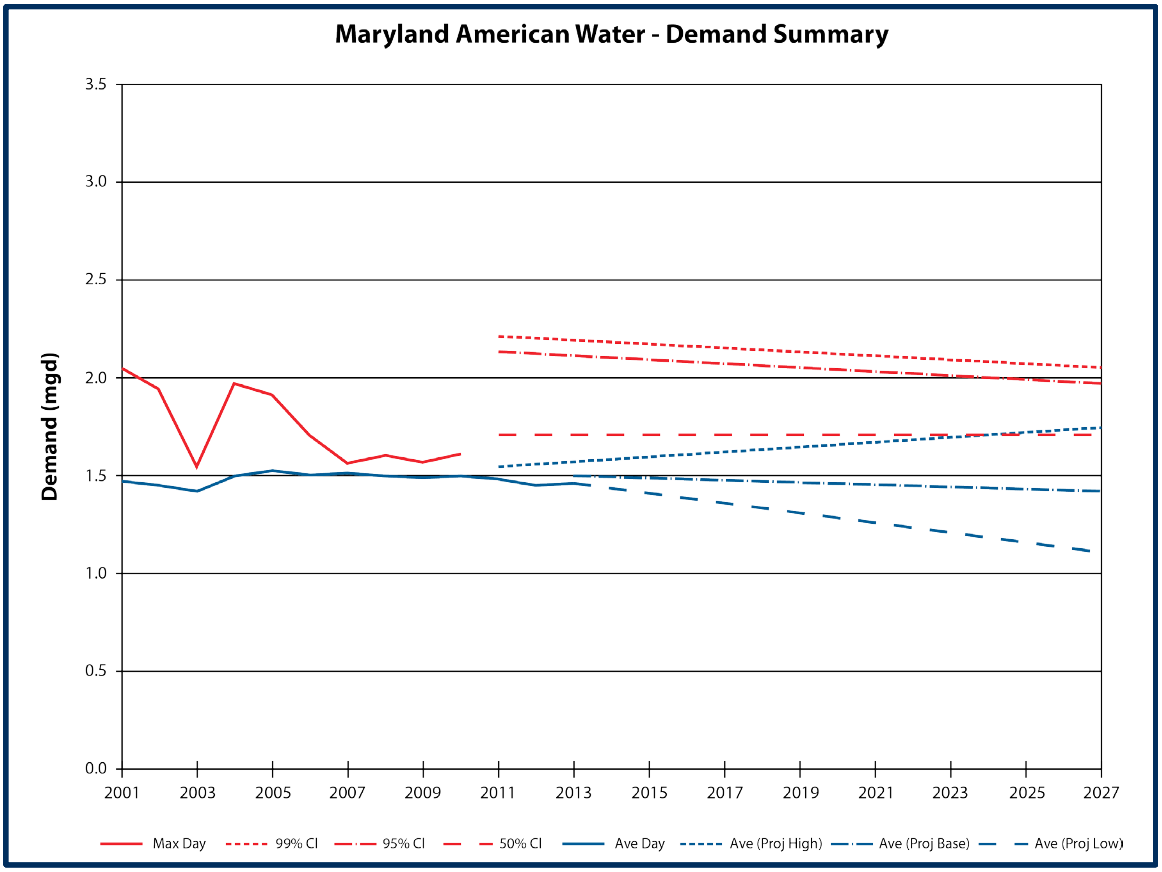
From the 2012 CPS, the Bel Air water system served 4,878 customers in 2010, with 85% of the customers being residential, 12% commercial, and the remainder identified as 'other'. The 2010 average water demand was 1.50 MGD. For the 2000 to 2010 period, the greatest annual average demand was 1.56 MGD in 2005. For the five year period of 2006 to 2010, the average water use was essentially flat at 1.49 to 1.52 MGD.

The study evaluated historical projected population changes for the Town and Harford County to develop projections for the average water demand through 2027. The study considered the relatively low population growth (approximately 1% per year) and the reduction in per capita residential water use that has been seen in the historic data. The study developed a 'Base' demand projection and then a potential 'Low' range and a potential 'High' range of demands. The Base projections and the Low projections predict a reduction in average water use over the study period. The High range projection showed a slight increase in projected use of up to 1.69 MGD in 2027. Figure 3.1 was taken from the 2012 CPS showing the demand projections developed in that study.

For this study, Gannett Fleming evaluated the system supply and demand records for the previous 5 years; from 2009 to 2013. Since 2010, the average demand has markedly decreased to 1.40 MGD in 2013, supporting the lower demand projections developed in the 2012 CPS.

The Maximum Day Demand (MDD) was also evaluated in the 2012 CPS. Typically the MDD is evaluated as a ratio relative to the annual average demand, known as the Maximum Day Factor (MDF). The MDF varies from year to year, with weather being the primary factor related to the variation. In system planning the MDD can generally be thought of as a 'potential' demand. During years with warm, dry summers, the MDD is typically higher due to increased outdoor water use, resulting in a higher MDF. A review of the range of historic MDF values allows the system planners to evaluate the potential maximum demand that could occur in a future year and ensure that the supply capacity is available to meet that demand. The 2012 CPS identified the average MDF for the Bel Air system is 1.203, and there is a 95% probability that it will be 1.406 or less. For planning purposes, the study recommended using the 1.41 MDF to plan for the maximum system supply capacity requirement.

Figure 3.1 *- Historic and Projected Water Demand*
(Figure 3-10 from 2012 Comprehensive Study)



Graph updated using latest information

3.3 Assumed Demands for Feasibility Study

As noted above, the purpose of this study is to evaluate the amount of water needed to meet the system demands during a long duration interruption in raw water supply from Winters Run. It is assumed that the long duration interruption is due to low stream flow and drought conditions which typically occur during the warmer times of the year. Consequently, it is also expected that the concurrent water system demand will be increased due to the increased outdoor water use as noted above.

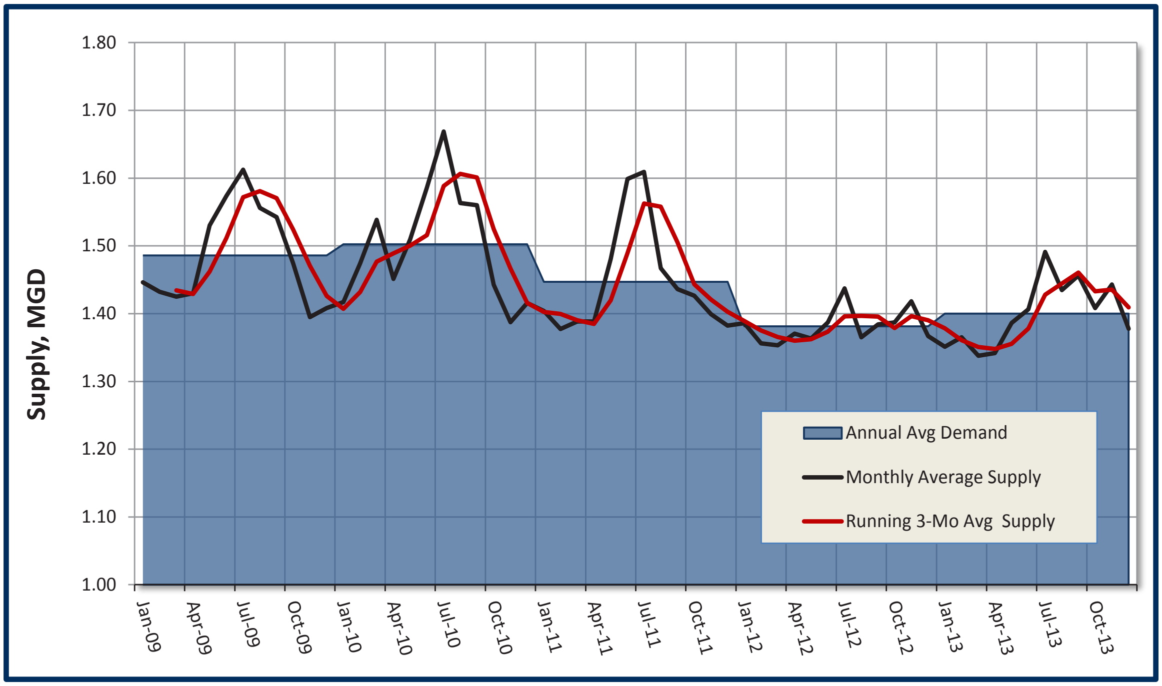
Over a longer evaluation period of one to three months, the average water use will be much closer to the annual average use. However, the ratio of the demand during the outage to the annual average demand can be evaluated, just as is done for the MDD and MDF to predict the water needs during a long term stream withdrawal prohibition.

From 2009 to 2013 the ratio of the maximum month usage to the annual average usage ranged from 1.09 to 1.13, and the maximum 3-month average usage to annual average usage ratio ranged from 1.01 to 1.08. Applying these factors to the projected water demands data from the 2012 CPS, the water usage during a one-month to three-month supply interruption can be projected, as shown in Table 3.1. It would be expected that the longer the duration of the design outage duration, the closer the average outage demand would be to the annual average demand.

***Table 3.1** - Maximum Month Demand and 3-Month Water Demand, Peaking Factors*

Year	Annual Average Demand (MGD)	Maximum Month		Maximum 3-Month	
		Demand (MGD)	Peak Factor	Demand (MGD)	Peak Factor
2009	1.49	1.61	1.09	1.56	1.06
2010	1.50	1.67	1.11	1.61	1.07
2011	1.48	1.61	1.11	1.56	1.08
2012	1.38	1.44	1.04	1.40	1.01
2013	1.40	1.49	1.07	1.46	1.04
Projected Water Demand					
2027 Low	1.12	1.24	1.11	1.21	1.08
2027 Base	1.39	1.54	1.11	1.50	1.08
2027 High	1.69	1.88	1.11	1.83	1.08

***Figure 3.2** - Water Demand during Pass-by Restriction*



It is evident from the discussion above that the volume of water needed to meet system demands during an extreme duration drought is subject to certain assumptions. The most critical is the duration of the stream withdrawal restriction that will be the 'design outage', which is the subject of Chapter 5 of this report. However, water demand projection establishes the basis for the estimation of the average demand during the design outage. For the purpose of this feasibility evaluation, an average demand during the design outage was assumed to be 1.50 MGD. This demand assumption will need to be investigated in greater detail using more historical data if this concept proceeds to a design project.

3.4 Water Supply Requirement

In addition to the system demand during an outage, water treatment plant losses due to filter backwashing, maintenance, and other process uses must also be supplied. While this volume is typically a minor component of the raw water requirement, it should be evaluated. The 2012 CPS reports that plant losses have been around 1.5% of the finished water production. A review of the system operating reports for 2009 to 2013, however, show the difference between raw water and finished water at the Winters Run plant to average around 0.03 MGD, or 1.74% of finished water, until November 2012. Beginning in November 2012 the plant records show a sharp increase in plant losses, up to around 0.13 MGD. It was reported that the raw water meter failed in mid-2013 when the plant losses were negative. Because a more thorough evaluation of the sudden increase in plant losses is beyond the scope of this study, the raw water meter records from November 2012 onward have been discounted.

The 1.74% factor will be used to estimate the plant losses. Adding the plant losses to the 1.50 MGD system demand results in a 1.53 MGD raw water supply requirement, assuming all of the water is supplied from the Winters Run WTP. During a drought restriction, however, this system demand will likely be supplied from other sources such as the Bynum Well and water purchased from Harford County as well as the WTP. Since this is a feasibility study and the plant losses are a minor component of the raw water need, these losses will not be considered further.

3.5 Water Supply Required from Storage

The discussion above develops the basis for estimating the total system supply requirement. The volume of water needed in a storage reservoir can be reduced by maximizing the use of water from other sources, such as the system wells. As noted in an earlier section, during the 2002 outage, the existing wells were only minimally used and most of the supply was from Harford County. The County supply in excess of 0.5 MGD cannot be relied upon for future outage supplies.

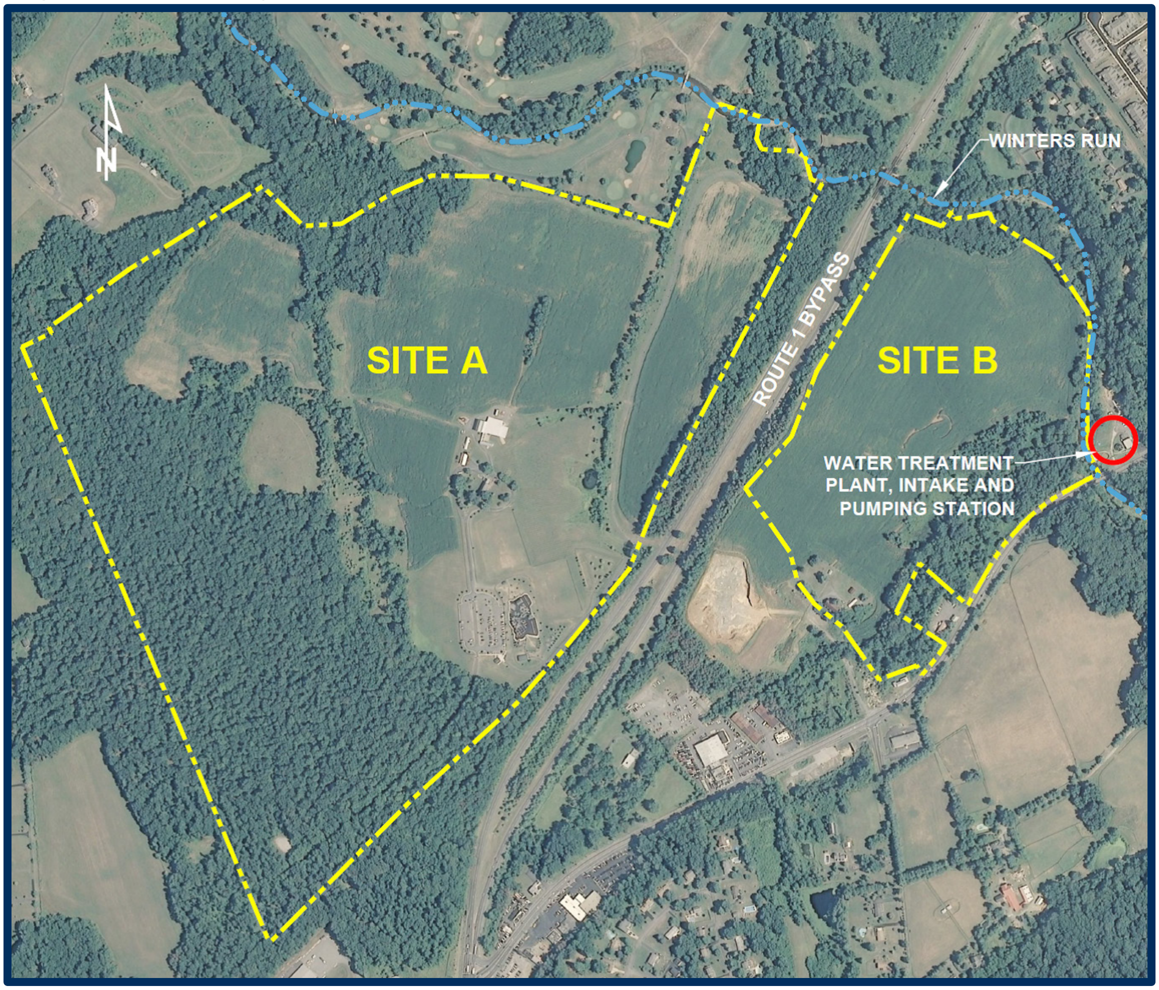
4. Description of Potential Reservoir Sites

4.1 General

Harford County identified two county-owned parcels immediately upstream of the Winters Run Water Treatment Plant that have the potential to be suitable sites for the construction of a pump-storage reservoir. Both parcels are also adjacent to the Winters Run stream along their Northern edge. Site A (the Edgely Grove Site) is located to the West of the Route 1 Bypass and Site B (the Soma site) is located to the East of the bypass as shown in Figure 4.1. The proposed pump-storage reservoir will allow raw water to be pumped from Winters Run, during high flows, and stored in the reservoir. The reservoir will supply the water treatment plant with raw water when withdrawal from Winters Run is restricted or prohibited. Based on the safe yield model results, a reservoir at each site is unnecessary; however both sites were evaluated for this study to determine the optimum site. County topographic mapping was supplemented with geotechnical and environmental information gathered at each site to assist in determining the most cost efficient layout. See Appendix A, Exhibit 1 for the location of the geotechnical investigation and environmental features.

The proposed dam embankment at both Site A and B consists of a 20 foot wide crest, 3H:1V downstream slope and a 2.5H:1V upstream slope. The embankment

Figure 4.1 *- Exisiting Site Map*



at each site will be constructed of on-site soils. Based on the current geotechnical investigations, the embankment and reservoir bottom will require a liner system to control seepage. Based on the current layout and past experiences, it is recommended that a Carpi PVC liner system is used. See Geotechnical Studies Section 7.4 for discussion of different types of liner systems. This type of liner system will be exposed on the upstream slope of the embankment and require an anchoring and drainage system beneath the liner. The liner system at the reservoir bottom can be covered with 3 feet of soil to eliminate the drainage and anchoring system, and therefore reduce the costs of the liner system. The footprint for each site was reduced as much as practical to minimize the liner area.

***Photo 4.1** - Example of Lined Reservoir, Courtesy of Carpi USA Inc.*

There are four main components of the proposed pump-storage reservoir to function properly: 1) the dam embankment, 2) the control tower, 3) the raw water transmission pipeline and 4) the Winters Run intake structure and pumping station. The raw water from Winters Run will enter the intake structure and be pumped into the raw water transmission pipeline, which will discharge into the reservoir through the control tower. The control tower will also include intake portals for releasing water, during periods of withdrawal, back into the raw water pipeline and ultimately into the water treatment plant.

The Maryland Dam Safety Division categorizes dams according to their size and potential downstream hazard. Below is a table prepared by the Maryland Department of the Environment, Dam Safety Division to provide general guidance on hazard classification of state regulated dams in Maryland. The classification of the dam must include the potential for future downstream development within the dam failure inundation zone. Based on a review of the area downstream of the dam site, it is judged that the proposed impoundment will be classified as a High Hazard (Class I) dam, where loss of live and extensive property damage are probable should the dam fail. The consequences for a Class I dam includes major increases to existing flood levels at residential, industrial, or commercial buildings; major interstates, state roads and public roads or railroads; with more than 6 lives in jeopardy.

High Hazard (Class I) dams require the preparation and maintenance of an

***Table 4.1** - Guide to Classification of Dams*

Category	Normal Pool Storage Volume (in acre-feet)	Normal Depth (in feet)	Potential for Loss of Life	Potential for Damage
I	20,000 or more	50 or more	probable	Serious damage to: residential, industrial, or commercial buildings; important public utilities, public roads; or railroads
II	1,000 or more and less than 20,000	25 or more and less than 50	small possibility	Located in predominately rural or agricultural areas where failure may cause damage to isolated residences or cause interruption of use or service of public utilities or roads. Damage is within the financial capability of owner to repair.
III	less than 1,000	less than 25	very unlikely	Damage is of the same magnitude as cost of dam and within the financial capability of owner to repair.
IV*	less than 100	less than 15		

** Category IV is reserved for those structures which have a contibuting drainage area of less than 1 square mile (640 acres), and a normal depth of water less than 15 feet above the original stream bed, and a normal surface area less than 12 acres*

Emergency Action Plan for the dam should problems arise that would require an immediate response, including evacuation of persons within the inundation zone downstream of the dam. High Hazard dams also require regular inspection of the dam including submitting inspection reports to the Maryland Dam Safety Division.

4.2 Site A

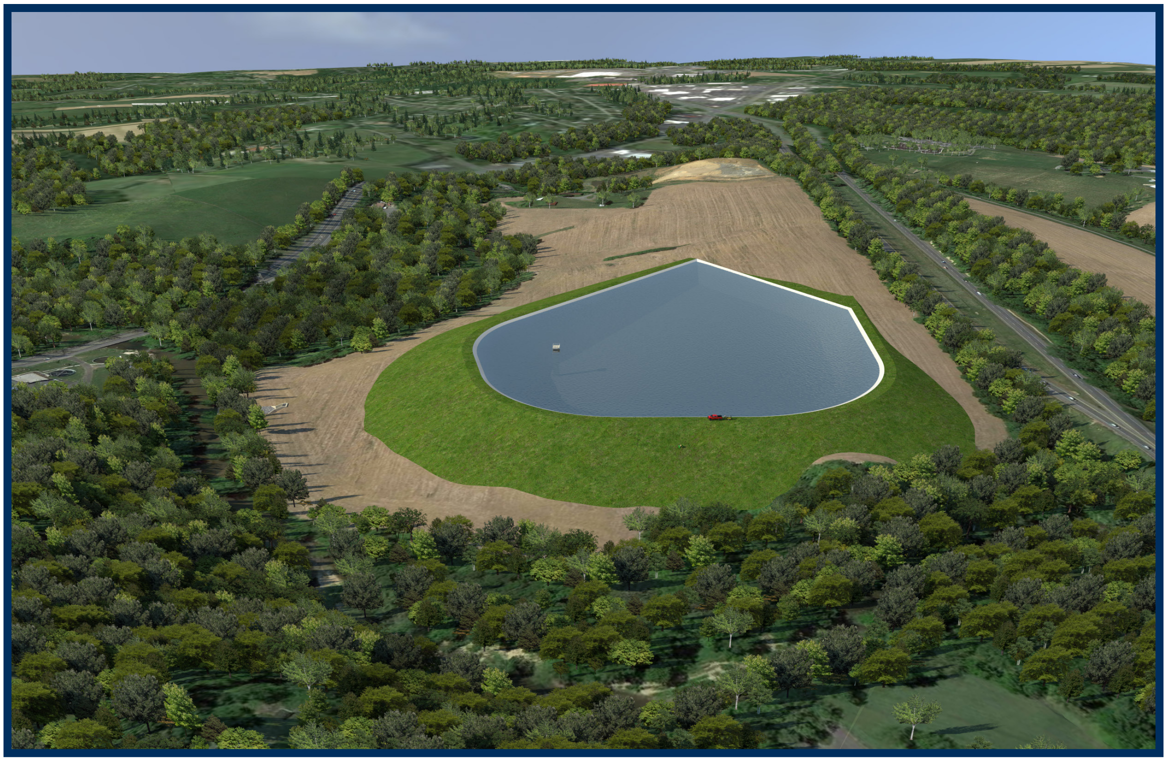
The groundcover at Site A is about half forest cover and half farmland. It also has several environmental features and structures throughout the property that were avoided with this conceptual layout in order to alleviate permitting difficulties and create a cleaner construction site. Site A is also the home of several public attractions, Edgeley Grove Farm, Annie's Playground and a walking trail. Due to the location of these features and the required size of the reservoir based on the results of safe yield model, the reservoir was located in the field at the toe of the hill north of Edgeley Grove Farm. The reservoir shown in Figure 4.2 is cut into the hillside with depths of excavation ranging between 20 feet and 50 feet. Because of the reservoir's proximity to the hill, there is a surplus of excavated material that will be spoiled on-site. This reservoir concept requires an embankment approximately 1,900 feet long and 56 feet high to store 350 acre-feet of raw water.

Figure 4.2 *- Rendering of Site A, looking South*

4.3 Site B

The Site B property adjoins the water treatment plant property along its respective northern edge adjacent to Winters Run. The groundcover at Site B consists mostly of farmland. It also has some environmental features along the eastern portion of the property including a reforestation zone. The proposed reservoir at this site is located such that it will not impact either of these features. In order to maximize the reservoir storage and keep the liner footprint to a minimum, the reservoir is located at the northern portion of the site. This also reduces the length of raw water pipeline. The reservoir shown in Figure 4.3 is cut into the hillside with depths of excavation ranging between 20 feet and 30 feet. The excavation and fill quantities balance for this site and there is no need to spoil material. This reservoir concept requires an embankment approximately 2,300 feet long and 58 feet high to store 350 acre-feet of raw water.

Figure 4.3 *- Rendering of Site B, looking South*



4.4 Control Tower

The Control Tower for each site is a free-standing reinforced concrete riser structure approximately 55 feet high with an operating platform and two interior chambers. One chamber is dedicated for water supply with the ability to both fill the reservoir and withdraw water from the reservoir. This chamber has multiple ports for withdrawing water at different reservoir elevations, as well as a port for discharging raw water into the reservoir. It is connected to the raw water transmission pipeline at the base of the chamber. The second chamber serves as a principal spillway with a weir opening at the top to control maximum pool level. Although the reservoir does not have any contributing drainage area, this spillway serves as a safeguard against accidentally over-filling the reservoir. An outlet pipe connects at the base of the principal spillway chamber. The raw water transmission pipeline and outlet pipe are supported on a concrete cradle and run parallel through the dam embankment. At the toe of the dam embankment, the raw water transmission pipe diverts away from the outlet pipe towards the pumping station and water treatment plant. The outlet pipe exits into a standard reinforced concrete impact basin located near the toe of the dam embankment, where an excavated channel lined with riprap connects the impact basin to the stream.

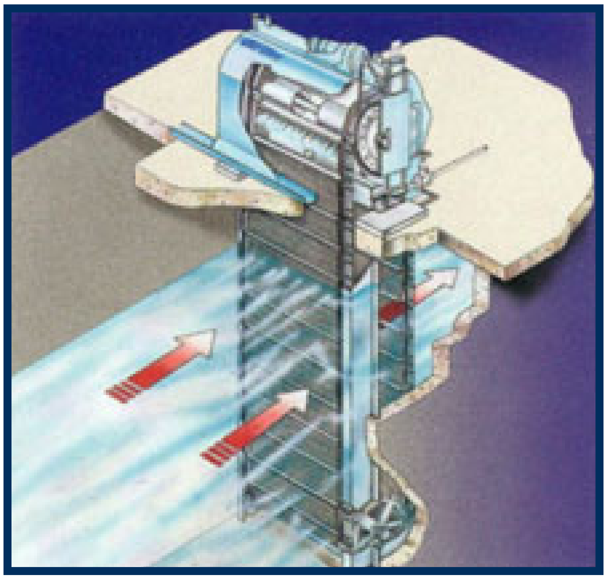
4.5 Winters Run Intake and Pumping Station

The existing Winters Run Intakes are located on the east bank of Winters Run and the Raw Water Pumping Station is located within the water treatment plant (WTP) property, on the east side of Winters Run. Water is currently withdrawn for Winters Run through a gabion style concrete intake. A low level concrete dam impounds a small pool at the location of the intake. Water from Winters Run passes through two screened gates and flows by gravity to an eight foot grit chamber. The grit chamber is piped to a twelve foot diameter suction well that is equipped with four submersible pumps. Three pumps deliver water to the WTP and the fourth pump is used to flush the intake lines of sediment periodically.

A new raw water intake and pumping station on Winters Run is required to accommodate the operation of the proposed pump-storage reservoir. During periods of high flow, the reservoir supply pumps will be sized to fill the reservoir. The conceptual design assumes that the existing intakes and raw water pumps that supply the WTP from Winters Run will be retired. The design indicates the construction of a new intake and pumping station to supply the reservoir and WTP. A wetwell to house both the reservoir fill (high duty) and WTP supply (low duty) pumps will allow for only one intake in the stream to be required. This arrangement also assists with construction sequencing. The existing intake(s) and raw water pump station can remain in service during the construction of the new intake and pumping station. As shown in Appendix A, Exhibits 7 and 8, the new pump station will be located north of the existing pump station. Further evaluation will determine if the suggested location is free of underground utilities and if the selected land possesses the geological characteristics required to support the construction the proposed structure.

The conceptual design of the raw water intake and pump station is shown in Appendix A, Exhibit 9. The bar screen on the intake located within the stream will prevent large debris from entering the supply piping. Flow enters the intake and through a short pipeline before passing through a traveling screen near the pump station wet-well. The traveling screen will collect the solid particles preventing them from entering the wetwell and being pumped to the reservoirs or WTP. Figure 4.4 shows a through flow traveling screen. The traveling screen is installed with submerged screening surfaces perpendicular to the intake flow. The screen collects and transports debris to the top of the screen's enclosure where jets of flush water send the refuse to disposal.

Figure 4.4 *- . Through Flow Traveling Water Screen*



Source: Ovoqua Water Technologies

Screened water enters the pump station wetwell. As shown in Appendix A, Exhibit 9, the pump station design incorporates submersible, centrifugal pumps. Two (2) high duty pumps will supply the reservoir, and two (2) low duty pumps will be dedicated to the WTP when treating raw water directly from Winters Run. The high duty pumps will operate on variable frequency drives (VFDs), so that they can provide a range of flows depending the stream conditions during operation. The low duty pumps will be constant speed and will operate similar to the existing raw water pumps at the WTP. If deemed operationally beneficial, the low duty pumps can also be equipped with VFDs. To monitor the flow withdrawn from Winters Run the existing flow meter at the WTP will monitor the flow into the plant, and a new flow meter located inside the pump station valve chamber will record the flow to the reservoir. When water is needed from the reservoirs, all pumps will be turned off and the valve that separates the discharge piping between the low duty and high duty pumps will be opened. This valve can be operated manually or automatically through SCADA programming. SCADA programming can also prevent low duty pump operation if the stream pass-by flow is at or below the required minimum rate.

4.6 Raw Water Transmission Pipelines

A common inlet/outlet pipe will extend to either reservoir from the location of a new raw water pumping station located on the WTP property. With each of the proposed reservoir locations, water will need to be pumped from Winters Run to fill the reservoir. As necessary, water will exit the reservoir by gravity. As shown in Appendix A, Exhibits 6-8, the pipe route to the Reservoir B location is more direct than the pipe route to the Reservoir A location. The existing topography dictated the routing of Reservoir A inlet/outlet transmission main to be near Winters Run in order to maintain a flat or downward slope from the reservoir to the WTP and to avoid high points in the pipeline. The pipeline will remain four (4) feet below grade to the extent possible to accommodate conventional open trench pipe installation. With either reservoir scenario, it is assumed that the pipeline will need to be installed under Winters Run using directional boring techniques. However, the transmission main route to Reservoir A also requires directional boring to cross the Bel Air Route 1 Bypass. The pipeline to Reservoir A also passes a second small stream. It is assumed that a contractor could divert the flow from the small stream during construction of the pipeline.

5. System Computer Model and Assumptions

5.1 Model Development

In order to simulate daily operation of an off-line reservoir at Bel Air over an extensive period of record, a custom computer model of the reservoir and supply system was programmed using Microsoft Visual Basic Express software. The purpose of this model was to simulate the operation of the proposed reservoir and supply system for an extended period of record to estimate water availability during drought events under proposed conditions.

The safe yield of a water system is defined as the maximum quantity of water that can be continuously supplied during the most severe drought of record without exhausting the supply storage. It is assumed that the reservoir is full at the beginning of the simulation period. The safe yield of the system is reached when the specified demand can no longer be satisfied by the system without encroaching on dead storage.

5.2 Model Inputs

To calculate water availability, storage, and consumption; the model accepts multiple user-defined inputs. These inputs allow the user to define various aspects of the reservoir and intake system, such as normal pool elevation, minimum flowby requirements, dead storage elevation, and stage-storage relationships. Hydrologic data including daily river flows and monthly net evaporation rates are also required as model input. As water balance is tracked over the period of record, the model also creates output data files that can be used for further analysis.

The accuracy of model analysis is dependent on the use of representative model inputs and sound assumptions. Hydrologic data and additional system specific data help define both the natural and physical limitations of the reservoir system. The following sections describe the features of the model and the assumptions associated with them.

5.2.1 Streamflow at Winters Run Intake.

The U.S. Geological Survey (USGS) has collected daily streamflow values over long periods of record at selected gage sites. These streamflow records are a valuable source of hydrologic information. One stream gage is located on Winters Run approximately 0.4 miles upstream of the intake for the Bel Air water treatment plant. The data from this gage extends 47 years between 1967 and 2014.

In order to analyze system operation over an even longer span, the period of record can be extended using other stream data from a nearby watershed. The daily values from a stream gage with similar watershed characteristics can be transposed to the watershed in this study through a linear adjustment based on drainage area. Ideally, the stream gage to be used in the analysis should be in the same watershed. However, in this case, no other stream gaging stations exist within the Winters Run watershed. Therefore, streamflow records from other nearby watersheds must be correlated and transposed to the watershed being studied, provided the watersheds and streamflow characteristics are similar.

Seven additional stream gages were analyzed within a 31 mile radius of the Winters Run stream gage for potential use in this analysis. The criteria considered in selecting an appropriate gage include the distance from the Winters Run stream gage, the average unit watershed runoff, and the available period of record. Based upon these criteria, the Deer Creek gage at Rocks, MD (USGS Gage No. 01580000) was selected to provide the streamflow data for this study. The gage is located approximately 7.8 miles from the Winters Run stream gage and has a drainage area of 94.4 square miles. The average runoff per square mile of drainage area is slightly lower than that of Winters Run which provides a more conservative streamflow estimate. Summary statistics and a timeline of record for the aforementioned USGS stream gages are presented in Table 5.1 and Figure 5.1, respectively. A map showing the locations of the gaging stations relative to the WTP intake is presented in Figure 5.2.

By transposing the flows measured at the Deer Creek gage to the site, a continuous record of daily streamflows at the Winters Run stream gage was developed from 1926 to the present. Between the stream gage and the intake structure for the Bel Air WTP, the drainage area of the stream increases from 34.8 square miles to 36.8 square miles. The streamflow record from the gage location was increased linearly to account for the additional drainage area.

***Table 5.1** - USGS Stream Gaging Stations near Bel Air, MD*

Station	Distance from Winters Run gage (miles)	Drainage Area (sq mi)	Average Runoff (cfsm)	Period of Record
01581700 Winters Run near Benson, MD	-	34.80	1.51	8/1967-Present
01584500 Little Gunpowder Falls at Laurel Brook, MD	3.30	36.10	1.26	11/1926-9/1970, 10/1998-Present
01580000 Deer Creek at Rocks, MD	7.80	94.40	1.35	10/1926-Present
01582500 Gunpowder Falls at Glencoe, MD	14.10	160.00	1.32	10/1977-6/1980, 12/1982-Present
01582000 Little Falls at Blue Mount, MD	14.40	52.90	1.32	7/1944-Present
01583600 Beaverdam Run at Cockeysville, MD	14.90	20.90	1.48	10/1982-Present
01583500 Western Run at Western Run, MD	16.20	59.80	1.18	9/1944-Present
01495000 Big Elk Creek at Elk Mills, MD	31.00	51.60	1.38	4/1932-Present

***Figure 5.1** - Timeline of Nearby USGS Stream Gaging Stations*

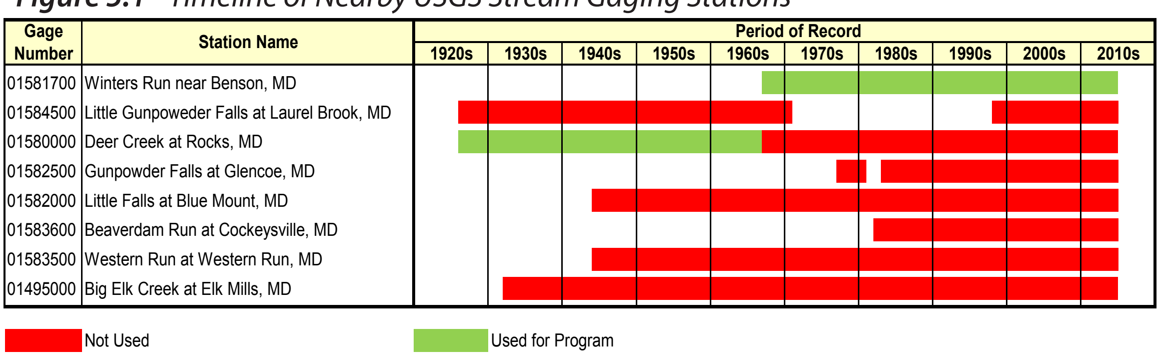


***Figure 5.2** - Map Showing Locations of Nearby USGS Stream Gaging Stations*

5.2.2 Net Evaporation.

An additional hydrologic data requirement in the model is the estimation of net evaporation. Evaporative losses and direct rainfall inputs from reservoirs can be substantial and are especially important in accurately simulating a water system during times of drought. Net evaporation is gross evaporation minus precipitation on the surface area of the reservoir.

Monthly evaporation rates are available from published sources. Table 5.2 lists the monthly gross evaporation in the vicinity of the project site which were used to compute net evaporation from the reservoir. These estimates are based upon the publication Evaporation from Lakes and Reservoirs by Adolph F. Meyer of the National Resources Planning Board (1942).

To compute the net evaporation, precipitation over the reservoir surface must also be estimated. Due to spatial variation in precipitation, it is best to use the climatological stations that are closest to the site. The National Climatic Data Center (NCDC) maintains historic records of monthly precipitation in the United States.

***Table 5.2** - Monthly Gross Evaporation Rates[1]*

Month	Evaporation (in)	Month	Evaporation (in)
January	1.2	July	6.3
February	1.4	August	5.0
March	1.8	September	4.8
April	3.2	October	3.3
May	3.7	November	2.2
June	5.4	December	1.4

[1]*Meyer, 1942.* Evaporation from Lakes and Reservoirs

Seven NCDC precipitation gages within a thirty mile radius of the dam site were analyzed. Four gages were selected due to their close proximity to the site and periods of record. One additional gage was used as a supplemental source.

The Fallston, MD gage (USC00183050) provided data for the study from 1926 to 1954. The Benson Police Barrac, MD gage (USC00180732) provided the majority of precipitation data from 1954 through 1997. The Conowingo Dam, MD gage (USW00013701) provided data from 1997 to 2007, and the Bel Air 1.7 W, MD gage (US1MDHR0011) provided data from 2007 to 2014. The Aberdeen Phillips Field, MD gage (USW00013777) was used to supplement data for all gages which were missing small sections of data. These gages provided an acceptable representation of the monthly precipitation over the proposed Bel Air reservoir site from 1926 to 2014, the same period of record as the daily streamflow data. A summary of the precipitation gages used in this study is presented in Table 5.3. A timeline of precipitation data availability as well as a map showing the locations of precipitation gages considered for this study are shown in Figures 5.3 and 5.4, respectively.

***Table 5.3** - Precipitation Gage Station Data near Bel Air, MD*

Station	Latitude	Longitude	Period of Record	Distance from Intake (miles)
Benson Police Barrac, MD US GHCND:USC00180732	39.50000	-76.38333	8/1948 - 2/1995	1.3
Bel Air 1.7 W, MD US GHCND:US1MDHR0011	39.53850	-76.37880	6/2007 - 7/2014	1.6
Fallston, MD US GHCND:USC00183050	39.51667	-76.40000	6/1919 - 4/1953	1.6
Conowingo Dam, MD US GHCND:USC00182060	39.65000	-76.16667	1/1936 - 1/1992 7/1993 – 7/2014	13.9
Aberdeen Phillips Field, MD US GHCND:USW00013701	39.46667	-76.11667	6/1919 - 12/1957 6/1966 - 7/2014	14.0
Baltimore Customs House, MD US GHCND:USW00013777	39.28333	-76.61667	6/1919 - 1/1999	20.8
Baltimore Washington Intl. Airport, MD US GHCND:USW00093721	39.18333	-76.66667	7/1939 - 7/2014	27.9

***Figure 5.3** - Timeline of Nearby Precipitation Gages*

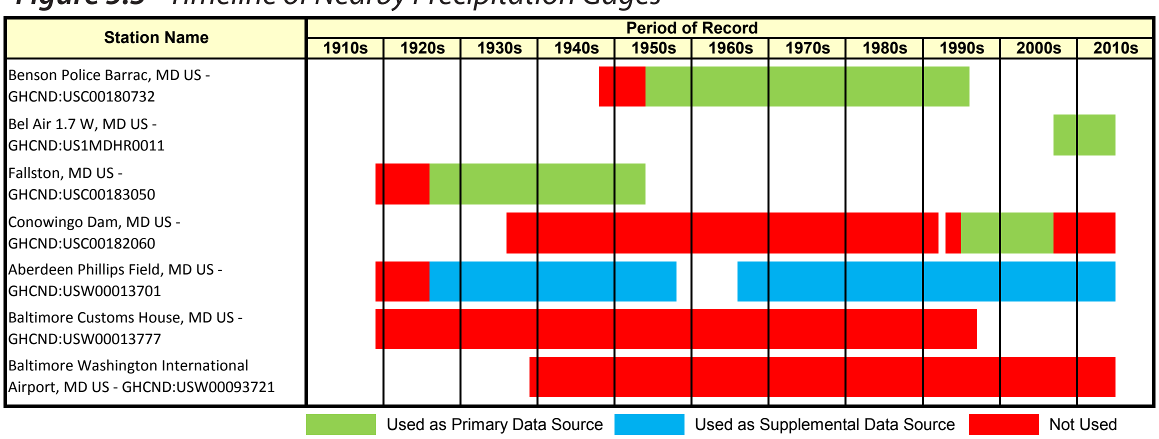
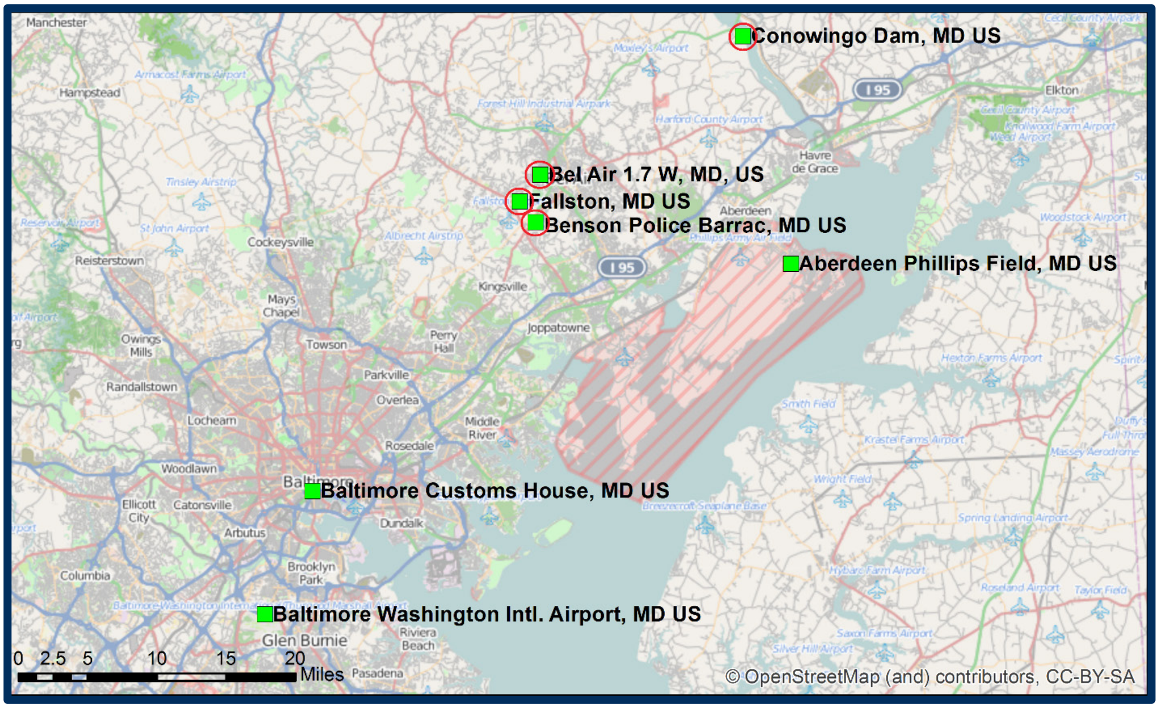


Figure 5.4 - Map Showing Locations of Precipitation Stations Analyzed for Study



Daily net evaporation was computed by subtracting the monthly precipitation from the monthly gross evaporation and dividing the result by the number of days in each month. The daily net evaporation is an input to the computer program model for each day of the simulation.

5.2.3 Reservoir Characteristics.

Within the model, the user is able to provide the stage-storage-surface area relationship of the reservoir. The surface area is used to calculate the total gains or losses due to net evaporation during each time step of the model. The user also defines the normal pool and dead storage elevations. In typical applications, a safe yield model will include provisions to account for runoff into a reservoir from its contributing drainage area. In the case of the Bel Air system, both of the proposed sites are off-line reservoirs with little or no natural drainage area. Therefore, natural inflows in this case were assumed to be negligible.

An inflow indicating elevation is also identified to control how often the reservoir will be filled. This simulates an operating mode where water will not be pumped into the reservoir until the water elevation is below a user-specified indicator elevation. If the reservoir elevation is lower than the indicator elevation and water is available, the pumping station will fill the reservoir to the normal pool level.

5.2.4 Flowby Requirement and Other Permitting Constraints.

In accordance with the State of Maryland Department of Natural Resources (DNR), the amount of water that may be withdrawn from Winters Run is subject to a minimum flowby requirement. Also associated with this withdrawal permit are average and maximum daily withdrawal limits. Since the current permit will be in effect only until 2015, the model allows the user to assess the impact of a change in flowby requirement and other permitting constraints on storage requirements. Chapter 2 provides a detailed summary of current permit requirements with regards to Winters Run withdrawals.

5.3 Assumed Operating Rules

The primary source of water for the Bel Air system is Winters Run. Within the model, it is assumed that all water above the minimum flowby requirement and below the permitted withdrawal limit is available to meet demands and/or fill the reservoir. The available water from the stream is used to either meet the demand or fill the reservoir whenever the water elevation is below the normal pool level. If the available flow in the stream is not sufficient to meet the daily demand, the model supplements the withdrawal with the Winters Run Well supply which has an average safe yield of 0.115 MGD. If the amount of water from the stream and the well is still insufficient, the system is supplemented by Bynum Run Well which has an average safe yield of 0.144 MGD.

Water within the reservoir is used as an emergency supply only. Flows from the reservoir are used to meet demand only when the amount of water from Winters Run and the two wells are below the daily water demand. Water released from the reservoir into the stream only occur when the reservoir is full and the daily precipitation is larger than the evaporation rate. Inflows from a contributing drainage area into the reservoirs and losses due to seepage were assumed to be negligible.

The Bel Air WTP has a maximum capacity of 1.7 MGD and processes water from Winters Run and Winters Run Well. The model also assumes that water from the reservoir will also be processed at the same treatment plant. Water from the Bynum Run Well is treated at a separate facility. Therefore, the maximum possible safe yield of the system is limited to the capacity of the two treatment facilities, or 1.844 MGD. Currently, MDAW is capable of purchasing up to 0.5 MGD of treated water from Harford County. For the purposes of this study, this additional supply from Harford County was neglected. Preliminary analyses indicate that the proposed reservoir will eliminate the need to purchase county water.

5.4 Critical Variables

The reservoir storage is considered sufficient when it is able to meet the average day demand during the critical drought period of record. The storage needed in the reservoir depends on three variables:

1. Minimum flowby requirement in Winters Run
2. Allowable withdrawal from the stream by permit
3. Average daily demand

As the minimum flowby increases, the amount of water available for possible withdrawal decreases. Consequently, the reservoir storage would need to increase in order to have enough storage to meet demands during periods of low streamflow. This would also results in longer refill periods and require that reservoir water be used more often. Conversely, if the minimum flowby is decreased, a smaller amount of storage would be needed to meet a specified demand, and the reservoir would be used less often.

The maximum allowable withdrawal has a similar impact on the amount of storage required to meet a specified demand. As the allowable withdrawal increases, the reservoir is able to be filled more rapidly which is critical to a water supply during and just following a drought event. This will also allow the maximum capacity of the reservoir to be reduced.

5.5 Quality Control

As part of the programming process, the custom computer model was thoroughly tested to ensure that all computations and internal logic were correct. The daily computations including inflow/outflow, reservoir evaporation, reservoir storage and elevation were verified. Additionally, an overall check was made by performing a mass balance test for the entire system for the entire period of simulation. The mass balance test involved computing the total inflows, withdrawals, losses, and the net change in reservoir storage from the beginning to the end of the simulation, and verifying that there were no net gains or losses of water computed by the model.

6. Safe Yield Model Results

6.1 Modeled Scenario

Note that all model results and statistics presented in this section are based on conceptual design parameters. The analysis provides useful information regarding the feasibility of the project approach and reservoir sizing. However, additional model analysis should be performed once withdrawal permit requirements are agreed upon if the project is pursued. The results in this section were calculated using conceptual characteristics of the reservoir at Site B. As the Site A reservoir is similar in storage and size, these findings may also apply if Site A is selected. Slight distinctions may occur due to the differences in net evaporation losses because of the differing stage-surface area curves of each conceptual reservoir. Figures showing graphical representations of the model results for Site B are included in Appendix B.

The average demand is projected to be highest in 2017 with a value of 1.5 MGD. This value was used as the daily demand and was held constant throughout the entire 88 year modeling period. The constant flowby requirement was assumed to remain the same as its current value of 6.07 MGD. The reservoir is assumed to start at full capacity with a normal pool elevation of 259 ft. (360.8 ac-ft.) and a 10% dead storage volume at elevation 222.8 ft. (36.1 ac-ft.). The inflow indicator elevation was set equal to the normal pool elevation. In other words, the reservoir continuously replaced water lost from evaporation as long as water was available to do so. This assumption was made in order to maximize the safe yield of the system, though it is recognized that such may not be desirable from an operation standpoint.

Currently, the permit allows an average daily withdrawal of 1.4 MGD with a 1.7 MGD maximum daily withdrawal. This permit will be in effect through 2015. Because the model assumes that water from Winters Run is primarily used to meet demands in Bel Air, this allotment was not sufficient to meet the constant 1.5 MGD demand. The withdrawal rate needed from Winters Run was determined for a range of flowby requirements and reservoir storage volumes using the daily flow model developed for this study and was found to vary between approximately 4 MGD to 8 MGD. For the proposed reservoir configuration, an 8 MGD pump station was assumed.

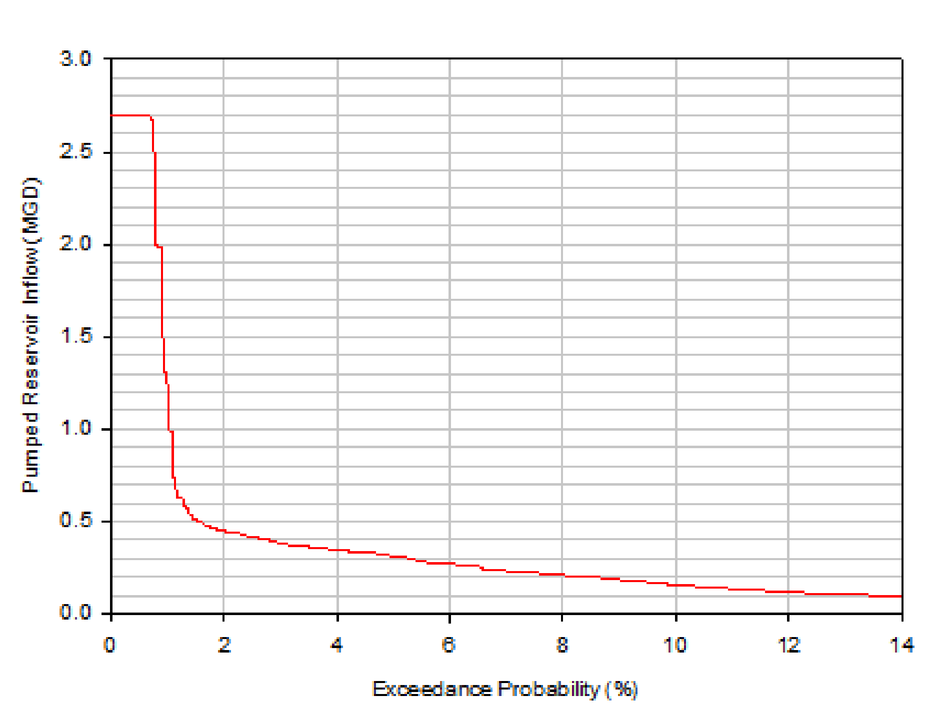
6.2 Reservoir Fluctuation and Pumping Statistics

Over the course of the modeling period, stored reservoir water often went years without being used as a supply. Out of 32,081 modeled days, the system only required reservoir water for 838 days. However, major fluctuations occurred in the reservoir during periods of drought. The drought of record in the early 2000s required water from the system for 132 near-consecutive days. The model showed that all available water from the reservoir was used to meet the water supply demand. After which, the reservoir was refilled to the normal pool elevation 42 days later.

If the minimum flowby requirement is increased, more water would need to be stored in the reservoir. This could also result in a higher withdrawal permit.

The model assumes that the water used to fill the reservoir comes only from Winters Run. Therefore, water is only available to fill the reservoir if the stream alone is capable of meeting the water demand in Bel Air and the flow rate is still above the minimum passing flow requirement. For the model scenario presented here, it was assumed that up to 4.2 MGD was permitted to be withdrawn from Winters Run. This means that a maximum of 2.7 MGD of water is available to fill the reservoir with the remaining 1.5 MGD being treated at the plant to meet demands. During most years, however, the water pumped into the reservoir is to replace water lost due to evaporation. Figure 6.1 displays the exceedance probability of the pumped flow rates. On average, significant pumping to refill the reservoir would occur only about 4 days every year.

***Figure 6.1** - Exceedance Probability Plot of Pumped Inflow into the Reservoir*



6.3 Winters Run Intake, Pump Station, and Pipelines

The conceptual design of the Winters Run intake, pump station and pipelines was completed assuming a normal reservoir fill rate of 4 MGD. The intake, supply piping and screen will be sized accordingly. The reservoir fill pumps were selected to have a maximum pumping capacity of 4 MGD per pump. Therefore, using both pumps provided results in an approximate fill rate of 8 MGD to the reservoir. Equipping the fill pumps with variable speed drives (VFDs), allows the operator (or programming) to pump the appropriate amount of water to the reservoir without exceeding the stream flowby requirement. The upstream USGS Stream gauge measurements will be used to determine the stream flow and the amount of water that can be withdrawn from Winters Run to fill the reservoir.

The location of Reservoir A requires approximately 3,800 feet of piping to be installed. The additional piping will result in further pipe friction losses. Reservoir A is also located at a higher elevation than Reservoir B, thus increasing the static head required. The calculated friction losses and static head result in an approximate total dynamic head of 140 feet to pump water from the intake to Reservoir A. The pipe routing of approximately 900 feet and elevation of Reservoir B result in total dynamic head of approximately 100 feet for the Reservoir B alternative. The lower head requirement associated with Reservoir B will result in a lower horsepower motor to be required.

The pipeline diameter for both alternatives is 18 inches. This pipe diameter was selected in order to maintain pipeline velocities of less than 7 feet per second during the maximum fill rate of 8 MGD. Additionally, it is proposed that ductile iron pipe be used and supported for thrust restraint as necessary.

6.4 Model Results Summary

In summary, the model showed that the maximum daily permitted withdrawal from Winters Run must be at least 4.2 MGD to supply an average demand of 1.5 MGD during the extreme drought event. This calculation is based on the assumption that the reservoir has a capacity of 360 ac-ft., and the stream has a minimum flowby requirement of 6.07 MGD. With this volume and simulation conditions, it appears feasible to meet the demand during the drought period of record without having to purchase county water.

In any scenario, the maximum daily permitted stream withdrawal must be increased to allow the reservoir to be refillled. Increasing the maximum permitted daily withdrawal, however, does not increase the annual average supply allocation because the total water used by the system is not changed (except for the minor replenishment of evaporative losses.) The higher the permitted maximum withdrawal, the quicker the reservoir can be refilled, and a higher maximum withdrawal rate may reduce the required reservoir storage volume. For this feasibility study, a raw water pump station with a capacity of 8 MGD is recommended for pumping water into the reservoir to provide flexibility for operating conditions.

7. Geotechnical Studies

The geotechnical studies were focused on assessing the suitability of subsurface materials for use in reservoir embankments and as liner material for the proposed reservoirs. The studies considered the development of reservoirs on lands owned by Harford County south of Winters Run on both the west side (Site A) and on the east side (Site B) of the Bel Air Bypass (US 1). The assessment is based on office research, limited field exploration, and laboratory testing.

7.1 Office Research

The office research consisted of a review of aerial photographs, topographic maps, published soils and bedrock mapping, and water well records.

7.1.1 Aerial Photographs

Aerial photographs taken over the previous two decades were reviewed to assess previous site use. The review generated the following observations:

» April 7, 1994 (black and white images): Sites A and B appear to be in predominantly agricultural use. Several buildings appear in the central portion of Site A, and a small building, possibly a residence, appears in the southeastern portion of Site B. A small, oval-shaped pond is apparent in the eastern portion of Site A. The Bel Air Bypass (US 1) is visible running between Sites A and B. Winters Run golf course is adjacent to the north side of Site A, and the Winters Run Water Treatment Plant is visible on the north side of Winters Run northeast of Site B.

» June 5, 2007 (color image): Overall land usage appears to be primarily agricultural. A paved parking facility accommodating approximately 140 vehicles and a playground facility (Annie's Playground) are apparent in Edgeley Grove Park in the southern portion of Site A.

» June 3, 2011 (color image): Some earth disturbance is evident in the southern portion of Site B.

» May 25, 2013 (color image): Overall land usage appears to remain primarily agricultural. Earth disturbance in the southwestern portion of Site B is evident.

7.1.2 Topographic Maps

The site lies within the south central portion of the Bel Air 15 minute quadrangle and straddles the boundary between the Jarrettsville and Bel Air 7.5 minute quadrangles. The review of topographic maps included 1:62,500 scale USGS maps of the Bel Air 15 minute quadrangle dated 1901, 1942, 1945, and 1948 and 1:24,000 scale USGS maps of the Jarrettsville and Bel Air 7.5-minute quadrangles dated 1956, 2011, and 2014. The review generated the following observations:

» 1901 Bel Air 15' Quad (1:62,500): Only cultural features shown are unimproved roads leading to a dwelling in the south central portion of Site A and a dwelling in the southern portion of Site B. No stream is shown in the northeast-trending swale on Site A.

» 1942 Bel Air 15' Quad (1:62,500): No dwelling and unimproved road are shown on Site A. An intermittent stream shown in the northeast-trending swale on Site A. A second dwelling is shown on Site B.

» 1945 Bel Air 15' Quad (1:62,500): Unchanged from 1942 map.

» 1948 Bel Air 15' Quad (1:62,500): Two dwellings are shown on Site A, both accessed by extension of the unimproved road from Site B. No stream shown in the north-trending swale along the west side of Site A.

» 1956 Jarrettsville and Bel Air 7.5' Quads (1:24,000): Bel Air Bypass (US 1) is shown. Access to dwelling and large outbuilding on Site A is modified to come from the south (Smith Lane). A small pond is shown on Site A. No stream indicated in both the northeast-trending swale on Site A and the north-trending swale along the west side of Site A. Winters Run golf course is shown on the north side of Site A. An additional dwelling is shown in the southern portion of Site B. Waterworks are shown on the north side of Winters Run adjacent to Site B.

» 2011 Jarrettsville and Bel Air 7.5' Quads (1:24,000): Maps feature 2009 imagery. Annie's Playground is apparent in the southern portion of Site A.

» 2014 Jarrettsville and Bel Air 7.5' Quads (1:24,000): Maps feature 2011 imagery. No significant changes in land use are apparent.

7.1.3 Site Soils

General soils information was obtained from the USDA Natural Resources and Conservation Service's (NRCS) Web Soil Survey. The soil units mapped within the potential reservoir sites are listed in Table 7.1, shown graphically is Figure 7.1 and a custom soils report generated from the NRCS Web Soil Survey is provided in Appendix C.

According to the NRCS, these soils are developed in residuum derived from diabase or gabbro (Kelly, Legore, Montalto, and Neshaminy soils), residuum derived from phyllite and/or schist (Glenelg and Manor soils), alluvium derived from metamorphic and/or igneous rocks (Codorus, Delanco, Elsinboro, and Hatboro soils), and alluvium derived from micaceous sediment (Kinkora silt loam).

Silt is generally the most abundant constituent of the soils mapped in the study area. The reported representative silt contents range from approximately 41 to 58 percent, with the exceptions of the Delanco silt loams (36 percent) and the Glenelg loam (34 percent). The soils also tend to be sandy as the reported representative sand contents range from approximately 17 to 47 percent. The Delanco, Glenelg, and Manor soils are reported to be the most sandy (typically 45 to 47 percent sand). The most clay-rich soils are the Kelly silt loam (40 percent), Kinkora silt loam (35 percent), and Montalto silt loam (32 percent). The other soils, which account for more than 90 percent of the area, have representative clay contents ranging from 14 to 27 percent.

Soils having higher reported representative organic contents include the Legore silt loams, 3 to 15 percent slopes (1.38 percent), Codurus silt loam (0.89 percent), Legore very stony silt loam, 25 to 45 percent slopes (0.89 percent), Kinkora silt loam (0.83 percent), Hatboro silt loam (0.77 percent), and Montalto silt loam (0.64 percent). The other soils have reported representative organic contents ranging from 0.47 to 0.54 percent.

***Figure 7.1** - Soil Units Mapped within Potential Reservoir Sites A and B*

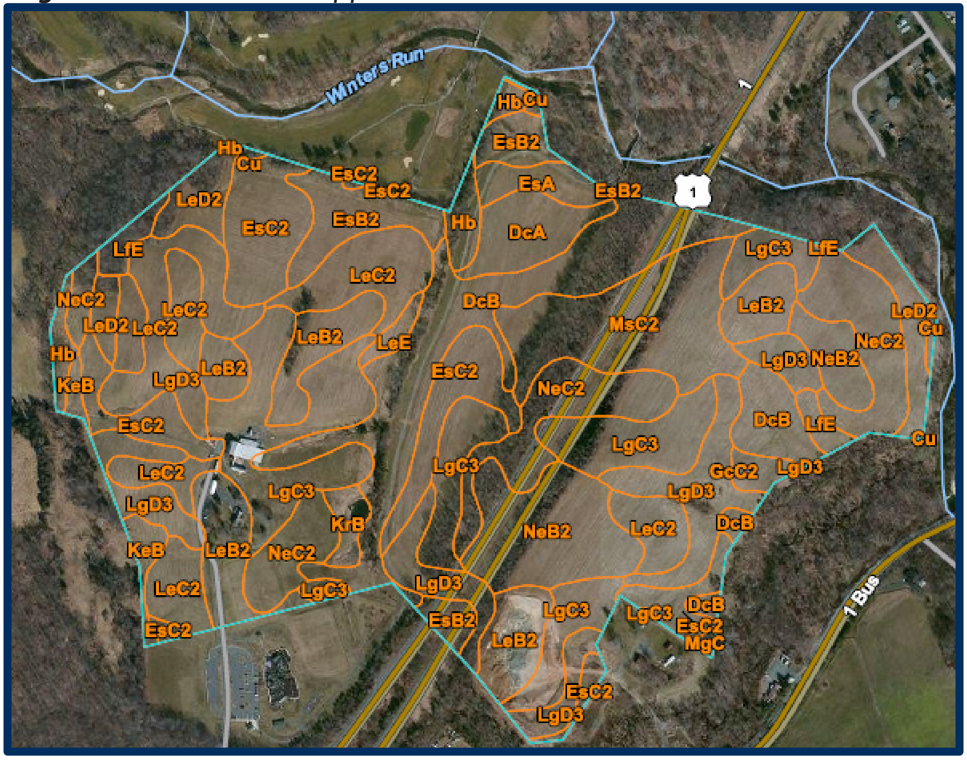


***Table 7.1** - Soil Units Mapped within Potential Reservoir Sites A and B*

Site	Map Unit	Description	Acres	Percent
A, B	Cu	Codorus silt loam	0.6	0.3
A	DcA	Delanco silt loam, 0 to 3 percent slopes	3.8	2.2
A, B	DcB	Delanco silt loam, 3 to 8 percent slopes	19.5	11.5
A	EsA	Elsinboro loam, 0 to 2 percent slopes	2.1	1.2
A	EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	6.7	3.9
A, B	EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	15.0	8.8
B	GcC2	Glenelg loam, 8 to 15 percent slopes, moderately eroded	1.0	0.6
A	Hb	Hatboro silt loam	2.9	1.3
A	KeB	Kelly silt loam, 3 to 8 percent slopes	1.5	0.9
A	KrB	Kinkora silt loam, 3 to 8 percent slopes	1.2	0.7
A, B	LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	13.5	7.9
A, B	LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	13.7	8.0
A, B	LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	6.0	3.5
A	LeE	Legore silt loam, 25 to 45 percent slopes	0.8	0.4
A, B	LfE	Legore very stony silt loam, 25 to 45 percent slopes	1.9	1.1
A, B	LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	23.0	13.5
A, B	LgD3	Legore silty clay loam, 15 to 25 percent slopes, severely eroded	19.8	11.6
B	MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	0.2	0.1
A, B	MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	11.1	6.5
B	NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	10.7	6.3
A, B	NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	15.6	9.1

The most clay-rich soils have higher reported representative liquid limits—44.9 percent for the Kelly silt loam, 40.5 percent for the Montalto silt loam, and 38.9 percent for the Kinkora silt loam. The most sandy and alluvial soils tend to have lower reported representative liquid limits—23.6 percent for the Delanco silt loams, 25.6 percent for the Codorus silt loam, 30.3 percent for the Glenelg loam, 31.2 percent for the Manor and Glenelg very stony loams, 32.6 percent for the Elsinboro loams, and 33.4 percent for the Hatboro silt loam. The other soils have reported representative liquid limits ranging from 35.9 to 38.4 percent.

Higher reported representative plasticity indices are generally found among the more clay-rich soils—21.3 percent for the Kelly silt loam, 19.4 percent for the Montalto silt loam, 17.5 percent for the Neshaminy silt loams, and 16.0 percent for the Kinkora silt loam. The sandiest and some of the alluvial soils tend to have lower reported representative plasticity indices—6.7 percent for the Delanco silt loams, 7.4 percent for the Manor and Glenelg very stony loams, 7.6 percent for the Codorus silt loam, and 8.1 percent for the Glenelg loam. The other soils have reported representative plasticity indices ranging from 11.1 to 14.1 percent.

Reported representative saturated hydraulic conductivities range from 2.7 x 10-4 cm/sec (Kelly silt loam) to 2.0 x 10-3 cm/sec (Legore silt loams, 3 to 15 percent slopes). The reported representative hydraulic conductivities fall into the moderately high to high conductivity ranges.

The reported representative depth to the water table is more than 6.6 feet (200 cm) in the residual soils. Shallower representative depths to the water table are reported in the alluvial soils: 0.26 feet (8 cm) in the Hatboro silt loam (Hb) and Kinkora silt loam (KrB), 2 feet (61 cm) in the Codorus silt loam (Cu), Delanco silt loams 0 to 8 percent slopes (DcA and DcB), and Kelly silt loam (KeB), and 5 feet (152 cm) in the Elsinboro loams (EsA, EsB2, and EsC2).

The reported representative depth to a restrictive layer (lithic bedrock) is more than 6 feet (200 cm) for all the soil map units with the exception of the Kelly silt loam (4.2 feet [127 cm]). The reported representative depth to bedrock is 9.8 feet (300 cm) in the Montalto silt loam (MsC2) and 8.2 feet (250 cm) in the Neshaminy silt loams (NeB2, NeC2).

The soils most suitable for embankment construction appear to be the Legore silt loam, 3 to 15 percent slopes (LeB2 and LeC2) and the Montalto silt loam (MsC2). These soils account for approximately 22 percent of the study area. The NRCS rates these soils as "somewhat limited" for embankment construction, apparently because of their dustiness. The least suitable soils for embankment construction appear to include the following: Codorus silt loam (piping and depth to saturated zone), Glenelg loam (piping), Hatsboro silt loam (ponding, depth to saturated zone, and piping), Kinkora silt loam (depth to saturated zone), Legore very stony silt loam, 25 to 45 percent slopes (piping), Legore silty clay loam, 15 to 25 percent slopes (piping), and Manor and Glenelg loams (piping). These soils account for approximately 16 percent of the study area. The NRCS rates these soils as "very limited" for embankment construction, primarily due to the reasons cited above in parentheses. The other soils are somewhat less suitable and rated by the NRCS as "somewhat limited" for embankment construction, primarily due a concern for piping; however, the piping potential is considered to have less of a negative impact than in the soils considered to be least suitable for embankment construction.

The soils most suitable for pond areas include the following: Codorus silt loam (Cu), Elsinboro loam, 0 to 5 percent slopes (EsA and EsB2), Kelly silt loam (KeB), the Kinkora silt loam (KrB), and Neshaminy silty loam, 3 to 8 percent slopes (NeB2). These soils account for approximately 13 percent of the study area. The NRCS considers these soils "somewhat limited" for pond areas, primarily due to their seepage potential. The remaining soils, which occupy about 87 percent of the study area, are considered "very limited" for pond areas, either due to their seepage potential, their steepness, or both.

Hydric characteristics of the soils are discussed in the environmental section of this report (Section 8.1).

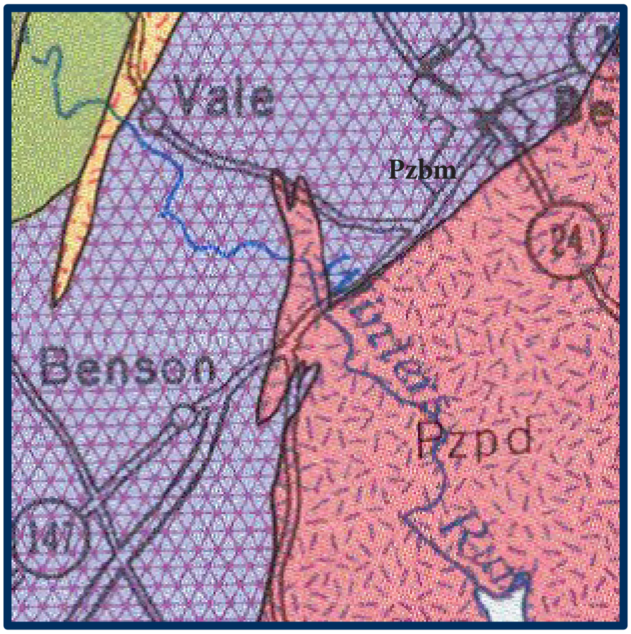
7.1.4 Site Geology

The project site is situated within the Bel Air Upland District of the Harford Plateaus and Gorges Region of the Piedmont Upland Section of the Piedmont Plateau Province (Reger and Cleaves, 2008). The Bel Air Upland District is characterized by gently rolling to flat surfaces with typical local topographic relief varying from 40 to 150 feet (less on uplands, more in valleys), as shown in Photo 7.1

***Photo 7.1** - Typical Site Topography (Site B, looking South)*

The bedrock beneath the site is mapped primarily as shown in Figure 7.2 as a portion of the Baltimore Gabbro complex (map unit Pzbm) and described as follows: "thoroughly recrystallized lineated epidiorite and amphibolite; cut by numerous dikes and stringers of quartz-diorite gneiss that are too small to show separately" (Southwick, 1968). The western portion of Site A is mapped as map unit Pzbp, which is described as "pyroxenite, mostly converted to light green talc-amphibole and amphibole rock" (Southwick, 1968). The northeastern portion of the Site B is mapped as Port Deposit Gneiss (map unit Pzpd), which is described as follows: "Moderately to strongly deformed intrusive complex, chiefly composed of quartz diorite gneiss. Rock types include gneissic biotite-quartz diorite, hornblende-biotite-quartz diorite, with minor amounts of quartz monzonite and hornblend-quartz diorite. Moderate protoclastic foliation grades into strong cataclastic shearing" (Southwick, 1968).

Figure 7.2 - *Bedrock Geologic Units Mapped within Potential Reservoir Sites A and B*



7.1.5 Water Well Records

Water well information was obtained from published reports and the Harford County Health Department. An interim technical report entitled "Impact of a Public Water-Supply Well on Availability of Ground Water to Neighboring Domestic Wells near Bel Air, Maryland" (Duigon and Cooper, 1999) includes tables listing 75 wells and 2 springs in the vicinity of the Winters Run water plant and a figure showing well and spring locations. All of the wells are located north of Winters Run and/or east of Business US 1; none are located within the proposed reservoir sites. The well inventory includes one production well and two observation wells owned by MDAW, 57 domestic wells, three institutional wells (Baltimore Fresh Air Camp), one commercial well (Twin-Kiss Drive-in), and 11 unused wells. Reported well depths range from 26.5 feet to 540 feet. The table indicates the MDAW production well is 540 feet deep, and the observation wells are 420 and 540 feet deep. The 57 domestic wells range from 29 to 300 feet deep with a median depth of 96 feet. Casing depths are reported for 34 of the wells and range from 10 to 90 feet with a median depth of 29.5 feet. The depth to water is reported for 69 wells and ranges from 2 to 69 feet with a median depth of 23 feet.

Records for five wells were obtained from the Harford County Health Department. Three of the records are for MDAW's production well and the two observation wells located on the Winters Run Water Treatment Plant (WTP) property east of Site B. The other records are for the well drilled for the mobile home on the State of Maryland (SOMA) site south of proposed Reservoir B and for the well drilled for public facilities at Annie's Playground south of proposed Reservoir A. Pertinent data from the well logs are summarized below:

- MDAW Winters Run WTP Well #1 (production well, Permit No. HA-94-0142)
  - Stratigraphy:
    - 0’ to 16’: Overburden
    - 16’ to 23’: Brown Sand
    - 23’ to 37’: Green Granite
    - 37’ to 540’: Grayish Black Granite
  - Water-bearing zones encountered at depths of 345 and 375 feet.
  - Construction:
    - 0’ to 26’: 8-inch steel casing, grouted
    - 26’ to 540’: open hole
  - Testing: 14 hours of pumping by air at a rate of 215 gallons per minute (gpm) lowered the water level in the well from a depth of 8 feet to 500 feet below the land surface.
- MDAW Winters Run WTP Well #2 (observation well, Permit No. HA-94-0143)
  - Stratigraphy:
    - 0’ to 10’: Overburden
    - 10’ to 25’: Sand
    - 25’ to 30’: Green Granite
    - 30’ to 420’: Grayish Black Granite
  - Water-bearing zones encountered at depths of 37 and 210 feet.
  - Construction:
    - 0’ to 28’: 6-inch steel casing, grouted
    - 28’ to 420’: open hole
  - Testing: Three hours of pumping by air at a rate of 5 gpm lowered the water level in the well from a depth of 5 feet to 415 feet below the land surface.
- MDAW Winters Run WTP Well #3 (observation well, Permit No. HA-94-0144)
  - Stratigraphy:
    - 0’ to 8’: Overburden
    - 8’ to 18’: Sand
    - 18’ to 48’: Green Granite
    - 48’ to 540’: Grayish Black
  - Water-bearing zones encountered at depths of 35, 117, 270, and 445 feet.
  - Construction:
    - 0’ to 22’: 6-inch steel casing, grouted
    - 0’ to 60’: 4-inch steel casing, grouted
    - 60’ to 540’: open hole

- Testing: Three hours of pumping by air at a rate of 60 gpm lowered the water level in the well from a depth of 8 feet to 500 feet below the land surface.

» SOMA Property Well (Permit No. HA-94-4077)

- Stratigraphy:
  - 0' to 37': Soft Tan Dirt
  - 37' to 94': Medium Hard to Hard Green and Tan Rock
  - 94' to 97': Medium Tan/White Rock, water-bearing
  - 97' to 99': Hard Green Rock
  - 99' to 100': Medium Hard Green Rock, water-bearing
  - 100' to 124': Medium Hard Tan/Green
  - 124' to 300': Medium Hard to Hard Green Rock
- Construction:
  - 0' to 42': 6-inch plastic casing, grouted
  - 32' to 85': 5-inch steel screen riser
  - 85' to 127': 5-inch steel screen, 0.025-inch slot
  - 127' to 300': open hole
- Testing: Three hours of pumping with a submersible pump at a rate apparently varying from 3 to 15 gpm lowered the water level in the well from a depth of 42 feet to 280 feet below the land surface.

» Annie's Playground Well (Permit No. 95-0842)

- Stratigraphy:
  - 0' to 3': Dirt
  - 3' to 89': Soft Brown
  - 89' to 97': Hard Gray [rock?]
  - 97' to 98': Medium Gray, water-bearing
  - 98' to 119': Hard Gray
  - 119' to 120': Medium Hard Gray, water-bearing
  - 120' to 161': Hard Gray
  - 161' to 162: Medium Hard Gray, water-bearing
  - 162' to 200': Hard Gray
- Construction:
  - 0' to 93': 6-inch plastic casing, grouted
  - 82' to 122': 4.5-inch plastic casing, ungrouted
  - 93' to 200': open hole
- Testing: Three hours of pumping with a submersible pump at a rate of 10 gpm lowered the water level in the well from a depth of 48 feet to 80 feet below the land surface.

The Source Water Assessment for the MDAW Bel Air System (Maryland Department of the Environment, 2005) indicates the Winters Run Water Plant well pumped an average of 52,000 gallons per day based on reported pumpage from January through June 2004. The report includes a figure (5 2) showing two fracture traces connecting proposed reservoir Site B with the Winters Run Plant well and a drawing (M645564-00-A) dated March 21, 1995, by R.E. Wright Associates, Inc., which shows four fracture traces on proposed reservoir Site B.

7.2 Field Explorations

Field explorations included ten test pits, lab testing of four soil samples, and eight infiltration tests using a double-ring infiltrometer. Test Pit locations are shown in Figure 7.3.

7.2.1 Test Pits

Ten test pits were performed—five on Site B on August 6, 2014, and five on Site A on September 5, 2014. Test pit locations are shown in Figure 7.3 and Appendix A, Exhibit 1. Test pit logs are presented in Appendix D. See Photos 7.2 and 7.3 for equipment utilized.

Tables 7.2A and 7.2B list test pit horizontal coordinates (determined by GPS), surface elevations (determined from CAD drawing), NRCS soil map units, and field descriptions. The test pits exposed soils described in the field as clay, silt, silt with sand, silt with gravel, sandy silt, sandy silt with gravel, silty sand, silty sand with gravel, sand with gravel, and poorly graded sand with gravel. At Site B, fill material was noted in four of the five test pits with the fill varying from 4 to 8 feet in depth. Test pit soils are generally described as becoming more saprolitic and including

Figure 7.3 *- Test Pit Locations within Potential Reservoir Sites A and B*

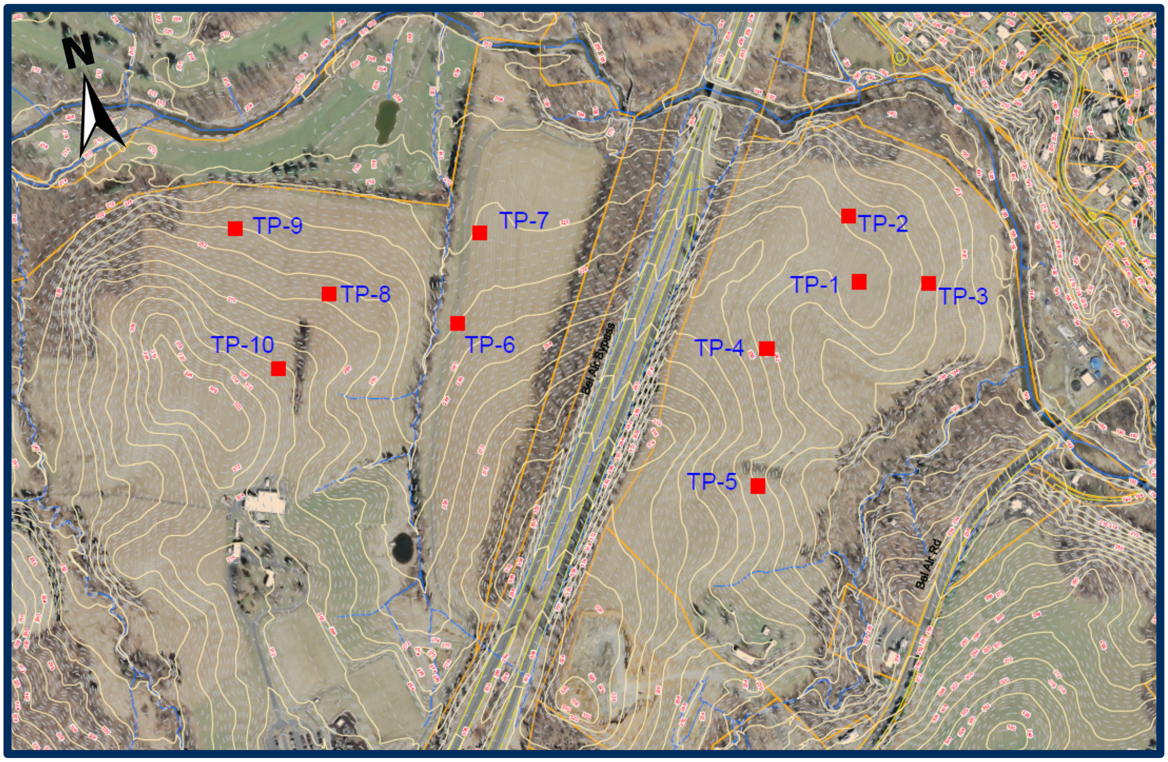


Photo 7.2 - *Site A Test Pit Excavator and Sample Test Pit*

Photo 7.3 - *Site B Test Pit Excavator and Sample Test Pit*

***Table 7.2A** - Site A Test Pit Summary*

Test Pit ID *Easting* *Northing* *Elevation*	NCRS Soil Mapping	Depth (ft)	Field Descriptions
TP-6 *1,488,138* *675,010* *227.97*	DcB: Delanco silt loam, 3 to 5 percent slopes	0.0 - 1.0 1.0 - 6.0 6.0 - 14.0	Sandy SILT (ml), topsoil Silty SAND (sm) SILT w/ sand (ml)
TP-7 *1,488,272* *675,260* *219.14*	DcA: Delanco silt loam, 0 to 3 percent slopes	0.0 - 1.0 1.0 - 6.0 6.0 - 9.0 9.0 - 12.0	Silty SAND (sm) Sandy SILT w/ gravel (ml) Sandy SILT (ml) Poorly graded SAND w/ gravel (sp) • Water visible at 11.0' • Bedrock at 12.0'
TP-8 *1,487,412* *674,995* *262.76*	LeC2: Legore silt loam, 8 to 15 percent slopes, moderately eroded	0.0 - 1.0 1.0 - 10.0 10.0 - 12.0	SILT w/ sand (ml) Silty SAND w/ gravel (sm) Poorly graded SAND w/ gravel (sp) (decomposed gneiss)
TP-9 *1,487,125* *675,410* *239.09*	EsC2: Elsinboro loam, 5 to 10 percent slopes, moderately eroded	0.0 - 1.0 1.0 - 10.0 10.0 - 15.0	SILT (ml), topsoil Silty SAND w/ gravel (sm) Poorly graded SAND w/ gravel (sp) (decomposed gneiss)
TP-10 1,487,157 674,882 283.66	LgC3: Legore silty clay loam, 8 to 15 percent slopes, severely eroded	0.0 - 1.0 1.0 - 10.0 10.0 - 15.0	SILT (ml), topsoil Silty SAND w/ gravel (sm) Poorly graded SAND w/ gravel (sp) (decomposed gneiss)

***Table 7.2B** - Site B Test Pit Summary*

Test Pit ID *Easting* *Northing* *Elevation*	NCRS Soil Mapping	Depth (ft)	Field Descriptions
TP-1 *1,489,665* *674,702* *242.03*	NeB2: Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	0.0 - 0.7 0.7 - 4.0 4.0 - 12.0	TOP SOIL Silty SAND with boulders & gravel (sm), fill Silty Sand (sm), occasional boulders
TP-2 *1,489,729* *675,035* *230.60*	NeC2: Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	0.0 - 0.9 0.9 - 4.0 4.0 - 8.0 8.0 - 12.0	TOP SOIL Elastic SILT (mh) & lean CLAY (cl), fill Silty SAND w/ gravel (sm), fill Silty SAND (sm), saprolitic
TP-3 *1,489,809* *674,563* *233.82*	NeB2: Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	0.0 - 0.7 0.7 - 6.0 6.0 - 8.0 8.0 - 12.0	TOP SOIL Sandy SILT (ml) & Silty SAND w/ gravel, fill Rock fragments w/ sand, fill Silty SAND (sm), saprolitic
TP-4 *1,489,033* *674,749* *260.83*	MsC2: Montalto silt loam, 8 to 15 percent slopes, moderately eroded	0.0 - 1.0 1.0 - 5.0 5.0 - 12.0	TOP SOIL SILT w/ sand (ml) Silty SAND (sm), more saprolitic with depth
TP-5 *1,489,000* *673,978* *259.32*	LeC2: Legore silt loam, 8 to 15 percent slopes, moderately eroded	0.0 - 1.5 1.5 - 7.5 7.5 - 8.5 8.5 - 9.0 9.0 - 12.0	TOP SOIL SILT w/ gravel & boulders, fill Sandy SILT (ml) Silty SAND (sm) Silty SAND (sm), saprolitic

decomposed rock fragments with depth, especially below a depth of 8 to 10 feet. In TP 7 on Site A, rock was encountered at a depth of 12 feet, and water began seeping and ponding in the excavation at a depth of 11 feet. TP 7 has the lowest surface elevation of the ten test pits, and none of the other test pits encountered a water table. The deepest extent of chiefly fine textured soil was found in TP 6 on Site A, where lab testing indicates elastic silt from the surface to a depth of 6 feet, and the test pit log indicates a layer of silt with sand and little fine gravel from a depth of 6 to 14 feet.

7.2.2 Lab Testing

Four soil samples—two from Site A and two from Site B—were submitted for laboratory testing. The samples were collected from the zone of infiltration testing. Both Site B samples and the Site A sample from TP-8 tested as non-plastic (N/P). The lab results indicate a plastic limit of 33 percent and a liquid limit of 52 percent for the Site A sample from TP-6. Lab test results are presented in Appendix E. Lab test results are summarized in Table 7.3.

***Table 7.3** - Lab Test Results*

Site	Sample No.	Test Pit	Depth (ft)	Grain Size Distribution					Water Content	Description
				%+3"	%Gravel	%Sand	%Silt	%Clay		
A	Bag	TP-6	0.0 - 6.0	0.0	0.0	10.5	45.7	43.8	33.1	Brown Elastic SILT (ML)
A	Bag	TP-8	0.0 - 6.0	0.0	5.5	48.8	35.4	10.3	26.3	Brown Silty SAND (SM)
B	S-1	TP-1	2.5 - 12.0	0.0	10.4	48.5	33.4	7.7	28.7%	Brown Silty SAND (SM)
B	S-2	TP-4	5.0 - 12.0	0.0	0.0	46.8	45.7	7.5	24.9%	Brown Sandy SILT (ML)

7.2.3 Infiltration Testing

Infiltration tests were performed using a double-ring infiltrometer (6-inch and 12-inch rings) in two test pits at Site A and two test pits at Site B, as shown in Photo 7.4. Infiltration test data sheets are presented in Appendix F. Infiltration test results are summarized in Table 7.4. The fastest infiltration rate was measured in TP-6, located in the Delanco silt loam, which is a loamy alluvium derived from igneous and metamorphic rocks. The lowest infiltration rate was measured in TP-8, located in the Legore silt loam, which is loamy residuum weathered from gabbro and diabase.

***Table 7.4** - Infiltration Testing Results*

Site	Test Pit	Depth (ft)	Location	Water Drop (in)	Time (min)	Rate (cm/sec)
A	TP-6	6	Next to ledge of bench	3-1/4	10	1×10^{-2}
A	TP-6	6	Next to end of bench (exit)	1/8	30	2×10^{-4}
A	TP-8	6	Near ledge of bench	5/16	30	4×10^{-4}
A	TP-8	6	Near end of trench (exit)	3/32	30	1×10^{-4}
B	TP-1	6	Against back of trench	1-7/8	10	8×10^{-3}
B	TP-1	6	Near edge of ledge	1-1/8	10	5×10^{-3}
B	TP-4	5	Against slope	1-11/16	30	2×10^{-3}
B	TP-4	5	Near edge with ledge	9/16	30	1×10^{-3}

Photo 7.4 - *Double Ring Infiltrometer Testing, Site A. Representative of both sites.*

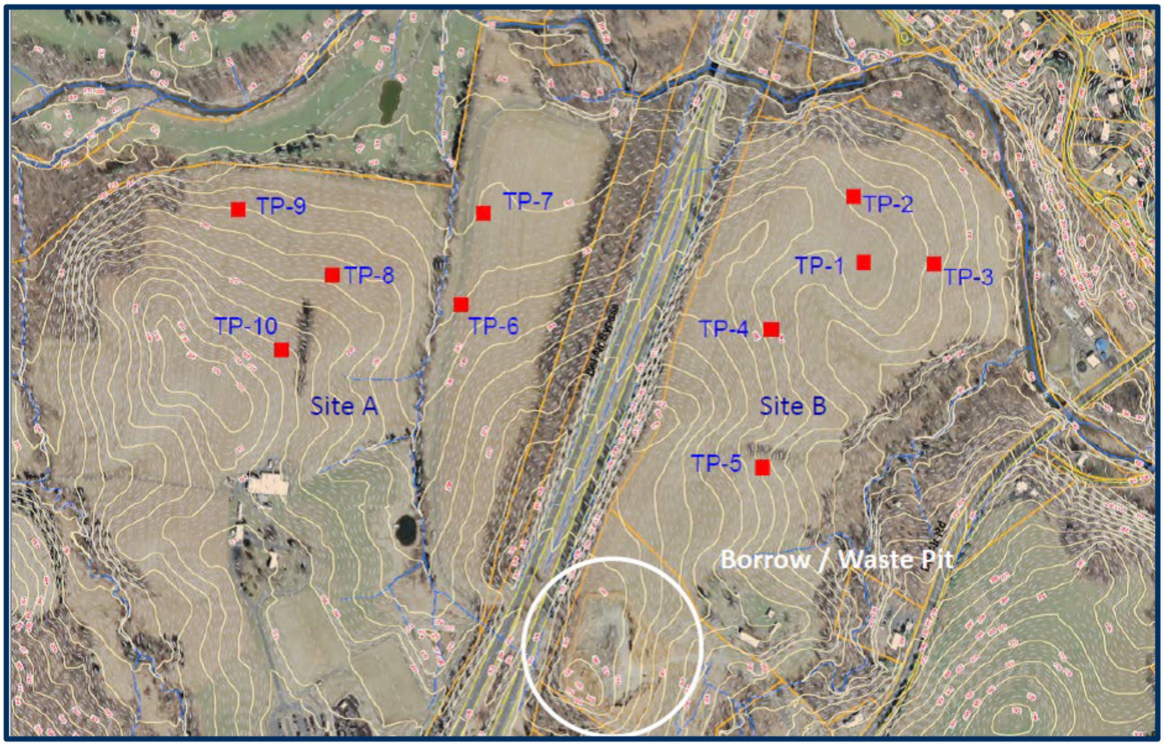
7.2.4 Borrow / Waste Pit

The property bordering the southern limit of Site B contains a waste / borrow pit of uncertain origin and use. Gannett Fleming's Geotechnical Engineer viewed the site on August 6, 2014. Photo 7.5 provides representative views of the test pits and Figure 7.4 provides relative pit location.

The pit consists of a side hill excavation, i.e. soil has been removed and the excavation is cut into the rolling terrain. Exposed on the pit surface is soil and rock. The rock outcrops and boulders lying on the ground surface were field classified as quartz, gneiss and schist. It is possible that the exposed rock may be bedrock. The undulating top of rock surface exposed in the pit is typical of the metamorphic geology of the area. Note that the rock quality is poor due to rapid weathering and decomposition of the rock exposed to the natural elements.

Photo 7.5 - *Representative Photos of Borrow / Waste Pit, adjacent to Site B.*

***Figure 7.4 -** Borrow / Waste Pit Location*



7.3 General Assessment of Reservoir Sites

Both Sites A and B provide suitable topography for an upland reservoir. From a Geotechnical perspective, the sites are similar and neither site provides an advantage. Both sites appear to have had similar past uses as agriculture fields. Both sites contain sandy soils which grade into saprolite (fully decomposed bedrock), underlain by bedrock. Depth to bedrock throughout the footprint of the two sites is unknown. Rock was encountered in one test pit at Site A, at a depth of 12 feet. All other test pits extended this deep, or deeper, without encountering bedrock.

Both Sites A and B infiltration test results indicate fairly high permeability of site soils at a depth of five and six feet. The infiltration test results indicate that lining the reservoir bottom and slopes will be required when constructed with on-site soils to maintain the reservoir pool. There are many lining options which are discussed below.

From the limited field exploration, Site A may be less preferred than Site B due to presence of Elastic Silt encountered at Site A. However, this soil type may be present at Site B as well, but was not encountered by the limited test pit operation. Elastic silt is problematic with regard to embankment construction. Elastic silt's handling properties change drastically with very little change in moisture content. Adequate compaction can only be achieved with proper control of the soil's moisture content. This often requires additional handling of the soil, i.e. wetting, harrowing and disking of soil on-site, to allow embankment construction which can increase cost.

7.4 Recommendations for Preliminary Dam Embankment Configurations

Based on preliminary information, site soils are suitable for construction of the earth embankments required to impound the reservoir. Assuming a lined embankment, i.e. no through or underseepage of reservoir contents, an interior drainage collection system or granular filter system is not required. Maximum recommended slope of the compacted site soils, non-plastic sandy silts and silty sands, is 3H:1V. Foundation preparation is limited to removal of organics. No core trench or cut-off trench is anticipated for the embankment if a lined reservoir system is used. The liner on the embankment slopes should be exposed (due to constructability issues with placing cover soil on the upstream slope and related slope stability issues), therefore a thicker liner installed with anchor trenches is recommended. The liner on the reservoir bottom can be constructed with cover soil, therefore a thinner more economical can be used to save costs.

The liner system shall be of low permeability and demonstrated past successful performance in dams. It shall also have appropriate physical and mechanical properties for the proposed construction (Survivability), conform to the subgrade without waves and folds, be dimensionally stable with variations in temperature and have a design life in excess of 50 years.

There are many different types of liner systems for dams such as PVC, HDPE, LLDPE and other polyethylene products. Based on the history of successful projects, the recommended liner system for this project is the Carpi PVC liner system.

Demonstration of Successful Past Use in Dams

The update to ICOLD Bulletin 78, Geomembrane Sealing Systems for Dams (2005) documents 250 dams incorporating geomembranes for seepage control. The count was as of March 2005 and the current number would be higher. 174 of the 250 dams were fill or embankment dams. 38 of the 250 dams are in the US. 143 or 60% of the dams built or repaired with a geomembrane include a PVC geomembrane, with the majority of these being Carpi geomembranes.

The following is a direct quote from Bulletin 78:

> "For more than 45 years membranes have been successfully used to provide a watertight facing for new RCC dams up to 188 M high, repair of old masonry and concrete dams up to 174 M high and the main imperious components of fill dams up to 110 M high."

The oldest documented use of a geomembrane in a dam was at Contrada Sabetta, Italy in 1959 and is now 52 years old. The oldest covered PVC installation was installed in 1960 at Terzaghi Dam in Canada and is still functioning after more than 50 years in service.

Survivability

The best test to compare the ability of a geomembrane or geocomposite to resist damage from rough subgrades or aggregate drains is the multiaxial puncture test. Photographs of the test procedure substrate and the PVC geomembrane after the test are provided as Photo7.6. This test was developed during research USACE Waterways Experiment Station as documented in Technical Report REMR-CS-50 dated 1995. The test involves placing the geomembrane or geocomposite over the substrate, sealing the vessel, and then pressurizing the vessel to 1.5 MPa (218 psi). If the material survives the pressurization stage, the pressure is then applied for 24 hours. The superior puncture resistance of the PVC geomembrane is demonstrated in Table 7.5. Table 7.5 is a summary table documenting the results of the multiaxial puncture testing on various geomembranes and geocomposites. As indicated in the table, the PVC geomembrane survived the test with a pressure of 1.5 MPA applied for 24 hours. HDPE performed very poorly in the tests and did not survive the pressurization phase for a product with similar thickness. The reasons for superior performance of the PVC is the material itself has greater puncture resistance than polyethylene products, but more importantly is the fact that the geotextile on the bottom is physically attached to the geomembrane. The geotextile attached to the geomembrane vastly increases the puncture resistance.

***Photo 7.6** - Puncture Test Substrate and the PVC Geomembrane After the Test*

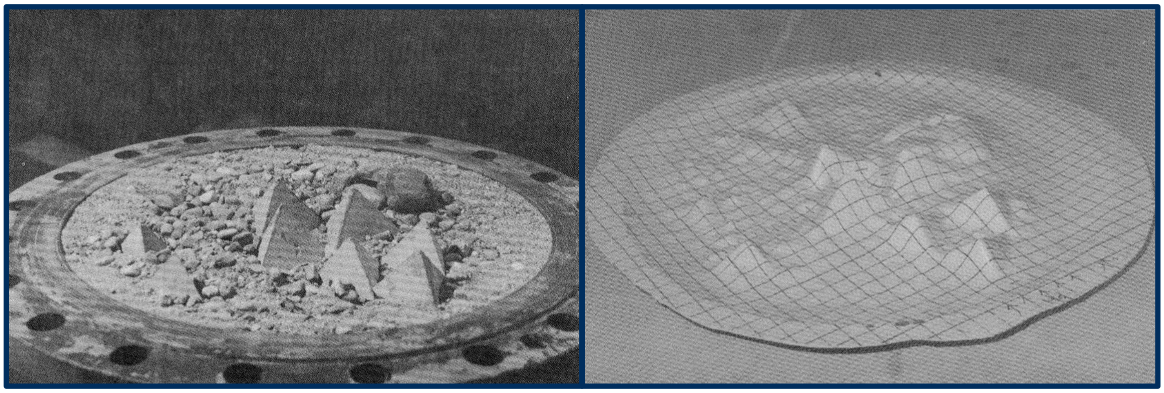


***Table 7.5** - Multiaxial Puncture Test Results Summary*

PVC 1 mm	Rupture at 0.6 MPa (between pyramids at cavity). Conforms to substrate. Good elastic recovery.
PVC 1.5 mm	Rupture at 1 MPa after 6 hr (at sharp stone). Conforms to substrate. Good elastic recovery.
PVC 2 mm	No failure. Conforms to substrate. Very good elastic recovery.
PVC 2.5 mm	No failure. Does not conform perfectly to substrate. Very good elastic recovery.
PVC-R PVC 1 mm + 200 g/m2 NW	Rupture at 1 MPa after 10 hr (between pyramids at cavity). Conforms to substrate. Elastic recovery superior to correspondent unreinforced PVC.
PVC-R PVC 1.5 mm + 200 g/m2 NW	Rupture at 1 MPa after 10 hr (at sharp stone). Conforms to substrate. Elastic recovery superior to correspondent unreinforced PVC.
PVC-R PVC 2 mm + 200 g/m2 NW	No failure. Conforms to substrate. Elastic recovery superior to correspondent unreinforced PVC.
PVC-R PVC 2.5 mm + 500 g/m2 NW	**No failure. Conforms to substrate. Elastic recovery superior to correspondent unreinforced PVC.**
HDPE 1.5 mm	Rupture at all pyramids at 0.15 MPa. Does not conform to substrate. No elastic recovery.
HDPE 2 mm	Rupture at all pyramids at 0.3 MPa. Does not conform to substrate. No elastic recovery.
HDPE 2.5 mm	Rupture at all pyramids at 0.35 MPa. Does not conform to substrate. No elastic recovery.

Note: NW=Nonwoven Geotextile

Dimensional Stability

The duration of time that the geomembrane will be exposed or located near the surface requires that the material have dimensional stability. The PVC geomembrane is very stable. The dimensional stability in comparison to other products is due to the fact that the coefficient of thermal expansion for PVC is about 50% of polyethylene product. Even more significant is the geotextile backing. The geotextile has significantly lower thermal expansion characteristics than the geomembrane and it restrains the geomembrane from changes in length when the temperature rises or falls. The high plasticity of the product and the high dimensional stability allows the material to conform to the subgrade and allows it to be covered without folds and waves being created. Both HDPE and LLDPE have significant coefficients of thermal expansion. The elongation of the polyethylene products will result in waves in the geomembrane when it heats up. These waves often become folds when the geomembrane is covered and are likely locations of stress cracking. Covering a polyethylene geomembrane when it is elongated will result in the membrane going into tension when it contracts during cooling and can pull the membrane up off the subgrade.

Photo 7.7 *- PVC installation on left showing material conforming to subgrade. Waves and folds in HDPE installation shown or right.*

Design Life

The Geosynthetic Research Institute (GRI) at Drexel University has an ongoing research program to identify the design life of geomembranes. GRI recently issued an update to GRI White Paper #6 titled "Geomembrane Lifetime Predictions Unexposed and Exposed Conditions." The updated document is dated February 8, 2011. This document identifies the design life of Carpi's PVC formulation (European PVC referenced in the document) being greater than 32 years in an exposed condition with the testing ongoing. The design life of a buried geomembrane will be significantly greater than an exposed geomembrane and will exceed 50 years. Carpi has exposed geomembranes performing successfully for more than 40 years with minimal change in physical properties. ICOLD Bulletin 78 states that a geomembrane covered by a permanent layer of concrete should last at least 200 years and that scientific studies of PVC and PE geomembranes predict a life in excess of 950 years.

The Italian National Power Board (ENEL) is the largest and oldest CARPI client in Italy. To date, 11 dams owned by ENEL have been waterproofed with the CARPI systems. In all these dams, the geomembrane has been left **exposed to the environment**. ENEL is to our knowledge the only dam owner in the world who has performed a monitoring campaign on the behavior of PVC geomembranes installed on dams. ENEL has analyzed this behavior by exhuming samples from 6 of their dams, where they had been in service for different periods of time, up to 19 years. The exhumed samples have been tested for plasticizer content, hardness, tensile properties and permeability. An important remark on the results obtained by ENEL is that the decrease in plasticizer content was not matched by a corresponding decrease in imperviousness and the functionality of the geomembrane was not affected. As stated by ENEL, the permeability coefficient of Carpi exposed PVC geomembranes after 19 years of service is "quite constant vs. time". These are to our knowledge the only available results of assessed behavior of geomembranes in service on dams.

Carpi installations on dams where ENEL has taken sample coupons of geomembranes to assess the life expectancy. Typical plasticisers content of CARPI geomembranes is approximately 33% to 34%. Considering that most PVC manufacturers state that the functionality of the geomembrane is not affected until the plasticizer content is reduced to 50 % of the original value. This would equate to 17% plasticizer content for Carpi geomembranes.

The ENEL test results are provided in Table 7.6 and identifies the variation of plasticizer content over time in CARPI exposed PVC geomembranes installed on Italian dams monitored by ENEL.

***Table 7.6** - ENEL Test Results*

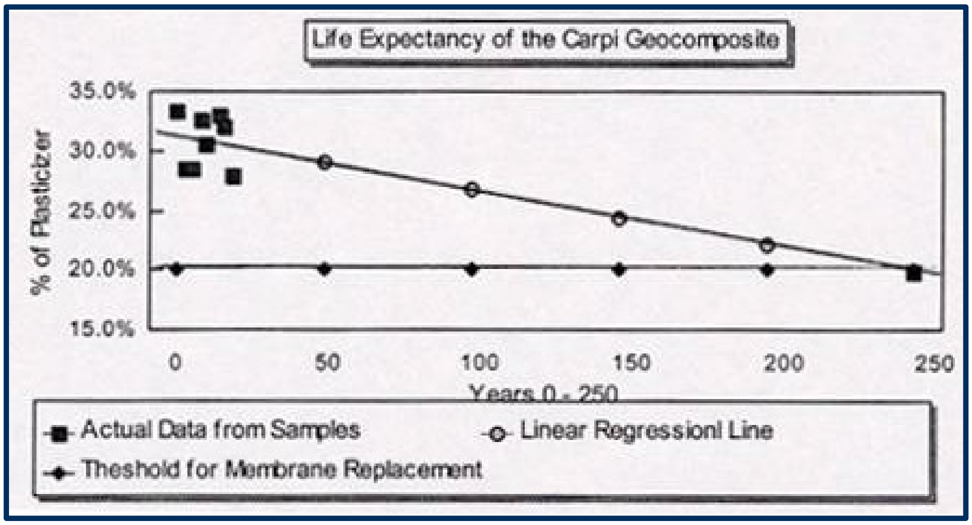
Dam	Year of Installation	Plasticizer Content in PVC
Lago Miller	1976	After 19 years : 27.9%
Lago Negro	1980	After 14 years : 33.0% After 16 years : 32.1%
Piano Barbellino	1987	After 8 years : 32.5% After 10 years : 30.5%
Cignana	1988	After 8 years : 31.9%
Pantano d'Avio	1991 - 1992	Virgin : 29.5% After 3 years : 28.4%
Ceresole	1992	Virgin : 33.4% After 2 years : 33.4%
Camposecco	1993	Virgin : 33.4% After 3 years : 28.5

Figure 7.5 is a graph with the ENEL test results plotted with linear regression projections to show the expected plasticizer loss. With a conservative approach, a threshold of 20% plasticizer content has been established for geomembrane replacement. The chart based on data collected by ENEL shows the exposed geomembrane life will easily exceed 50 years.

The ENEL test results are documented in "Long Term Performance of Exposed Geomembranes on Dams in Italian Alps" published at the Sixth International

Conference on Geosynthetics in 1998 and "Experimental study on the behavior vs. time of different geosynthetics used in canals owned by ENEL" published in Geotextiles – Geomembranes Recontres 1995.

Figure 7.5 *- Expected Behavior Based on Data from ENEL*



7.5 Recommendations for Addressing Uncertainties Regarding Subsurface Conditions

Recommendations for further subsurface exploration include geophysical studies to determine the depth of soil and saprolite; test borings to characterize soil and bedrock and correlate with results of geophysical study; falling head tests to measure soil permeability; water pressure testing to measure bedrock permeability; installation of piezometers to monitor water levels and possible influence of groundwater withdrawal; and test pits and infiltration testing to identify possible borrow sites, if needed.

8. Environmental Studies

The environmental studies were focused on identifying environmental features within the potential project areas for the proposed reservoirs. The preliminary studies included threatened and endangered species, wetlands, waterways (streams), cultural resources, and environmental contamination (hazardous waste) on lands owned by Harford County south of Winters Run on both the west side (Site A) and on the east side (Site B) of the Bel Air Bypass (US 1). The assessment is based on office research and limited field reconnaissance.

8.1 Office Research

The office research consisted of a review of aerial photographs, topographic maps, and published soils mapping.

8.1.1 Aerial Photographs

Aerial photographs taken over the previous two decades were reviewed to assess previous site use. The review generated the following observations:

» April 7, 1994 (black and white images): Sites A and B appear to be in predominantly agricultural use. Several buildings appear in the central portion of Site A, and a small building, possibly a residence, appears in the southeastern portion of Site B. A small, oval-shaped pond is apparent in the eastern portion of Site A. The Bel Air Bypass (US 1) is visible running between Sites A and B. Winters Run Golf Club is apparent adjacent to the north side of Site A, and the Winters Run Water Treatment Plant is visible on the north side of Winters Run and northeast of Site B.

» March 12, 2004 (color image): Taken during leaf-off, a stream channel is apparent within the tree line bisecting Site A. A stream channel is also apparent within the forest along the southeastern portion of Site B.

» June 5, 2007 (color image): Overall land usage appears to be primarily agricultural. A paved parking facility accommodating approximately 140 vehicles and a playground facility (Annie's Playground) are apparent in Edgeley Grove Park in the southern portion of Site A.

» June 3, 2011 (color image): Some earth disturbance is evident in the southern portion of Site B.

» May 25, 2013 (color image): Overall land usage appears to remain primarily agricultural. Earth disturbance in the southwestern portion of Site B is evident.

8.1.2 Topographic Maps

The site lies within the south central portion of the Bel Air 15 minute quadrangle and straddles the boundary between the Jarrettsville and Bel Air 7.5 minute quadrangles. The review of topographic maps included 1:24,000 scale USGS maps of the Jarrettsville and Bel Air 7.5-minute quadrangles dated 1956 (Photorevised 1974), 2011, and 2014. The review generated the following observations:

» 1956 Jarrettsville and Bel Air 7.5' Quads (1:24,000): A dwelling, large outbuilding, and small pond are shown in the center of Site A. No streams indicated in either the northeast-trending swale on Site A or the north-trending swale along the west side of Site A. Winters Run golf course is shown on the north side of Site A. Winters Run located along the north side of Sites A and B. A dwelling is shown in the southern portion of Site B. A stream is shown in the northeast-trending swale on the east side of Site B. Waterworks are shown on the north side of Winters Run adjacent to Site B.

» 2011 Jarrettsville and Bel Air 7.5' Quads (1:24,000): Maps feature 2009 imagery. Annie's Playground is apparent in the southern portion of Site A.

» 2014 Jarrettsville and Bel Air 7.5' Quads (1:24,000): Maps feature 2011 imagery. No significant changes in land use are apparent.

8.1.3 USDA-NRCS Soil Maps

General soils information was obtained from the USDA Natural Resources and Conservation Service's (NRCS) Web Soil Survey. The soil units mapped within the potential reservoir sites are listed in Table 8.1, and a custom soils report generated from the NRCS Web Soil Survey is provided in Appendix C.

According to the NRCS, Alluvial land, Hatsboro, and Kinkora soils are strongly hydric. They are all recognized as nationally hydric soils. Codorus and Kelly soils have hydric components but are not listed as national hydric soils.

***Table 8.1** - Soil Units Mapped within Potential Reservoir Sites A and B*

Site	Map Unit	Description	Hydric Rating
B	Av	Alluvial land	100
A, B	Cu	Codorus silt loam	15
A	DcA	Delanco silt loam, 0 to 3 percent slopes	0
A, B	DcB	Delanco silt loam, 3 to 8 percent slopes	0
A	EsA	Elsinboro loam, 0 to 2 percent slopes	0
A	EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	0
A, B	EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	0
B	GcC2	Glenelg loam, 8 to 15 percent slopes, moderately eroded	0
A	Hb	Hatboro silt loam	85
A	KeB	Kelly silt loam, 3 to 8 percent slopes	5
A	KrB	Kinkora silt loam, 3 to 8 percent slopes	100
A, B	LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	0
A, B	LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	0
A, B	LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	0
A	LeE	Legore silt loam, 25 to 45 percent slopes	0
A, B	LfE	Legore very stony silt loam, 25 to 45 percent slopes	0
A, B	LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	0
A, B	LgD3	Legore silty clay loam, 15 to 25 percent slopes, severely eroded	0
B	MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	0
A, B	MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	0
B	NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	0
A, B	NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	0

8.1.4 NWI Wetland Maps

U.S. Fish and Wildlife Service's National Wetland Inventory (NWI) mapping identified two palustrine wetland complexes at Site A. The NWI-mapped wetlands included a 0.20-acre palustrine unconsolidated bottom, permanently flooded, excavated wetland (PUBHx). The PUBHx wetland was a manmade, oval, farm pond. The second NWI-mapped wetland at Site A was a 1.77-acre palustrine forested, broad-leaved deciduous, temporary flooded wetland (PFO1A) along Winters Run. No wetlands were mapped by NWI at Site B. The NWI map for Sites A and B is provided in Appendix Y.

8.2 *Field Reconnaissance*

On August 22, 2014, Gannett Fleming environmental scientists performed field investigations across both sites (Site A and Site B). Site A and Site B had a combined area of 178 acres. Investigations included the presence/absence of wetlands and waterways, potential habitat for state and federally listed species (specifically the bog turtle, *Glyptemys muhlenbergii*), potential cultural resources, and the potential for environmental contamination within and immediately adjacent to the project study areas.

Gannett Fleming conducted a preliminary walk-through of both project study area, documenting potential resources on field mapping, and photo-documenting site conditions during the investigation. Information collected during the field reconnaissance was used to prepare the following chapter sections.

8.3 *Preliminary Review for Species Listed as Endangered or Threatened*

On August 27, 2014, Gannett Fleming submitted letters to the Maryland Department of Natural Resources Wildlife Heritage Service (DNR), and the U.S. Fish and Wildlife Service (USFWS) requesting information pertaining to species of concern under their respective jurisdiction that were known to the vicinity of the project area. These agencies are responsible for maintaining an inventory of state and federally listed threatened and endangered species.

DNR issued a clearance letter on September 17, 2014 stating "that there are no State or Federal records for rare, threatened or endangered species within the boundaries of the project site". An online certification letter was obtained from the USFWS on September 22, 2014 stating that "no federally proposed or listed endangered or threatened species are known to exist within the project area." Copies of the agency coordination and clearance letters for protected species are located in Appendix Y.

During the field reconnaissance discussed in Section 8.2, wetlands were investigated for potential bog turtle habitat. Based on the high-level approach taken during the feasibility stage, a detailed investigation of the wetlands was not performed. The wetlands observed at both sites appeared to meet the criteria for potential bog turtle habitat. A detailed Phase I Habitat Survey and coordination with the USFWS will be required for the selected alternative.

8.4 *Preliminary Review of Wetlands and Waterways*

Wetlands and waterways receive protection under regulations issued by the Maryland Department of the Environmental (MDE). Waters of the U.S. are also protected under federal regulations issued by the U.S. Army Corps of Engineers

(USACE) through Section 404 of the Clean Water Act. Permits for unavoidable temporary and permanent impacts to wetlands and waterways are required from MDE and USACE. Therefore, an analysis of potential wetland and waterway impacts is a critical factor in determining the viability of each potential site.

On August 22, 2014, Gannett Fleming environmental scientists performed field investigations across both sites (Site A and Site B) for the presence/absence of wetlands and waterways within the combined 178-acre study area.

8.4.1 Wetlands

Preliminary wetlands investigations were performed with the intent of achieving the following objectives:

- » Verify NWI mapped wetland boundaries throughout the study area.
- » Verify wetland types mapped by NWI at various sample locations throughout the study area.
- » Identify but not delineate additional wetlands not mapped by NWI within the study area.

These objectives were established based on the size of the study areas, the type/availability of mapping utilized and the regulatory significance of particular habitats. NWI mapped wetlands boundaries are based on aerial surveys. The NWI maps techniques were evaluated for accuracy by limited "ground truthing" of those same habitats by environmental scientists during the August 2014 field investigation. The principle objective of the study was to confirm the accuracy of the NWI mapped wetlands and to document the actual site conditions.

A comparison between NWI mapped wetland area/type and Gannett Fleming "ground truthing" proved to be reasonably accurate. Based on NWI data, the palustrine forested wetland mapped at the north end of the Site A study area and the palustrine unconsolidated wetland (farm pond) mapped near the south end of the Site A study area were confirmed. No NWI mapped wetlands were located at the Site B study area.

Field investigations were focused on "ground truthing" wetland boundaries across the study area according to guidance in the *Regional Supplement to the Corps of Engineers Wetlands Delineation Manual: Eastern Mountains & Piedmont Region (Version 2.0)* (Environmental Laboratory, 2012). The study areas included active soybean fields, floodplains along Winters Run, and its tributaries. In addition to the PFO1A and PUBHx wetlands mapped by NWI within the Site A study area, several palustrine emergent (PEM) wetlands were observed upslope and downslope of the PUBHx complex along an unmapped perennial tributary to Winters Run. A large PEM wetland complex was observed along the east side of the Site B study area. The proposed reservoirs are not expected to impact the wetland complexes at either site.

Photo 8.1 - *Farm Pond (PUBHx) with PEM Wetland at Site A*

Photo 8.2 - *PEM Wetland near barn at Site A*

Photo 8.3 - *PFO1A Wetland at Site A*

Photo 8.4 - *PEM Wetland at Site B*

8.4.2 Waterways

The study area was investigated to confirm or "ground truth" aerial photos and existing project mapping. Mapping sources included USGS topographic and NWI wetland maps. A field investigation for streams within and immediately adjacent to the project study areas was conducted during the wetland verification exercise on August 22, 2014.

Winters Run was confirmed and flowed from west to east along the northern boundary of the project study areas. Winters Run was approximately 50 feet wide. Winters Run was capable of supporting game fish species. In general, the Winters Run substrate consisted of boulder, cobble and gravel embedded in fine material, largely sand and silt.

Flowing from south to north, a previously unmapped perennial tributary to Winters Run was located within the Site A project study area. The upstream portion of the unnamed tributary was approximately 3 feet wide with a sand and gravel substrate. The downstream portion of the tributary was approximately 8 feet wide with a cobble and gravel substrate.

Flowing from south to north, a USGS-mapped perennial tributary to Winters Run was located along the east side of the Site B project study area. The upstream portion of the unnamed tributary was approximately 6 feet wide with a boulder, cobble, and gravel substrate. The downstream portion of the tributary was approximately 12 feet wide with a cobble, gravel, and sand substrate.

The proposed reservoir at Site A will require a pipeline crossing of the unnamed tributary. The proposed reservoir at Site B will not require a pipeline crossing of the unnamed tributary. Both reservoir options will require a pipeline crossing of Winters Run to connect to the treatment plant.

***Photo 8.5** - Perennial Tributary to Winters Run at Site A*

Photo 8.6 - *Winters Run along Site A*

Photo 8.7 - *Perennial Tributary to Winters Run at Site B*

Photo 8.8 - *Winters Run along Site B at the Water Treatment Plant*

8.5 Cultural Resources Review

On August 27, 2014, Gannett Fleming submitted a letter to the Maryland Historical Trust (MHT) requesting information pertaining to historic properties known to the vicinity of the project area. To date, a response letter has not been received from MHT. MHT assigned the project tracking number 201404661 and stated via email that a response from MHT should be received by the middle of October 2014. A copy of the agency coordination letter to MHT for historic properties is located in Appendix Y.

During the field reconnaissance discussed in Section 8.2, the Edgeley Grove Farmhouse, Barn, and Springhouse were identified at Site A. The proposed Site A reservoir will not impact any of these structures. At Site B, two barns were identified. The proposed Site B reservoir will not impact either of these structures.

Even after MHT clearance is obtained, the discovery of any archaeological artifacts during construction could halt the project.

Photo 8.9 - *Edgeley Grove Farmhouse at Site A*

Photo 8.10 - *Edgeley Grove Farm Barn at Site A*

***Photo 8.11** - Springhouse at the Edgeley Grove Farm Pond at Site A*

***Photo 8.12** - Barns at Site B*

8.6 Environmental Contamination Review

A review was conducted to determine if environmental contamination could present a conflict for the project. The review consisted of a site visit and evaluation of secondary resources to develop an understanding of the study area's history, current land use, and nearest known environmental contamination issues to make the determination if environmental contamination could present a conflict or concern for the project.

8.6.1 Site Investigation

On August 22, 2014, Gannett Fleming environmental scientists performed field investigations across Site A and Site B totaling 178 acres. The field investigation consisted of a site walk to look for earth disturbance activities, evidence of dumping, soil staining, and activities that could present an environmental concern. All portions of the study area were investigated and access was not restricted. There does not appear to be any aboveground or underground storage tanks within the study area. The current land use consisted of active agricultural fields planted in soybean. The edges of forest, field and stream were investigated for likely dump sites and no dump sites were located. A borrow area was investigated on the south side of Site B. It was confirmed that existing soil and overburden was being excavated and hauled offsite as clean fill. This area had no signs of dumped foreign materials, construction debris or stained soils that would indicate another purpose for this disturbed area.

Agricultural practices have likely used pesticides and herbicides that may have accumulated metals and residual chemicals in the upper 10 inches of the soil profile. The presence of agricultural use compounds on farm fields would be expected and not likely to present an issue during construction. The upper 12 inches of the soil profile would not be recommended for use as a cover soil for the interior reservoir liner, since the possibility exists that any residual chemicals could leach into the water column.

Other than the possibility of residual agricultural chemicals persisting in the upper soil profile, the site investigation did not reveal any evidence of environmental contamination that could present a risk to the project or proposed uses of Site A and B.

8.6.2 Secondary Resources Review

In addition to the site investigation, a secondary resources review was conducted to investigate the proposed project areas and limits of disturbance for the potential of environmental contamination issues from current and past land-use practices that may not have been visible during the site investigation. The secondary resources review included aerial photography, topographic maps, federal and state database reviews of underground storage tanks, dump sites, mining operations, filling activities, and nearby contaminated sites.

Historical Site Use

Historical site use was researched by a review of aerial photographs, topographic maps, and Sanborn Maps. Sanborn® fire insurance maps were not available for this region. Historical aerial photographs were obtained from Environmental Data Resources, Inc. (EDR) USGS, County GIS Departments and online sources for 1955, 1973, 1982, 1988, 1991, 1994, 1998, 2005, 2007, 2008, 2009, 2011 and 2013. The photographs were reviewed to identify historical uses and general site characteristics of the subject site and the surrounding areas. A summary of this review is provided in Table 8.2.

***Table 8.2** - Historical Aerial Photograph Review*

Year Revised	Site A	Site B	Surrounding Properties
1973 Scale 1in. = 500ft.	Area consisted of agricultural fields, a farmstead and hedgerows between fields were more visible. The pond on Site A was shown on the aerial photograph. The stream connection between the pond and Winters Run had a very narrow line of trees. Annie's Playground was not present.	Area consisted of agricultural fields. More trees were present toward the southeast corner of Site B. The unnamed tributary to Winters Run appeared to have more trees along its banks.	Winters Run was present and was forested along its banks. The golf course located north of the study area was present. The Route 1 Bel Air By-Pass was present.
1982 Scale 1in. = 1,000ft.	Forested area began to establish a buffer between the Bel Air Bypass and the agricultural fields. No other major changes noted.	No major changes were noted.	No major changes were noted.
1988 Scale 1in. = 500ft.	The stream connection between the pond and Winters Run is densely vegetated with continuous trees. No other major changes were noted.	Forested area began to establish along the Bel Air Bypass and the agricultural fields. No other major changes were noted.	No major changes were noted.
1991 Scale 1in. = 500ft.	No major changes were noted.	No major changes were noted.	No major changes were noted.
1994 Scale 1in. = 500ft.	No major changes were noted.	No major changes were noted.	No major changes were noted.
1998 Scale 1in. = 500ft.	No major changes were noted.	No major changes were noted.	No major changes were noted.
2005 Scale 1in. = 500ft.	Earth disturbance activities appeared to be in the area of Annie's Playground. A stormwater basin was present along the Bel Air Bypass. No other major changes were noted.	The unnamed tributary to Winters Run was densely vegetated with trees and emergent vegetation.	No major changes were noted.
2007 Scale 1in. = 500ft.	Site A appeared to have the current layout of Annie's Playground and associated parking areas. The remainder of Site A appeared in its current configuration.	No major changes were noted.	No major changes noted.
2009 Scale 1in. = 500ft.	Site A appeared in its current configuration with the farmstead, agricultural fields, Annie's Playground, walking paths, parking areas, ponds, streams and forests all visible on the aerial photograph.	No major changes were noted.	No major changes noted.
2011 Scale 1in. = 500ft.	No major changes were noted.	No major changes were noted.	The borrow area south of Site B is visible on the aerial photograph.
2013 Scale 1in. = 500ft.	No major changes were noted.	No major changes were noted.	No major changes were noted.

Historic topographic maps were available from EDR from 1901, 1947, 1956, 1974, and 1986. These maps confirmed that the area was used for agricultural purposes. Gannett Fleming also conducted research on the building permits issued for the study area to confirm the land use over the course of its recorded history. Building permits issued for Site A were consisted with the improvements and development of the farmstead and Annie's Playground. The building permit file did not indicate any practices that may have occurred on the study area that would suggest the potential for environmental contamination concerns.

Regulatory Compliance Review

Gannett Fleming retained EDR to perform a computer database search of federal, state, local, and tribal regulatory agency files for the entire study area which included the file types listed in Table 8.3.

The database searches did not reveal any issues within the study area or in close proximity to the study area that would require further investigation or indicate a potential environmental contamination issue. Information on these and additional databases are in the EDR report.

Regulatory Compliance Review Conclusion

Based on the field reconnaissance and database research conducted, it does not appear that Site A or Site B present environmental contamination issues that would impede the project or impact construction costs.

***Table 8.3** - Databases Included in the EDR Database Search*

Federal	
NPL	National Priority List
Proposed NPL	Sites proposed to be listed on the NPL
Delisted NPL	Sites that EPA has delisted from the NPL
NPL Liens	Federal Superfund liens
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
FEDERAL FACILITY	Listing of NPL, Base Realignment and Closure (BRAC) sites and sites found in CERCLIS where EPA conducted cleanups.
CERCLIS-NFRAP	Comprehensive Environmental Response, Compensation, and Liability Information System – No Further Remedial Action Planned
CORRACTS	Corrective Action Report
RCRA-TSDF	Resource Conservation and Recovery Act (RCRA)- Treatment, Storage and Disposal
RCRA-LQG	RCRA – Large Quantity Generator List
RCRA-SQG	RCRA - Small Quantity Generator List
RCRA-CESQG	RCRA – Conditionally Exempt Small Quantity Generators
US ENG CONTROLS	Engineering Controls Sites List – USEPA
US INST CONTROL	Sites with Institutional Controls – USEPA
LUCIS	Land Use Control Information System
ERNS	Emergency Response Notification System
State and Tribal	
MD SHWS	State and tribal database equivalent to CERCLIS
MD SWF/LF	State and tribal database for landfill and /or solid waste disposal sites
MD OCPCASES	State and tribal leaking underground storage tank (LUST) databases.
MD HIST LUST	
INDIAN LUST	
MD UST & MD AST	State and tribal registered aboveground and underground storage tanks
INDIAN UST	
FEMA UST	
MD ENG CONTROLS & MD INST CONTROLS	State and tribal institutional controls and engineering controls registry
MD VCP & INDIAN VCP	State and tribal voluntary cleanup sites
MD BROWNFIELDS	State and tribal brownfields sites
Additional Environmental Records	
ODI	Open Dump Inventory
DEBRIS REGION 9	Torres Martinez Reservation Illegal Dump Site Locations
LIENS 2	Environmental liens
HMIRS & MD SPILLS 90	Records of Emergency Releases - Hazardous Materials Information Reporting System

9. Water Quality and Lake Management

Many of the water quality considerations described below occur naturally in Winters Run and its watershed. Winters Run is a perennial watercourse flowing in a naturally dynamic setting with ecological processes acting on maintaining balance within the watershed and as demonstrated in the water quality of Winters Run. The raw water supply reservoir is proposed as a stationary water supply contained within a lined basin and will inherently be deficient in controlling and balancing algae, bacteria, and other micro-organism populations on its own. Water quality goals and lake management decisions will need to be developed further as the project progresses beyond the feasibility level. This study did not identify any fatal flaws for the project regarding water quality and lake management since water quality issues can be addressed through various means of water treatment and reservoir management options.

Raw water pumped from Winters Run into the reservoir will introduce algae, bacteria, micro-organisms, sediments, organic material, and aquatic life. Water- and insect-borne diseases are water quality concerns in any isolated raw water reservoir. Such isolation has the potential under varying circumstances to concentrate and amplify pathogens. Most of these issues are expected in a raw water supply and are handled at the water treatment facility if the plant is designed to address them. The water quality of the raw water reservoir may differ greatly from the water quality observed in Winters Run depending on the season, storm events, or times of high stream flows.

Water quality goals for the raw water supply reservoir could be established and implemented through a lake management plan. Detailed plans and water quality goals will need to be developed beyond the feasibility level. These goals can be developed based on the existing or future treatment capabilities of the water treatment plant. At a feasibility level, it is understood that the water quality in the reservoir must be maintained at a level ready for immediate treatment and distribution to the public. Water quality issues that accompany a raw water supply reservoir are explained in the following sections.

9.1 Accumulation of Contaminants (Deposition and Evaporation)

Metals naturally occur in the environment and are released into the air and waterways as particulates from farming, mining, landscaping, golf courses, and manufacturing practices. Compounds of arsenic, barium, cadmium, lead, copper, mercury, selenium, nickel, thallium, antimony, and beryllium are known to impact water quality, human health and the environment depending on the concentrations detected. These compounds are detectable in the environment as wet and dry particulates. They enter waterways through runoff, industrial discharges and aerial deposition. Metals in the environment are typically held in fine sediments and are used in biological processes. High flow events and episodes of high turbidity can suspend these metals back into the water column. Decomposition of biotic tissue can reintroduce these metals back into the environment.

Winters Run would likely have lower detections of metals during low turbidity flows as compared to high turbidity flows. The reservoir would benefit from stream pumping events during low turbidity flows in Winters Run. The cover soils of the lined reservoir may be able to bind metals in the substrate and encourage settlement of these compounds as flows slow and particles have an opportunity to sink. Depending on the rate of circulation and pumping of the reservoir, a standing water supply could acidify with limited freshwater inflow and naturally-occurring chemical reactions that stabilize pH.

Evaporation is a natural process that may amplify contaminants in a reservoir setting. As water leaves the system and sediments containing metals and microbes remain, these natural and anthropogenic contaminants potentially concentrate and amplify causing water quality issues.

Under this consideration, water quality in a reservoir environment may change depending on the season, and the quality of water in Winters Run. Lake management decisions to monitor water quality, remove sludge, and add new water may maintain water quality within the reservoir. Other lake management options could be the addition of a biotic cover within the reservoir itself in the form of floating wetlands that naturally uptake metals and bind contaminants. Mechanical and chemical means of lake management could be used to remove sludge and encourage particulates to settle out of the water column.

9.2 Algae, Bacteria, Protozoans and Viruses

The reservoir liner prevents ground water interaction with the reservoir water and may prevent natural geothermal cooling cycles from regulating water temperature within the reservoir. Increased water temperature promotes algae and bacteria growth, reduces dissolved oxygen, and holds particles in suspension. Algae growth and blooms occur from an oversupply of nutrients in standing or slow flowing water, and leads to oxygen level depletion. Full exposure to sunlight creates an additional oversupplied resource to algae growth. Algae blooms utilize available oxygen in the water and cause aquatic organisms to die from hypoxia, which then impacts the taste and odor of water supplies. Under varying circumstances bacteria, protozoans, and viruses can proliferate and colonize quickly when conditions are optimal.

Bacteria, protozoans and viruses occur within the natural environment, and would be introduced to the raw water reservoir through pumping water from Winters Run. Increases in bacteria populations are a side effect of algae blooms and can continue to degrade water quality during warmer periods. Algae and suspended particulates can limit the effects of anti-bacterial disinfection practices. Below is a list of harmful bacteria, protozoans and viruses that impact water supplies.

Bacteria

Harmful bacteria are present in natural and man-made environments. When circumstances arise that present bacteria with an opportunity for rapid growth and colonization; these bacteria present a human health concern. The following bacteria can be found in water supplies that are man-made or naturally occurring:

» *Escherichia coli and Other Coliform Bacteria*

» *Legionella*

» *Salmonella and Typhoid*

» *Mycobacteria*

» *Campylobacter*

» *Cyanobacteria & Cyanotoxins*

Protozoans

Harmful protozoans are also present in natural and man-made environments. When wildlife are present, the following protozoans can be introduced into the water supply:

- *Giardia*
- *Cryptosporidium*
- *Naegleria fowleri*

Viruses

Harmful viruses are also present in natural and man-made environments that can present a human health concern to the water supply:

- *Norovirus or Norwalk Virus*
- *Enterovirus*

Water quality in the reservoir environment may decline and create challenges for the treatment plant depending on the issue that arises. Circulation pumps, aerators and new water from Winters Run are lake management steps that can be implemented to physically control algae. Chemical controls of algae are also feasible. Natural controls of algae can also be implemented in a reservoir setting. Recirculation, partial draining and refilling may be management options to maintain water quality. Allowing aquatic life to establish in the reservoir will encourage a natural balance through ecological processes. The combination of floating wetlands and the establishment of a fish population would act on consuming the algae and promote water quality factors that limit algae blooms. A biotic cover would provide structure and shade to the water which would block sunlight, create temperature variability, remove nutrients, and add oxygen. The introduction of an aquatic community may be able to recreate a natural aquatic system that will function to balance algae and bacteria growth.

9.3 Terrestrial Wildlife

Migratory waterfowl, local residential populations of Canada geese, and other birds are expected to use the reservoir and will introduce waste, bacteria, viruses, and other contaminates to the water supply. Other wildlife, such as beavers, deer, bear, raccoon, muskrats, and groundhogs pose similar contamination issues to the water supply and are also capable of physically damaging the liner. Wildlife will likely investigate the reservoir and become trapped and unable to escape due to the liner's slick surface, thereby introducing dead biomass to the reservoir. Snakes may utilize the exposed liner edge as basking habitat. *Cryptosporidium* is naturally carried by beavers and several bird species which poses a risk to public health. All natural water systems are contaminated. The ecological interactions between wildlife and their environment reduces those occurrences where *Cryptosporidium* presents a health concern.

The presence of terrestrial wildlife in a reservoir environment may impact water quality depending on the season, and ability for wildlife to access and escape the reservoir. Lake management practices can address wildlife concerns. Physical barriers such as fencing can deter wildlife, however their ability to climb or burrow can present challenges. Aerial cables over the reservoirs could deter flocks of geese from landing on the reservoir, but this method will not deter ducks. There are several methods that can be implemented to address the specific wildlife concern. One particular method is not designed for all target species. Bird and wildlife harassment programs have been implemented on other reservoirs which include automated noise makers, chase dogs, controlled hunts, and periodic loud blasts.

Adding floating biotic cover that functions as wetlands and introducing a complete aquatic community may be able to balance the nutrients and control the influences of wildlife on water quality. The presence of vegetation in the reservoir, would also be an attractant to waterfowl, so woody vegetation in combination with herbaceous plants would be recommended.

The cover soil substrate would provide a layer for organic matter to decay and stratify within the substrate, rather than within the free water column. Substrate and biotic cover would bind contaminants and remove them from free water, and maintain water oxygenation. Planting shrub buffer (eco-tone) between the reservoir and the forest tree line may naturally dissuade deer from investigating too closely. Reducing the amount of uncontrolled wildlife interactions with reservoir may reduce the waste and contamination to the water supply.

9.4 Aquatic Wildlife

The intake of water from Winters Run is likely to carry aquatic life directly to the reservoir. Warm water fish species like largemouth bass, sunfish, catfish, and minnows would likely survive in the reservoir, but may not be able to reproduce due to a lack of spawning habitat. Reservoirs have been found to support fish and amphibian populations unbeknownst to reservoir operators. These uncontrolled fish populations have been found to accumulate waste layers up to 2 feet in thickness in bottoms of reservoirs.

Reservoirs also support aquatic insect populations, including mosquito and midges. *Culex* mosquitoes are transmission vectors for West Nile virus and St. Louis encephalitis. Midges do not bite, but are resistant to chlorine and other chemical control agents. Swarms of adult insects breeding over water surfaces increase the presence of insectivorous birds. Elevated water temperatures can impair and kill aquatic wildlife that exist in the reservoir, introducing further contamination to the water supply.

Under this consideration, water quality in a reservoir environment may change depending on the season, and ability for aquatic wildlife to enter and survive in the reservoir. Lake management options could include establishing a warm water fish population to feed on aquatic insects, mosquito larvae and other micro-organisms. Herbivorous fish species would feed on plant life, especially algae. Other fish species would serve as predators and scavengers to feed on live and dead frogs, fish, and salamanders. The establishment of a balanced fish population would be recommended with a floating biotic system to provide cover, structure, spawning habitat and source of oxygen. Establishing a complete aquatic community would be beneficial to absorb an influx of biota and nutrients during reservoir filling events. If the reservoir can replicate a naturally functioning aquatic system, water quality would be expected to be sustainable at a level ready for treatment and distribution.

9.5 Human Contamination

Public water supplies before and after water treatment are possible targets for direct and deliberate contamination for the purposes of bioterrorism to poor judgment and behavior. Security measures and monitoring would be recommended to protect the water supply.

Accidental releases or spills can occur and enter Winters Run. Petroleum or chemical spills from a roadway accident or other circumstance could cause contaminated water to flow towards the treatment plant. During these types of accidents, the water quality of Winters Run would not be useable for drinking water supply until the problem passes or it is addressed. During these episodes, the isolated reservoirs can continue to meet the public water demand while Winters Run is remediated of any spills or returns to a safe condition.

10. Project Cost

10.1 General

An Engineer's Opinion of Probable Cost (cost estimate) has been prepared for each site. These estimates are intended to be used as a basis for comparing relative costs between the different alternatives. The cost estimate for the selected alternative should be reviewed and updated in the future as the project moves through preliminary and final design and as more site specific information is gathered (i.e., such as topographic surveys, subsurface information, etc.). These cost estimates are conceptual in nature. The conceptual layouts from which the cost estimates are based are contained on Appendix A, Exhibit 1.

It is noted that actual contractor bids are affected by a number of factors beyond the control of the Owner and Engineer, such as the supply and demand for materials and labor, weather conditions, global and local economic conditions, etc. Consequently, actual contractor bids may significantly vary from the conceptual cost estimates provided herein. If it is believed a more accurate cost estimate is necessary, an expert third party contractor/estimator could be brought on board to refine the estimate.

10.2 Capital Costs

Quantity estimates were developed using the conceptual designs shown on Appendix A, Exhibit 1. Where available, quantities were estimated through the use of Computer Aided Design (CAD). However, given the conceptual nature of the designs, many of the quantities are based on assumptions and engineering judgment.

Unit costs were derived from past construction projects, RS Means, and engineering judgment. The logic, methods and procedures for developing the unit costs are typical for the construction industry and are generally accepted as standard engineering practice. The Unit Price for each pay item is shown in Table 10-1.

Based on the conceptual nature of the proposed alternatives and the limited amount of information available, it is necessary to make assumptions in the development of the cost estimates. Key assumptions used in the development of the cost estimate are as follows:

» Contractor mobilization and demobilization is assumed to be five percent of the estimated construction costs (refer to Item 1 in Table 10-1).

» Contractor required bonds and insurances are assumed to be one percent of the estimated construction costs (refer to Item 2 in Table 10-1).

» Erosion control measures are assumed to be two percent of the estimated construction costs (refer to Item 4 in Table 10-1).

» A $20,000 allowance is allocated for care and diversion of water (refer to Item 5 in Table 10-1).

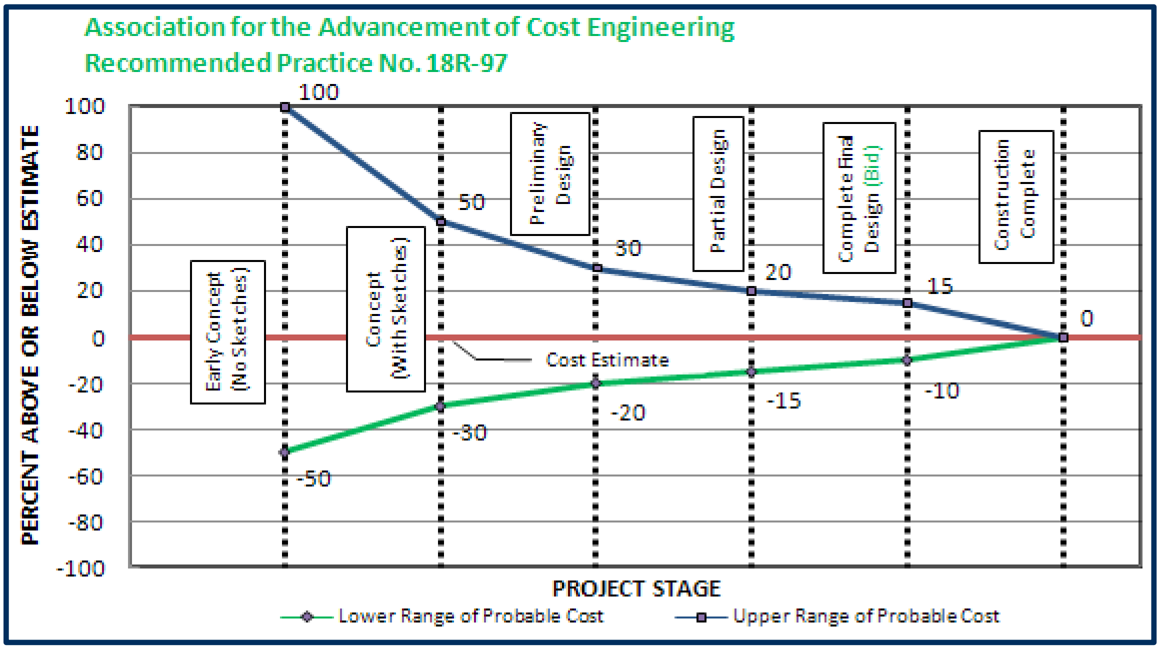
» A $20,000 allowance is allocated for site dewatering (refer to Item 6 in Table 10-1).

» It is assumed the excavation of the reservoir alternatives will not encounter rock.

Based on the conceptual level of design, a thirty (30) percent contingency has been applied to all construction related items. This contingency is intended to account for unlisted items, items which are not yet designed, quantity uncertainties, changes in site conditions, etc.

The Association for the Advancement of Cost Engineering International (AACE International) has published a Recommended Practice No. 18R-97, which provides guidance on the Definition of Cost Accuracy during the design process. Figure 10.1 illustrates this, and is used with permission of AACE International.

***Figure 10.1** - Definition of Cost Accuracy*



10.3 Operation and Maintenance Costs

After the reservoir is constructed, there will be some operation and maintenance costs associated with the reservoir that are not included in the cost estimate. These items include mowing and keeping the area free of woody vegetation, weekly patrolling of the reservoir area and any associated costs for pumping. It is also required to have an inspection performed annually. These costs total approximately $50,000 annually.

10.4 Total Project Costs

The total project cost of each site described within Section Four is presented in Table 10-1. In addition to the construction costs, the total project costs include engineering design and subsurface investigations (assumed to be twelve percent of the construction cost), permitting (assumed to be three percent of the construction cost), and construction management services (assumed to be twelve percent of the construction cost).

Table 10.1 - Project Costs

MARYLAND - AMERICAN WATER COMPANY
PROJECT TITLE: Bel Air Reservoir Feasibility Study
Harford County, Bel Air, MD
Conceptual Opinion of Estimated Construction Costs

Item No.	Item Description	Quantity Site A	Quantity Site B	Unit	Unit Price	Total Cost Site A	Total Cost Site B
Mobilization and Demobilization:							
1	Mobilization, Demobilization & Preparatory Work	Job	Job	Lump Sum	-	$ 628,329	$ 507,015
2	Bonds and Insurance	Job	Job	Lump Sum	-	$ 125,666	$ 101,403
3	Field Office	Job	Job	Lump Sum	-	$ 100,000	$ 100,000
Care and Diversion of Water:							
4	E&S, Surveys, Haul Roads, Etc.	Job	Job	Lump Sum	-	$ 251,332	$ 202,806
5	Care and Diversion of Water	Job	Job	Lump Sum	-	$ 20,000	$ 20,000
Dewatering:							
6	Site Dewatering	Job	Job	Lump Sum	-	$ 20,000	$ 20,000
Site Clearing and Restoration:							
7	Clearing and Grubbing	1.3	1.4	Acre	$6,000.00	$ 7,800	$ 8,400
8	Seeding	18	10	Acre	$3,300.00	$ 59,400	$ 33,000
Excavation:							
9	Unclassified Excavation (includes stripping)	515,000	350,000	Cubic Yard	$5.00	$ 2,575,000	$ 1,750,000
Fill:							
10	Approved Fill	315,000	333,800	Cubic Yard	$4.00	$ 1,260,000	$ 1,335,200
11	Riprap	400	300	Cubic Yard	$60.00	$ 24,000	$ 18,000
12	Topsoil	30,000	16,200	Cubic Yard	$15.00	$ 450,000	$ 243,000
13	Spoil	170,000	0	Cubic Yard	$4.00	$ 680,000	$ -
Geocomposite:							
14	Geocomposite on Embankment	313,540	275,060	Square Feet	$10.00	$ 3,135,400	$ 2,750,600
15	Geocomposite on Reservoir Bottom	214,245	280,026	Square Feet	$4.00	$ 856,980	$ 1,120,104
Outlet Works:							
16	30" Dia. Outlet pipe with Concrete Cradle	320	440	Linear Foot	$800.00	$ 256,000	$ 352,000
17	Control Tower (includes gates and valves)	Job	Job	Lump Sum	-	$ 800,000	$ 800,000
18	Impact Basin	Job	Job	Lump Sum	-	$ -	$ 100,000
Water Supply:							
19	Raw Water Intake, Pump Station and Piping	Job	Job	Lump Sum	-	$ 2,100,000	$ 1,300,000
Instrumentation:							
20	Instrumentation	Job	Job	Lump Sum	-	$ 50,000	$ 50,000
Miscellaneous Metals:							
21	Fencing	4,800	4,000	Linear Foot	$40.00	$ 192,000	$ 160,000
Subtotal						$ 13,591,906	$ 10,971,528
Contingency (30%)						$ 4,077,572	$ 3,291,458
Total Construction Costs						**$ 17,669,478**	**$ 14,262,987**
Engineering (12%)						$ 2,120,337	$ 1,711,558
Permits (3%)						$ 530,084	$ 427,890
Construction Management (12%)						$ 2,120,337	$ 1,711,558
Total Other Projects Costs						**$ 4,770,759**	**$ 3,851,006**
Total Project Costs						**$ 22,440,237**	**$ 18,113,993**

11. Project Permits

11.1 Environmental Regulatory Review and Required Permits

The proposed project will require regulatory approval by federal and state governments. The U.S. Army Corps of Engineers (USACE) has authority under Section 404 of the Clean Water Act (33 U.S. Code § 1344(a)) and Section 401 of the Clean Water Act (33 U.S. Code § 1341(1)). The Maryland Department of the Environmental (MDE) has authority under Environment Article, Titles 4, 5, and 9. The following information was obtained from USACE and MDE permitting fact sheets.

11.1.1 Section 404 Permit

The USACE and MDE have a Joint Federal/State Application for the Alteration of any Floodplain, Waterway, Tidal or Nontidal Wetland in Maryland. The anticipated stream crossings proposed for the project will require this permit. Seven copies of the joint permit application are submitted to MDE. The typical approval process for this permit is twelve months.

The USACE Nationwide Permits (NWP) may be applicable to the proposed project. Federal authorization could be satisfied by NWP 7 – *Outfall Structures and Associated Intake Structures*, and NWP 12 – *Utility Line Activities*. The typical approval process for these permits is two months.

11.1.2 Section 401 Water Quality Certification

A Section 401 Water Quality Certification (WQC) insures the protection of waters of the State and is necessary for activities requiring a U.S. Army Corps of Engineers Section 404 permit. When an activity is approved by a nontidal wetlands and waterways authorization, the WQC is incorporated into that authorization. When an activity is exempt from the requirement to obtain a nontidal wetlands and waterways authorization, an individual WQC is issued by MDE.

11.1.3 Surface Water Discharge Permit

The general surface water discharge permit is a combined state and federal permit under the National Pollutant Discharge Elimination System (NPDES). This permit is issued for industrial facilities that discharge over 10,000 gallons per day to the ground or a State surface waters. The permit is designed to meet federal effluent guidelines when applicable and also ensure the discharge satisfies State water quality standards.

The MDE has legal authority for these activities under the Federal Clean Water Act and Environment Article, Title 9, Subtitle 3; COMAR 26.08.01 through 26.08.04 and for the Pretreatment Permit, COMAR 26.08.08.

The proposed reservoir project will require this permit if there is a discharge to Winters Run. As part of this permit, a sample of the reservoir water would have to be analyzed and presented to ensure that the discharged water would not adversely affect the environment. The typical approval process for this permit is six months.

11.1.4 Water and Sewerage Construction Permit

The purpose of water and sewerage construction permit is to ensure that infrastructure projects throughout the State are designed on sound engineering principles and comply with State design guidelines to protect water quality and public health. Water and sewerage construction permits are required before installing, extending, or modifying community water supply and/or sewerage systems including treatment plants, pumping stations, and major water mains and sanitary sewers. These permits ensure conformity with local water and wastewater comprehensive plans and ensure that there is adequate funding for long-term operation.

The MDE has legal authority for these activities under Environment Article, Title 9; COMAR 26.03.12.

As part of this permit, MDE will review the final design drawings and specifications. For this project the MDE water supply division will also review the design for its impact to the water treatment plant and the overall potable water supply. The typical approval process for this permit is three to six months.

11.1.5 Water Appropriation and Use Permit

The State is responsible for conserving, protecting, and using water resources in the best interest of the people of Maryland. Therefore, it is necessary to control the appropriation and use of surface and ground waters.

The MDE has legal authority for these activities under Environment Article, Title 5, §5-203 and §5-501 through §5-516 and §5-5B-01 through §5-5B-05, Annotated Code of Maryland; COMAR 26.17.06 and COMAR 26.17.07.

This permit is required for the proposed additional water withdrawals from Winters Run as part of the reservoir project. A public notice period is required for this permit. The approval process for this permit is up to 18 months.

If the minimum flowby requirement is increased by MDE, more water would be needed from the reservoir. This would also result in a higher withdrawal permit and/or a larger reservoir storage capacity. Increasing the minimum flowby rate above the current 6.07 MGD would require changes to the design and operation of the proposed reservoir.

11.1.6 Non-Tidal Wetlands and Waterways Permit

The following activities are regulated by USACE and MDE, requiring the Joint Federal/State Application discussed in Section 12.1.1:

» Grading or filling
» Excavating or dredging
» Changing existing drainage patterns
» Disturbing the water level or water table
» Destroying or removing vegetation

The MDE has legal authority for these activities under Environment Article Title 5, Subtitle 5-901 through 5-911; Annotated Code of Maryland; COMAR 26.23.

The utility line stream crossings proposed for the reservoir project will require this permit even if wetland impacts are avoided. The typical approval process for this permit is twelve months.

11.1.7 Waterways Construction Permit – 100-Year Floodplain

The following activities are regulated by USACE and MDE, requiring authorization for projects in a waterway or a 100-year floodplain by way of the Joint Federal/State Application discussed in Section 11.1.1:

» Dams and reservoirs

» Bridges and culverts

» Excavation, filling or construction

» Channelization

» Changing the course, current or cross-section of any stream

» Temporary construction (e.g. utility lines)

» Any other similar project.

Ponds and dams require a separate review (See Section 12.1.9).

The MDE has legal authority for these activities under Environment Article Title 5, Subtitle 5-501 through 5-514; COMAR 26.17.04.

The utility line stream crossings proposed for the reservoir project will require this permit. The typical approval process for this permit is twelve months.

11.1.8 Erosion and Sediment Control and Stormwater Management Plans

The purpose of Maryland's erosion/sediment control and stormwater management programs is to reduce stream channel erosion, pollution, siltation, and local flooding caused by land use changes associated with urbanization. Erosion/sediment control plan approval is required, before construction, to prevent siltation due to releases of sediment (soil) from active construction sites. Plan approval is required for any construction activity that disturbs 5,000 square feet or more of soil, or results in the excavation of 100 cubic yards or more of soil.

Stormwater management plan approval is required to prevent stream bank erosion by controlling the rate of stormwater runoff from newly developed areas by using infiltration practices, shallow marshes, retention, and detention ponds. After construction, stormwater runoff typically increases due to the loss of ground cover and the increase of impervious surfaces such as roofs, sidewalks, roads, and parking lots. Therefore, stormwater management is needed to control runoff to the same rate prior to construction. This approval is required for any new development project that disturbs 5,000 square feet or more of land. It can be obtained at the same time as the erosion and sediment control approval.

The MDE has legal authority for these activities under Environment Article, Title 4, Subtitle 1 for erosion and sediment control, and Subtitle 2 for stormwater management. These statutes are further defined in COMAR 26.17.01 and 26.17.02.

The proposed for the reservoir project will require these approvals. The typical approval process for these permits is six months.

11.1.9 General Permit for Construction Activity

Separate from the Federal NPDES permit, this general permit is required for all construction activities in Maryland with a planned total disturbance of one acre or more. Conditions of the permit include compliance with approved erosion/sediment control and stormwater management plans, compliance with water quality standards and TMDLs, self-monitoring and record keeping.

The MDE has legal authority for these activities under the Federal Clean Water Act Section 402 and the Code of Federal Regulations (40 CFR 122.26 and 40 CFR 450), and Environment Article, Title 9, Subtitle 3: COMAR 26.08.04.

This permit is required for the proposed project, as the planned total disturbance will exceed one acre. The typical approval process for this permit is three months.

11.1.10 Dam Safety Permit

The Dam Safety Division of MDE issues waterway construction permits for new dams and ponds, and permits for alterations to existing impoundment structures. The major goal of this permit is to ensure that dams are built and operated properly to protect public safety. Typically, permits are reviewed and issued in two phases, which can be combined at the applicant's request. The phases are as follows:

Phase 1: The feasibility of the project is evaluated in this phase. If the project is acceptable, a Plan Development Permit is issued which authorizes the applicant to proceed with detailed design of the dam. During the review, environmental impacts are evaluated, and the hazard classification, dam height and reservoir size are established. The hazard classification, which defines the potential for downstream damage if the dam were to fail, establishes minimum design criteria that the dam and spillway must safely accommodate.

Phase 2: The Waterway Construction Permit is issued after a very detailed review of the design construction documents and specifications which authorizes construction of the dam. The dam construction must be inspected by a professional engineer, preferably the design engineer.

The MDE has legal authority for these activities under Environment Article Title 5, Subtitle 05, COMAR 26.17.04.

The typical approval process for this permit is six months.

Public opposition or the denial of any required state or federal permit integral to the project could result in delay or possible defeat of the proposed project.

11.1.11 General Discharge Permit (11-HT)

The general discharge permit is for discharges from tanks, pipes, and other liquid containment structures at facilities other than oil terminals. For the purpose of this reservoir project, this permit is required for the discharge of untreated water in excess of 10,000 gallons per day as a monthly average from water storage to Winters Run.

The MDE has legal authority for these activities under the Federal Clean Water Act, 33 U.S.C and implementing regulations, 40 CFR Parts 122, 123, 124, and 125.

As part of this permit, a sample of the reservoir water would have to be analyzed for specific contaminants and MDE would be presented with the results to ensure that the discharged water would not adversely affect the environment. The typical approval process for this permit is four months.

12. Project Schedule

A planning level project schedule was prepared to assess the time required to design, permit, and construct the facilities needed to implement the off-stream reservoir storage concept for the MDAW system. Critical path elements of the schedule will be the permitting and the acutual reservoir construction.

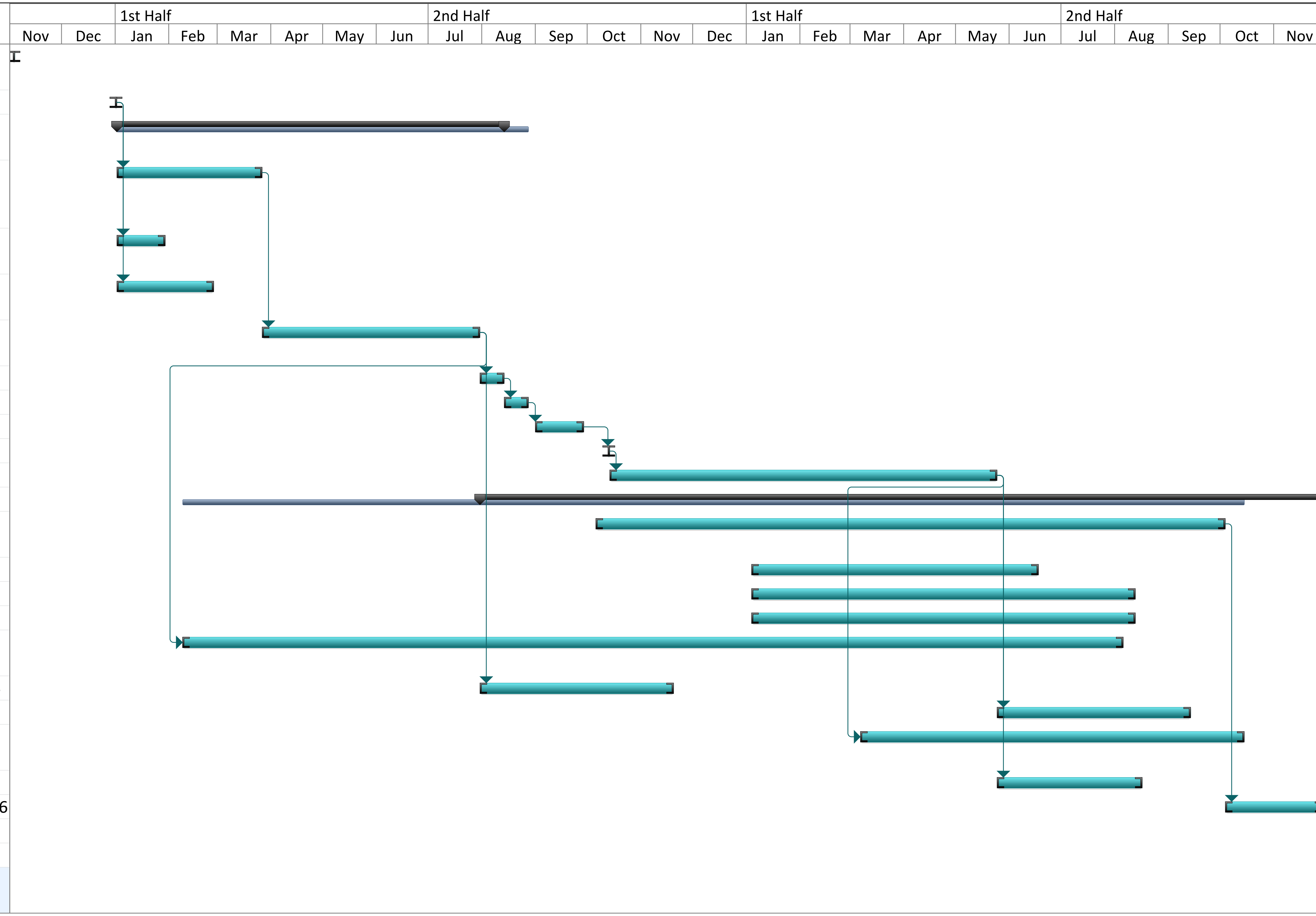
As identified in the schedule, early coordination with the Maryland Department of the Environment (MDE) is important to establish the design parameters before initiating the preliminary design. Water appropriation permits must be renewed in 2015 for the existing surface water and groundwater supplies so and potential changes to the permits should be discussed soon. To proceed with this concept, it will be necessary for the maximum daily surface withdrawal rate to be increased to allow reservoir refill after it is used for supply. Additionally, the flowby limitations in the permit will be a critical factor in establishing the reservoir sizing.

The Water Appropriation Permit task can take up to 18 months and should begin soon after the initiation of a preliminary engineering study. If MDAW does not request an increase in the annual withdrawal from Winters Run, then the permit renewal may not take the full 18 months. Although the renewed surface water permit must increase the maximum withdrawal from the stream for this concept to be feasible, the total annual water usage is a function of the water system demand and is not affected by the off-stream storage operation.

The project will also require other environmental and construction pertmits as noted in Chapter 11. As with the Water Appropriation Permit, permits with long processing and approval times should be started early in the design phase.

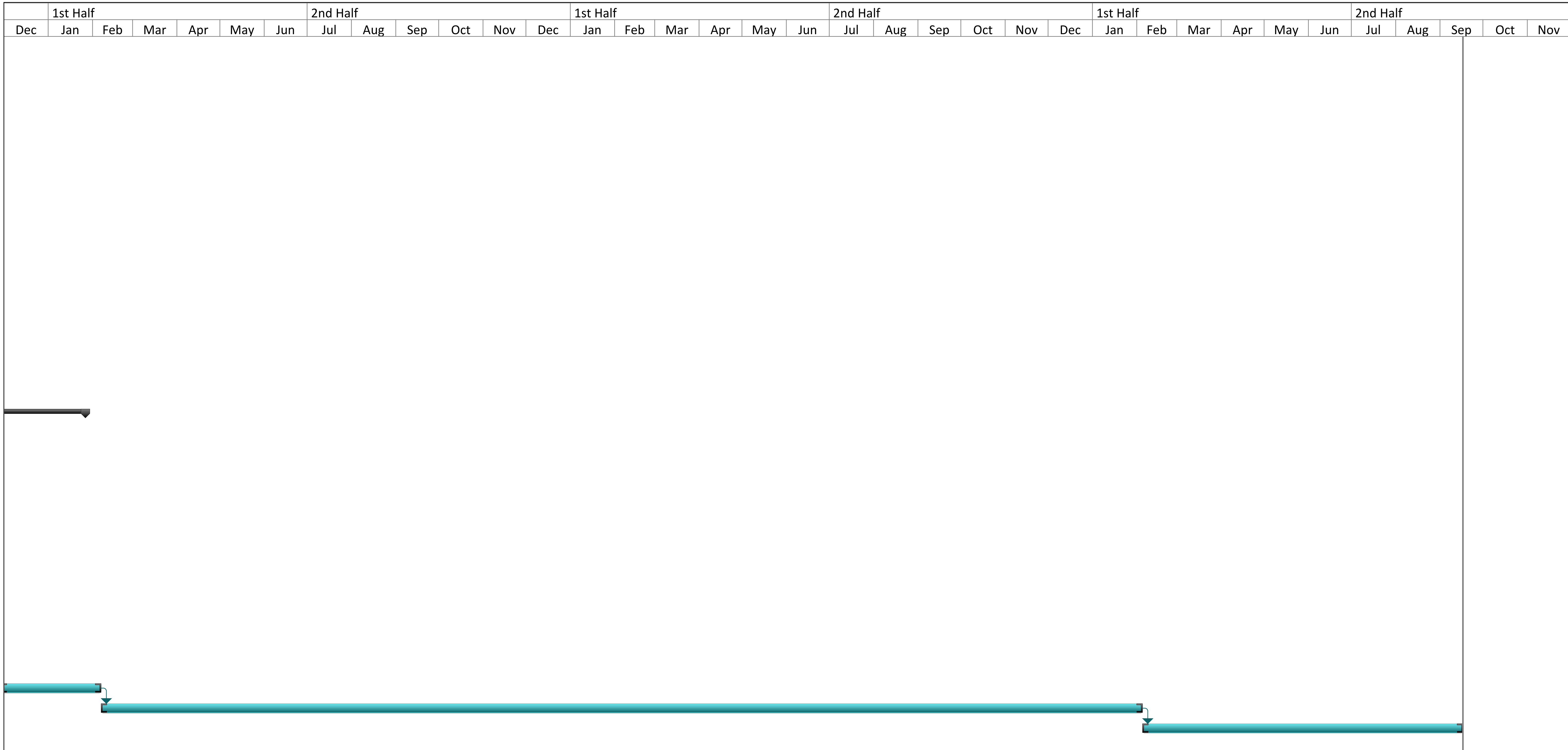
The Preliminary Design Study and Detailed Design tasks are expected to take at least a year, depending the geotechnical investigations, design requirements, and permit efforts. The schedule allows two years for construction following a bid and award phase.

ID	Task Name	Duration	Start	Finish
1	Meet with Regulators/MDE	1 day	Mon 11/3/14	Mon 11/3/14
2	Design Notice to Proceed	1 day	Thu 1/1/15	Thu 1/1/15
3	**Preliminary Engineering Report**	**32 wks**	**Fri 1/2/15**	**Thu 8/13/15**
4	Geotechnical Investigation and Report	12 wks	Fri 1/2/15	Thu 3/26/15
5	Environmental Field Investigation	4 wks	Fri 1/2/15	Thu 1/29/15
6	Surveying and base drawings	8 wks	Fri 1/2/15	Thu 2/26/15
7	Preliminary Design Report	18 wks	Fri 3/27/15	Thu 7/30/15
8	Cost Estimate	2 wks	Fri 7/31/15	Thu 8/13/15
9	Submit PER	2 wks	Fri 8/14/15	Thu 8/27/15
10	MAW Review of PER	4 wks	Tue 9/1/15	Mon 9/28/15
11	Review Workshop	1 day	Tue 10/13/15	Tue 10/13/15
12	Final Design	32 wks	Wed 10/14/15	Tue 5/24/16
13	**Permitting**	**78 wks**	**Fri 7/31/15**	**Thu 1/26/17**
14	MDE/Corp of Engineers Joint Permit	52 wks	Tue 10/6/15	Mon 10/3/16
15	Forrest Conservation	24 wks	Mon 1/4/16	Fri 6/17/16
16	SWM and ESC	32 wks	Mon 1/4/16	Fri 8/12/16
17	Dam Safety	32 wks	Mon 1/4/16	Fri 8/12/16
18	Water Appropriation Permit	78 wks	Mon 2/9/15	Fri 8/5/16
19	Water Discharge Permit	16 wks	Fri 7/31/15	Thu 11/19/15
20	NPDES	16 wks	Wed 5/25/16	Tue 9/13/16
21	MDE Construction Permit	32 wks	Mon 3/7/16	Fri 10/14/16
22	Prepare Bid Documents	12 wks	Wed 5/25/16	Tue 8/16/16
23	Advertisement for Bid	8 wks	Tue 10/4/16	Mon 11/28/16
24	Bid Evaluation and Award	10 wks	Tue 11/29/16	Mon 2/6/17
25	Construction	104 wks	Tue 2/7/17	Mon 2/4/19
26	Testing and Commissioning	32 wks	Tue 2/5/19	Mon 9/16/19



Project: 2014-9-7 Schedule
Date: Mon 9/29/14

Task
Split
Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Deadline
Progress



Project: 2014-9-7 Schedule
Date: Mon 9/29/14

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

13. Risk Assessment

13.1 General

Given the conceptual nature of this study, there are risks associated with this project that have the potential to affect the total project costs. Determining and understanding the risks associated with a project are an important part in the planning process. The following risks identified for this project are:

1. Cultural resources and permitting
2. Withdrawal and flowby from Winters Run
3. Subsurface conditions
4. Economy

13.2 Project Risks

13.2.1 Cultural Resources and Permitting

As discussed previously, there are several permits and clearances required to construct the proposed pump storage reservoir. Obtaining these permits is critical. Maryland Historical Trust (MHT) clearance has not been obtained yet and even if MHT clearance is obtained, the discovery of any archaeological artifacts during construction could halt the project. There is also a public notice period for some of the permits required, public opposition or the denial of any required state or federal permits integral to the project could result in delay or possible defeat of the proposed project.

13.2.2 Withdrawal and Flowby from Winters Run

The Water Appropriation and Use Permit is required for the proposed withdrawals from Winters Run. The amount of water that may be withdrawn from Winters Run is subject to a minimum flowby requirement. Also associated with this permit are average and maximum daily withdrawal limits. Since the current permit will be in effect until 2015, the model allows the user to define the minimum flowby requirement, the allowable withdrawal from the stream and other permitting constraints to estimate the impact of any possible changes on storage requirements. As the minimum flowby increases, the amount of water available for possible withdrawal decreases. Consequently, the reservoir storage would need to increase in order to have enough storage to meet demands during periods of low stream flow. Conversely, if the minimum flowby is decreased, a smaller amount of storage would be needed to meet a specified demand.

The maximum allowable withdrawal has a similar impact on the amount of storage required to meet a specified demand. As the allowable withdrawal increases, the reservoir is able to be filled more rapidly which is critical to water supply during and just following a drought event. This will also allow the maximum capacity of the reservoir to be reduced.

13.2.3 Subsurface Conditions

An unknown for the project site is depth, i.e. location of bedrock. Test pit operations on site encountered rock only at Site A, depth twelve feet, in one of the ten test pits. Decomposed rock and saprolite was encountered at both Sites A and B in seven of the ten test pits at depths ranging from eight to ten feet. Based on site geology, the thickness of the saprolite could vary considerable. Saprolite thickness could range from five feet to greater than thirty feet. Although saprolite excavation with traditional earth moving equipment is feasible and would not affect project costs; excavation of rock, if and when encountered, would lead to considerable cost increase. Rock excavation may require blasting and hoe rams. Cost increase would be more than 100% of the project cost if rock excavation is required. Steps to reduce this risk include:

1. Subsurface exploration program to locate bedrock elevation and quality
2. Reconfigure reservoir to eliminate the need for rock excavation, i.e. reduce required excavation while increasing reservoir footprint.

The above mitigation steps to reduce risk associated with rock excavation are recommended and should commence as soon as feasible so that project schedule is not delayed.

A minor risk is need for lining the reservoir. We have assumed a liner is required and included this in the construction cost estimate. However, considerable savings would be achieved if the lining were not required. A detailed subsurface exploration program, testing the permeability of site soils and rock would serve to confirm the need for the liner. It is recommended that field falling head tests of overburden soil, as well as rock pressure testing be included in the subsurface exploration to provide confirmation that a liner system is required.

Another minor risk factor is the presence of elastic silt in the soil overburden. As discussed previously, this soil was identified to be present at Site A during the laboratory testing completed as part of the feasibility study. Future subsurface exploration should include sufficient laboratory testing to evaluate the presence and extent of elastic soils. If encountered, construction documents should include special handling procedures and possible zoning of the embankments to maximize use of the soil.

13.2.4 Economy

There are also economic risks that should be realized. Construction of this project is estimated to begin in 2017. While we can estimate inflation associated with construction costs, it is difficult to predict the economic future. Examples of variables affecting the project costs are interest rates, supply/demand in the contractor market, fuel costs, material costs, economic cycle as well as many other internal and external factors.

14. Summary and Recommendations

14.1 Summary

The feasibility level evaluations presented here indicate that a reservoir with 360 acre-feet of storage will meet the system supply requirements during a drought of record event. This is based on an average system demand of 1.50 MGD during the outage, obtaining 0.115 MGD from Winters Run Well and 0.144 MGD from Bynum Well. If the flowby requirment is not increased from the current 6.07 MGD, and if the maximum stream withdrawal is increased to at least 4 MGD to permit the reservoir refill, then modeling indicates that the reservoir volume is sufficient to meet the system demand without purchasing water from Harford County. This operational scenario also assumes that flow from the stream in excess of the flowby plus water plant withdrawal is captured for reservoir refill.

The study evaluated the two alternative sites, Site A and Site B, for the reservoir. Both sites are owned by Harford County and have been offered to MDAW as possible reservoir sites. Both sites are sloping sites and require substantial earthwork to construct large earth embankments along much of the reservoir perimeter. To provide the required volume, the maximum embankment height on either site exceeds 50 feet. With the layouts developed here, Site A has a surplus of excavated material and Site B is roughly balanced assuming the excavated material can be used for the embankment construction. The reservoir construction will involve impacts to forests but minimal to no impact to wetlands. Construction of the pipeline from the reservoir to the proposed pump station will require a stream crossing of Winters Run. The soils at Sites A and B are similar so neither site is distinctly superior from a geological perspective.

Site B, however, does offer several advantages over Site A with respect to the other facilities required for operation. Most significanly, the length of the pipeline required between the reservoir and the Winters Run Plant is much greater for Site A. Additionally, construction of the pipeline to Site A would impact additional environmental resources and would require a trenchless crossing of Route 1 Bypass.

Site A is an active County park site and construction would require re-routing a popular walking trail. The playground, walking trails, and other public activities on Site A could increase the potential for unauthorized public use of the reservoir and increase liability risk concerns for MDAW. Site B is more remote with less visibility and no convenient public access.

Therefore, Site B is considered to be the superior site for a storage reservoir based on these evaluations.

It is recommended that the reservoir be constructed with a manufactured lining material to prevent water loss to leakage and permit the use of on-site materials for the embankment construction. The lining would be covered with a soil layer on the bottom of the reservoir but will be exposed on the interior slopes. A control tower will be required for the piped connection to the water treatment plant and pump station for refill and withdrawal, and for the level control overflow.

At the water treatment plant site, a new raw water intake is proposed with a bar screen at the stream A mechanical traveling screen is recommended to continuously remove debris and minimize the maintenance cleaning required at the wetwell. The intake will be sized to handle the increased withdrawal from Winters Run necessary to refill the reservoir while meeting system demands.

The intake will be connected to a wetwell and a new raw water pump station is required. Submersible pumps are recommended similar to the existing raw water pumps. It is recommend that the new pump station include two pumps sized to pump raw water to the plant to replace the existing raw water pump station. The remaining pumps will be used to pump from the wetwell to refill the reservoir and will have a higher capacity and head requirement than the plant pumps. When water is being withdrawn from the reservoir for treatment at the Winters Run plant, it can be supplied by gravity without pumping.

14.2 Recommendations

The evaluations demonstrate that the concept is operationally feasible if the permit conditions can be modified to permit the reservoir refill. MDAW must evaluate the project cost to determine if it is economically feasible for the Bel Air system. Because the regulatory permits (flowby requirement, maximum stream withdrawal) affect the reservoir sizing, and the sizing of the reservoir affects the project costs, the permit conditions can control the project feasibility. Therefore, it is recommended that MDAW begin coordination meetings with the regulatory agencies as soon as possible.

15. References

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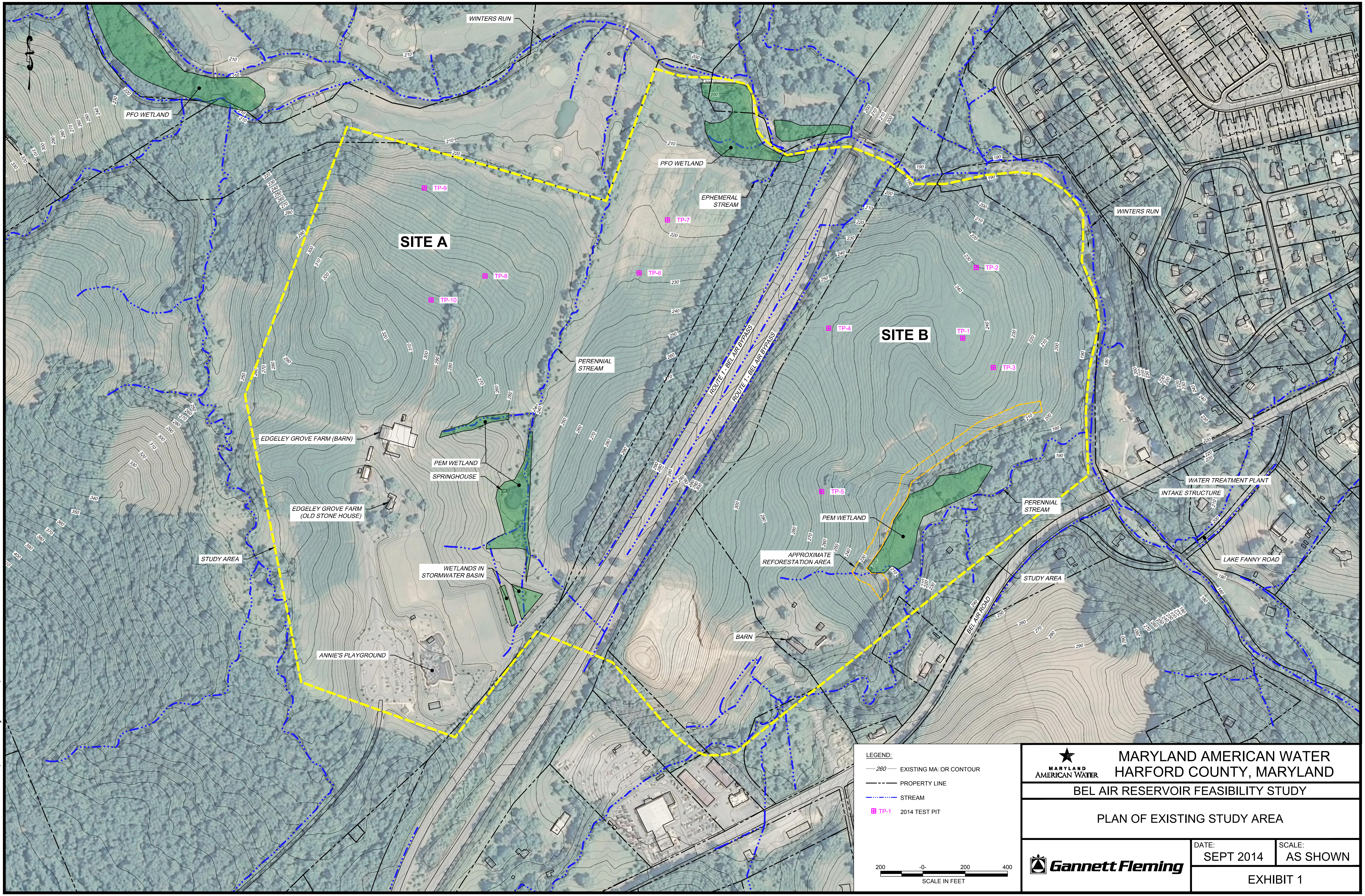
Appendix A

Exhibits



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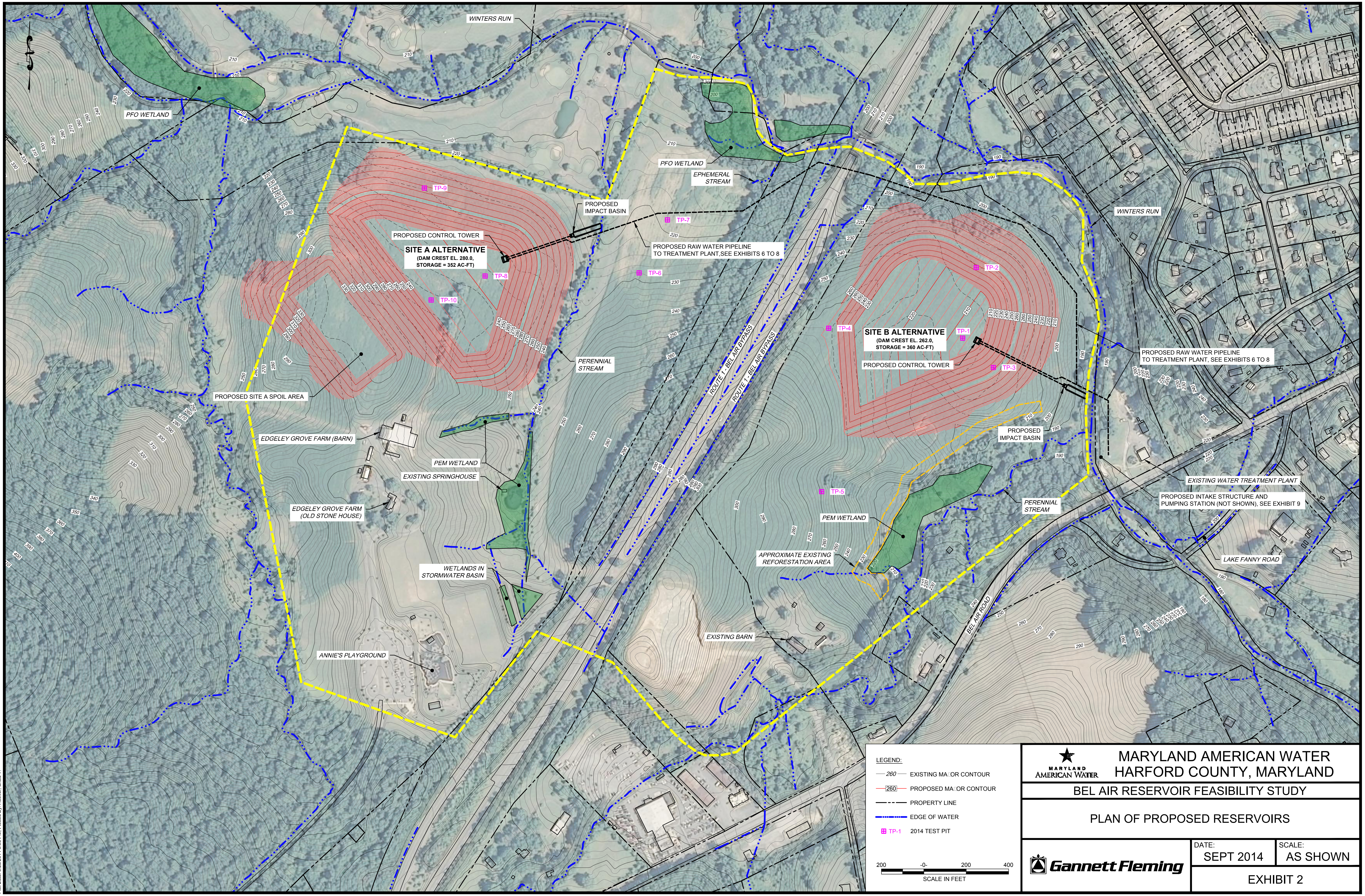
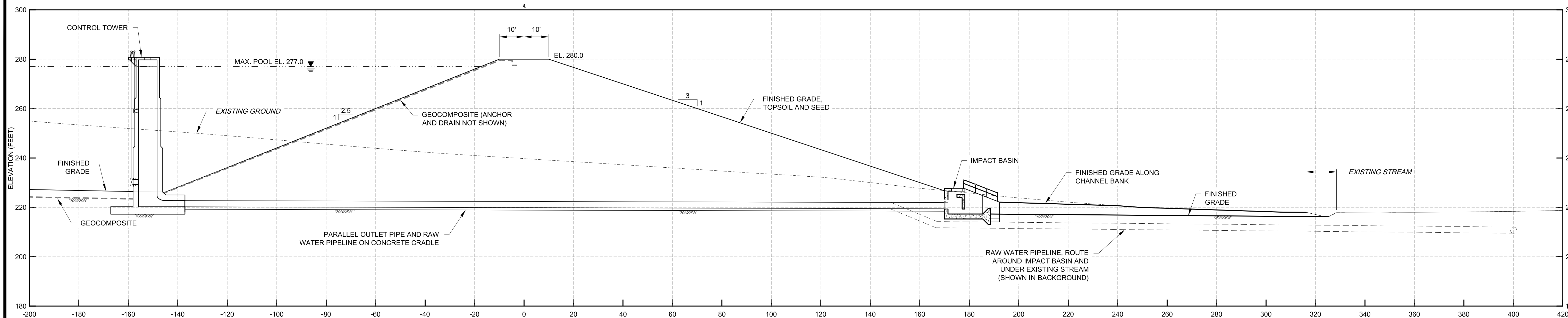
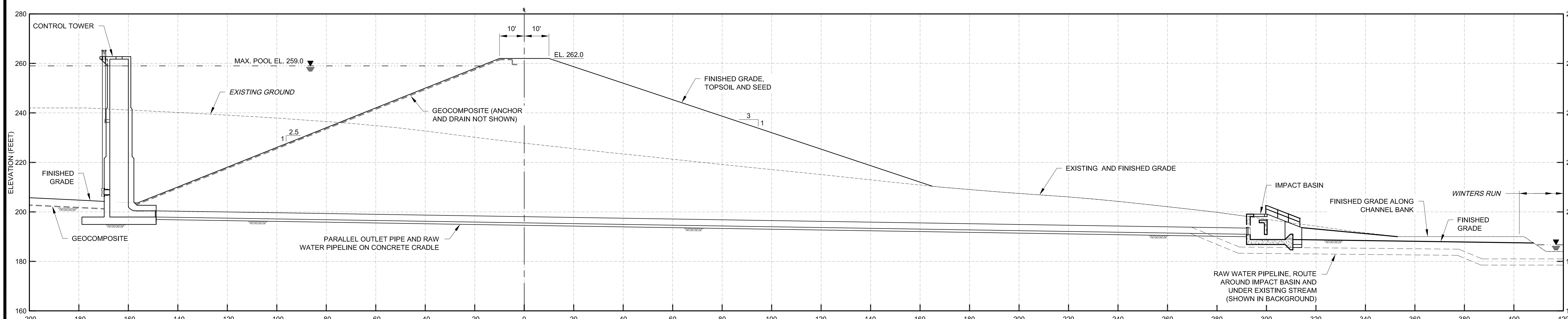

WINTERS RUN
PFO WETLAND
PFO WETLAND
EPHEMERAL STREAM
PROPOSED IMPACT BASIN
PROPOSED CONTROL TOWER
SITE A ALTERNATIVE
(DAM CREST EL. 280.0, STORAGE = 352 AC-FT)
PROPOSED RAW WATER PIPELINE TO TREATMENT PLANT, SEE EXHIBITS 6 TO 8
TP-1
TP-2
TP-3
TP-4
TP-5
TP-6
TP-7
TP-8
TP-9
TP-10
PERENNIAL STREAM
PROPOSED SITE A SPOIL AREA
EDGELEY GROVE FARM (BARN)
PEM WETLAND
EXISTING SPRINGHOUSE
EDGELEY GROVE FARM (OLD STONE HOUSE)
WETLANDS IN STORMWATER BASIN
ANNIE'S PLAYGROUND
ROUTE 1 - BEL AIR BYPASS
ROUTE 1 - BEL AIR BYPASS
WINTERS RUN
SITE B ALTERNATIVE
(DAM CREST EL. 262.0, STORAGE = 360 AC-FT)
PROPOSED CONTROL TOWER
PROPOSED RAW WATER PIPELINE TO TREATMENT PLANT, SEE EXHIBITS 6 TO 8
PROPOSED IMPACT BASIN
EXISTING WATER TREATMENT PLANT
PROPOSED INTAKE STRUCTURE AND PUMPING STATION (NOT SHOWN), SEE EXHIBIT 9
PERENNIAL STREAM
PEM WETLAND
APPROXIMATE EXISTING REFORESTATION AREA
LAKE FANNY ROAD
EXISTING BARN
BEL AIR ROAD
LEGEND:
260 EXISTING MAJOR CONTOUR
260 PROPOSED MAJOR CONTOUR
PROPERTY LINE
EDGE OF WATER
TP-1 2014 TEST PIT
200 -0- 200 400
SCALE IN FEET
MARYLAND AMERICAN WATER
MARYLAND AMERICAN WATER
HARFORD COUNTY, MARYLAND
BEL AIR RESERVOIR FEASIBILITY STUDY
PLAN OF PROPOSED RESERVOIRS
Gannett Fleming
DATE:
SEPT 2014
SCALE:
AS SHOWN
EXHIBIT 2



SITE A ALTERNATIVE EMBANKMENT SECTION



SITE B ALTERNATIVE EMBANKMENT SECTION

20 -0- 20 40
SCALE IN FEET

MARYLAND AMERICAN WATER
HARFORD COUNTY, MARYLAND

BEL AIR RESERVOIR FEASIBILITY STUDY

PROPOSED EMBANKMENT SECTIONS

Gannett Fleming

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	EXHIBIT 3

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MARYLAND AMERICAN WATER

MARYLAND AMERICAN WATER
HARFORD COUNTY, MARYLAND

BEL AIR RESERVOIR FEASIBILITY STUDY

PROPOSED SITE A RENDERING

Gannett Fleming

DATE:	SCALE:
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MARYLAND AMERICAN WATER
HARFORD COUNTY, MARYLAND

BEL AIR RESERVOIR FEASIBILITY STUDY

PROPOSED SITE B RENDERING

Gannett Fleming

DATE:	SCALE:
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EXHIBIT 5

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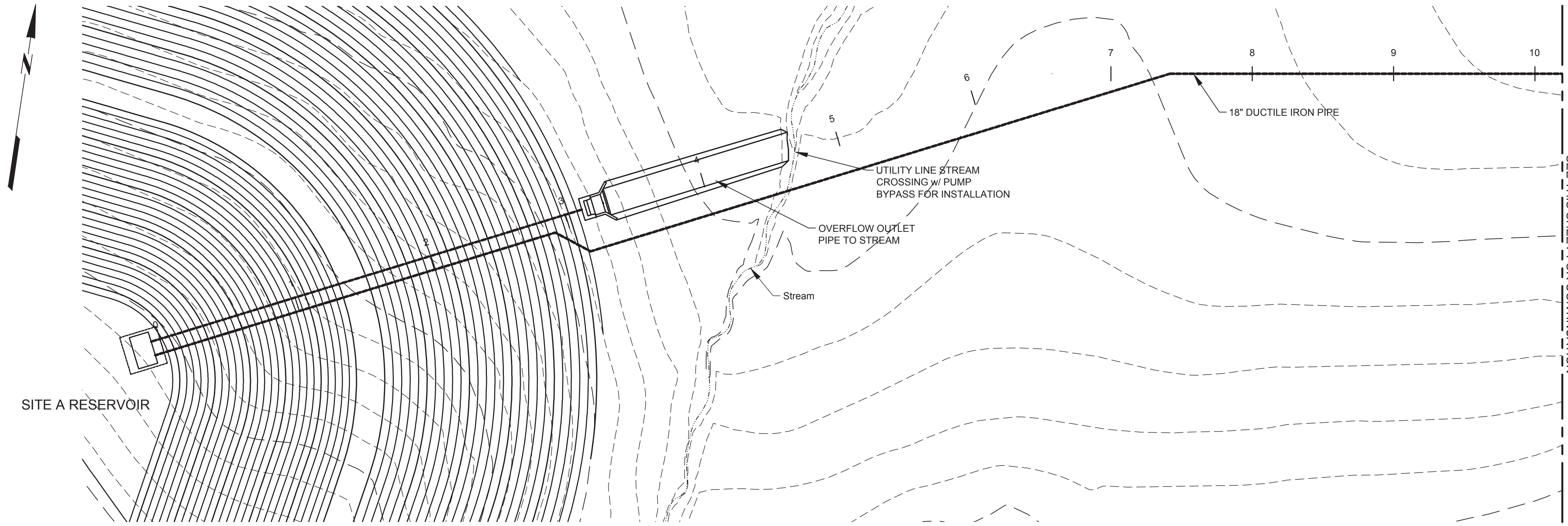
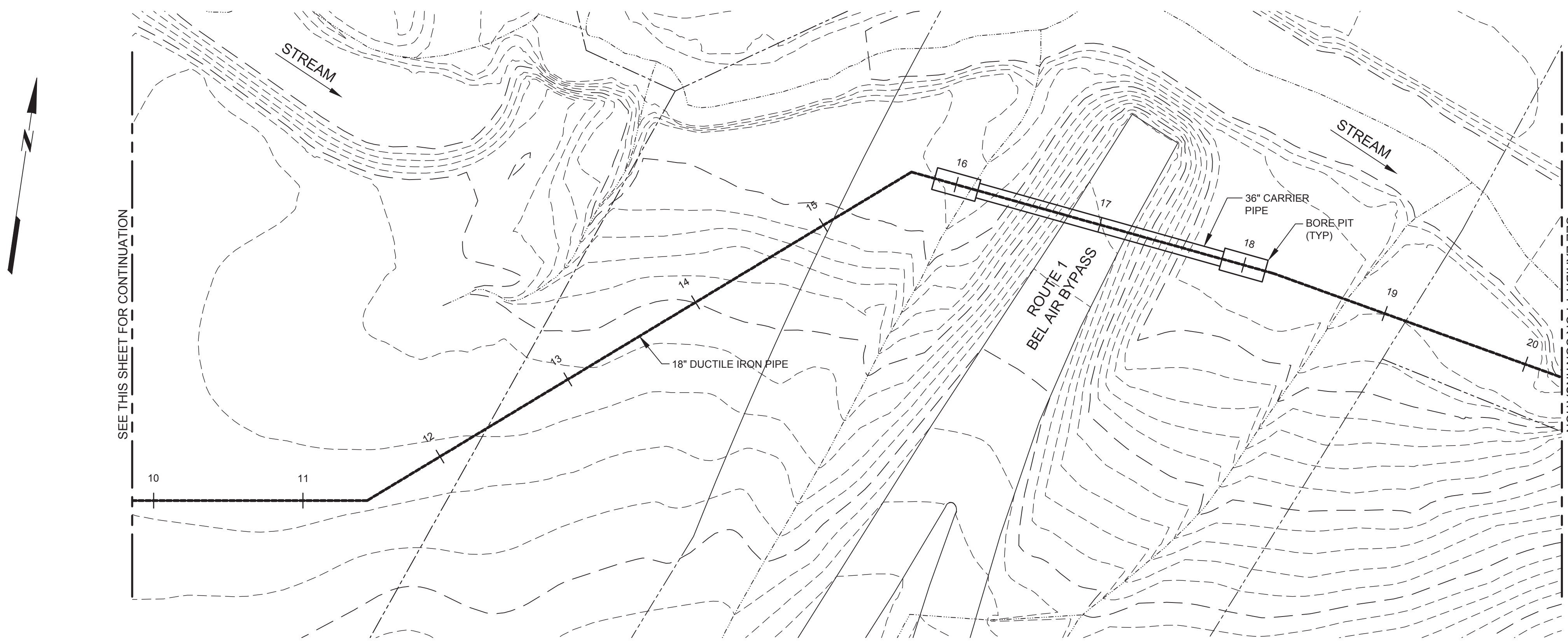


SITE A RESERVOIR PIPING PLAN

SCALE: 1"=50'



SITE A RESERVOIR PIPING PLAN

SCALE: 1"=50'

MARYLAND AMERICAN WATER

MARYLAND AMERICAN WATER
HARFORD COUNTY, MARYLAND

BEL AIR RESERVOIR FEASIBILITY STUDY

SITE A RESERVOIR
PIPING PLANS
SHEET 1

Gannett Fleming

DATE:	SCALE:
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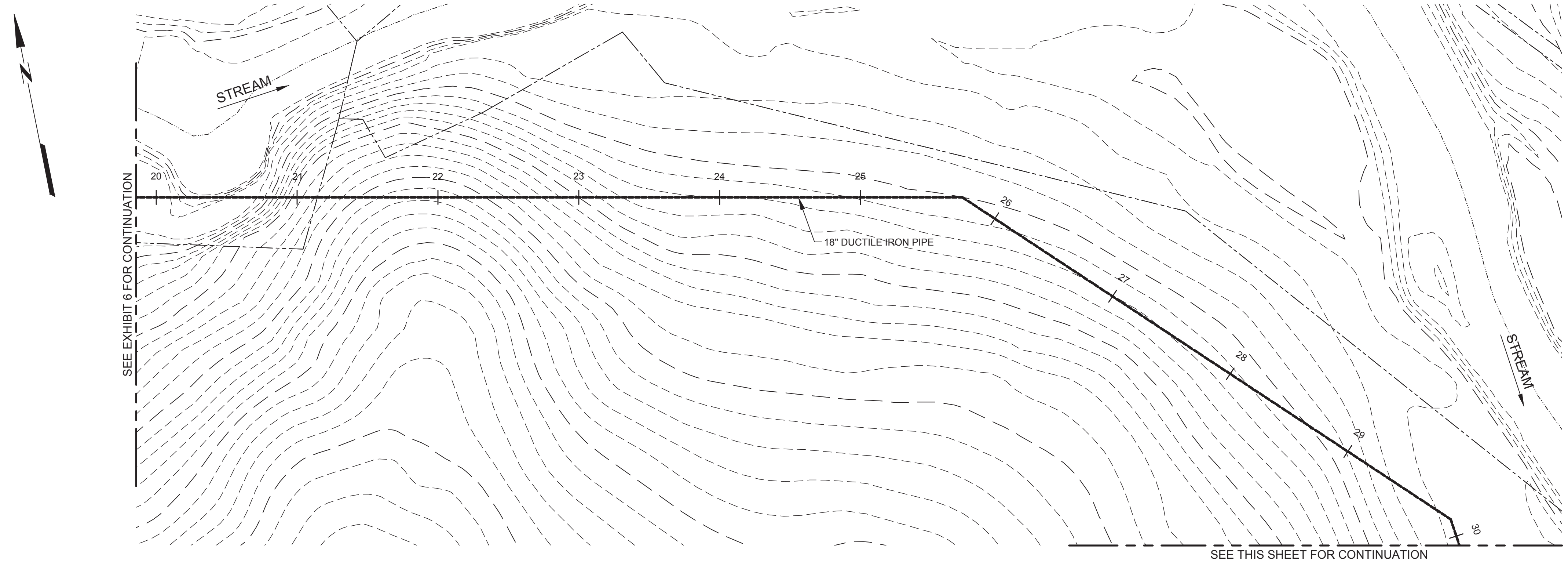
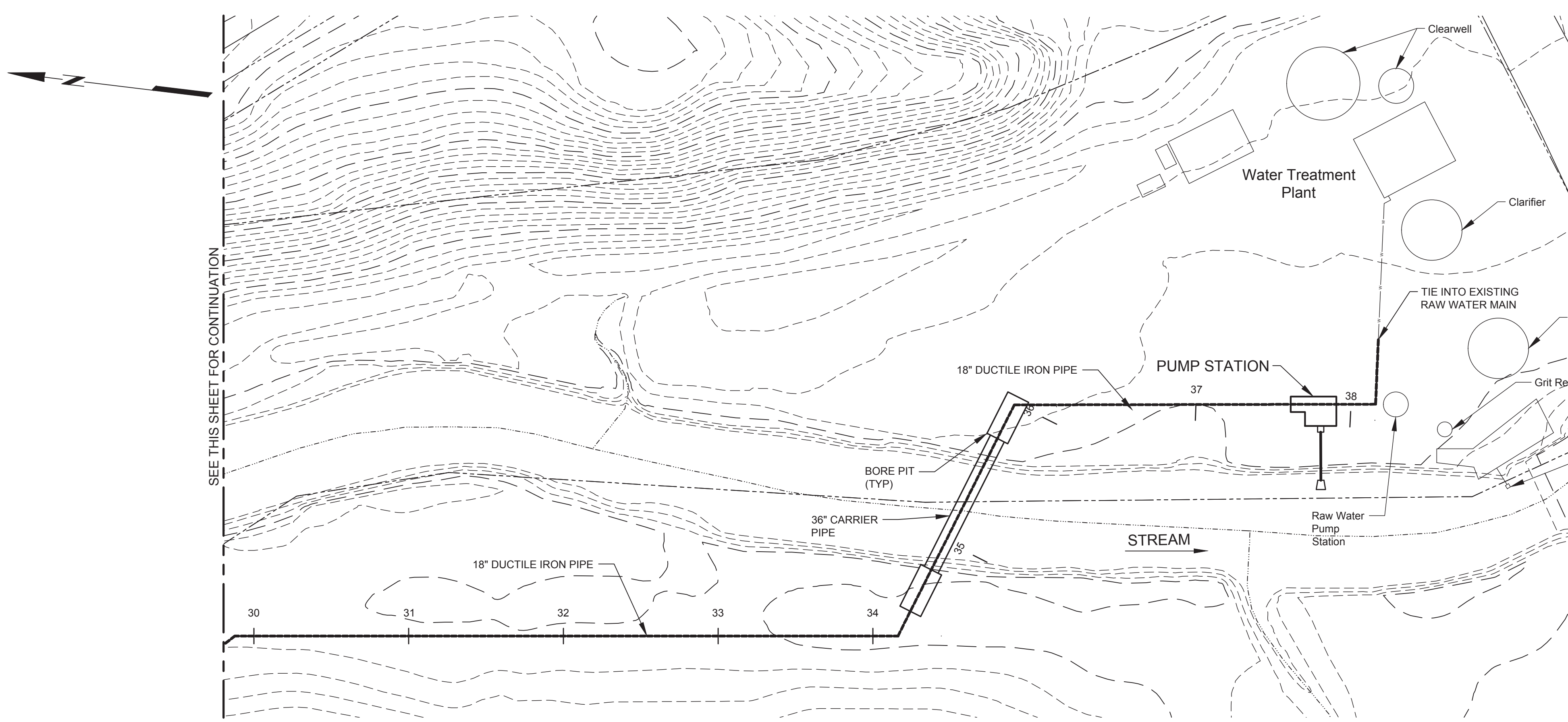
EXHIBIT 6



SITE A RESERVOIR PIPING PLAN

SCALE: 1"=50'



SITE A RESERVOIR PIPING PLAN

SCALE: 1"=50'

MARYLAND AMERICAN WATER

MARYLAND AMERICAN WATER
HARFORD COUNTY, MARYLAND

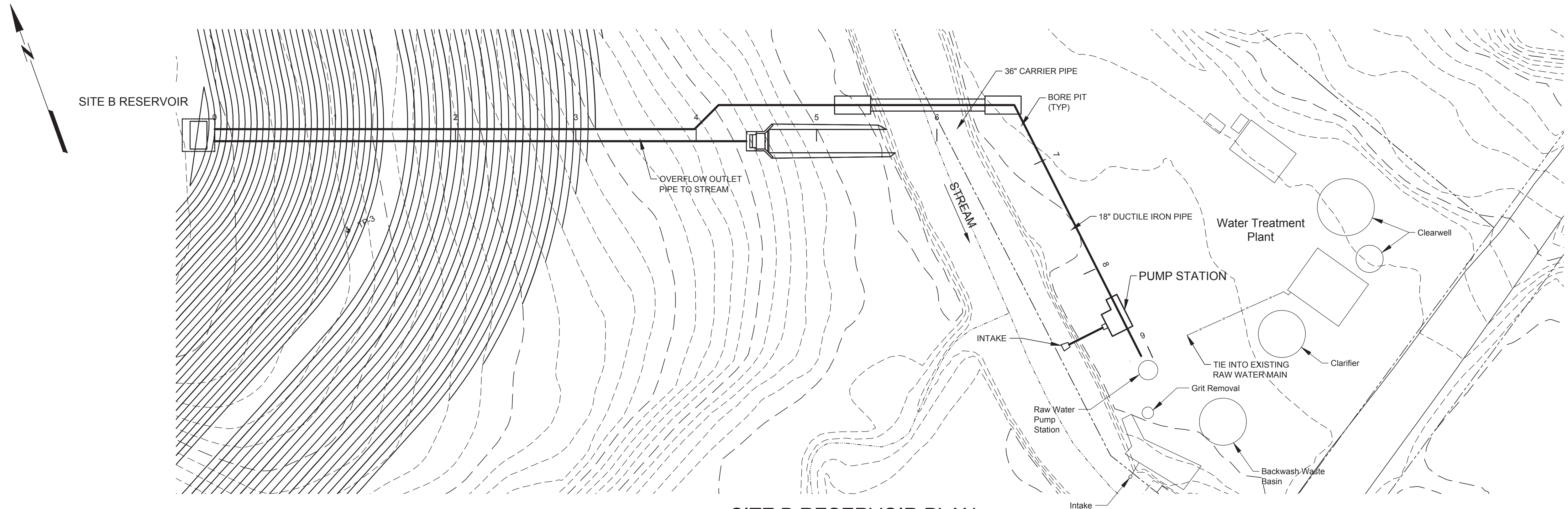
BEL AIR RESERVOIR FEASIBILITY STUDY

SITE A RESERVOIR
PIPING PLANS
SHEET 2

Gannett Fleming

DATE:	SCALE:
SEPT 2014	AS SHOWN

EXHIBIT 7



SITE B RESERVOIR PLAN

SCALE: 1"=100'

MARYLAND AMERICAN WATER	MARYLAND AMERICAN WATER HARFORD COUNTY, MARYLAND
BEL AIR RESERVOIR FEASIBILITY STUDY	
SITE B RESERVOIR PIPING PLAN SHEET 3	
Gannett Fleming	DATE: SEPT 2014 / SCALE: AS SHOWN EXHIBIT 8

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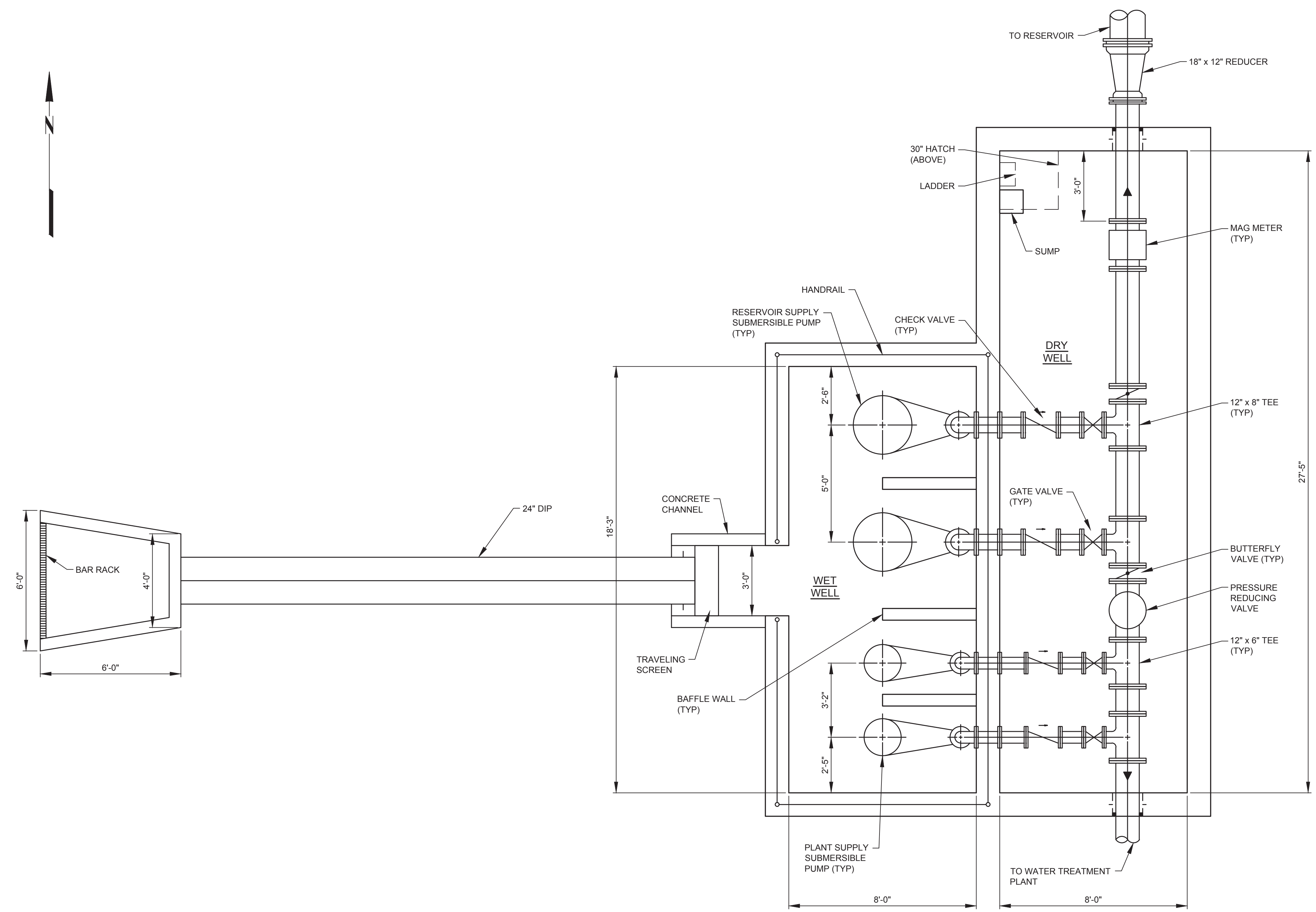

PLAN

SCALE: 3/8" = 1'-0"

MARYLAND AMERICAN WATER	MARYLAND AMERICAN WATER HARFORD COUNTY, MARYLAND
BEL AIR RESERVOIR FEASIBILITY STUDY	
PUMP STATION PLAN	
Gannett Fleming	DATE: SEPT 2014 / SCALE: AS SHOWN
	EXHIBIT 9

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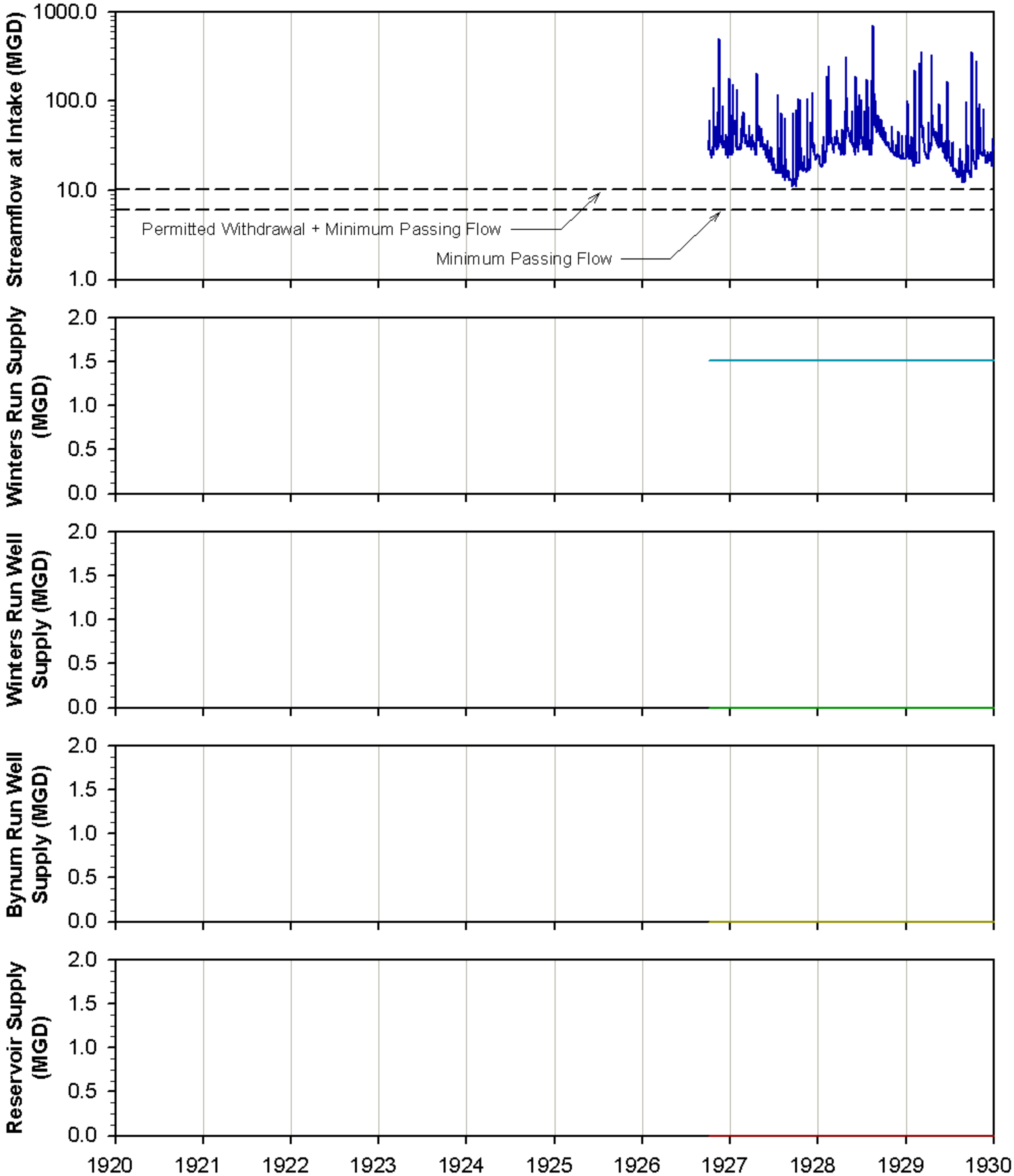
Appendix B
Reservoir Operations

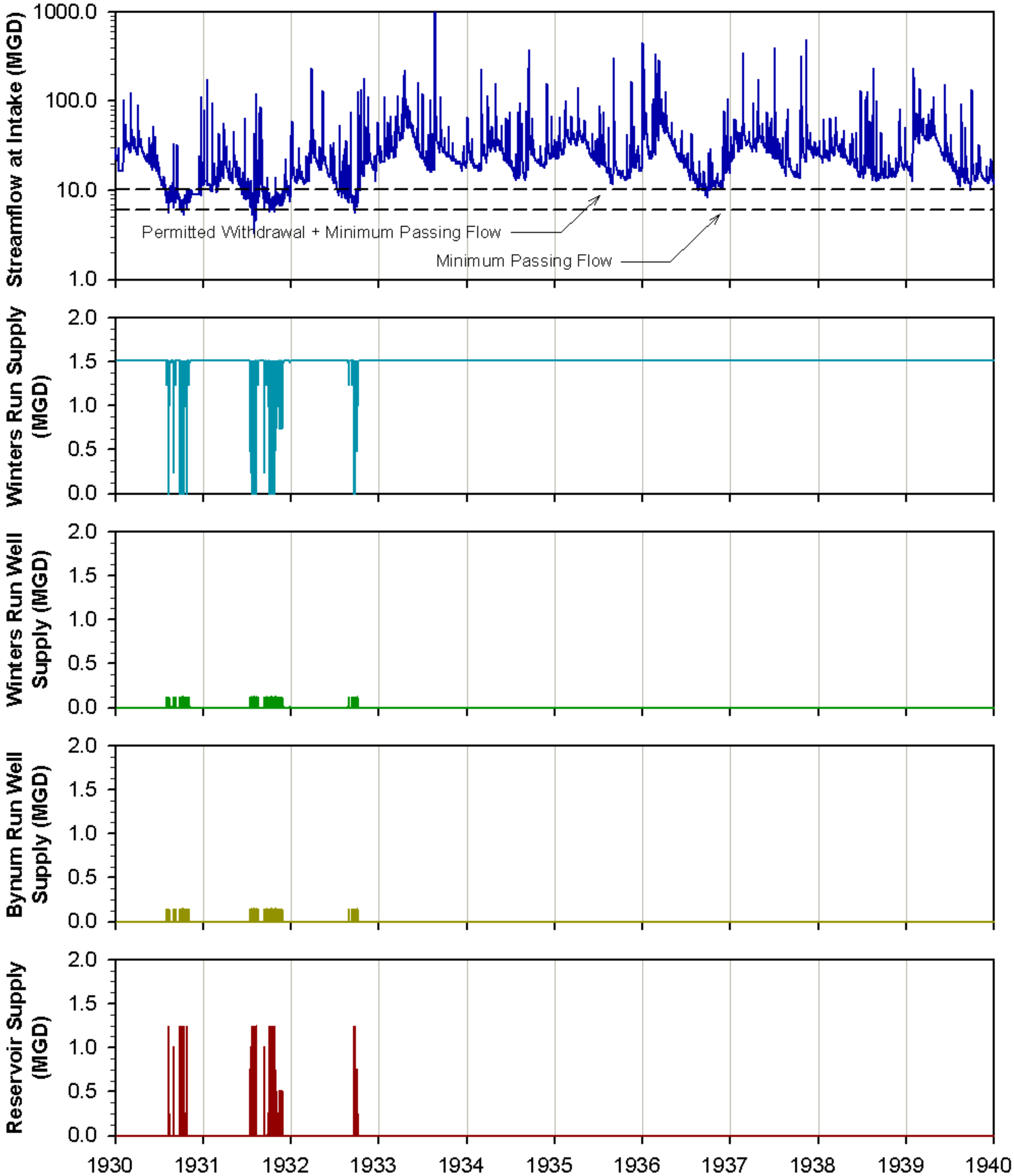
Summary of Delivered Supply **1920 – 1930**

Constant Demand:	1.50 MGD	**Minimum Passing Flow:**	6.07 MGD
Normal Pool Elevation:	259 feet	**Permitted Daily Withdrawal:**	4.20 MGD



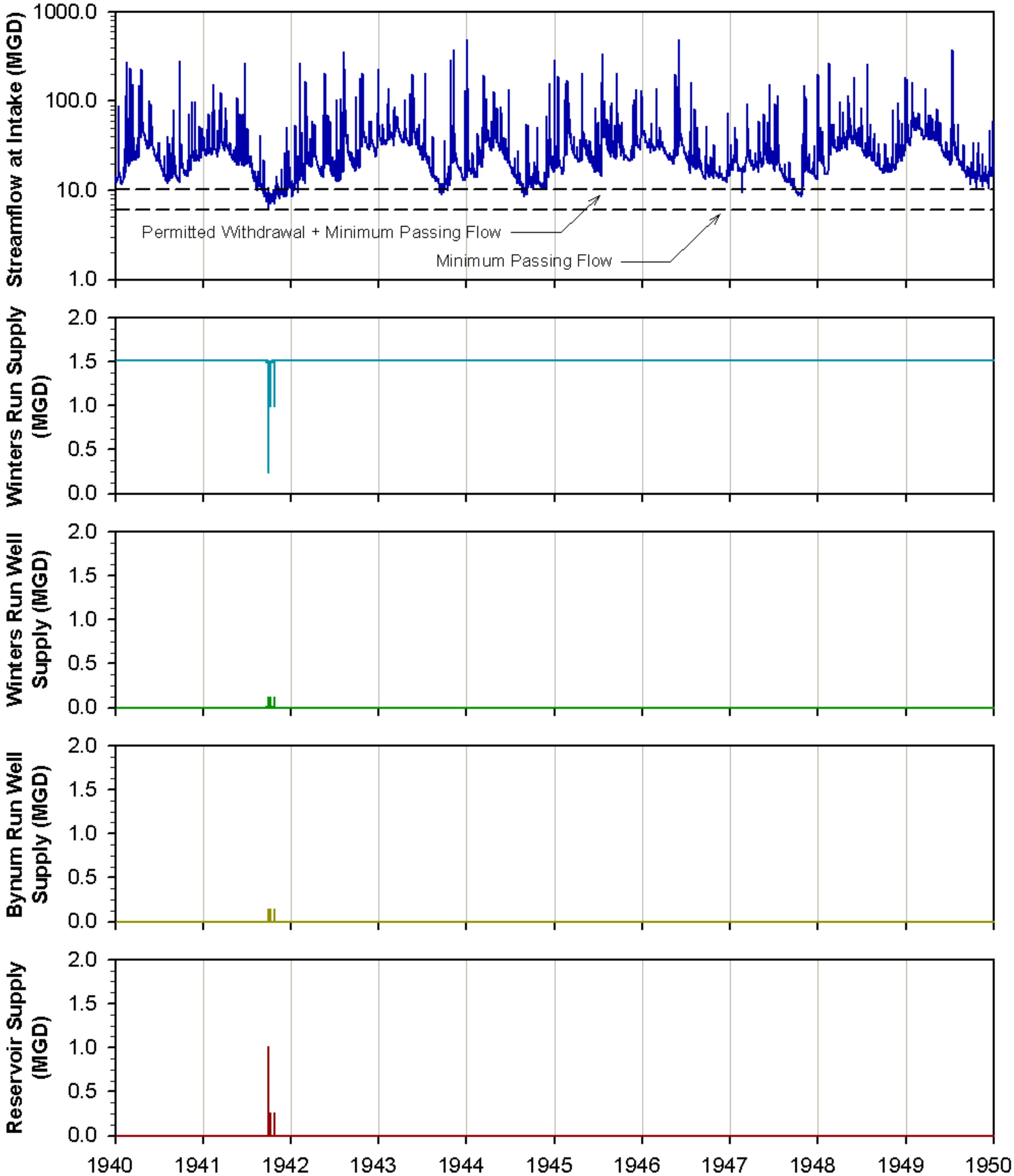
Summary of Delivered Supply **1930 – 1940**

Constant Demand: 1.50 MGD
Normal Pool Elevation: 259 feet
Minimum Passing Flow: 6.07 MGD
Permitted Daily Withdrawal: 4.20 MGD



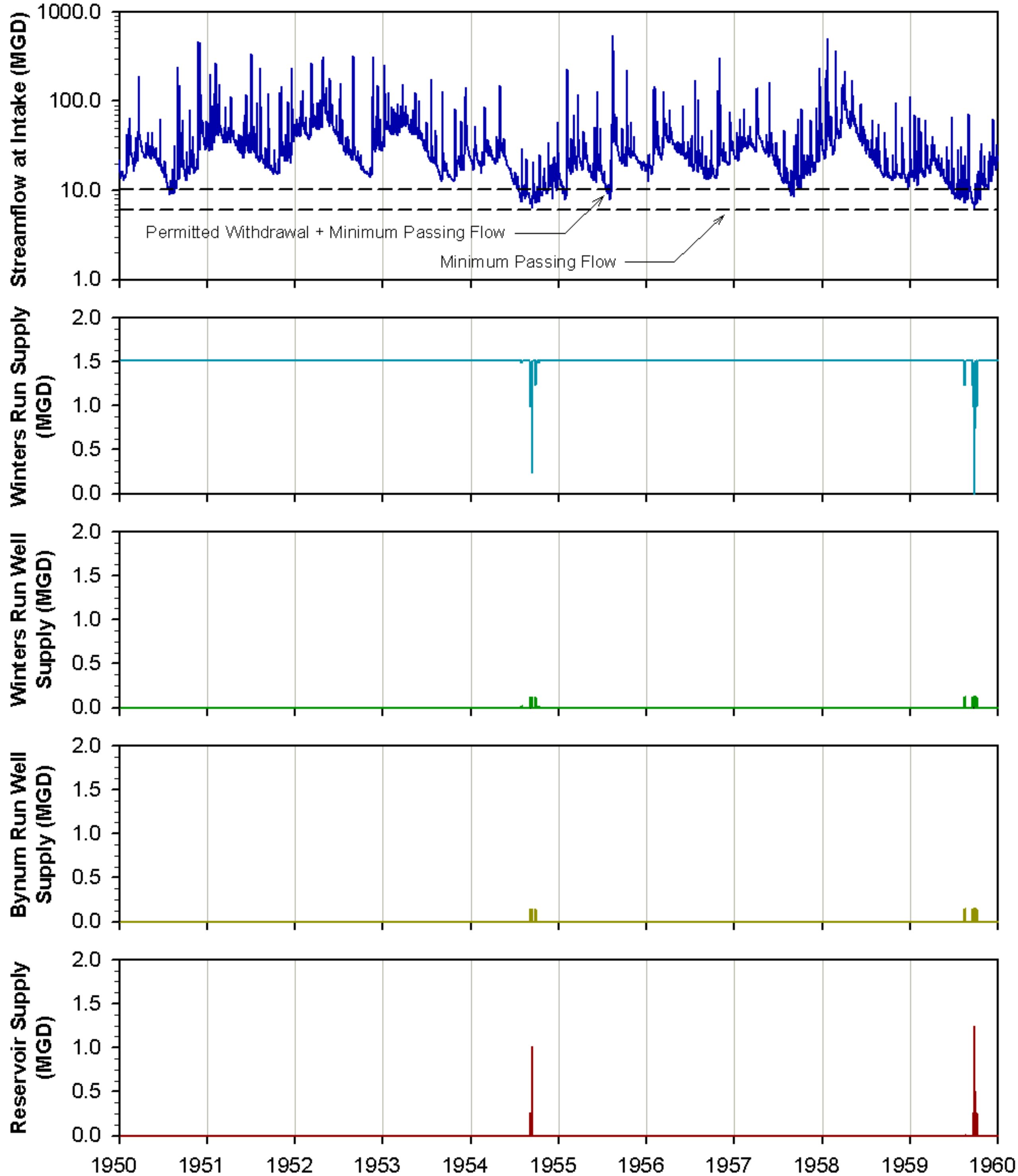
Summary of Delivered Supply 1940 – 1950

Constant Demand: 1.50 MGD
Normal Pool Elevation: 259 feet
Minimum Passing Flow: 6.07 MGD
Permitted Daily Withdrawal: 4.20 MGD



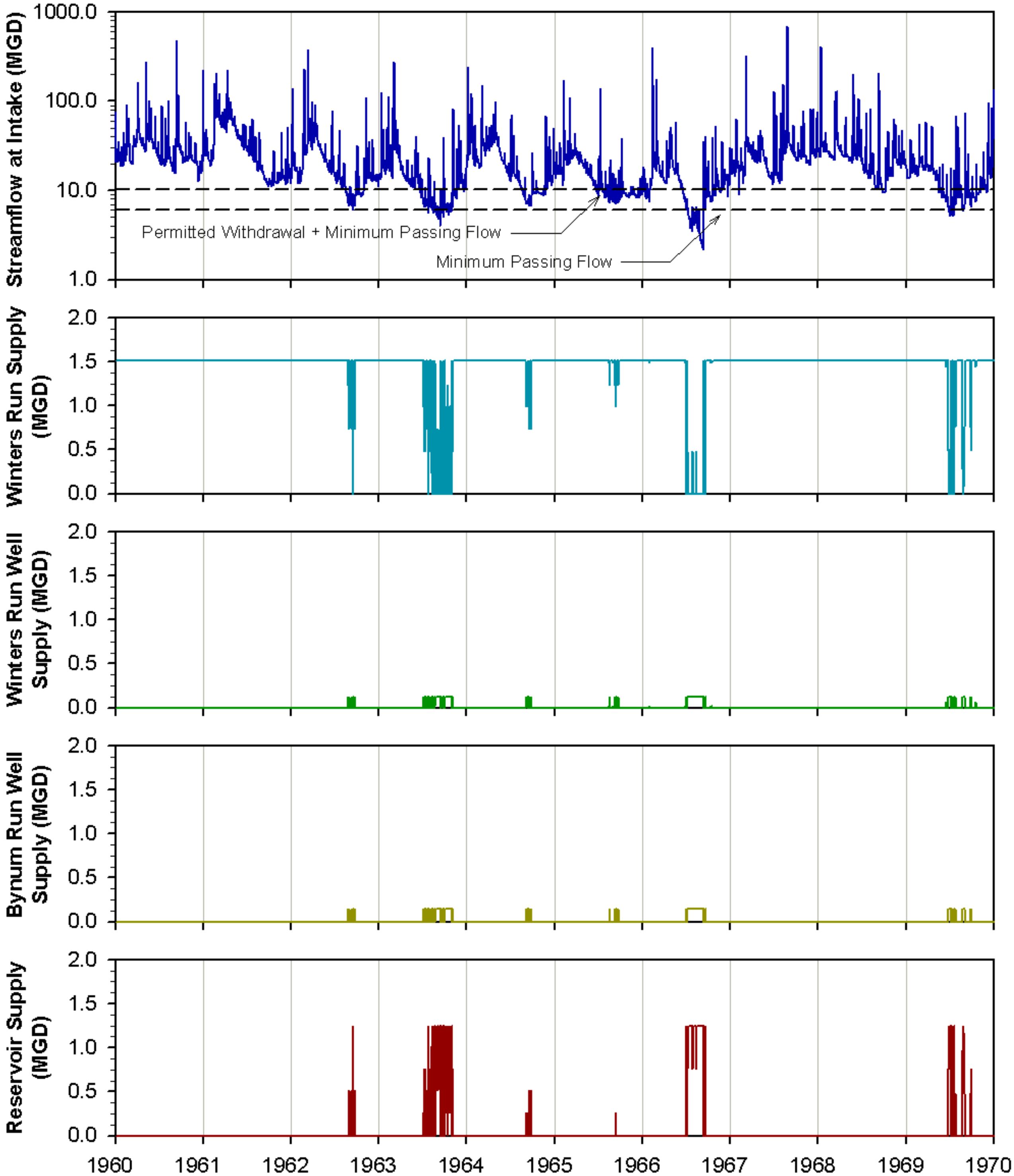
Summary of Delivered Supply **1950 – 1960**

Constant Demand: 1.50 MGD **Minimum Passing Flow:** 6.07 MGD
Normal Pool Elevation: 259 feet **Permitted Daily Withdrawal:** 4.20 MGD



Summary of Delivered Supply 1960 – 1970

Constant Demand:	1.50 MGD	**Minimum Passing Flow:**	6.07 MGD
Normal Pool Elevation:	259 feet	**Permitted Daily Withdrawal:**	4.20 MGD



Summary of Delivered Supply — 1970 – 1980

Constant Demand:	1.50 MGD	**Minimum Passing Flow:**	6.07 MGD
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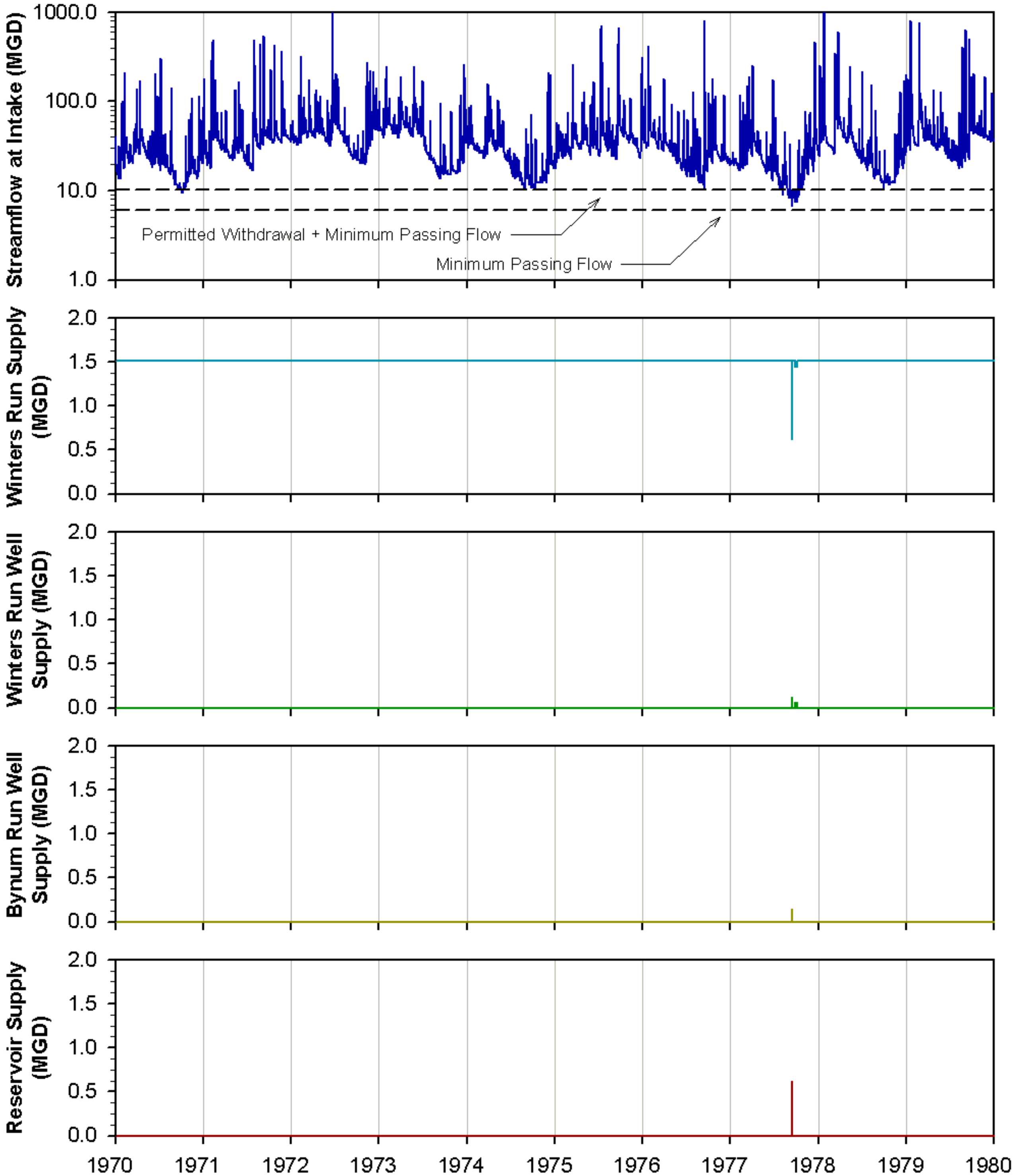
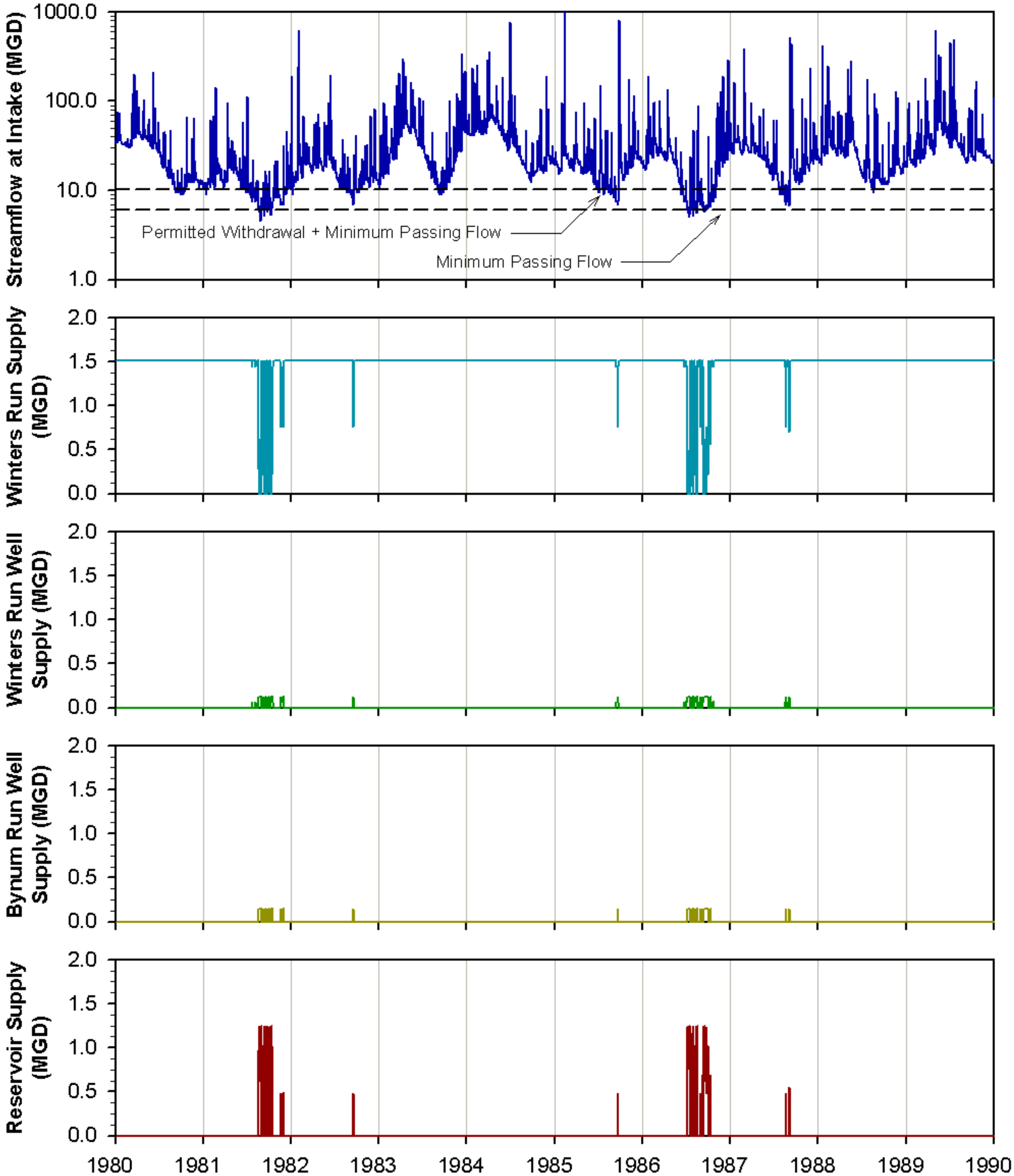


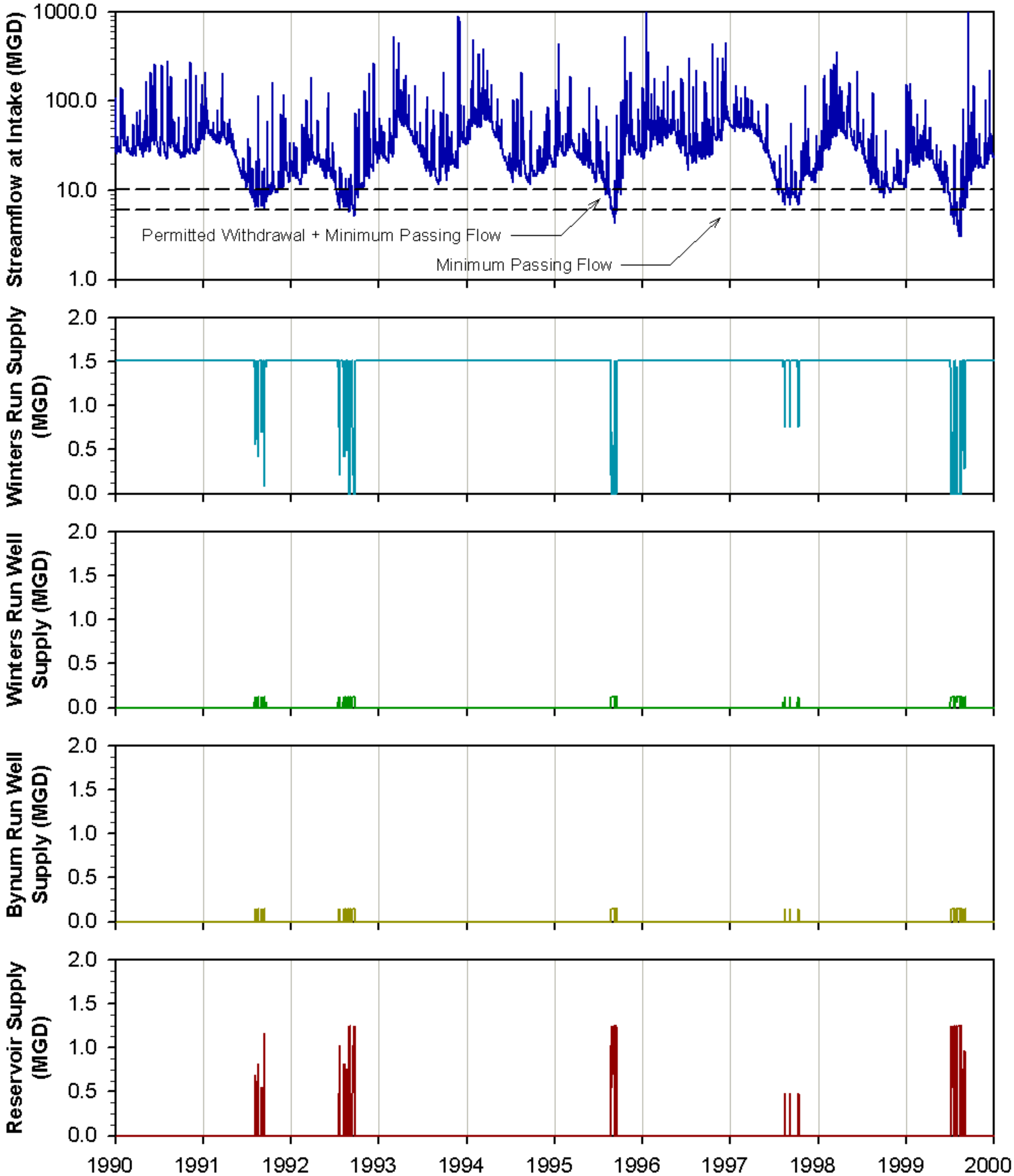
Summary of Delivered Supply **1980 – 1990**

Constant Demand:	1.50 MGD	**Minimum Passing Flow:**	6.07 MGD
Normal Pool Elevation:	259 feet	**Permitted Daily Withdrawal:**	4.20 MGD



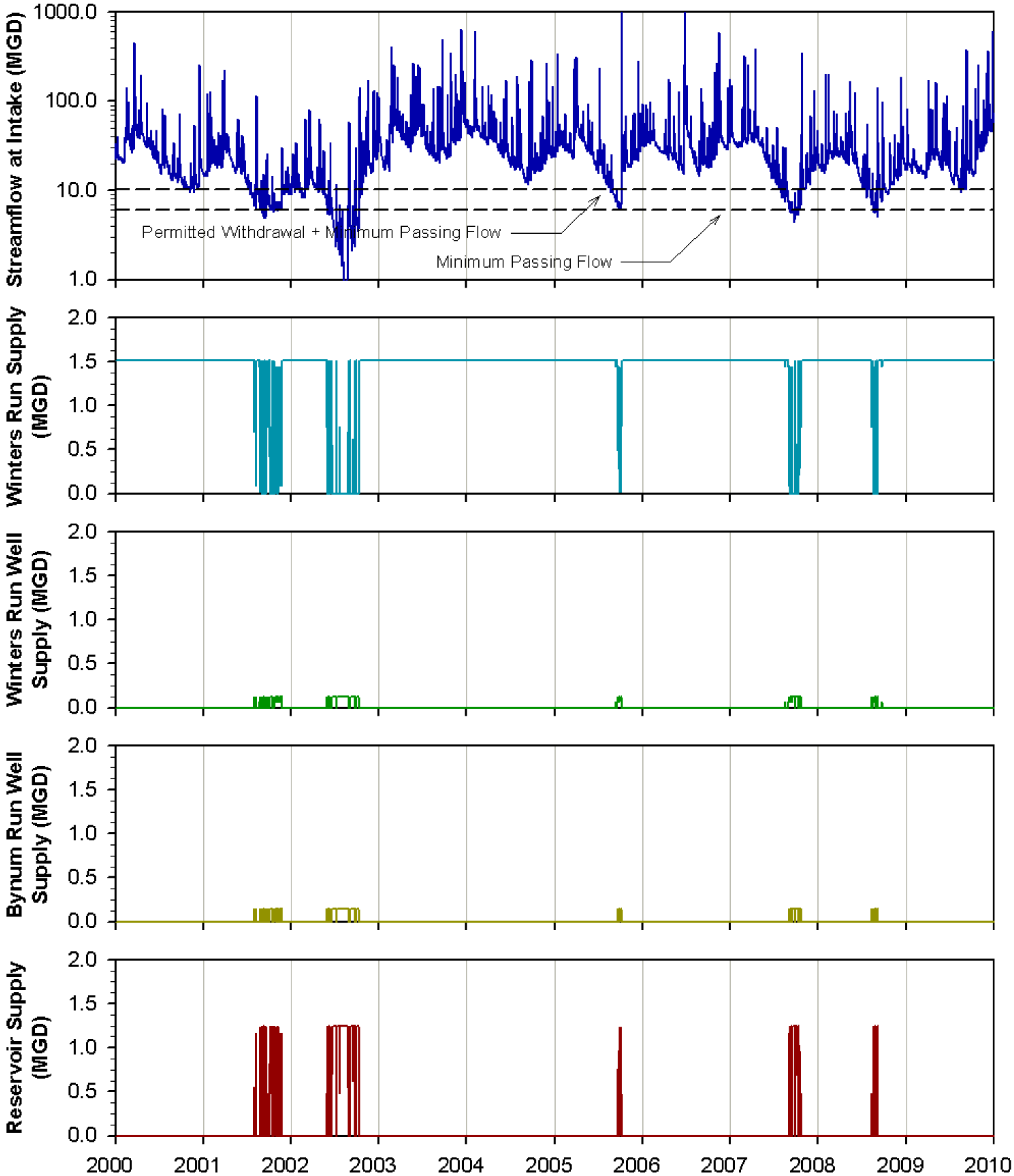
Summary of Delivered Supply 1990 – 2000

Constant Demand: 1.50 MGD
Normal Pool Elevation: 259 feet
Minimum Passing Flow: 6.07 MGD
Permitted Daily Withdrawal: 4.20 MGD



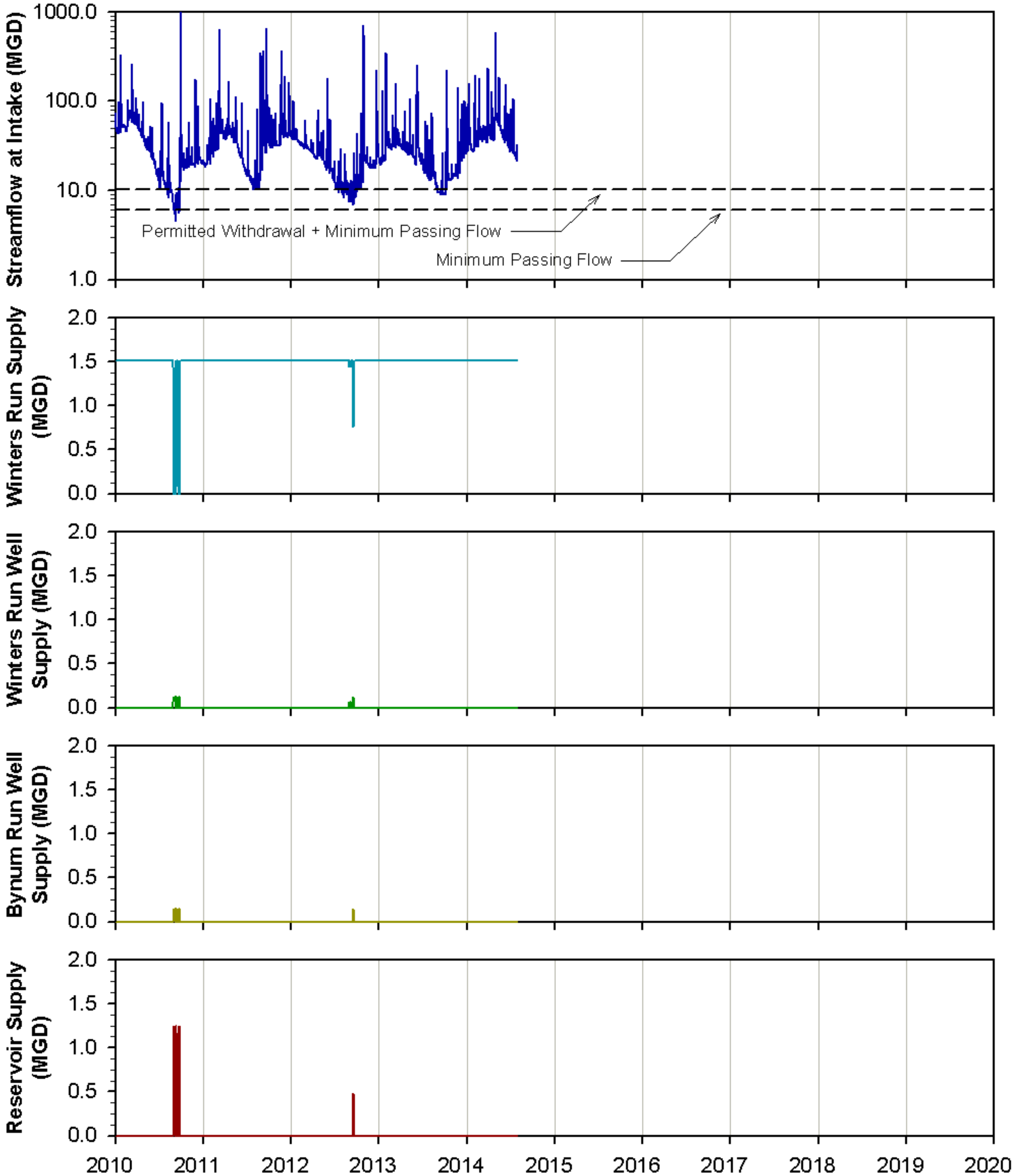
Summary of Delivered Supply 2000 – 2010

Constant Demand: 1.50 MGD
Normal Pool Elevation: 259 feet
Minimum Passing Flow: 6.07 MGD
Permitted Daily Withdrawal: 4.20 MGD



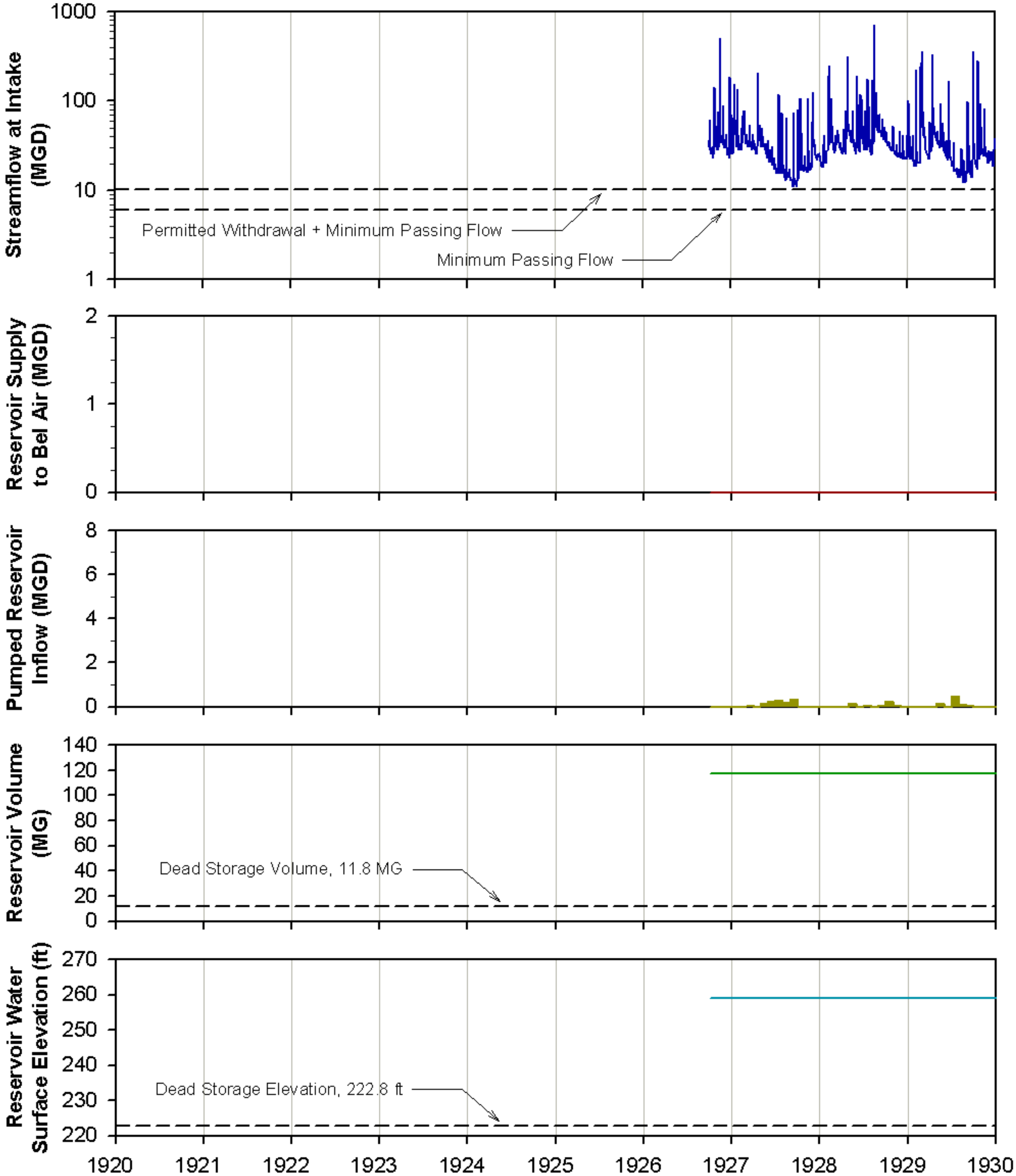
Summary of Delivered Supply 2010 – 2020

Constant Demand: 1.50 MGD
Normal Pool Elevation: 259 feet
Minimum Passing Flow: 6.07 MGD
Permitted Daily Withdrawal: 4.20 MGD



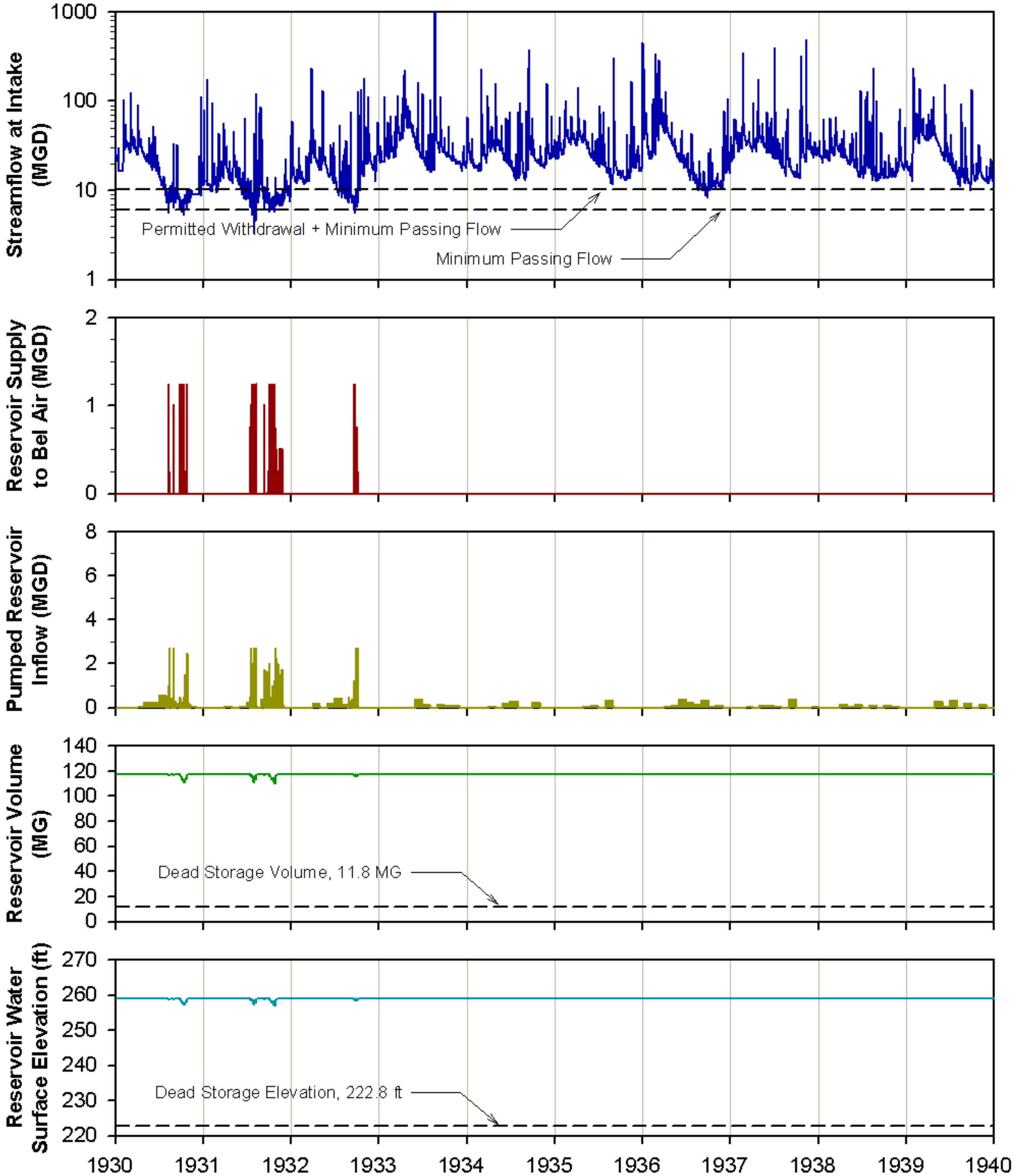
Summary of Reservoir B Operations 1920 – 1930

Constant Demand: 1.50 MGD
Normal Pool Elevation: 259 feet
Minimum Passing Flow: 6.07 MGD
Permitted Daily Withdrawal: 4.20 MGD



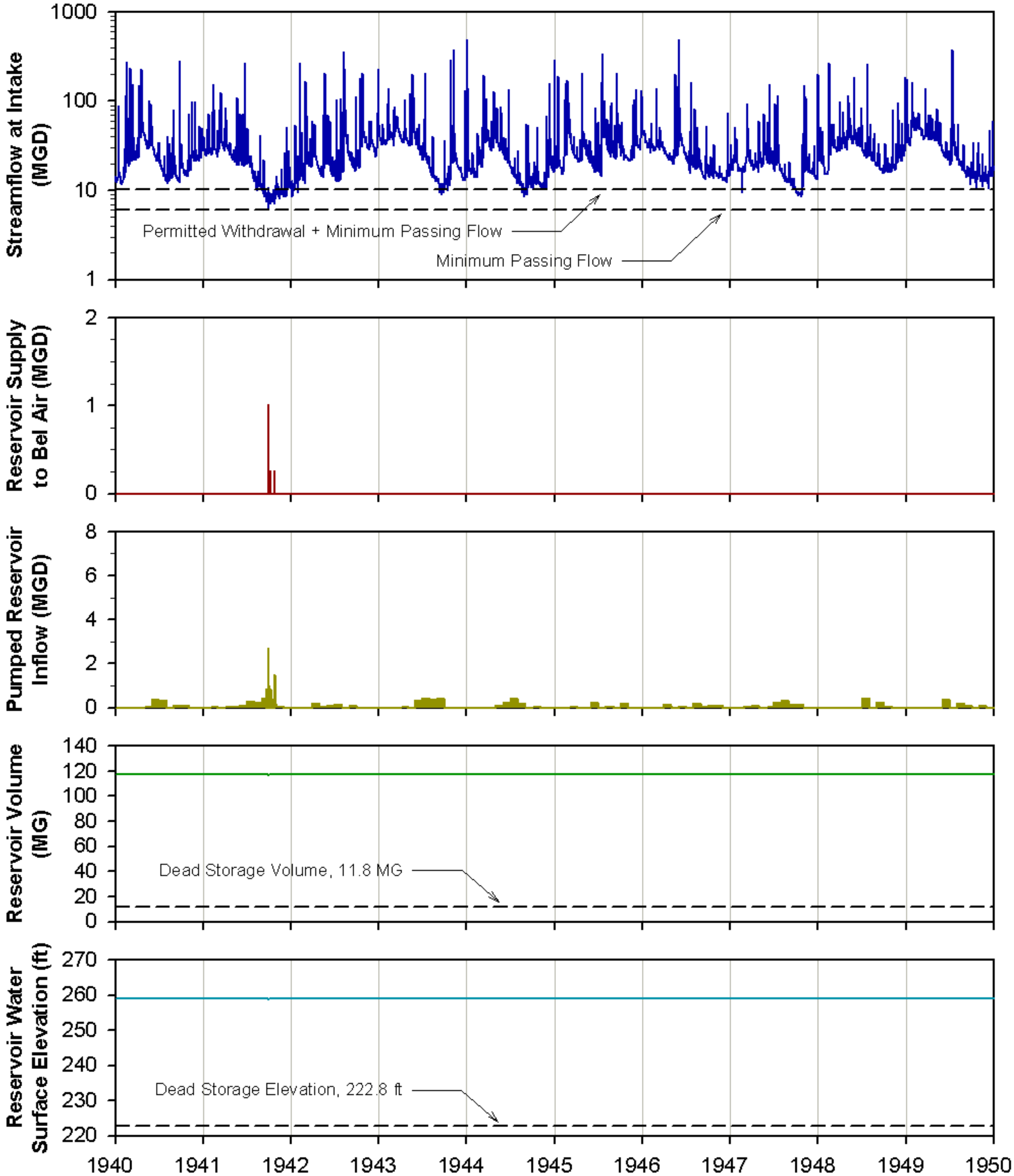
Summary of Reservoir B Operations 1930 – 1940

Constant Demand: 1.50 MGD
Normal Pool Elevation: 259 feet
Minimum Passing Flow: 6.07 MGD
Permitted Daily Withdrawal: 4.20 MGD



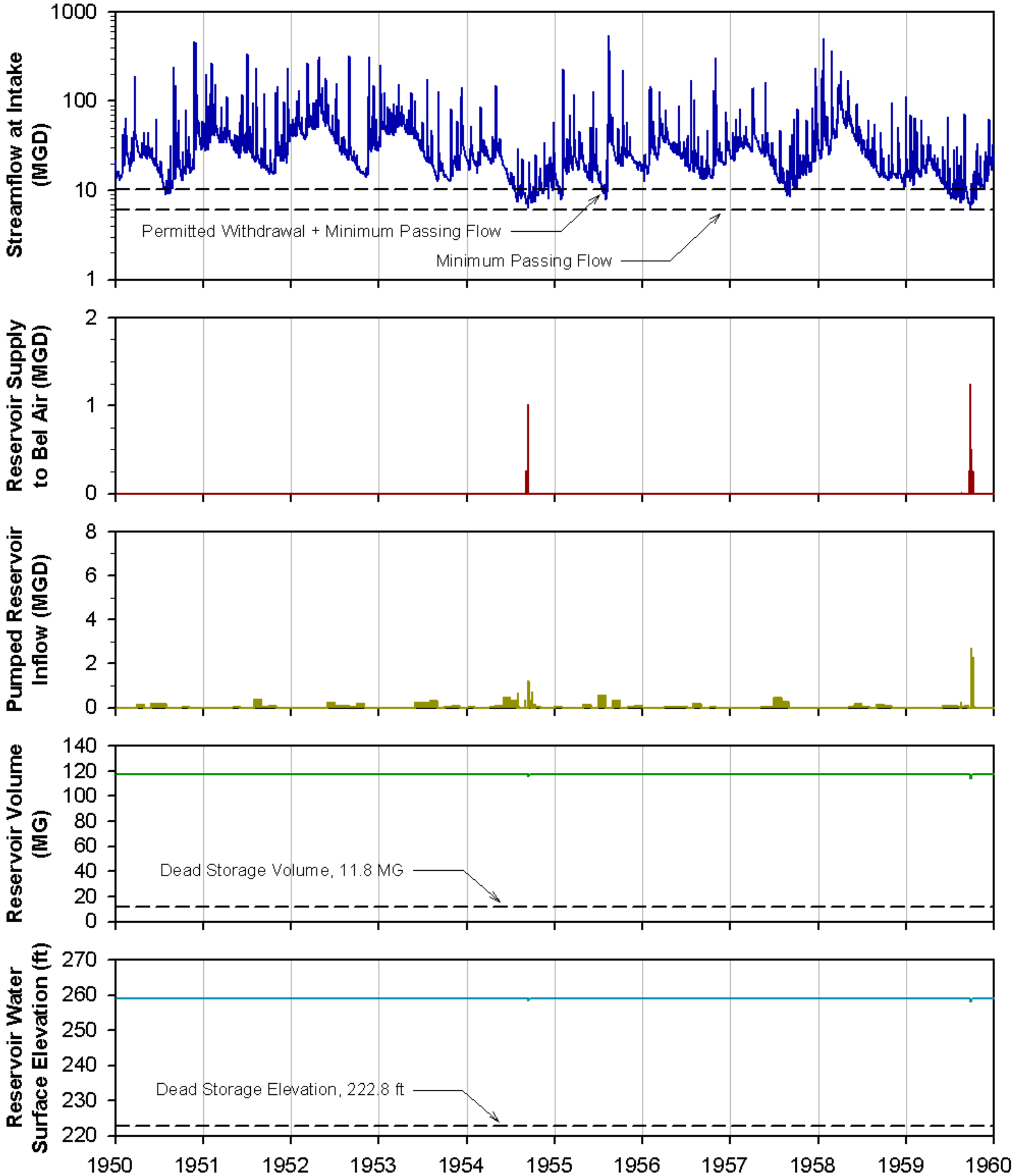
Summary of Reservoir B Operations 1940 – 1950

Constant Demand: 1.50 MGD
Normal Pool Elevation: 259 feet
Minimum Passing Flow: 6.07 MGD
Permitted Daily Withdrawal: 4.20 MGD



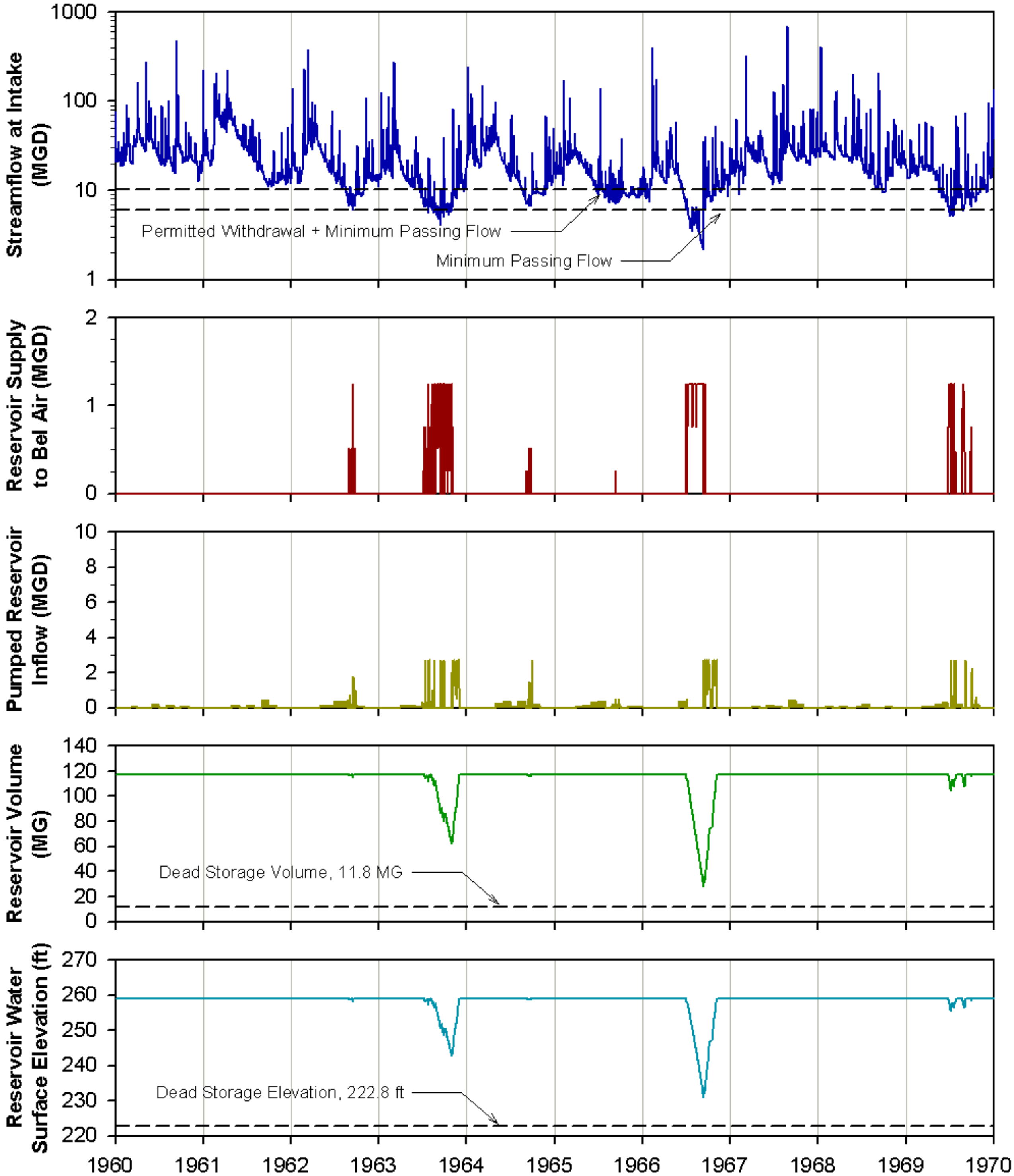
Summary of Reservoir B Operations 1950 – 1960

Constant Demand: 1.50 MGD **Minimum Passing Flow:** 6.07 MGD
Normal Pool Elevation: 259 feet **Permitted Daily Withdrawal:** 4.20 MGD



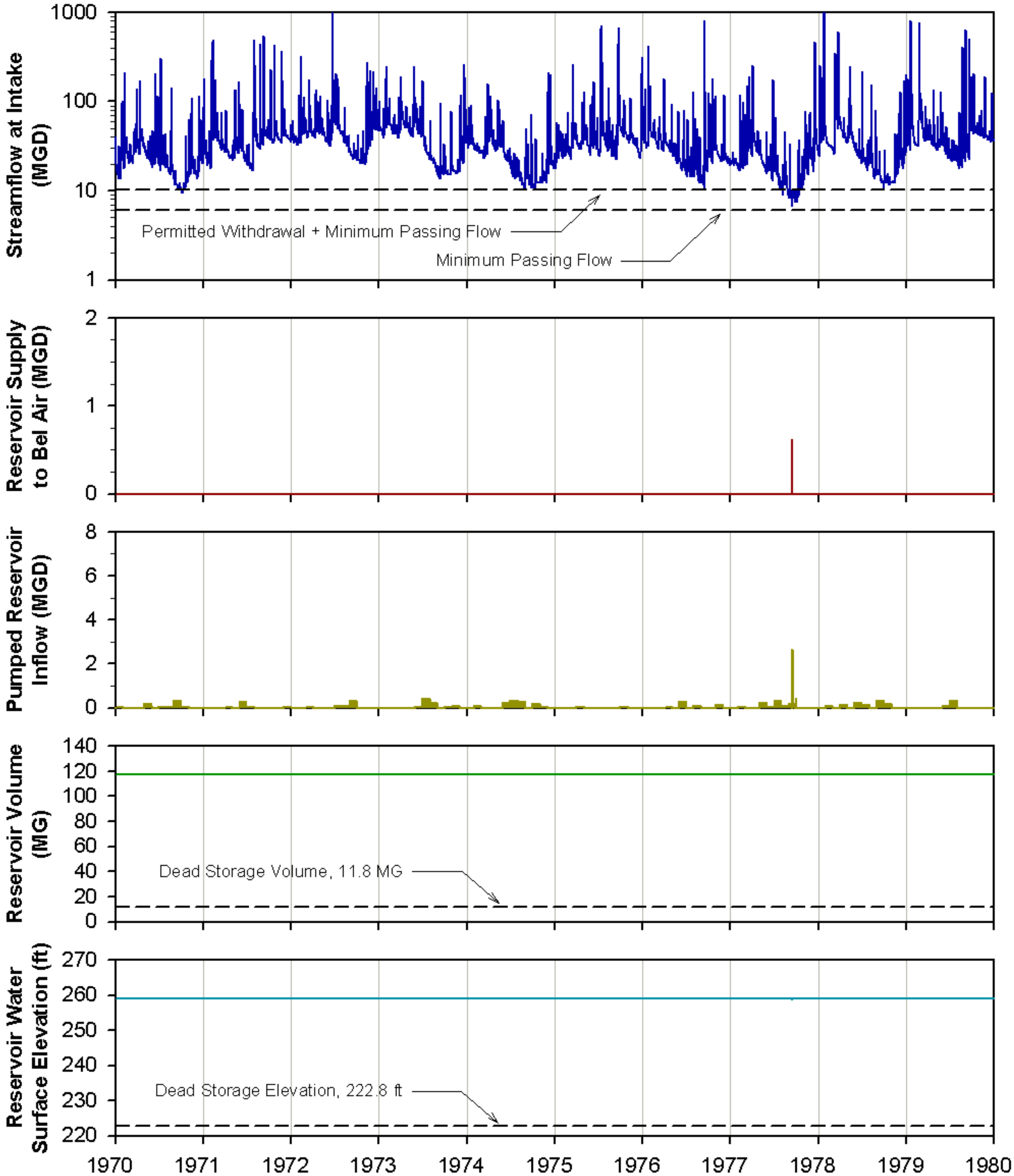
Summary of Reservoir B Operations **1960 – 1970**

Constant Demand:	1.50 MGD	**Minimum Passing Flow:**	6.07 MGD
Normal Pool Elevation:	259 feet	**Permitted Daily Withdrawal:**	4.20 MGD



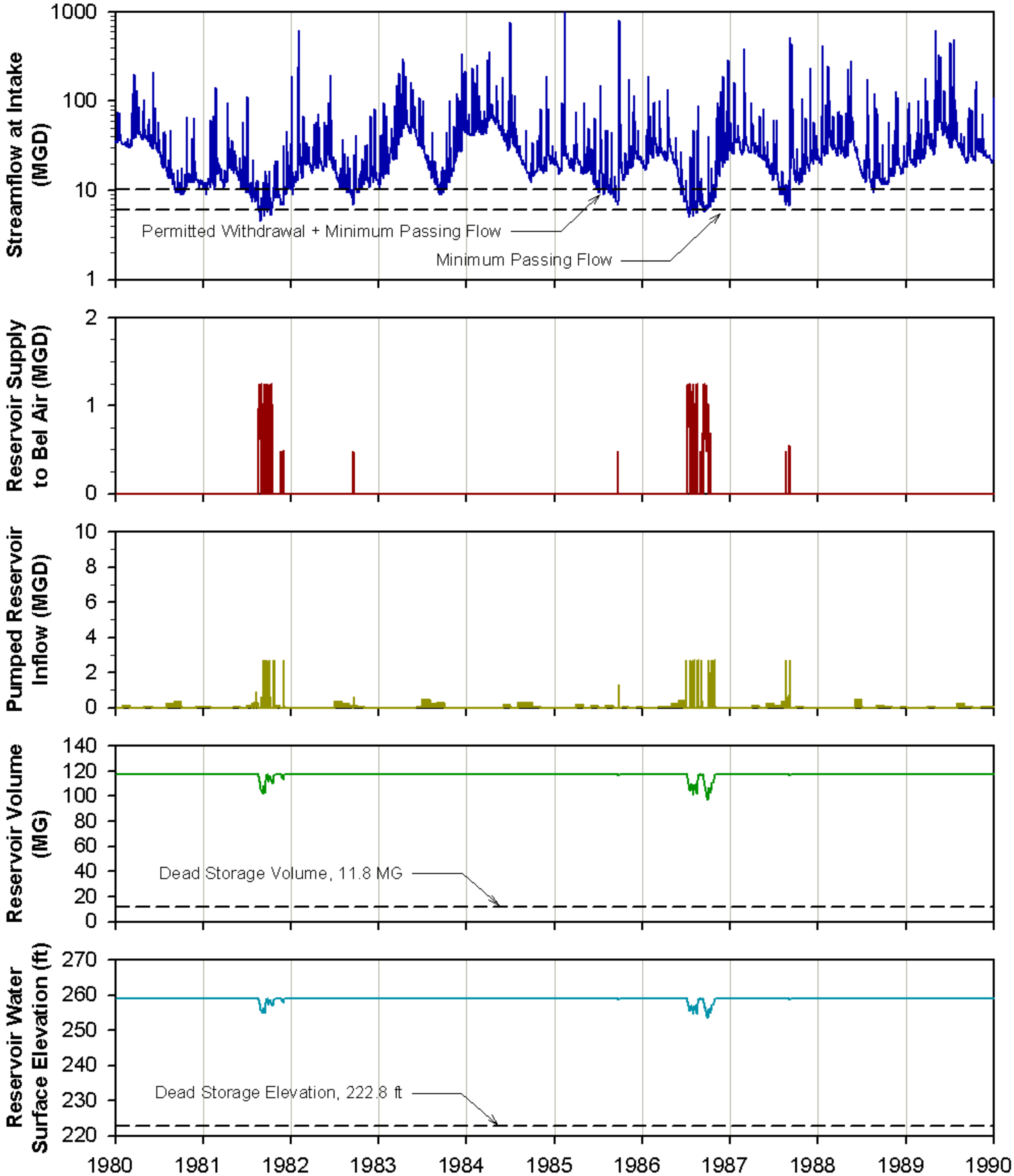
Summary of Reservoir B Operations 1970 – 1980

Constant Demand: 1.50 MGD
Normal Pool Elevation: 259 feet
Minimum Passing Flow: 6.07 MGD
Permitted Daily Withdrawal: 4.20 MGD



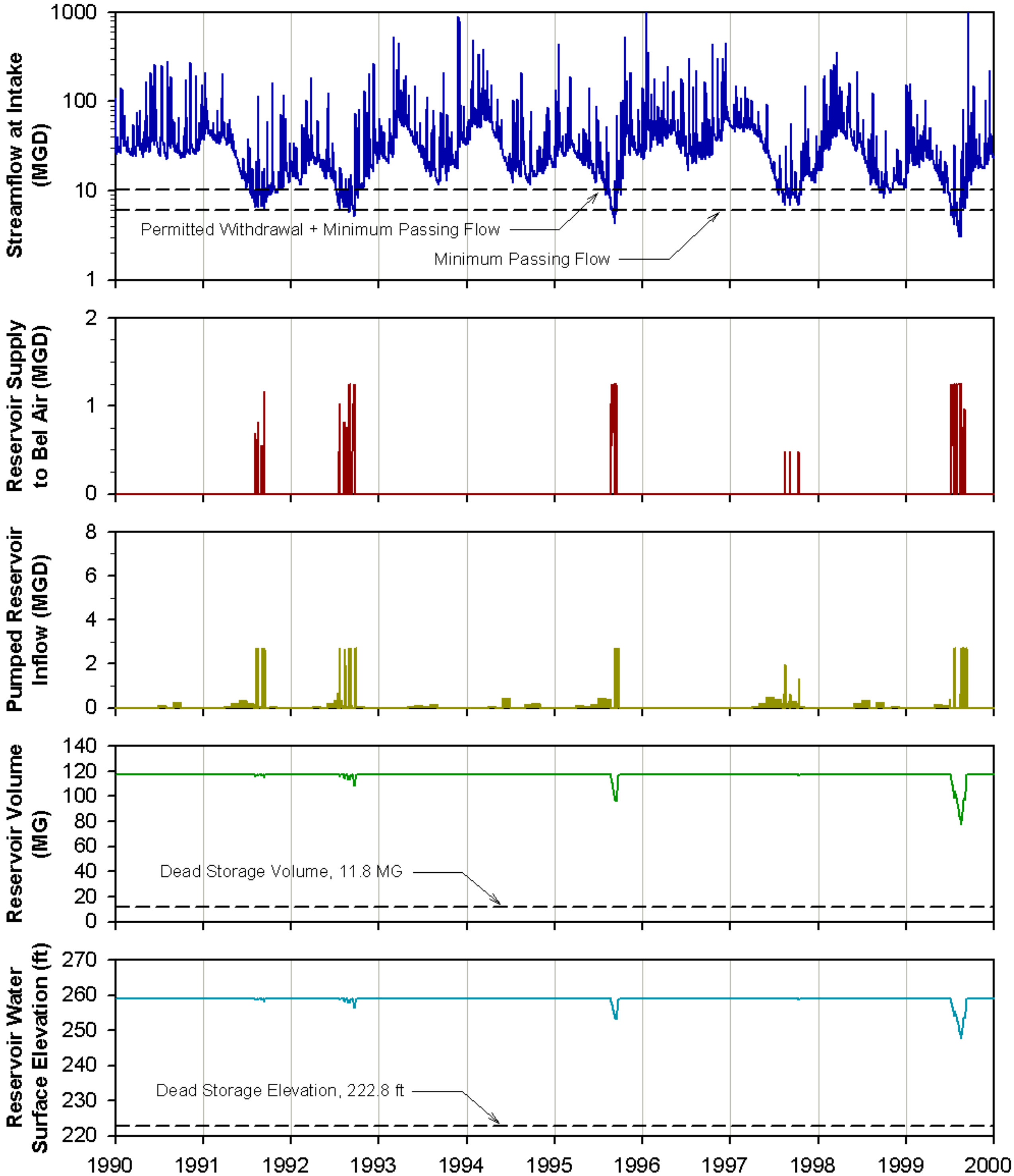
Summary of Reservoir B Operations 1980 – 1990

Constant Demand: 1.50 MGD
Normal Pool Elevation: 259 feet
Minimum Passing Flow: 6.07 MGD
Permitted Daily Withdrawal: 4.20 MGD



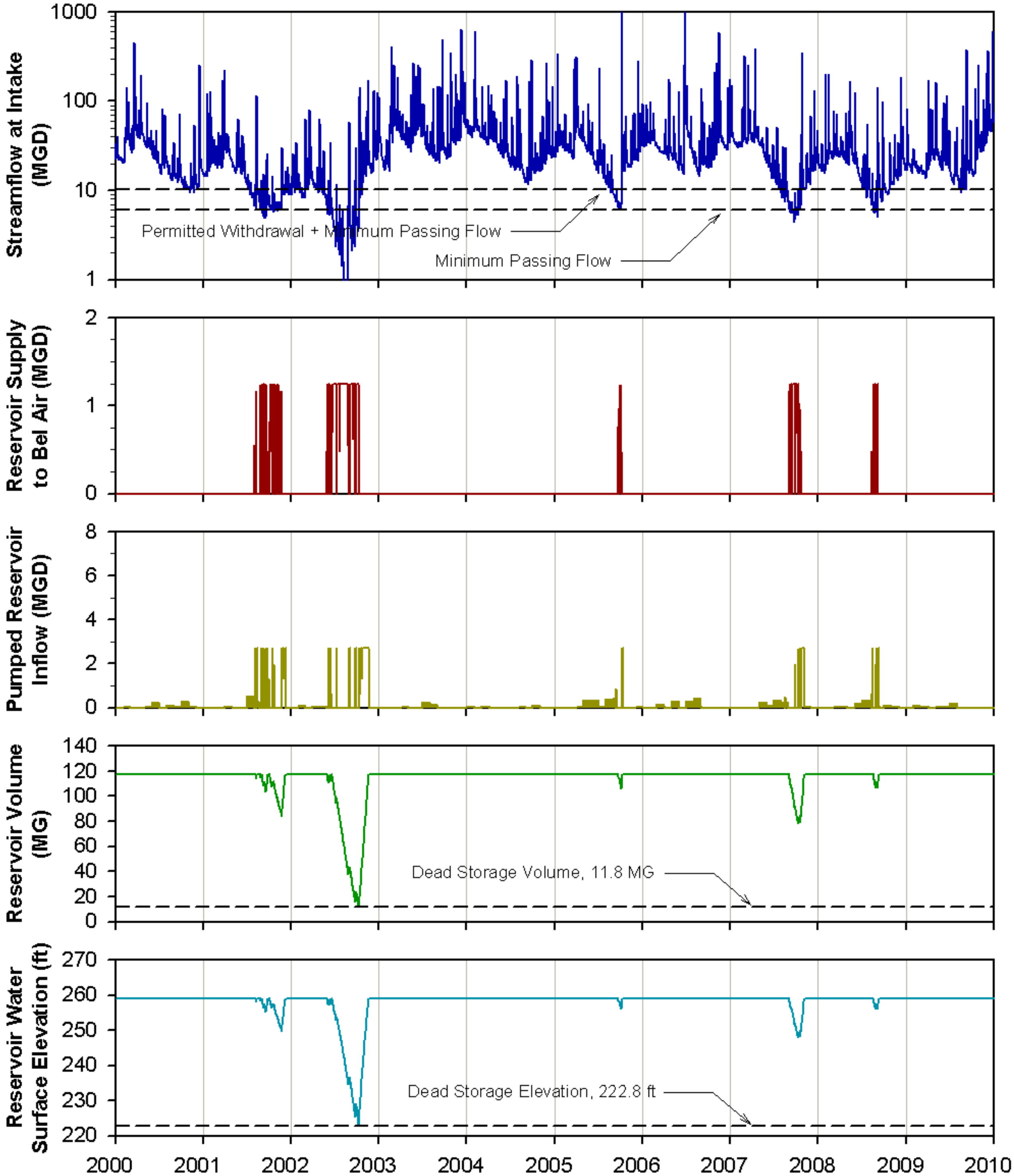
Summary of Reservoir B Operations 1990 – 2000

Constant Demand: 1.50 MGD
Normal Pool Elevation: 259 feet
Minimum Passing Flow: 6.07 MGD
Permitted Daily Withdrawal: 4.20 MGD



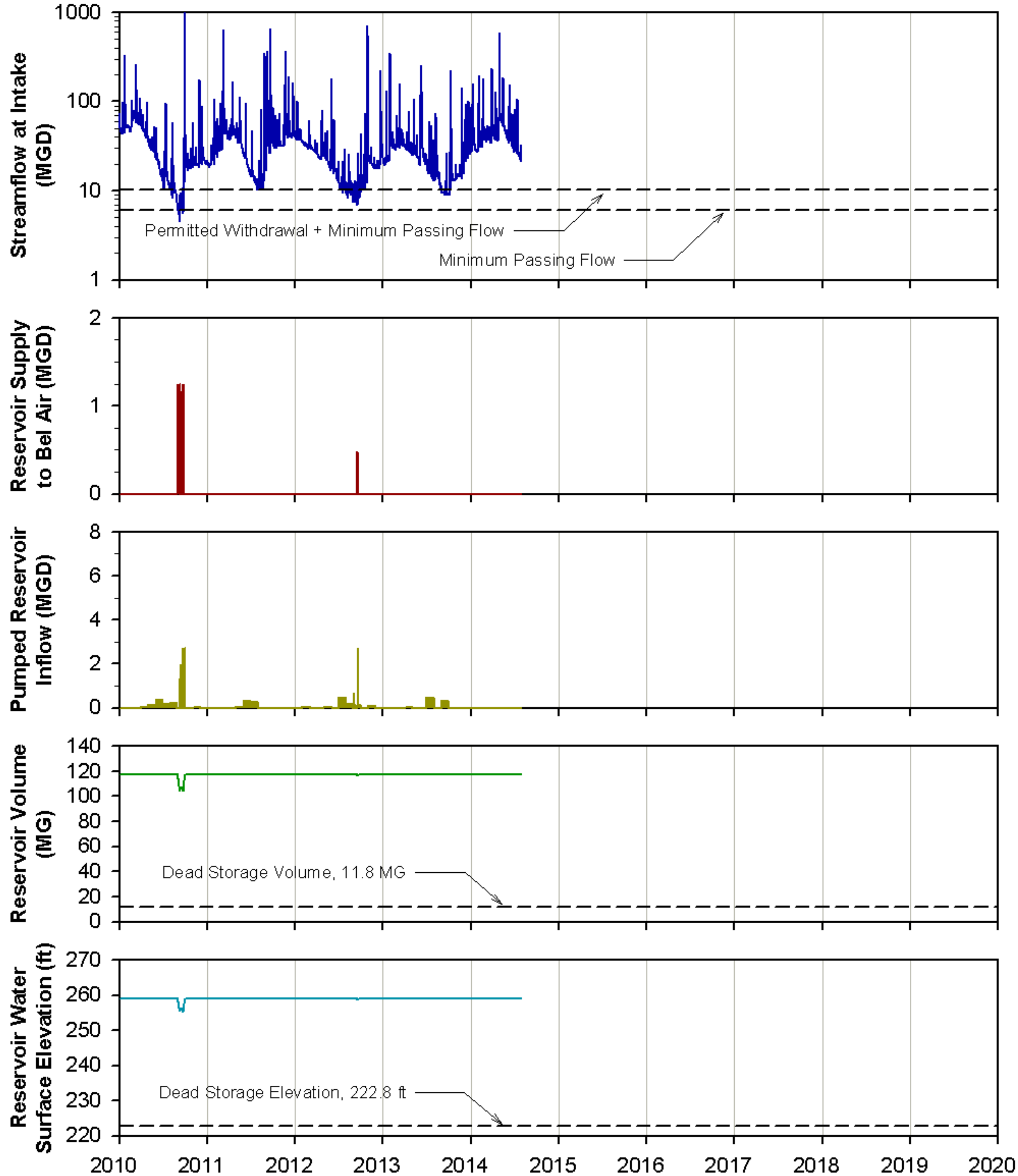
Summary of Reservoir B Operations 2000 – 2010

Constant Demand: 1.50 MGD
Normal Pool Elevation: 259 feet
Minimum Passing Flow: 6.07 MGD
Permitted Daily Withdrawal: 4.20 MGD



Summary of Reservoir B Operations — 2010 – 2020

Constant Demand: 1.50 MGD
Normal Pool Elevation: 259 feet
Minimum Passing Flow: 6.07 MGD
Permitted Daily Withdrawal: 4.20 MGD



Appendix C

NRCS Web Soil Survey

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Harford County Area, Maryland

Bel Air Sites A and B Part 1

August 22, 2014

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map

Map Scale: 1:8,040 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 100, 200, 400, 600

Feet: 0, 350, 700, 1400, 2100

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Harford County Area, Maryland
Survey Area Data: Version 6, Dec 30, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 26, 2011—Mar 2, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Harford County Area, Maryland (MD600)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Cu	Codorus silt loam	0.6	0.3%
DcA	Delanco silt loam, 0 to 3 percent slopes	3.8	2.2%
DcB	Delanco silt loam, 3 to 8 percent slopes	19.5	11.5%
EsA	Elsinboro loam, 0 to 2 percent slopes	2.1	1.2%
EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	6.7	3.9%
EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	15.0	8.8%
GcC2	Glenelg loam, 8 to 15 percent slopes, moderately eroded	1.0	0.6%
Hb	Hatboro silt loam	2.9	1.7%
KeB	Kelly silt loam, 3 to 8 percent slopes	1.5	0.9%
KrB	Kinkora silt loam, 3 to 8 percent slopes	1.2	0.7%
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	13.5	7.9%
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	13.7	8.0%
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	6.0	3.5%
LeE	Legore silt loam, 25 to 45 percent slopes	0.8	0.4%
LfE	Legore very stony silt loam, 25 to 45 percent slopes	1.9	1.1%
LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	23.0	13.5%
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	19.8	11.6%
MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	0.2	0.1%
MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	11.1	6.5%
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	10.7	6.3%

Harford County Area, Maryland (MD600)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	15.6	9.1%
Totals for Area of Interest		**170.3**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Harford County Area, Maryland

Cu—Codorus silt loam

Map Unit Setting

National map unit symbol: kx0j
Elevation: 200 to 600 feet
Mean annual precipitation: 36 to 46 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 140 to 200 days
Farmland classification: Prime farmland if protected from flooding or not frequently flooded during the growing season

Map Unit Composition

Codorus and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Codorus

Setting

Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium derived from phyllite, schist, diabase and/or greenstone

Typical profile

Ap - 0 to 11 inches: silt loam
Bw1 - 11 to 18 inches: silt loam
Bw2 - 18 to 40 inches: gravelly silt loam
2C - 40 to 60 inches: stratified sand to very gravelly loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water storage in profile: High (about 9.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C

Minor Components

Hatboro

Percent of map unit: 15 percent
Landform: Flood plains
Down-slope shape: Concave

Across-slope shape: Linear

DcA—Delanco silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: kx0m
Elevation: 0 to 1,050 feet
Mean annual precipitation: 35 to 50 inches
Mean annual air temperature: 48 to 61 degrees F
Frost-free period: 110 to 220 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Delanco and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Delanco

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear, concave
Across-slope shape: Convex, linear
Parent material: Loamy alluvium derived from igneous and metamorphic rock

Typical profile

Ap - 0 to 13 inches: silt loam
BE - 13 to 26 inches: silt loam
Bt1 - 26 to 33 inches: silty clay loam
Bt2 - 33 to 43 inches: silt loam
2BC - 43 to 72 inches: stratified loamy sand to sandy clay loam
2C - 72 to 79 inches: gravelly loamy sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.13 to 0.71 in/hr)
Depth to water table: About 20 to 40 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C

Minor Components

Elsinboro

Percent of map unit: 15 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex, concave
Across-slope shape: Convex, linear

DcB—Delanco silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: kx0n
Elevation: 0 to 1,050 feet
Mean annual precipitation: 35 to 50 inches
Mean annual air temperature: 48 to 61 degrees F
Frost-free period: 110 to 220 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Delanco and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Delanco

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread, riser
Down-slope shape: Linear, concave
Across-slope shape: Convex, linear
Parent material: Loamy alluvium derived from igneous and metamorphic rock

Typical profile

Ap - 0 to 13 inches: silt loam
BE - 13 to 26 inches: silt loam
Bt1 - 26 to 33 inches: silty clay loam
Bt2 - 33 to 43 inches: silt loam
2BC - 43 to 72 inches: stratified loamy sand to sandy clay loam
2C - 72 to 79 inches: gravelly loamy sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.13 to 0.71 in/hr)
Depth to water table: About 20 to 40 inches
Frequency of flooding: None

Frequency of ponding: None
Available water storage in profile: High (about 10.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C

Minor Components

Elsinboro

Percent of map unit: 15 percent
Landform: Terraces
Landform position (three-dimensional): Tread, riser
Down-slope shape: Convex, concave
Across-slope shape: Convex, linear

EsA—Elsinboro loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: kx0s
Elevation: 0 to 1,050 feet
Mean annual precipitation: 35 to 55 inches
Mean annual air temperature: 48 to 61 degrees F
Frost-free period: 110 to 235 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Elsinboro and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Elsinboro

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex, concave
Across-slope shape: Linear
Parent material: Loamy alluvium derived from phyllite and/or loamy alluvium derived from mica schist and/or loamy alluvium derived from quartzite

Typical profile

Ap - 0 to 9 inches: silt loam
Bt, BC - 9 to 37 inches: silt loam
C1-2 - 37 to 60 inches: silt loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained

Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 60 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 1
Hydrologic Soil Group: B

Minor Components

Delanco, piedmont

Percent of map unit: 10 percent
Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear, concave
Across-slope shape: Convex, linear

Glenelg

Percent of map unit: 5 percent
Landform: Interfluves, hillslopes
Landform position (two-dimensional): Summit, backslope, shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear

EsB2—Elsinboro loam, 2 to 5 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: kx0t
Elevation: 0 to 1,050 feet
Mean annual precipitation: 35 to 55 inches
Mean annual air temperature: 48 to 61 degrees F
Frost-free period: 110 to 235 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Elsinboro and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Elsinboro

Setting

Landform: Terraces
Landform position (three-dimensional): Tread, riser
Down-slope shape: Convex, concave

Across-slope shape: Convex, linear
Parent material: Loamy alluvium derived from phyllite and/or loamy alluvium derived from mica schist and/or loamy alluvium derived from quartzite

Typical profile
Ap - 0 to 9 inches: silt loam
Bt, BC - 9 to 37 inches: silt loam
C1-2 - 37 to 60 inches: silt loam

Properties and qualities
Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 60 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.4 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B

Minor Components

Delanco
Percent of map unit: 10 percent
Landform: Stream terraces
Landform position (three-dimensional): Tread, riser
Down-slope shape: Linear, concave
Across-slope shape: Convex, linear

Glenelg
Percent of map unit: 5 percent
Landform: Interfluves, hillslopes
Landform position (two-dimensional): Summit, backslope, shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear

EsC2—Elsinboro loam, 5 to 10 percent slopes, moderately eroded

Map Unit Setting
National map unit symbol: kx0v
Elevation: 0 to 1,050 feet
Mean annual precipitation: 35 to 55 inches
Mean annual air temperature: 48 to 61 degrees F
Frost-free period: 110 to 235 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Elsinboro and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Elsinboro

Setting

Landform: Terraces
Landform position (three-dimensional): Tread, riser
Down-slope shape: Convex, concave
Across-slope shape: Convex, linear
Parent material: Loamy alluvium derived from phyllite and/or loamy alluvium derived from mica schist and/or loamy alluvium derived from quartzite

Typical profile

Ap - 0 to 9 inches: silt loam
Bt, BC - 9 to 37 inches: silt loam
C1-2 - 37 to 60 inches: silt loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 60 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B

Minor Components

Delanco

Percent of map unit: 10 percent
Landform: Stream terraces
Landform position (three-dimensional): Tread, riser
Down-slope shape: Linear, concave
Across-slope shape: Convex, linear

Glenelg

Percent of map unit: 5 percent
Landform: Interfluves, hillslopes
Landform position (two-dimensional): Summit, backslope, shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear

GcC2—Glenelg loam, 8 to 15 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: kx0z
Elevation: 250 to 1,050 feet
Mean annual precipitation: 37 to 55 inches
Mean annual air temperature: 45 to 57 degrees F
Frost-free period: 110 to 255 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Glenelg and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Glenelg

Setting

Landform: Hillslopes, interfluves
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Loamy residuum weathered from phyllite

Typical profile

Ap - 0 to 10 inches: loam
Bt1,Bt2,BCt1 - 10 to 30 inches: clay loam
BCt2, CBt - 30 to 54 inches: loam
C - 54 to 76 inches: very channery sandy loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B

Minor Components

Gaila

Percent of map unit: 10 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope, shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear

Manor

Percent of map unit: 5 percent
Landform: Ridges, hillslopes
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear

Hb—Hatboro silt loam

Map Unit Setting

National map unit symbol: kx1b
Elevation: 200 to 600 feet
Mean annual precipitation: 36 to 46 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 140 to 200 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Hatboro and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hatboro

Setting

Landform: Flood plains
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Loamy alluvium derived from greenstone, quartzite, phyllite, schist and/or diabase

Typical profile

A - 0 to 11 inches: silt loam
Bg1,Bg2,BCg - 11 to 44 inches: silt loam
Cg1 - 44 to 55 inches: silty clay loam
Cg2 - 55 to 60 inches: sandy loam

Properties and qualities

Slope: 0 to 3 percent

Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Frequent
Frequency of ponding: Frequent
Available water storage in profile: High (about 10.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: D

Minor Components

Codorus

Percent of map unit: 15 percent
Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear

KeB—Kelly silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: kx1f
Elevation: 300 to 2,000 feet
Mean annual precipitation: 35 to 50 inches
Mean annual air temperature: 45 to 55 degrees F
Frost-free period: 150 to 220 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Kelly and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kelly

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Clayey residuum weathered from diabase

Typical profile

H1 - 0 to 9 inches: silt loam

Properties and qualities

Slope: 3 to 7 percent
Depth to restrictive feature: 40 to 60 inches to lithic bedrock
Natural drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: D

Minor Components

Watchung

Percent of map unit: 5 percent
Landform: Flats
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Linear

KrB—Kinkora silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: kx1m
Mean annual precipitation: 37 to 52 inches
Mean annual air temperature: 48 to 57 degrees F
Farmland classification: Not prime farmland

Map Unit Composition

Kinkora and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kinkora

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium from micaceous sediment

Typical profile

H1 - 0 to 12 inches: silt loam
H2 - 12 to 30 inches: clay

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Rare
Frequency of ponding: None
Available water storage in profile: Low (about 5.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: D

LeB2—Legore silt loam, 3 to 8 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: kx1n
Elevation: 250 to 1,050 feet
Mean annual precipitation: 35 to 50 inches
Mean annual air temperature: 45 to 55 degrees F
Frost-free period: 120 to 220 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Legore and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Legore

Setting

Landform: Hillslopes, dikes, interfluves
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear, convex
Parent material: Loamy residuum weathered from diabase

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 2 inches: silt loam
BE - 2 to 11 inches: silt loam
Bt - 11 to 27 inches: silty clay loam
BC - 27 to 52 inches: silt loam
C - 52 to 72 inches: sandy loam

Properties and qualities

Slope: 3 to 8 percent

Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 11.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B

Minor Components

Montalto

Percent of map unit: 10 percent
Landform: Dikes, hillslopes
Landform position (two-dimensional): Backslope, summit
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex, linear

Gladstone

Percent of map unit: 5 percent
Landform: Interfluves, flats, hillslopes
Landform position (two-dimensional): Summit, backslope, shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear

LeC2—Legore silt loam, 8 to 15 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: kx1p
Elevation: 250 to 1,050 feet
Mean annual precipitation: 35 to 50 inches
Mean annual air temperature: 48 to 55 degrees F
Frost-free period: 120 to 220 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Legore and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Legore

Setting

Landform: Dikes, hillslopes
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy residuum weathered from gabbro; loamy residuum weathered from diabase

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 2 inches: silt loam
BE - 2 to 11 inches: silt loam
Bt - 11 to 27 inches: silty clay loam
BC - 27 to 52 inches: silt loam
C - 52 to 72 inches: sandy loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 11.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B

Minor Components

Montalto

Percent of map unit: 10 percent
Landform: Dikes, hillslopes
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex

Gladstone

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope, interfluve
Down-slope shape: Convex
Across-slope shape: Convex

LeD2—Legore silt loam, 15 to 25 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: kx1q
Elevation: 80 to 2,000 feet
Mean annual precipitation: 35 to 50 inches
Mean annual air temperature: 45 to 55 degrees F
Frost-free period: 150 to 220 days
Farmland classification: Not prime farmland

Map Unit Composition

Legore and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Legore

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy residuum weathered from diabase and/or loamy residuum weathered from gabbro

Typical profile

H1 - 0 to 10 inches: silt loam
H2 - 10 to 24 inches: gravelly silty clay loam
H3 - 24 to 66 inches: gravelly silt loam

Properties and qualities

Slope: 15 to 25 percent
Depth to restrictive feature: 61 to 94 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B

LeE—Legore silt loam, 25 to 45 percent slopes

Map Unit Setting

National map unit symbol: kx1r
Elevation: 80 to 2,000 feet
Mean annual precipitation: 35 to 50 inches
Mean annual air temperature: 45 to 55 degrees F
Frost-free period: 150 to 220 days
Farmland classification: Not prime farmland

Map Unit Composition

Legore and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Legore

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy residuum weathered from diabase and/or loamy residuum weathered from gabbro

Typical profile

H1 - 0 to 10 inches: silt loam
H2 - 10 to 24 inches: gravelly silty clay loam

Properties and qualities

Slope: 25 to 45 percent
Depth to restrictive feature: 61 to 94 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B

LfE—Legore very stony silt loam, 25 to 45 percent slopes

Map Unit Setting

National map unit symbol: kx1v
Elevation: 80 to 2,000 feet
Mean annual precipitation: 35 to 50 inches
Mean annual air temperature: 45 to 55 degrees F
Frost-free period: 150 to 220 days
Farmland classification: Not prime farmland

Map Unit Composition

Legore and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Legore

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy residuum weathered from diabase and/or loamy residuum weathered from gabbro

Typical profile

H1 - 0 to 10 inches: very stony silt loam

Properties and qualities

Slope: 25 to 45 percent
Percent of area covered with surface fragments: 1.6 percent
Depth to restrictive feature: 61 to 94 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: B

LgC3—Legore silty clay loam, 8 to 15 percent slopes, severely eroded

Map Unit Setting

National map unit symbol: kx1w
Elevation: 80 to 2,000 feet
Mean annual precipitation: 35 to 50 inches
Mean annual air temperature: 45 to 55 degrees F
Frost-free period: 150 to 220 days
Farmland classification: Not prime farmland

Map Unit Composition

Legore and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Legore

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy residuum weathered from diabase and/or loamy residuum weathered from gabbro

Typical profile

H1 - 0 to 10 inches: silty clay loam
H2 - 10 to 24 inches: gravelly silty clay loam
H3 - 24 to 66 inches: gravelly sandy clay loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 61 to 94 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B

LgD3—Legore silty clay loam 15 to 25 percent slopes, severely eroded

Map Unit Setting

National map unit symbol: kx1x
Elevation: 80 to 2,000 feet
Mean annual precipitation: 35 to 50 inches
Mean annual air temperature: 45 to 55 degrees F
Frost-free period: 150 to 220 days
Farmland classification: Not prime farmland

Map Unit Composition

Legore and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Legore

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy residuum weathered from diabase and/or loamy residuum weathered from gabbro

Typical profile

H1 - 0 to 10 inches: silty clay loam

Properties and qualities

Slope: 15 to 25 percent
Depth to restrictive feature: 61 to 94 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B

MgC—Manor and Glenelg very stony loams, 3 to 15 percent slopes

Map Unit Setting

National map unit symbol: kx2g
Elevation: 250 to 1,000 feet
Mean annual precipitation: 35 to 50 inches
Mean annual air temperature: 48 to 57 degrees F
Frost-free period: 150 to 220 days
Farmland classification: Not prime farmland

Map Unit Composition

Manor and similar soils: 50 percent
Glenelg and similar soils: 50 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Glenelg

Setting

Landform: Hillslopes
Landform position (two-dimensional): Summit, backslope
Landform position (three-dimensional): Side slope, interfluve
Down-slope shape: Convex
Across-slope shape: Linear

Typical profile

H1 - 0 to 10 inches: very stony loam
H2 - 10 to 20 inches: channery loam
H3 - 20 to 72 inches: channery loam

Properties and qualities

Slope: 3 to 15 percent
Percent of area covered with surface fragments: 1.6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: B

Description of Manor

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope

Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Loamy residuum weathered from phyllite and/or loamy residuum weathered from schist

Typical profile

H1 - 0 to 10 inches: very stony loam
H2 - 10 to 20 inches: channery loam
H3 - 20 to 72 inches: channery loam

Properties and qualities

Slope: 3 to 15 percent
Percent of area covered with surface fragments: 1.6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: B

MsC2—Montalto silt loam, 8 to 15 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: kx2q
Elevation: 250 to 1,050 feet
Mean annual precipitation: 35 to 50 inches
Mean annual air temperature: 48 to 55 degrees F
Frost-free period: 120 to 200 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Montalto and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Montalto

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Side slope, interfluve
Down-slope shape: Linear
Across-slope shape: Convex

Parent material: Clayey residuum weathered from gabbro

Typical profile

Ap - 0 to 8 inches: silt loam
BE - 8 to 14 inches: gravelly silt loam
Bt - 14 to 46 inches: clay
BC - 46 to 80 inches: very parachannery loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 60 to 142 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C

Minor Components

Legore

Percent of map unit: 10 percent

NeB2—Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: kx2s
Elevation: 400 to 1,600 feet
Mean annual precipitation: 36 to 50 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 155 to 210 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Neshaminy, very deep over gabbro, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Neshaminy, Very Deep Over Gabbro

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope, summit, shoulder
Landform position (three-dimensional): Interfluve, side slope

Down-slope shape: Convex, linear
Across-slope shape: Linear, convex
Parent material: Residuum weathered from gabbro

Typical profile
A - 0 to 6 inches: silt loam
BE - 6 to 17 inches: silt loam
Bt1 - 17 to 32 inches: silt loam
Bt2 - 32 to 59 inches: channery silt loam
BC - 59 to 80 inches: very channery loam

Properties and qualities
Slope: 3 to 8 percent
Depth to restrictive feature: 60 to 99 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.5 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B

Minor Components

Montalto
Percent of map unit: 10 percent

Mount lucas
Percent of map unit: 5 percent

NeC2—Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded

Map Unit Setting
National map unit symbol: kx2t
Elevation: 400 to 1,600 feet
Mean annual precipitation: 36 to 50 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 155 to 210 days
Farmland classification: Farmland of statewide importance

Map Unit Composition
Neshaminy, very deep over gabbro, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Neshaminy, Very Deep Over Gabbro

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope, summit, shoulder
Landform position (three-dimensional): Interfluve, side slope
Down-slope shape: Convex, linear
Across-slope shape: Linear, convex
Parent material: Residuum weathered from gabbro

Typical profile

A - 0 to 6 inches: silt loam
BE - 6 to 17 inches: silt loam
Bt1 - 17 to 32 inches: silt loam
Bt2 - 32 to 59 inches: channery silt loam
BC - 59 to 80 inches: very channery loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 60 to 99 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B

Minor Components

Montalto

Percent of map unit: 10 percent

Soil Information for All Uses

Suitabilities and Limitations for Use

The Suitabilities and Limitations for Use section includes various soil interpretations displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each interpretation.

Building Site Development

Building site development interpretations are designed to be used as tools for evaluating soil suitability and identifying soil limitations for various construction purposes. As part of the interpretation process, the rating applies to each soil in its described condition and does not consider present land use. Example interpretations can include corrosion of concrete and steel, shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping.

Shallow Excavations (Bel Air Sites A and B)

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for graves, utility lines, open ditches, or other purposes. The ratings are based on the soil properties that influence the ease of digging and the resistance to sloughing. Depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, the amount of large stones, and dense layers influence the ease of digging, filling, and compacting. Depth to the seasonal high water table, flooding, and ponding may restrict the period when excavations can be made. Slope influences the ease of using machinery. Soil texture, depth to the water table, and linear extensibility (shrink-swell potential) influence the resistance to sloughing.

The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the specified use. "Not limited" indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. "Somewhat limited" indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected.

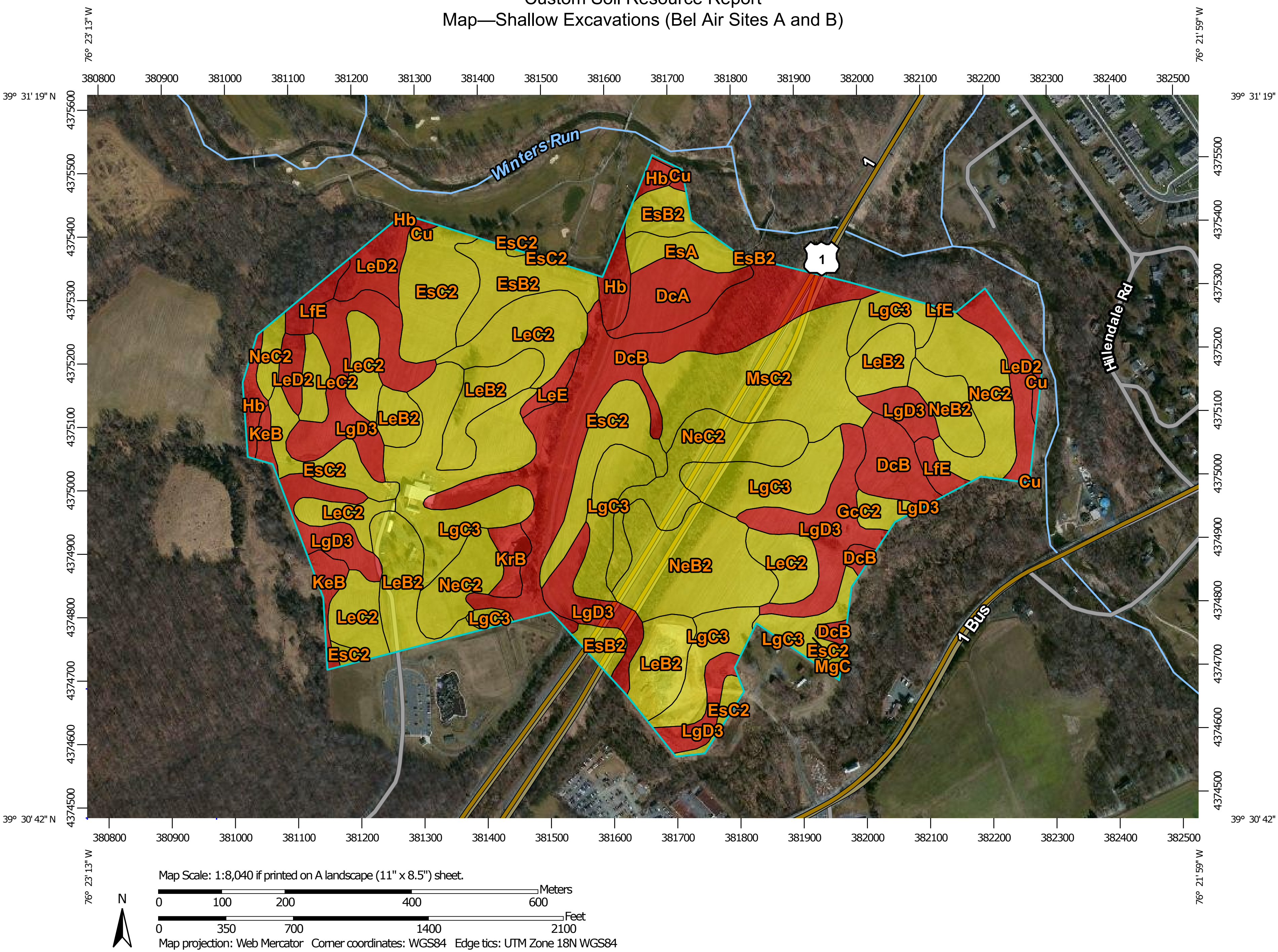
"Very limited" indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as listed for the map unit. The percent composition of each component in a particular map unit is presented to help the user better understand the percentage of each map unit that has the rating presented.

Other components with different ratings may be present in each map unit. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

Custom Soil Resource Report
Map—Shallow Excavations (Bel Air Sites A and B)



Map Scale: 1:8,040 if printed on A landscape (11" x 8.5") sheet.

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- Very limited
- Somewhat limited
- Not limited
- Not rated or not available

Soil Rating Lines
- Very limited
- Somewhat limited
- Not limited
- Not rated or not available

Soil Rating Points
- Very limited
- Somewhat limited
- Not limited
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Harford County Area, Maryland
Survey Area Data: Version 6, Dec 30, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 26, 2011—Mar 2, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Tables—Shallow Excavations (Bel Air Sites A and B)

Shallow Excavations— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
Cu	Codorus silt loam	Very limited	Codorus (85%)	Depth to saturated zone (1.00)	0.6	0.3%
				Flooding (0.60)		
				Dusty (0.07)		
				Unstable excavation walls (0.01)		
			Hatboro (15%)	Ponding (1.00)		
				Depth to saturated zone (1.00)		
				Flooding (0.80)		
				Dusty (0.08)		
				Unstable excavation walls (0.01)		
DcA	Delanco silt loam, 0 to 3 percent slopes	Very limited	Delanco (85%)	Depth to saturated zone (1.00)	3.8	2.2%
				Dusty (0.04)		
				Unstable excavation walls (0.01)		
DcB	Delanco silt loam, 3 to 8 percent slopes	Very limited	Delanco (85%)	Depth to saturated zone (1.00)	19.5	11.5%
				Dusty (0.04)		
				Unstable excavation walls (0.01)		
EsA	Elsinboro loam, 0 to 2 percent slopes	Somewhat limited	Elsinboro (85%)	Depth to saturated zone (0.16)	2.1	1.2%
				Dusty (0.05)		
				Unstable excavation walls (0.01)		
			Glenelg (5%)	Dusty (0.03)		
				Unstable excavation walls (0.01)		
EsB2	Elsinboro loam, 2 to 5 percent slopes,	Somewhat limited	Elsinboro (85%)	Depth to saturated zone (0.16)	6.7	3.9%

Shallow Excavations— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
	moderately eroded			Dusty (0.05)		
				Unstable excavation walls (0.01)		
			Glenelg (5%)	Dusty (0.03)		
				Unstable excavation walls (0.01)		
EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	Somewhat limited	Elsinboro (85%)	Slope (0.37)	15.0	8.8%
				Depth to saturated zone (0.16)		
				Dusty (0.05)		
				Unstable excavation walls (0.01)		
			Glenelg (5%)	Slope (0.63)		
				Dusty (0.03)		
				Unstable excavation walls (0.01)		
GcC2	Glenelg loam, 8 to 15 percent slopes, moderately eroded	Somewhat limited	Glenelg (85%)	Slope (0.63)	1.0	0.6%
				Dusty (0.03)		
				Unstable excavation walls (0.01)		
			Gaila (10%)	Slope (0.63)		
				Dusty (0.05)		
				Unstable excavation walls (0.01)		
			Manor (5%)	Slope (0.63)		
				Unstable excavation walls (0.01)		
				Dusty (0.01)		
Hb	Hatboro silt loam	Very limited	Hatboro (85%)	Ponding (1.00)	2.9	1.7%
				Depth to saturated zone (1.00)		
				Flooding (0.80)		
				Dusty (0.08)		
				Unstable excavation walls (0.01)		

Shallow Excavations— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
			Codorus (15%)	Depth to saturated zone (1.00)		
				Flooding (0.60)		
				Dusty (0.07)		
				Unstable excavation walls (0.01)		
KeB	Kelly silt loam, 3 to 8 percent slopes	Very limited	Kelly (95%)	Depth to saturated zone (1.00)	1.5	0.9%
				Unstable excavation walls (0.51)		
				Depth to hard bedrock (0.42)		
				Too clayey (0.28)		
				Dusty (0.04)		
			WATCHUNG (5%)	Depth to saturated zone (1.00)		
				Too clayey (0.72)		
				Dusty (0.03)		
				Unstable excavation walls (0.01)		
KrB	Kinkora silt loam, 3 to 8 percent slopes	Very limited	Kinkora (100%)	Depth to saturated zone (1.00)	1.2	0.7%
				Too clayey (0.13)		
				Dusty (0.03)		
				Unstable excavation walls (0.01)		
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	Somewhat limited	Legore (85%)	Dusty (0.03)	13.5	7.9%
				Unstable excavation walls (0.01)		
			Montalto (10%)	Dusty (0.03)		
				Too clayey (0.02)		
				Unstable excavation walls (0.01)		
			Gladstone (5%)	Dusty (0.03)		
				Unstable excavation walls (0.01)		

Shallow Excavations— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	Somewhat limited	Legore (85%)	Slope (0.37)	13.7	8.0%
				Dusty (0.03)		
				Unstable excavation walls (0.01)		
			Montalto (10%)	Slope (0.37)		
				Dusty (0.03)		
				Too clayey (0.02)		
				Unstable excavation walls (0.01)		
			Gladstone (5%)	Slope (0.37)		
				Dusty (0.03)		
				Unstable excavation walls (0.01)		
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	Very limited	Legore (100%)	Slope (1.00)	6.0	3.5%
				Dusty (0.03)		
				Unstable excavation walls (0.01)		
LeE	Legore silt loam, 25 to 45 percent slopes	Very limited	Legore (100%)	Slope (1.00)	0.8	0.4%
				Dusty (0.03)		
				Unstable excavation walls (0.01)		
LfE	Legore very stony silt loam, 25 to 45 percent slopes	Very limited	Legore (100%)	Slope (1.00)	1.9	1.1%
				Dusty (0.03)		
				Unstable excavation walls (0.01)		
LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	Somewhat limited	Legore (100%)	Slope (0.63)	23.0	13.5%
				Dusty (0.03)		
				Unstable excavation walls (0.01)		
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	Very limited	Legore (100%)	Slope (1.00)	19.8	11.6%
				Dusty (0.03)		
				Unstable excavation walls (0.01)		
MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	Somewhat limited	Glenelg (50%)	Slope (0.04)	0.2	0.1%
				Dusty (0.03)		

Shallow Excavations— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
				Unstable excavation walls (0.01)		
			Manor (50%)	Slope (0.04)		
				Dusty (0.03)		
				Unstable excavation walls (0.01)		
MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	Somewhat limited	Montalto (90%)	Slope (0.37)	11.1	6.5%
				Dusty (0.03)		
				Unstable excavation walls (0.01)		
				Too clayey (0.01)		
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	Somewhat limited	Neshaminy, very deep over gabbro (85%)	Dusty (0.04)	10.7	6.3%
				Unstable excavation walls (0.01)		
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	Somewhat limited	Neshaminy, very deep over gabbro (90%)	Slope (0.63)	15.6	9.1%
				Dusty (0.04)		
				Unstable excavation walls (0.01)		
Totals for Area of Interest					**170.3**	**100.0%**

Shallow Excavations— Summary by Rating Value		
Rating	**Acres in AOI**	**Percent of AOI**
Somewhat limited	112.4	66.0%
Very limited	57.9	34.0%
Totals for Area of Interest	**170.3**	**100.0%**

Rating Options—Shallow Excavations (Bel Air Sites A and B)

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie. The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: *None Specified*

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Unpaved Local Roads and Streets (Bel Air Sites A and B)

Unpaved local roads and streets are those roads and streets that carry traffic year round but have a graded surface of local soil material or aggregate.

Description:

Unpaved local roads and streets are those roads and streets that carry traffic year round but have a graded surface of local soil material or aggregate.

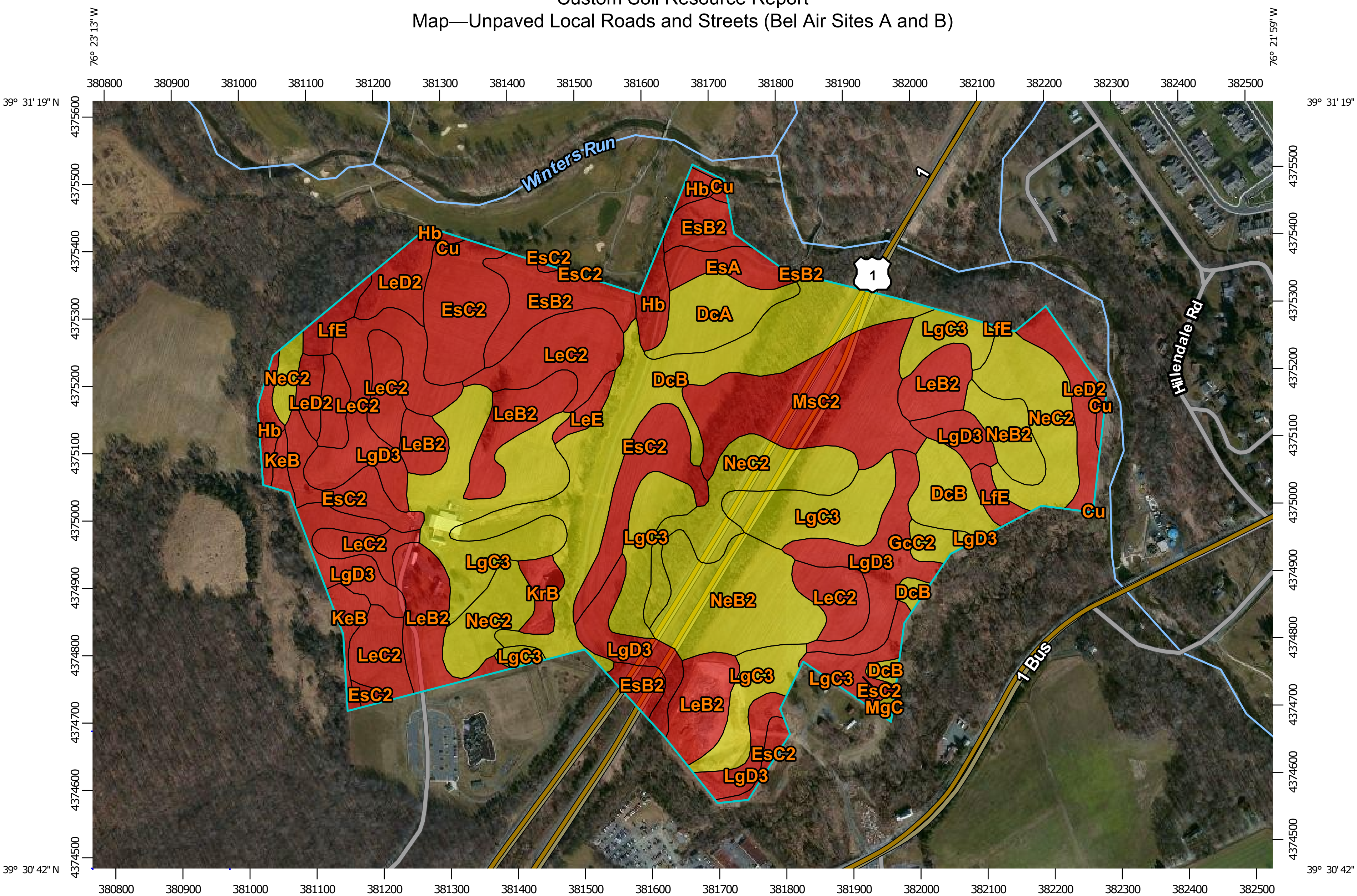
The roads and streets consist of

(1) the underlying local soil material, either cut or fill, which is called "the sub-grade";

(2) the surface, which may be the same as the subgrade or may have aggrate such as crushed limestone added.

They are graded to shed water, and conventional drainage measures are provided. These roads and streets are built mainly from the soil at the site. Soil interpretations for local roads and streets are used as a tool in evaluating soil suitability and identifying soil limitations for the practice. The rating is for soils in their present condition and does not consider present land use. Soil properties and qualities that affect local roads and streets are those that influence the ease of excavation and grading and the traffic-supporting capacity. The properties and qualities that affect the ease of excavation and grading are hardness of bedrock or a cemented pan, depth to bedrock or a cemented pan, depth to a water table, flooding, the amount of large stones, and slope. The properties that affect traffic-supporting capacity are soil strength as inferred from the AASHTO group index and the Unified classification, subsidence, shrink-swell behavior, potential frost action, and depth to the seasonal high water table. The dust generating tendacy of the soil is also considered.

Custom Soil Resource Report
Map—Unpaved Local Roads and Streets (Bel Air Sites A and B)



Map Scale: 1:8,040 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 350 700 1400 2100

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- Very limited
- Somewhat limited
- Not limited
- Not rated or not available

Soil Rating Lines

- Very limited
- Somewhat limited
- Not limited
- Not rated or not available

Soil Rating Points

- Very limited
- Somewhat limited
- Not limited
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Harford County Area, Maryland
Survey Area Data: Version 6, Dec 30, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 26, 2011—Mar 2, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Tables—Unpaved Local Roads and Streets (Bel Air Sites A and B)

Unpaved Local Roads and Streets— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
Cu	Codorus silt loam	Very limited	Codorus (85%)	Frost action (1.00)	0.6	0.3%
				Flooding (1.00)		
				Depth to saturated zone (0.19)		
				Dusty (0.07)		
			Hatboro (15%)	Ponding (1.00)		
				Depth to saturated zone (1.00)		
				Frost action (1.00)		
				Flooding (1.00)		
				Dusty (0.08)		
DcA	Delanco silt loam, 0 to 3 percent slopes	Somewhat limited	Delanco (85%)	Frost action (0.50)	3.8	2.2%
				Depth to saturated zone (0.19)		
				Dusty (0.04)		
DcB	Delanco silt loam, 3 to 8 percent slopes	Somewhat limited	Delanco (85%)	Frost action (0.50)	19.5	11.5%
				Depth to saturated zone (0.19)		
				Dusty (0.04)		
EsA	Elsinboro loam, 0 to 2 percent slopes	Very limited	Elsinboro (85%)	Low strength (1.00)	2.1	1.2%
				Frost action (0.50)		
				Dusty (0.05)		
EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	Very limited	Elsinboro (85%)	Low strength (1.00)	6.7	3.9%
				Frost action (0.50)		
				Dusty (0.05)		
EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	Very limited	Elsinboro (85%)	Low strength (1.00)	15.0	8.8%
				Frost action (0.50)		
				Slope (0.37)		
				Dusty (0.05)		

Unpaved Local Roads and Streets— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)	Acres in AOI	Percent of AOI
GcC2	Glenelg loam, 8 to 15 percent slopes, moderately eroded	Somewhat limited	Glenelg (85%)	Low strength (0.78)	1.0	0.6%
				Slope (0.63)		
				Frost action (0.50)		
				Dusty (0.03)		
			Gaila (10%)	Slope (0.63)		
				Frost action (0.50)		
				Dusty (0.05)		
			Manor (5%)	Slope (0.63)		
				Frost action (0.50)		
				Dusty (0.01)		
Hb	Hatboro silt loam	Very limited	Hatboro (85%)	Ponding (1.00)	2.9	1.7%
				Depth to saturated zone (1.00)		
				Frost action (1.00)		
				Flooding (1.00)		
				Dusty (0.08)		
			Codorus (15%)	Frost action (1.00)		
				Flooding (1.00)		
				Depth to saturated zone (0.19)		
				Dusty (0.07)		
KeB	Kelly silt loam, 3 to 8 percent slopes	Very limited	Kelly (95%)	Shrink-swell (1.00)	1.5	0.9%
				Frost action (0.50)		
				Depth to saturated zone (0.19)		
				Dusty (0.04)		
			WATCHUNG (5%)	Depth to saturated zone (1.00)		
				Frost action (1.00)		
				Low strength (1.00)		
				Shrink-swell (0.50)		

Unpaved Local Roads and Streets— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
				Dusty (0.03)		
KrB	Kinkora silt loam, 3 to 8 percent slopes	Very limited	Kinkora (100%)	Depth to saturated zone (1.00)	1.2	0.7%
				Frost action (1.00)		
				Low strength (1.00)		
				Shrink-swell (0.98)		
				Flooding (0.40)		
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	Very limited	Legore (85%)	Low strength (1.00)	13.5	7.9%
				Frost action (0.50)		
				Shrink-swell (0.06)		
				Dusty (0.03)		
			Montalto (10%)	Low strength (1.00)		
				Frost action (0.50)		
				Shrink-swell (0.50)		
				Dusty (0.03)		
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	Very limited	Legore (85%)	Low strength (1.00)	13.7	8.0%
				Frost action (0.50)		
				Slope (0.37)		
				Shrink-swell (0.06)		
				Dusty (0.03)		
			Montalto (10%)	Low strength (1.00)		
				Frost action (0.50)		
				Shrink-swell (0.50)		
				Slope (0.37)		
				Dusty (0.03)		
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	Very limited	Legore (100%)	Slope (1.00)	6.0	3.5%
				Frost action (0.50)		
				Dusty (0.03)		

Unpaved Local Roads and Streets— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)	Acres in AOI	Percent of AOI
LeE	Legore silt loam, 25 to 45 percent slopes	Very limited	Legore (100%)	Slope (1.00)	0.8	0.4%
				Frost action (0.50)		
				Dusty (0.03)		
LfE	Legore very stony silt loam, 25 to 45 percent slopes	Very limited	Legore (100%)	Slope (1.00)	1.9	1.1%
				Frost action (0.50)		
				Dusty (0.03)		
LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	Somewhat limited	Legore (100%)	Slope (0.63)	23.0	13.5%
				Frost action (0.50)		
				Dusty (0.03)		
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	Very limited	Legore (100%)	Slope (1.00)	19.8	11.6%
				Frost action (0.50)		
				Dusty (0.03)		
MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	Somewhat limited	Glenelg (50%)	Frost action (0.50)	0.2	0.1%
				Slope (0.04)		
				Dusty (0.03)		
			Manor (50%)	Frost action (0.50)		
				Slope (0.04)		
				Dusty (0.03)		
MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	Very limited	Montalto (90%)	Low strength (1.00)	11.1	6.5%
				Shrink-swell (0.99)		
				Frost action (0.50)		
				Slope (0.37)		
				Dusty (0.03)		
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	Somewhat limited	Neshaminy, very deep over gabbro (85%)	Frost action (0.50)	10.7	6.3%
				Low strength (0.22)		
				Dusty (0.04)		
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	Somewhat limited	Neshaminy, very deep over gabbro (90%)	Slope (0.63)	15.6	9.1%
				Frost action (0.50)		
				Low strength (0.22)		

Unpaved Local Roads and Streets— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
				Dusty (0.04)		
Totals for Area of Interest					**170.3**	**100.0%**

Unpaved Local Roads and Streets— Summary by Rating Value		
Rating	**Acres in AOI**	**Percent of AOI**
Very limited	96.6	56.7%
Somewhat limited	73.7	43.3%
Totals for Area of Interest	**170.3**	**100.0%**

Rating Options—Unpaved Local Roads and Streets (Bel Air Sites A and B)

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie. The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

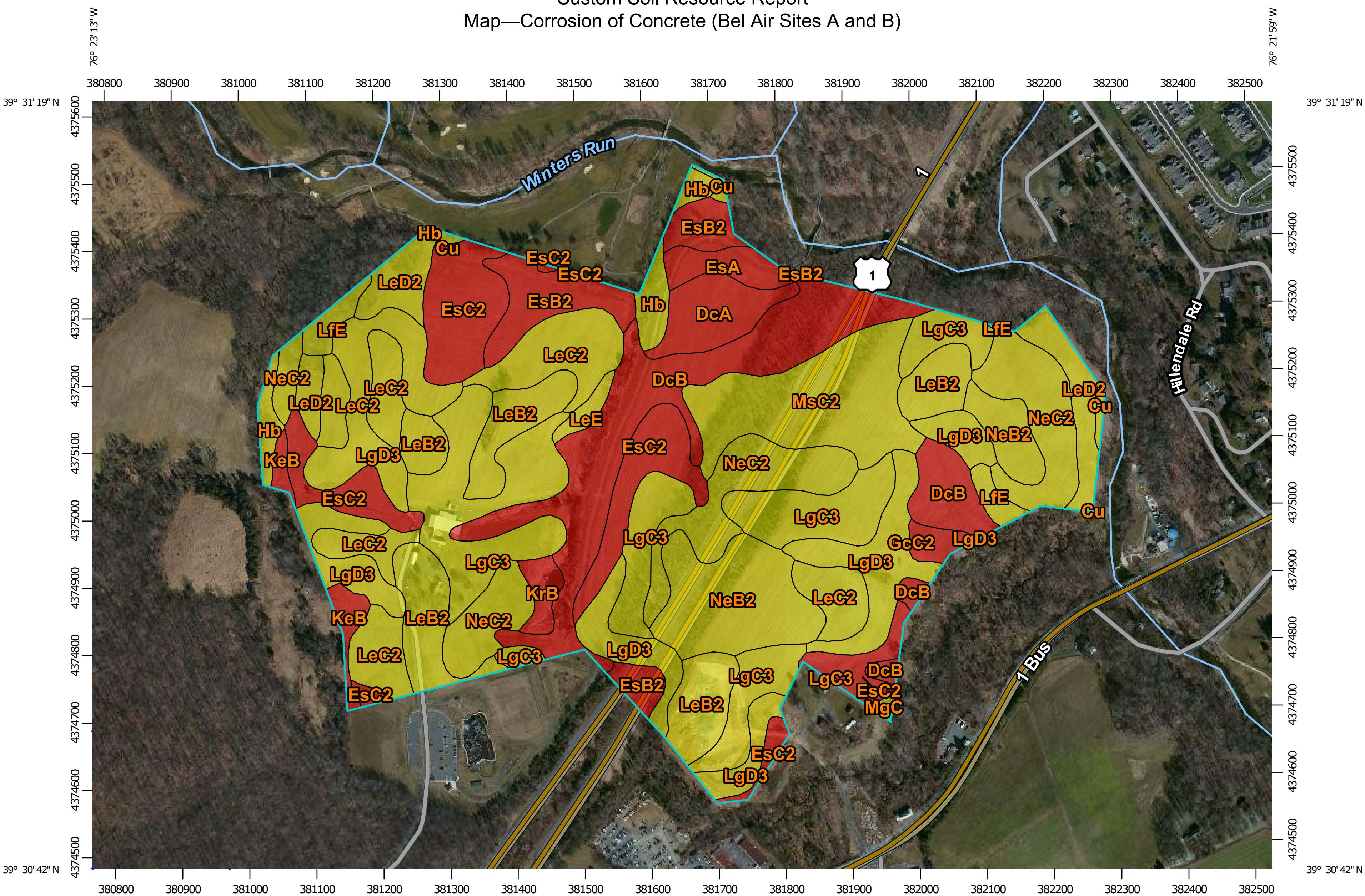
The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Corrosion of Concrete (Bel Air Sites A and B)

"Risk of corrosion" pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens concrete. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the concrete in installations that are entirely within one kind of soil or within one soil layer.

The risk of corrosion is expressed as "low," "moderate," or "high."

Custom Soil Resource Report
Map—Corrosion of Concrete (Bel Air Sites A and B)



Map Scale: 1:8,040 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 100, 200, 400, 600

Feet: 0, 350, 700, 1400, 2100

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

High

Moderate

Low

Not rated or not available

Soil Rating Lines

High

Moderate

Low

Not rated or not available

Soil Rating Points

High

Moderate

Low

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Harford County Area, Maryland
Survey Area Data: Version 6, Dec 30, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 26, 2011—Mar 2, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Corrosion of Concrete (Bel Air Sites A and B)

Corrosion of Concrete— Summary by Map Unit — Harford County Area, Maryland (MD600)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
Cu	Codorus silt loam	Moderate	0.6	0.3%
DcA	Delanco silt loam, 0 to 3 percent slopes	High	3.8	2.2%
DcB	Delanco silt loam, 3 to 8 percent slopes	High	19.5	11.5%
EsA	Elsinboro loam, 0 to 2 percent slopes	High	2.1	1.2%
EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	High	6.7	3.9%
EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	High	15.0	8.8%
GcC2	Glenelg loam, 8 to 15 percent slopes, moderately eroded	High	1.0	0.6%
Hb	Hatboro silt loam	Moderate	2.9	1.7%
KeB	Kelly silt loam, 3 to 8 percent slopes	High	1.5	0.9%
KrB	Kinkora silt loam, 3 to 8 percent slopes	High	1.2	0.7%
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	Moderate	13.5	7.9%
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	Moderate	13.7	8.0%
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	Moderate	6.0	3.5%
LeE	Legore silt loam, 25 to 45 percent slopes	Moderate	0.8	0.4%
LfE	Legore very stony silt loam, 25 to 45 percent slopes	Moderate	1.9	1.1%
LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	Moderate	23.0	13.5%
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	Moderate	19.8	11.6%
MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	Moderate	0.2	0.1%
MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	Moderate	11.1	6.5%

Corrosion of Concrete— Summary by Map Unit — Harford County Area, Maryland (MD600)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	Moderate	10.7	6.3%
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	Moderate	15.6	9.1%
Totals for Area of Interest			**170.3**	**100.0%**

Rating Options—Corrosion of Concrete (Bel Air Sites A and B)

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie. The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

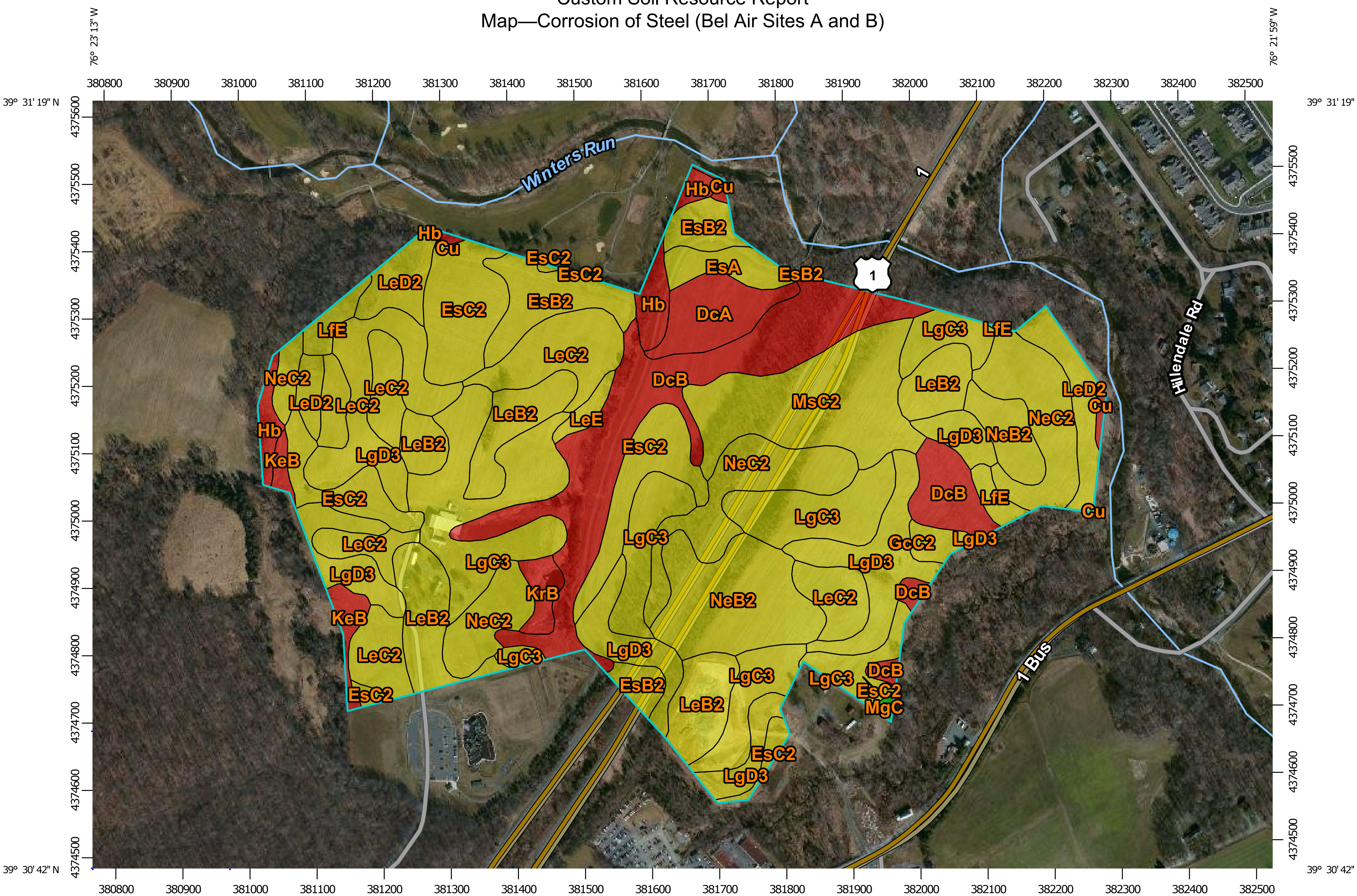
The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Corrosion of Steel (Bel Air Sites A and B)

"Risk of corrosion" pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel in installations that are entirely within one kind of soil or within one soil layer.

The risk of corrosion is expressed as "low," "moderate," or "high."

Map—Corrosion of Steel (Bel Air Sites A and B)



Map Scale: 1:8,040 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 100, 200, 400, 600

Feet: 0, 350, 700, 1400, 2100

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

High

Moderate

Low

Not rated or not available

Soil Rating Lines

High

Moderate

Low

Not rated or not available

Soil Rating Points

High

Moderate

Low

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Harford County Area, Maryland
Survey Area Data: Version 6, Dec 30, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 26, 2011—Mar 2, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Corrosion of Steel (Bel Air Sites A and B)

Corrosion of Steel— Summary by Map Unit — Harford County Area, Maryland (MD600)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Cu	Codorus silt loam	High	0.6	0.3%
DcA	Delanco silt loam, 0 to 3 percent slopes	High	3.8	2.2%
DcB	Delanco silt loam, 3 to 8 percent slopes	High	19.5	11.5%
EsA	Elsinboro loam, 0 to 2 percent slopes	Moderate	2.1	1.2%
EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	Moderate	6.7	3.9%
EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	Moderate	15.0	8.8%
GcC2	Glenelg loam, 8 to 15 percent slopes, moderately eroded	Moderate	1.0	0.6%
Hb	Hatboro silt loam	High	2.9	1.7%
KeB	Kelly silt loam, 3 to 8 percent slopes	High	1.5	0.9%
KrB	Kinkora silt loam, 3 to 8 percent slopes	High	1.2	0.7%
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	Moderate	13.5	7.9%
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	Moderate	13.7	8.0%
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	Moderate	6.0	3.5%
LeE	Legore silt loam, 25 to 45 percent slopes	Moderate	0.8	0.4%
LfE	Legore very stony silt loam, 25 to 45 percent slopes	Moderate	1.9	1.1%
LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	Moderate	23.0	13.5%
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	Moderate	19.8	11.6%
MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	Low	0.2	0.1%
MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	Moderate	11.1	6.5%

Corrosion of Steel— Summary by Map Unit — Harford County Area, Maryland (MD600)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	Moderate	10.7	6.3%
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	Moderate	15.6	9.1%
Totals for Area of Interest			**170.3**	**100.0%**

Rating Options—Corrosion of Steel (Bel Air Sites A and B)

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie. The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Construction Materials

Construction materials interpretations are tools designed to provide guidance to users in selecting a site for potential source of various materials. Individual soils or groups of soils may be selected as a potential source because they are close at hand, are the only source available, or they meets some or all of the physical or chemical properties required for the intended application. Example interpretations include roadfill, sand and gravel, topsoil and reclamation material.

Topsoil Source (Bel Air Sites A and B)

Topsoil is used to cover an area so that vegetation can be established and maintained. The surface layer of most soils is generally preferred for topsoil because of its content of organic matter. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area. Normal compaction, minor processing, and other standard construction practices are assumed.

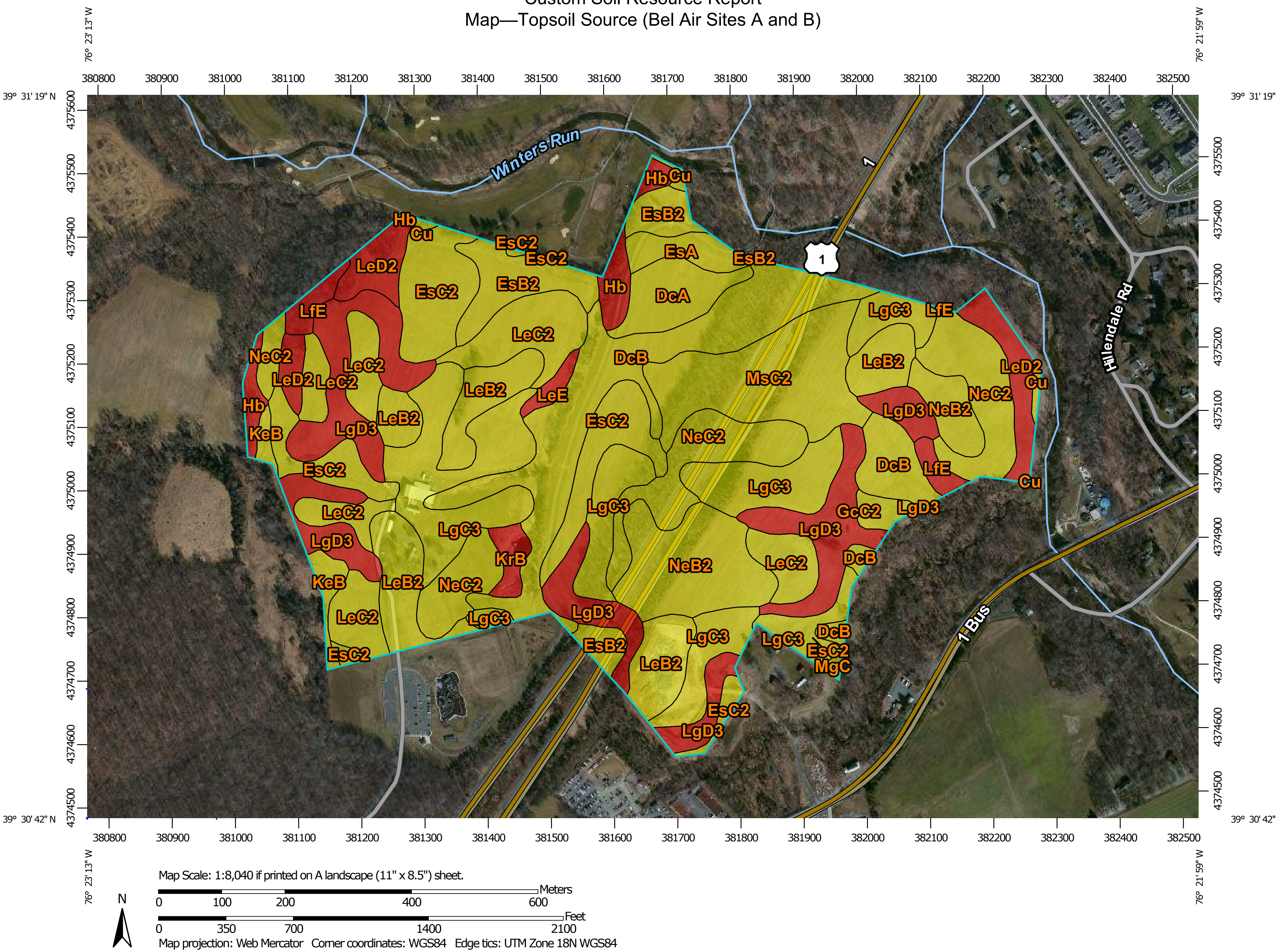
The soils are rated "good," "fair," or "poor" as potential sources of topsoil. The ratings are based on the soil properties that affect plant growth; the ease of excavating, loading, and spreading the material; and reclamation of the borrow area. Toxic substances, soil reaction, and the properties that are inferred from soil texture, such as available water capacity and fertility, affect plant growth. The ease of excavating, loading, and spreading is affected by rock fragments, slope, depth to a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, depth to a water table, rock fragments, depth to bedrock or a cemented pan, and toxic material.

Numerical ratings between 0.00 and 0.99 are given after the specified features. These numbers indicate the degree to which the features limit the soils as sources of topsoil. The lower the number, the greater the limitation.

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as listed for the map unit. The percent composition of each component in a particular map unit is presented to help the user better understand the percentage of each map unit that has the rating presented.

Other components with different ratings may be present in each map unit. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

Map—Topsoil Source (Bel Air Sites A and B)



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

Poor

Fair

Good

Not rated or not available

Soil Rating Lines

Poor

Fair

Good

Not rated or not available

Soil Rating Points

Poor

Fair

Good

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Harford County Area, Maryland
Survey Area Data: Version 6, Dec 30, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 26, 2011—Mar 2, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Tables—Topsoil Source (Bel Air Sites A and B)

Topsoil Source— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
Cu	Codorus silt loam	Fair	Codorus (85%)	Hard to reclaim (rock fragments) (0.03)	0.6	0.3%
				Rock fragments (0.13)		
				Wetness (0.53)		
				Exchange capacity (0.87)		
				Too acid (0.93)		
DcA	Delanco silt loam, 0 to 3 percent slopes	Fair	Delanco (85%)	Wetness (0.53)	3.8	2.2%
				Exchange capacity (0.70)		
			Elsinboro (15%)	Rock fragments (0.68)		
				Exchange capacity (0.78)		
				Too acid (0.88)		
DcB	Delanco silt loam, 3 to 8 percent slopes	Fair	Delanco (85%)	Wetness (0.53)	19.5	11.5%
				Exchange capacity (0.70)		
			Elsinboro (15%)	Rock fragments (0.68)		
				Exchange capacity (0.78)		
				Too acid (0.88)		
EsA	Elsinboro loam, 0 to 2 percent slopes	Fair	Elsinboro (85%)	Rock fragments (0.68)	2.1	1.2%
				Exchange capacity (0.78)		
				Too acid (0.88)		
			Delanco, Piedmont (10%)	Wetness (0.53)		
				Exchange capacity (0.70)		
			Glenelg (5%)	Hard to reclaim (rock fragments) (0.11)		
				Exchange capacity (0.85)		
				Rock fragments (0.90)		

Topsoil Source— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	Fair	Elsinboro (85%)	Rock fragments (0.68)	6.7	3.9%
				Exchange capacity (0.78)		
				Too acid (0.88)		
			Delanco (10%)	Wetness (0.53)		
				Exchange capacity (0.70)		
			Glenelg (5%)	Hard to reclaim (rock fragments) (0.11)		
				Exchange capacity (0.85)		
				Rock fragments (0.90)		
EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	Fair	Elsinboro (85%)	Slope (0.63)	15.0	8.8%
				Rock fragments (0.68)		
				Exchange capacity (0.78)		
				Too acid (0.88)		
			Delanco (10%)	Wetness (0.53)		
				Slope (0.63)		
				Exchange capacity (0.70)		
			Glenelg (5%)	Hard to reclaim (rock fragments) (0.11)		
				Slope (0.37)		
				Exchange capacity (0.85)		
				Rock fragments (0.90)		
GcC2	Glenelg loam, 8 to 15 percent slopes, moderately eroded	Fair	Glenelg (85%)	Hard to reclaim (rock fragments) (0.11)	1.0	0.6%
				Slope (0.37)		
				Exchange capacity (0.85)		
				Rock fragments (0.90)		
			Gaila (10%)	Slope (0.37)		
				Rock fragments (0.89)		

Topsoil Source— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)	Acres in AOI	Percent of AOI
				Too acid (0.96)		
			Manor (5%)	Slope (0.37)		
				Rock fragments (0.70)		
				Exchange capacity (0.78)		
				Aluminum saturation (0.89)		
				Too acid (0.99)		
Hb	Hatboro silt loam	Poor	Hatboro (85%)	Wetness (0.00)	2.9	1.7%
				Rock fragments (0.60)		
KeB	Kelly silt loam, 3 to 8 percent slopes	Fair	Kelly (95%)	Too clayey (0.50)	1.5	0.9%
				Wetness (0.53)		
				Hard to reclaim (rock fragments) (0.68)		
KrB	Kinkora silt loam, 3 to 8 percent slopes	Poor	Kinkora (100%)	Wetness (0.00)	1.2	0.7%
				Too clayey (0.42)		
				Too acid (0.74)		
				Exchange capacity (0.92)		
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	Fair	Legore (85%)	Exchange capacity (0.98)	13.5	7.9%
				Rock fragments (0.99)		
			Montalto (10%)	Too clayey (0.02)		
			Gladstone (5%)	Rock fragments (0.83)		
				Too acid (0.96)		
				Hard to reclaim (rock fragments) (0.98)		
				Exchange capacity (1.00)		
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	Fair	Legore (85%)	Slope (0.63)	13.7	8.0%
				Exchange capacity (0.98)		
				Rock fragments (0.99)		
			Montalto (10%)	Too clayey (0.02)		
				Slope (0.63)		

Topsoil Source— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)	Acres in AOI	Percent of AOI
			Gladstone (5%)	Slope (0.63)		
				Rock fragments (0.70)		
				Too acid (0.96)		
				Exchange capacity (1.00)		
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	Poor	Legore (100%)	Slope (0.00)	6.0	3.5%
				Rock fragments (0.38)		
				Hard to reclaim (rock fragments) (0.96)		
				Exchange capacity (0.97)		
LeE	Legore silt loam, 25 to 45 percent slopes	Poor	Legore (100%)	Slope (0.00)	0.8	0.4%
				Rock fragments (0.38)		
				Hard to reclaim (rock fragments) (0.96)		
				Exchange capacity (0.97)		
LfE	Legore very stony silt loam, 25 to 45 percent slopes	Poor	Legore (100%)	Slope (0.00)	1.9	1.1%
				Rock fragments (0.00)		
				Exchange capacity (0.96)		
				Hard to reclaim (rock fragments) (0.96)		
LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	Fair	Legore (100%)	Slope (0.37)	23.0	13.5%
				Rock fragments (0.38)		
				Hard to reclaim (rock fragments) (0.96)		
				Exchange capacity (0.97)		
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	Poor	Legore (100%)	Slope (0.00)	19.8	11.6%
				Rock fragments (0.38)		
				Hard to reclaim (rock fragments) (0.96)		

Topsoil Source— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
				Exchange capacity (0.97)		
MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	Fair	Glenelg (50%)	Rock fragments (0.44)	0.2	0.1%
				Too acid (0.76)		
				Exchange capacity (0.77)		
				Slope (0.96)		
			Manor (50%)	Rock fragments (0.44)		
				Too acid (0.76)		
				Exchange capacity (0.87)		
				Slope (0.96)		
MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	Fair	Montalto (90%)	Too clayey (0.28)	11.1	6.5%
				Rock fragments (0.50)		
				Slope (0.63)		
				Exchange capacity (0.96)		
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	Fair	Neshaminy, very deep over gabbro (85%)	Hard to reclaim (rock fragments) (0.35)	10.7	6.3%
				Rock fragments (0.84)		
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	Fair	Neshaminy, very deep over gabbro (90%)	Hard to reclaim (rock fragments) (0.35)	15.6	9.1%
				Slope (0.37)		
				Rock fragments (0.84)		
Totals for Area of Interest					**170.3**	**100.0%**

Topsoil Source— Summary by Rating Value		
Rating	**Acres in AOI**	**Percent of AOI**
Fair	137.8	80.9%
Poor	32.5	19.1%
Totals for Area of Interest	**170.3**	**100.0%**

Rating Options—Topsoil Source (Bel Air Sites A and B)

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie. The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Lower

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Land Classifications

Land Classifications are specified land use and management groupings that are assigned to soil areas because combinations of soil have similar behavior for specified practices. Most are based on soil properties and other factors that directly influence the specific use of the soil. Example classifications include ecological site classification, farmland classification, irrigated and nonirrigated land capability classification, and hydric rating.

Hydric Rating by Map Unit (Bel Air Sites A and B)

This rating indicates the percentage of map units that meets the criteria for hydric soils. Map units are composed of one or more map unit components or soil types, each of which is rated as hydric soil or not hydric. Map units that are made up dominantly of hydric soils may have small areas of minor nonhydric components in the higher positions on the landform, and map units that are made up dominantly of nonhydric soils may have small areas of minor hydric components in the lower positions on the landform. Each map unit is rated based on its respective components and the percentage of each component within the map unit.

The thematic map is color coded based on the composition of hydric components. The five color classes are separated as 100 percent hydric components, 66 to 99 percent hydric components, 33 to 65 percent hydric components, 1 to 32 percent hydric components, and less than one percent hydric components.

In Web Soil Survey, the Summary by Map Unit table that is displayed below the map pane contains a column named 'Rating'. In this column the percentage of each map unit that is classified as hydric is displayed.

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). Under natural conditions, these soils are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation.

The NTCHS definition identifies general soil properties that are associated with wetness. In order to determine whether a specific soil is a hydric soil or nonhydric soil, however, more specific information, such as information about the depth and duration of the water table, is needed. Thus, criteria that identify those estimated soil properties unique to hydric soils have been established (Federal Register, 2002). These criteria are used to identify map unit components that normally are associated with wetlands. The criteria used are selected estimated soil properties that are described in "Soil Taxonomy" (Soil Survey Staff, 1999) and "Keys to Soil Taxonomy" (Soil Survey Staff, 2006) and in the "Soil Survey Manual" (Soil Survey Division Staff, 1993).

If soils are wet enough for a long enough period of time to be considered hydric, they should exhibit certain properties that can be easily observed in the field. These visible properties are indicators of hydric soils. The indicators used to make onsite determinations of hydric soils are specified in "Field Indicators of Hydric Soils in the United States" (Hurt and Vasilas, 2006).

References:

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

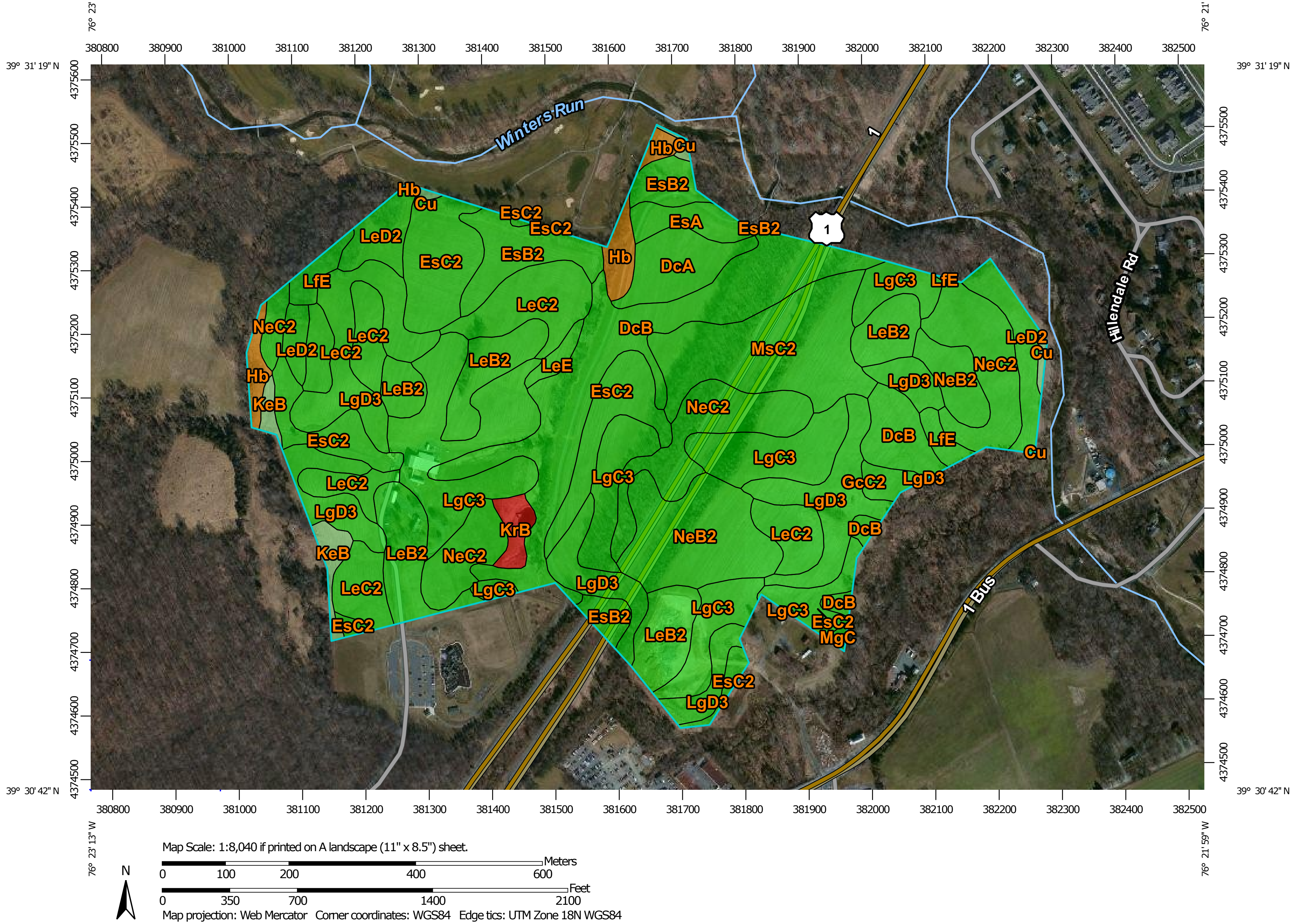
Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18.

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service. U.S. Department of Agriculture Handbook 436.

Soil Survey Staff. 2006. Keys to soil taxonomy. 10th edition. U.S. Department of Agriculture, Natural Resources Conservation Service.

Map—Hydric Rating by Map Unit (Bel Air Sites A and B)



MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- Hydric (100%)
- Predominantly Hydric (66 to 99%)
- Partially hydric (33 to 65%)
- Predominatly nonhydric (1 to 32%)
- Nonhydric (0%)
- Not rated or not available

Soil Rating Lines

- Hydric (100%)
- Predominantly Hydric (66 to 99%)
- Partially hydric (33 to 65%)
- Predominatly nonhydric (1 to 32%)
- Nonhydric (0%)
- Not rated or not available

Soil Rating Points

- Hydric (100%)
- Predominantly Hydric (66 to 99%)
- Partially hydric (33 to 65%)
- Predominatly nonhydric (1 to 32%)
- Nonhydric (0%)
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Harford County Area, Maryland
Survey Area Data: Version 6, Dec 30, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 26, 2011—Mar 2, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydric Rating by Map Unit (Bel Air Sites A and B)

Hydric Rating by Map Unit— Summary by Map Unit — Harford County Area, Maryland (MD600)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Cu	Codorus silt loam	15	0.6	0.3%
DcA	Delanco silt loam, 0 to 3 percent slopes	0	3.8	2.2%
DcB	Delanco silt loam, 3 to 8 percent slopes	0	19.5	11.5%
EsA	Elsinboro loam, 0 to 2 percent slopes	0	2.1	1.2%
EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	0	6.7	3.9%
EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	0	15.0	8.8%
GcC2	Glenelg loam, 8 to 15 percent slopes, moderately eroded	0	1.0	0.6%
Hb	Hatboro silt loam	85	2.9	1.7%
KeB	Kelly silt loam, 3 to 8 percent slopes	5	1.5	0.9%
KrB	Kinkora silt loam, 3 to 8 percent slopes	100	1.2	0.7%
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	0	13.5	7.9%
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	0	13.7	8.0%
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	0	6.0	3.5%
LeE	Legore silt loam, 25 to 45 percent slopes	0	0.8	0.4%
LfE	Legore very stony silt loam, 25 to 45 percent slopes	0	1.9	1.1%
LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	0	23.0	13.5%
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	0	19.8	11.6%
MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	0	0.2	0.1%
MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	0	11.1	6.5%

Hydric Rating by Map Unit— Summary by Map Unit — Harford County Area, Maryland (MD600)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	0	10.7	6.3%
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	0	15.6	9.1%
Totals for Area of Interest			**170.3**	**100.0%**

Rating Options—Hydric Rating by Map Unit (Bel Air Sites A and B)

Aggregation Method: Percent Present

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Percent Present" returns the cumulative percent composition of all components of a map unit for which a certain condition is true. For example, attribute "Hydric Rating by Map Unit" returns the cumulative percent composition of all components of a map unit where the corresponding hydric rating is "Yes". Conditions may be simple or complex. At runtime, the user may be able to specify all, some or none of the conditions in question.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Lower

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Land Management

Land management interpretations are tools designed to guide the user in evaluating existing conditions in planning and predicting the soil response to various land management practices, for a variety of land uses, including cropland, forestland, hayland, pastureland, horticulture, and rangeland. Example interpretations include suitability for a variety of irrigation practices, log landings, haul roads and major skid trails, equipment operability, site preparation, suitability for hand and mechanical planting, potential erosion hazard associated with various practices, and ratings for fencing and waterline installation.

Suitability for Roads (Natural Surface) (Bel Air Sites A and B)

The ratings in this interpretation indicate the suitability for using the natural surface of the soil for roads. The ratings are based on slope, rock fragments on the surface, plasticity index, content of sand, the Unified classification of the soil, depth to a water table, ponding, flooding, and the hazard of soil slippage.

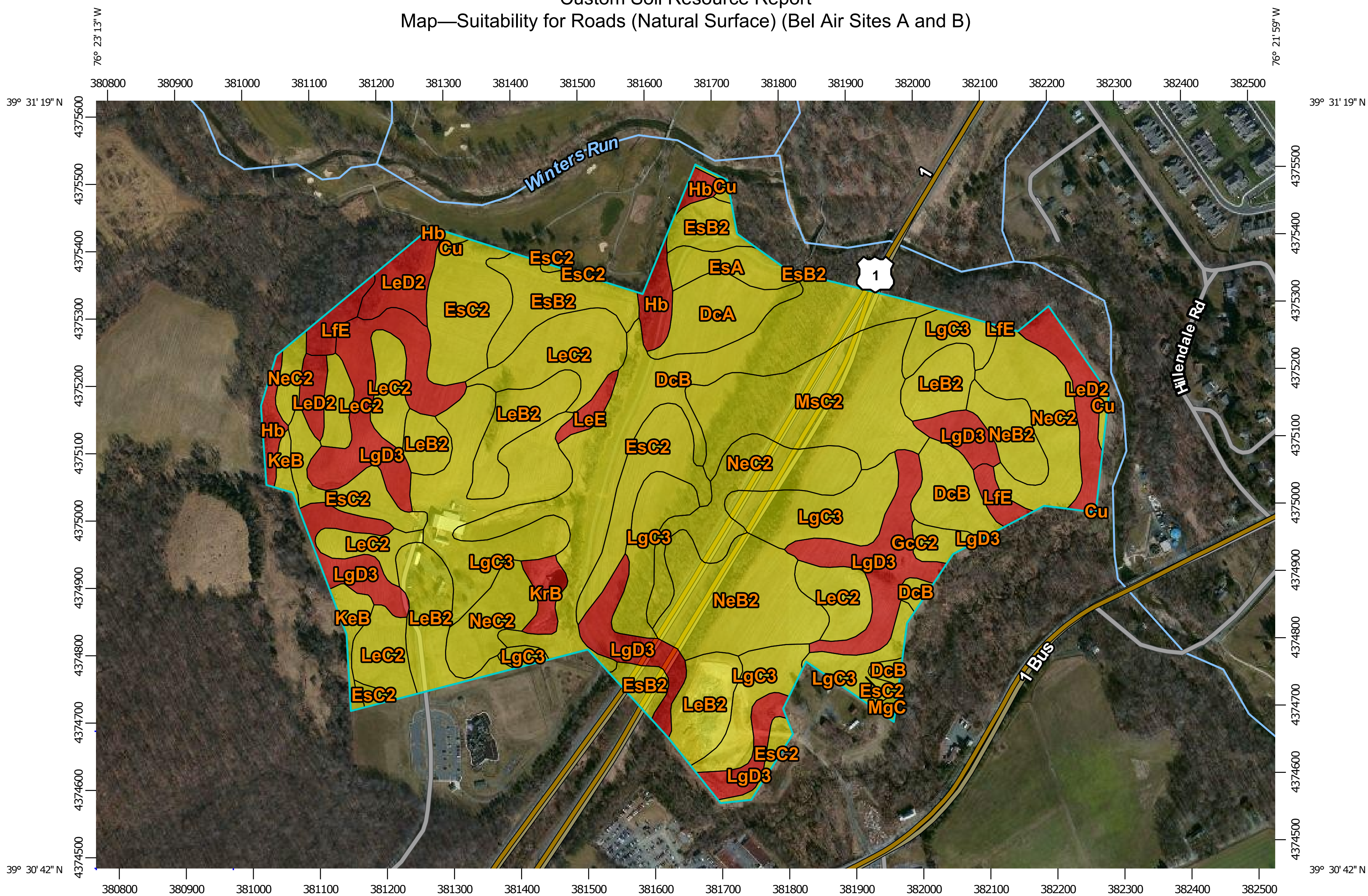
The ratings are both verbal and numerical. The soils are described as "well suited," "moderately suited," or "poorly suited" to this use. "Well suited" indicates that the soil has features that are favorable for the specified kind of roads and has no limitations. Good performance can be expected, and little or no maintenance is needed. "Moderately suited" indicates that the soil has features that are moderately favorable for the specified kind of roads. One or more soil properties are less than desirable, and fair performance can be expected. Some maintenance is needed. "Poorly suited" indicates that the soil has one or more properties that are unfavorable for the specified kind of roads. Overcoming the unfavorable properties requires special design, extra maintenance, and costly alteration.

Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the specified aspect of forestland management (1.00) and the point at which the soil feature is not a limitation (0.00).

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as listed for the map unit. The percent composition of each component in a particular map unit is presented to help the user better understand the percentage of each map unit that has the rating presented.

Other components with different ratings may be present in each map unit. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

Map—Suitability for Roads (Natural Surface) (Bel Air Sites A and B)



Map Scale: 1:8,040 if printed on A landscape (11" x 8.5") sheet.

Meters: 0 100 200 400 600

Feet: 0 350 700 1400 2100

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

Poorly suited

Moderately suited

Well suited

Not rated or not available

Soil Rating Lines

Poorly suited

Moderately suited

Well suited

Not rated or not available

Soil Rating Points

Poorly suited

Moderately suited

Well suited

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Harford County Area, Maryland
Survey Area Data: Version 6, Dec 30, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 26, 2011—Mar 2, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Tables—Suitability for Roads (Natural Surface) (Bel Air Sites A and B)

Suitability for Roads (Natural Surface)— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
Cu	Codorus silt loam	Moderately suited	Codorus (85%)	Low strength (0.50)	0.6	0.3%
				Flooding (0.50)		
				Dusty (0.07)		
DcA	Delanco silt loam, 0 to 3 percent slopes	Moderately suited	Delanco (85%)	Low strength (0.50)	3.8	2.2%
				Dusty (0.04)		
			Elsinboro (15%)	Low strength (0.50)		
				Dusty (0.05)		
DcB	Delanco silt loam, 3 to 8 percent slopes	Moderately suited	Delanco (85%)	Low strength (0.50)	19.5	11.5%
				Dusty (0.04)		
			Elsinboro (15%)	Low strength (0.50)		
				Dusty (0.05)		
EsA	Elsinboro loam, 0 to 2 percent slopes	Moderately suited	Elsinboro (85%)	Low strength (0.50)	2.1	1.2%
				Dusty (0.05)		
			Delanco, Piedmont (10%)	Low strength (0.50)		
				Dusty (0.04)		
			Glenelg (5%)	Low strength (0.50)		
				Dusty (0.03)		
EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	Moderately suited	Elsinboro (85%)	Low strength (0.50)	6.7	3.9%
				Dusty (0.05)		
			Delanco (10%)	Low strength (0.50)		
				Dusty (0.04)		
			Glenelg (5%)	Low strength (0.50)		
				Slope (0.50)		
				Dusty (0.03)		
EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	Moderately suited	Elsinboro (85%)	Slope (0.50)	15.0	8.8%
				Low strength (0.50)		
				Dusty (0.05)		

Suitability for Roads (Natural Surface)— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
			Delanco (10%)	Slope (0.50)		
				Low strength (0.50)		
				Dusty (0.04)		
			Glenelg (5%)	Slope (0.50)		
				Low strength (0.50)		
				Dusty (0.03)		
GcC2	Glenelg loam, 8 to 15 percent slopes, moderately eroded	Moderately suited	Glenelg (85%)	Slope (0.50)	1.0	0.6%
				Low strength (0.50)		
				Dusty (0.03)		
			Gaila (10%)	Slope (0.50)		
				Low strength (0.50)		
				Dusty (0.05)		
			Manor (5%)	Slope (0.50)		
				Dusty (0.01)		
Hb	Hatboro silt loam	Poorly suited	Hatboro (85%)	Ponding (1.00)	2.9	1.7%
				Flooding (1.00)		
				Wetness (1.00)		
				Low strength (0.50)		
				Dusty (0.08)		
KeB	Kelly silt loam, 3 to 8 percent slopes	Moderately suited	Kelly (95%)	Low strength (0.50)	1.5	0.9%
				Dusty (0.04)		
KrB	Kinkora silt loam, 3 to 8 percent slopes	Poorly suited	Kinkora (100%)	Wetness (1.00)	1.2	0.7%
				Low strength (0.50)		
				Slope (0.50)		
				Dusty (0.03)		
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	Moderately suited	Legore (85%)	Low strength (0.50)	13.5	7.9%
				Slope (0.50)		
				Dusty (0.03)		
			Montalto (10%)	Low strength (0.50)		
				Slope (0.50)		
				Dusty (0.03)		
			Gladstone (5%)	Low strength (0.50)		

Suitability for Roads (Natural Surface)— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)	Acres in AOI	Percent of AOI
				Slope (0.50)		
				Dusty (0.03)		
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	Moderately suited	Legore (85%)	Slope (0.50)	13.7	8.0%
				Low strength (0.50)		
				Dusty (0.03)		
			Montalto (10%)	Slope (0.50)		
				Low strength (0.50)		
				Dusty (0.03)		
			Gladstone (5%)	Slope (0.50)		
				Dusty (0.03)		
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	Poorly suited	Legore (100%)	Slope (1.00)	6.0	3.5%
				Low strength (0.50)		
				Dusty (0.03)		
LeE	Legore silt loam, 25 to 45 percent slopes	Poorly suited	Legore (100%)	Slope (1.00)	0.8	0.4%
				Low strength (0.50)		
				Dusty (0.03)		
LfE	Legore very stony silt loam, 25 to 45 percent slopes	Poorly suited	Legore (100%)	Slope (1.00)	1.9	1.1%
				Dusty (0.03)		
LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	Moderately suited	Legore (100%)	Slope (0.50)	23.0	13.5%
				Low strength (0.50)		
				Dusty (0.03)		
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	Poorly suited	Legore (100%)	Slope (1.00)	19.8	11.6%
				Low strength (0.50)		
				Dusty (0.03)		
MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	Moderately suited	Glenelg (50%)	Slope (0.50)	0.2	0.1%
				Low strength (0.50)		
				Dusty (0.03)		
			Manor (50%)	Slope (0.50)		
				Low strength (0.50)		
				Dusty (0.03)		
MsC2	Montalto silt loam, 8 to 15 percent slopes,	Moderately suited	Montalto (90%)	Slope (0.50)	11.1	6.5%
				Low strength (0.50)		

Suitability for Roads (Natural Surface)— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
	moderately eroded			Dusty (0.03)		
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	Moderately suited	Neshaminy, very deep over gabbro (85%)	Low strength (0.50)	10.7	6.3%
				Dusty (0.04)		
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	Moderately suited	Neshaminy, very deep over gabbro (90%)	Slope (0.50)	15.6	9.1%
				Low strength (0.50)		
				Dusty (0.04)		
Totals for Area of Interest					**170.3**	**100.0%**

Suitability for Roads (Natural Surface)— Summary by Rating Value		
Rating	**Acres in AOI**	**Percent of AOI**
Moderately suited	137.8	80.9%
Poorly suited	32.5	19.1%
Totals for Area of Interest	**170.3**	**100.0%**

Rating Options—Suitability for Roads (Natural Surface) (Bel Air Sites A and B)

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie. The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Water Management

Water Management interpretations are tools for evaluating the potential of the soil in the application of various water management practices. Example interpretations include pond reservoir area, embankments, dikes, levees, and excavated ponds.

Embankments, Dikes, and Levees (Bel Air Sites A and B)

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. Embankments that have zoned construction (core and shell) are not considered. The soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the suitability of the undisturbed soil for supporting the embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the specified use. "Not limited" indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. "Somewhat limited" indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected.

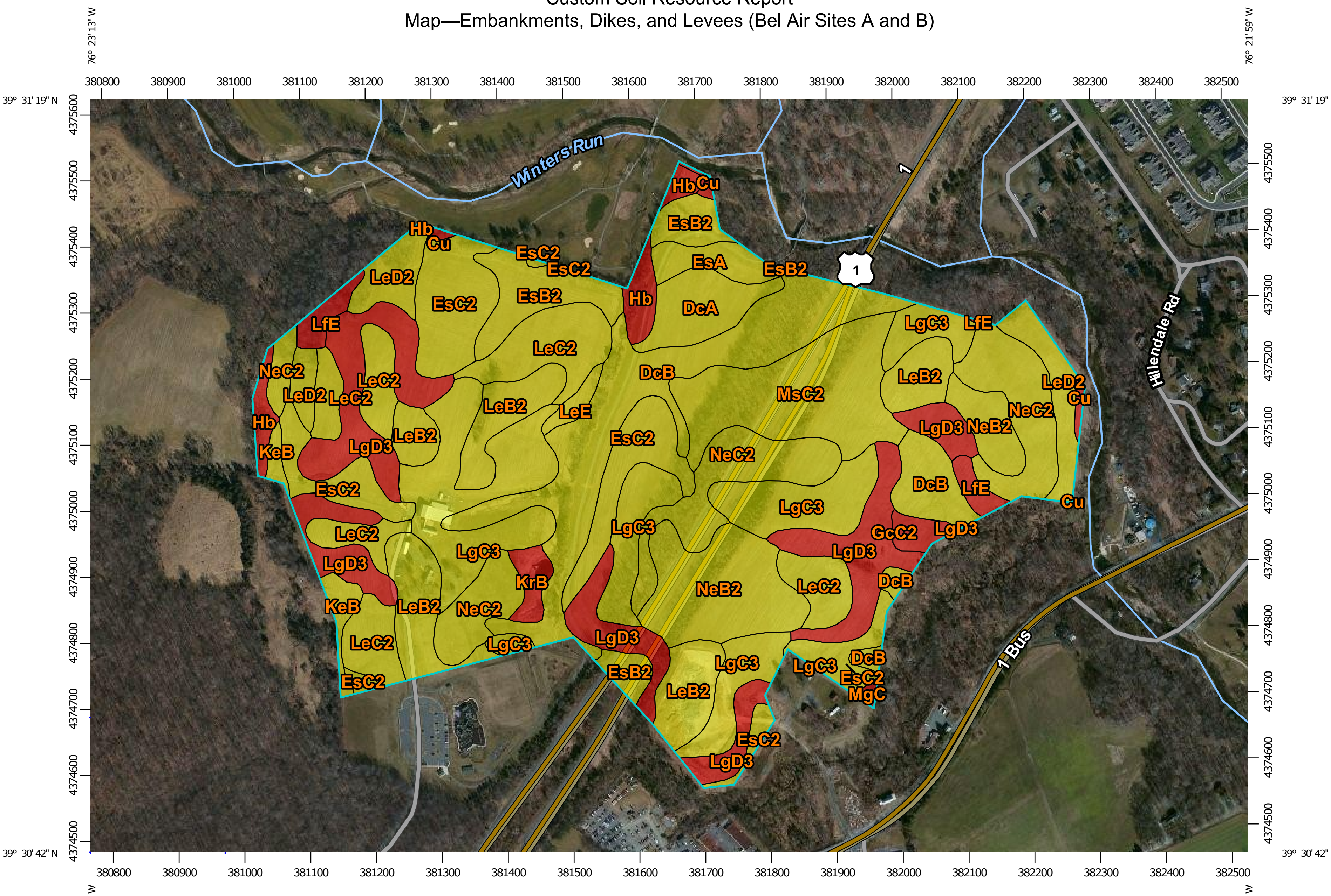
"Very limited" indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as listed for the map unit. The percent composition of each component in a particular map unit is presented to help the user better understand the percentage of each map unit that has the rating presented.

Other components with different ratings may be present in each map unit. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

Custom Soil Resource Report
Map—Embankments, Dikes, and Levees (Bel Air Sites A and B)



Map Scale: 1:8,040 if printed on A landscape (11" x 8.5") sheet.

Meters: 0 100 200 400 600

Feet: 0 350 700 1400 2100

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- Very limited
- Somewhat limited
- Not limited
- Not rated or not available

Soil Rating Lines
- Very limited
- Somewhat limited
- Not limited
- Not rated or not available

Soil Rating Points
- Very limited
- Somewhat limited
- Not limited
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Harford County Area, Maryland
Survey Area Data: Version 6, Dec 30, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 26, 2011—Mar 2, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Tables—Embankments, Dikes, and Levees (Bel Air Sites A and B)

Embankments, Dikes, and Levees— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
Cu	Codorus silt loam	Very limited	Codorus (85%)	Piping (1.00)	0.6	0.3%
				Depth to saturated zone (1.00)		
				Dusty (0.07)		
			Hatboro (15%)	Ponding (1.00)		
				Depth to saturated zone (1.00)		
				Piping (1.00)		
				Dusty (0.08)		
DcA	Delanco silt loam, 0 to 3 percent slopes	Somewhat limited	Delanco (85%)	Depth to saturated zone (1.00)	3.8	2.2%
				Piping (0.50)		
				Dusty (0.04)		
			Elsinboro (15%)	Dusty (0.05)		
DcB	Delanco silt loam, 3 to 8 percent slopes	Somewhat limited	Delanco (85%)	Depth to saturated zone (1.00)	19.5	11.5%
				Piping (0.50)		
				Dusty (0.04)		
			Elsinboro (15%)	Dusty (0.05)		
EsA	Elsinboro loam, 0 to 2 percent slopes	Somewhat limited	Elsinboro (85%)	Dusty (0.05)	2.1	1.2%
			Delanco, Piedmont (10%)	Depth to saturated zone (1.00)		
				Piping (0.50)		
				Dusty (0.04)		
EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	Somewhat limited	Elsinboro (85%)	Dusty (0.05)	6.7	3.9%
			Delanco (10%)	Depth to saturated zone (1.00)		
				Piping (0.50)		
				Dusty (0.04)		
EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	Somewhat limited	Elsinboro (85%)	Dusty (0.05)	15.0	8.8%
			Delanco (10%)	Depth to saturated zone (1.00)		
				Piping (0.50)		
				Dusty (0.04)		

Embankments, Dikes, and Levees— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)	Acres in AOI	Percent of AOI
GcC2	Glenelg loam, 8 to 15 percent slopes, moderately eroded	Very limited	Glenelg (85%)	Piping (1.00)	1.0	0.6%
				Dusty (0.03)		
Hb	Hatboro silt loam	Very limited	Hatboro (85%)	Ponding (1.00)	2.9	1.7%
				Depth to saturated zone (1.00)		
				Piping (1.00)		
				Dusty (0.08)		
			Codorus (15%)	Piping (1.00)		
				Depth to saturated zone (1.00)		
				Dusty (0.07)		
KeB	Kelly silt loam, 3 to 8 percent slopes	Somewhat limited	Kelly (95%)	Depth to saturated zone (1.00)	1.5	0.9%
				Hard to pack (0.20)		
				Dusty (0.04)		
KrB	Kinkora silt loam, 3 to 8 percent slopes	Very limited	Kinkora (100%)	Depth to saturated zone (1.00)	1.2	0.7%
				Dusty (0.03)		
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	Somewhat limited	Legore (85%)	Dusty (0.03)	13.5	7.9%
			Montalto (10%)	Dusty (0.03)		
			Gladstone (5%)	Dusty (0.03)		
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	Somewhat limited	Legore (85%)	Dusty (0.03)	13.7	8.0%
			Montalto (10%)	Dusty (0.03)		
			Gladstone (5%)	Dusty (0.03)		
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	Somewhat limited	Legore (100%)	Piping (0.50)	6.0	3.5%
				Dusty (0.03)		
LeE	Legore silt loam, 25 to 45 percent slopes	Somewhat limited	Legore (100%)	Piping (0.50)	0.8	0.4%
				Dusty (0.03)		
LfE	Legore very stony silt loam, 25 to 45 percent slopes	Very limited	Legore (100%)	Piping (1.00)	1.9	1.1%
				Dusty (0.03)		
LgC3	Legore silty clay loam, 8 to 15 percent slopes,	Somewhat limited	Legore (100%)	Piping (0.50)	23.0	13.5%

Embankments, Dikes, and Levees— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
	severely eroded			Dusty (0.03)		
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	Very limited	Legore (100%)	Piping (1.00)	19.8	11.6%
				Dusty (0.03)		
MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	Very limited	Glenelg (50%)	Piping (1.00)	0.2	0.1%
				Dusty (0.03)		
			Manor (50%)	Piping (1.00)		
				Dusty (0.03)		
MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	Somewhat limited	Montalto (90%)	Dusty (0.03)	11.1	6.5%
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	Somewhat limited	Neshaminy, very deep over gabbro (85%)	Piping (0.50)	10.7	6.3%
				Dusty (0.04)		
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	Somewhat limited	Neshaminy, very deep over gabbro (90%)	Piping (0.50)	15.6	9.1%
				Dusty (0.04)		
Totals for Area of Interest					**170.3**	**100.0%**

Embankments, Dikes, and Levees— Summary by Rating Value		
Rating	**Acres in AOI**	**Percent of AOI**
Somewhat limited	142.8	83.9%
Very limited	27.5	16.1%
Totals for Area of Interest	**170.3**	**100.0%**

Rating Options—Embankments, Dikes, and Levees (Bel Air Sites A and B)

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie. The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Pond Reservoir Areas (Bel Air Sites A and B)

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the saturated hydraulic conductivity (Ksat) of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

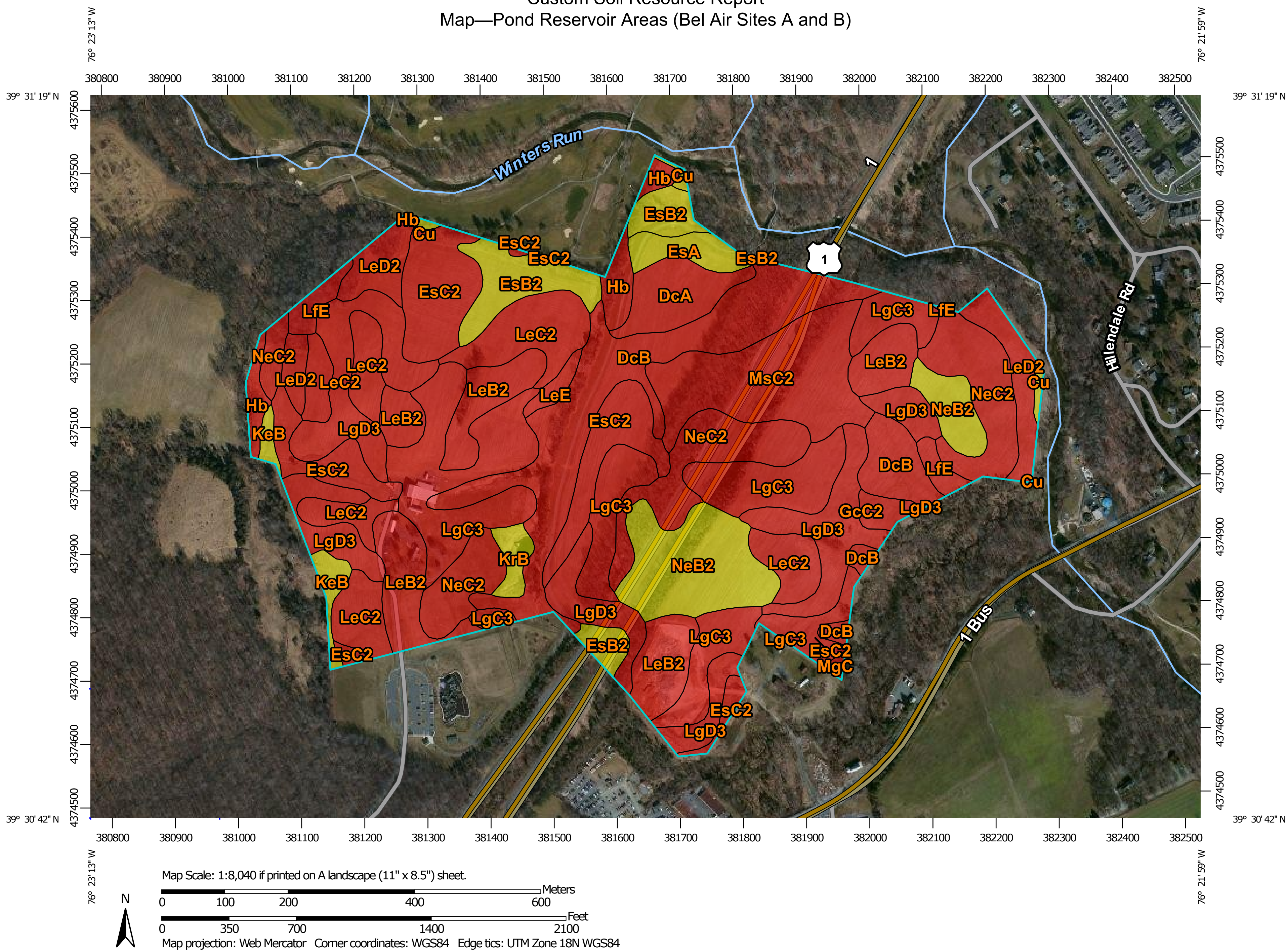
The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the specified use. "Not limited" indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. "Somewhat limited" indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. "Very limited" indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as listed for the map unit. The percent composition of each component in a particular map unit is presented to help the user better understand the percentage of each map unit that has the rating presented.

Other components with different ratings may be present in each map unit. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

Custom Soil Resource Report
Map—Pond Reservoir Areas (Bel Air Sites A and B)



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

Very limited

Somewhat limited

Not limited

Not rated or not available

Soil Rating Lines

Very limited

Somewhat limited

Not limited

Not rated or not available

Soil Rating Points

Very limited

Somewhat limited

Not limited

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Harford County Area, Maryland
Survey Area Data: Version 6, Dec 30, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 26, 2011—Mar 2, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Tables—Pond Reservoir Areas (Bel Air Sites A and B)

Pond Reservoir Areas— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)	Acres in AOI	Percent of AOI
Cu	Codorus silt loam	Somewhat limited	Codorus (85%)	Seepage (0.70)	0.6	0.3%
DcA	Delanco silt loam, 0 to 3 percent slopes	Very limited	Delanco (85%)	Seepage (1.00)	3.8	2.2%
DcB	Delanco silt loam, 3 to 8 percent slopes	Very limited	Delanco (85%)	Seepage (1.00)	19.5	11.5%
				Slope (0.32)		
EsA	Elsinboro loam, 0 to 2 percent slopes	Somewhat limited	Elsinboro (85%)	Seepage (0.70)	2.1	1.2%
			Glenelg (5%)	Seepage (0.72)		
EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	Somewhat limited	Elsinboro (85%)	Seepage (0.70)	6.7	3.9%
				Slope (0.32)		
			Glenelg (5%)	Seepage (0.72)		
				Slope (0.68)		
EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	Very limited	Elsinboro (85%)	Slope (1.00)	15.0	8.8%
				Seepage (0.70)		
			Delanco (10%)	Slope (1.00)		
				Seepage (1.00)		
			Glenelg (5%)	Slope (1.00)		
				Seepage (0.72)		
GcC2	Glenelg loam, 8 to 15 percent slopes, moderately eroded	Very limited	Glenelg (85%)	Slope (1.00)	1.0	0.6%
				Seepage (0.72)		
			Gaila (10%)	Seepage (1.00)		
				Slope (1.00)		
			Manor (5%)	Slope (1.00)		
				Seepage (1.00)		
Hb	Hatboro silt loam	Very limited	Hatboro (85%)	Seepage (1.00)	2.9	1.7%
KeB	Kelly silt loam, 3 to 8 percent slopes	Somewhat limited	Kelly (95%)	Seepage (0.46)	1.5	0.9%
				Slope (0.32)		
				Depth to bedrock (0.11)		
			WATCHUNG (5%)	Slope (0.68)		
				Seepage (0.53)		
KrB	Kinkora silt loam, 3 to 8 percent slopes	Somewhat limited	Kinkora (100%)	Seepage (0.70)	1.2	0.7%
				Slope (0.68)		
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	Very limited	Legore (85%)	Seepage (1.00)	13.5	7.9%
				Slope (0.68)		
			Gladstone (5%)	Seepage (1.00)		

Pond Reservoir Areas— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
				Slope (0.68)		
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	Very limited	Legore (85%)	Seepage (1.00)	13.7	8.0%
				Slope (1.00)		
			Montalto (10%)	Slope (1.00)		
				Seepage (0.70)		
			Gladstone (5%)	Seepage (1.00)		
				Slope (1.00)		
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	Very limited	Legore (100%)	Slope (1.00)	6.0	3.5%
				Seepage (1.00)		
LeE	Legore silt loam, 25 to 45 percent slopes	Very limited	Legore (100%)	Slope (1.00)	0.8	0.4%
				Seepage (1.00)		
LfE	Legore very stony silt loam, 25 to 45 percent slopes	Very limited	Legore (100%)	Slope (1.00)	1.9	1.1%
				Seepage (1.00)		
LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	Very limited	Legore (100%)	Slope (1.00)	23.0	13.5%
				Seepage (1.00)		
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	Very limited	Legore (100%)	Slope (1.00)	19.8	11.6%
				Seepage (1.00)		
MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	Very limited	Glenelg (50%)	Seepage (1.00)	0.2	0.1%
				Slope (1.00)		
			Manor (50%)	Seepage (1.00)		
				Slope (1.00)		
MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	Very limited	Montalto (90%)	Slope (1.00)	11.1	6.5%
				Seepage (0.12)		
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	Somewhat limited	Neshaminy, very deep over gabbro (85%)	Seepage (0.12)	10.7	6.3%
				Slope (0.08)		
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	Very limited	Neshaminy, very deep over gabbro (90%)	Slope (1.00)	15.6	9.1%
				Seepage (0.12)		
Totals for Area of Interest					**170.3**	**100.0%**

Pond Reservoir Areas— Summary by Rating Value		
Rating	**Acres in AOI**	**Percent of AOI**
Very limited	147.6	86.7%
Somewhat limited	22.7	13.3%
Totals for Area of Interest	**170.3**	**100.0%**

Rating Options—Pond Reservoir Areas (Bel Air Sites A and B)

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie. The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Surface Water Management, System (Bel Air Sites A and B)

The ratings for Surface Water Management, System are based on the soil properties that affect the capacity of the soil to convey surface water across the landscape. Factors affecting the system installation and performance are considered. Water conveyances include graded ditches, grassed waterways, terraces, and diversions. The ratings are for soils in their natural condition and do not consider present land use. The properties that affect the surface system performance include depth to bedrock, saturated hydraulic conductivity, depth to cemented pan, slope, flooding, ponding, large stone content, sodicity, surface water erosion, and gypsum content.

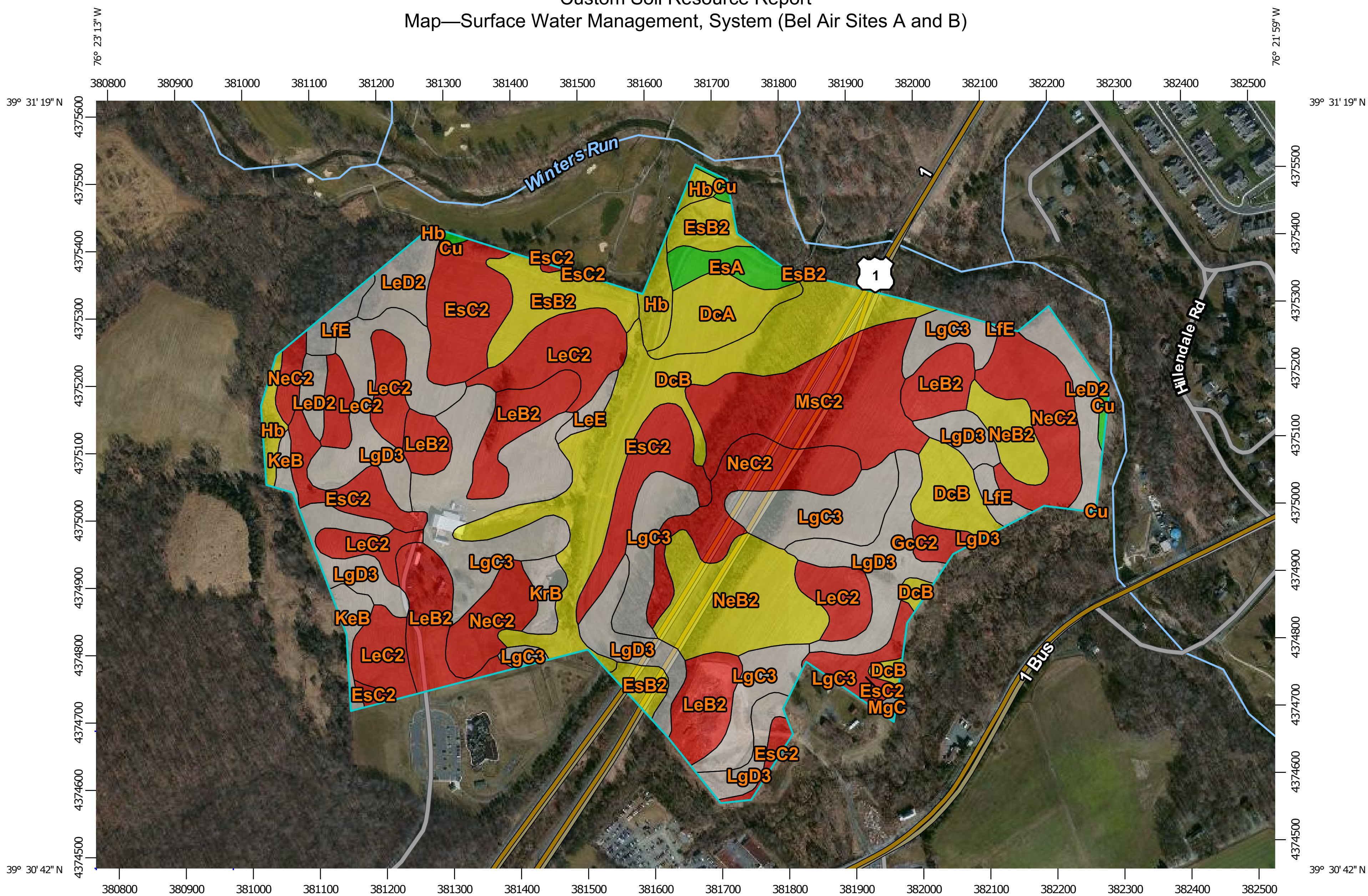
The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the specified use. "Not limited" indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. "Somewhat limited" indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. "Very limited" indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures.

Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as that listed for the map unit. The percent composition of each component in a particular map unit is given so that the user will realize the percentage of each map unit that has the specified rating.

A map unit may have other components with different ratings. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

Custom Soil Resource Report
Map—Surface Water Management, System (Bel Air Sites A and B)



Map Scale: 1:8,040 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 100, 200, 400, 600

Feet: 0, 350, 700, 1400, 2100

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

Very limited

Somewhat limited

Not limited

Not rated or not available

Soil Rating Lines

Very limited

Somewhat limited

Not limited

Not rated or not available

Soil Rating Points

Very limited

Somewhat limited

Not limited

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Harford County Area, Maryland
Survey Area Data: Version 6, Dec 30, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 26, 2011—Mar 2, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Tables—Surface Water Management, System (Bel Air Sites A and B)

Surface Water Management, System— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
Cu	Codorus silt loam	Not limited	Codorus (85%)		0.6	0.3%
DcA	Delanco silt loam, 0 to 3 percent slopes	Somewhat limited	Delanco (85%)	Slow water movement (0.20)	3.8	2.2%
DcB	Delanco silt loam, 3 to 8 percent slopes	Somewhat limited	Delanco (85%)	Slope (0.78)	19.5	11.5%
				Water Erosion (0.36)		
				Slow water movement (0.20)		
			Elsinboro (15%)	Water Erosion (0.85)		
				Slope (0.78)		
EsA	Elsinboro loam, 0 to 2 percent slopes	Not limited	Elsinboro (85%)		2.1	1.2%
EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	Somewhat limited	Elsinboro (85%)	Water Erosion (0.85)	6.7	3.9%
				Slope (0.78)		
			Delanco (10%)	Slope (0.78)		
				Water Erosion (0.36)		
				Slow water movement (0.20)		
EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	Very limited	Elsinboro (85%)	Slope (1.00)	15.0	8.8%
				Water Erosion (1.00)		
			Delanco (10%)	Slope (1.00)		
				Water Erosion (1.00)		
				Slow water movement (0.20)		
			Glenelg (5%)	Slope (1.00)		
				Water Erosion (1.00)		
				Large rock fragments (0.14)		
GcC2	Glenelg loam, 8 to 15 percent slopes,	Very limited	Glenelg (85%)	Slope (1.00)	1.0	0.6%

Surface Water Management, System— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)	Acres in AOI	Percent of AOI
	moderately eroded			Water Erosion (1.00)		
				Large rock fragments (0.14)		
			Gaila (10%)	Slope (1.00)		
				Water Erosion (1.00)		
				Large rock fragments (0.29)		
			Manor (5%)	Slope (1.00)		
				Water Erosion (1.00)		
Hb	Hatboro silt loam	Somewhat limited	Hatboro (85%)	Ponding (0.50)	2.9	1.7%
				Flooding (0.40)		
				Slow water movement (0.29)		
KeB	Kelly silt loam, 3 to 8 percent slopes	Not Rated	Kelly (95%)		1.5	0.9%
			WATCHUNG (5%)			
KrB	Kinkora silt loam, 3 to 8 percent slopes	Not Rated	Kinkora (100%)		1.2	0.7%
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	Very limited	Legore (85%)	Slope (1.00)	13.5	7.9%
				Slow water movement (0.29)		
			Montalto (10%)	Slope (1.00)		
				Water Erosion (0.10)		
			Gladstone (5%)	Slope (1.00)		
				Water Erosion (0.10)		
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	Very limited	Legore (85%)	Slope (1.00)	13.7	8.0%
				Slow water movement (0.29)		
			Montalto (10%)	Slope (1.00)		
				Water Erosion (0.94)		
			Gladstone (5%)	Slope (1.00)		
				Water Erosion (0.94)		

Surface Water Management, System— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	Not Rated	Legore (100%)		6.0	3.5%
LeE	Legore silt loam, 25 to 45 percent slopes	Not Rated	Legore (100%)		0.8	0.4%
LfE	Legore very stony silt loam, 25 to 45 percent slopes	Not Rated	Legore (100%)		1.9	1.1%
LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	Not Rated	Legore (100%)		23.0	13.5%
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	Not Rated	Legore (100%)		19.8	11.6%
MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	Not Rated	Glenelg (50%)		0.2	0.1%
			Manor (50%)			
MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	Very limited	Montalto (90%)	Slope (1.00)	11.1	6.5%
				Water Erosion (0.94)		
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	Somewhat limited	Neshaminy, very deep over gabbro (85%)	Slope (0.22)	10.7	6.3%
				Water Erosion (0.12)		
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	Very limited	Neshaminy, very deep over gabbro (90%)	Slope (1.00)	15.6	9.1%
				Water Erosion (1.00)		
Totals for Area of Interest					**170.3**	**100.0%**

Surface Water Management, System— Summary by Rating Value		
Rating	**Acres in AOI**	**Percent of AOI**
Very limited	69.8	41.0%
Not Rated	54.3	31.9%
Somewhat limited	43.6	25.6%
Not limited	2.6	1.6%
Null or Not Rated	54.3	31.9%
Totals for Area of Interest	**170.3**	**100.0%**

Rating Options—Surface Water Management, System (Bel Air Sites A and B)

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie. The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Pond Reservoir Areas (Bel Air Sites A and B)

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the saturated hydraulic conductivity (Ksat) of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

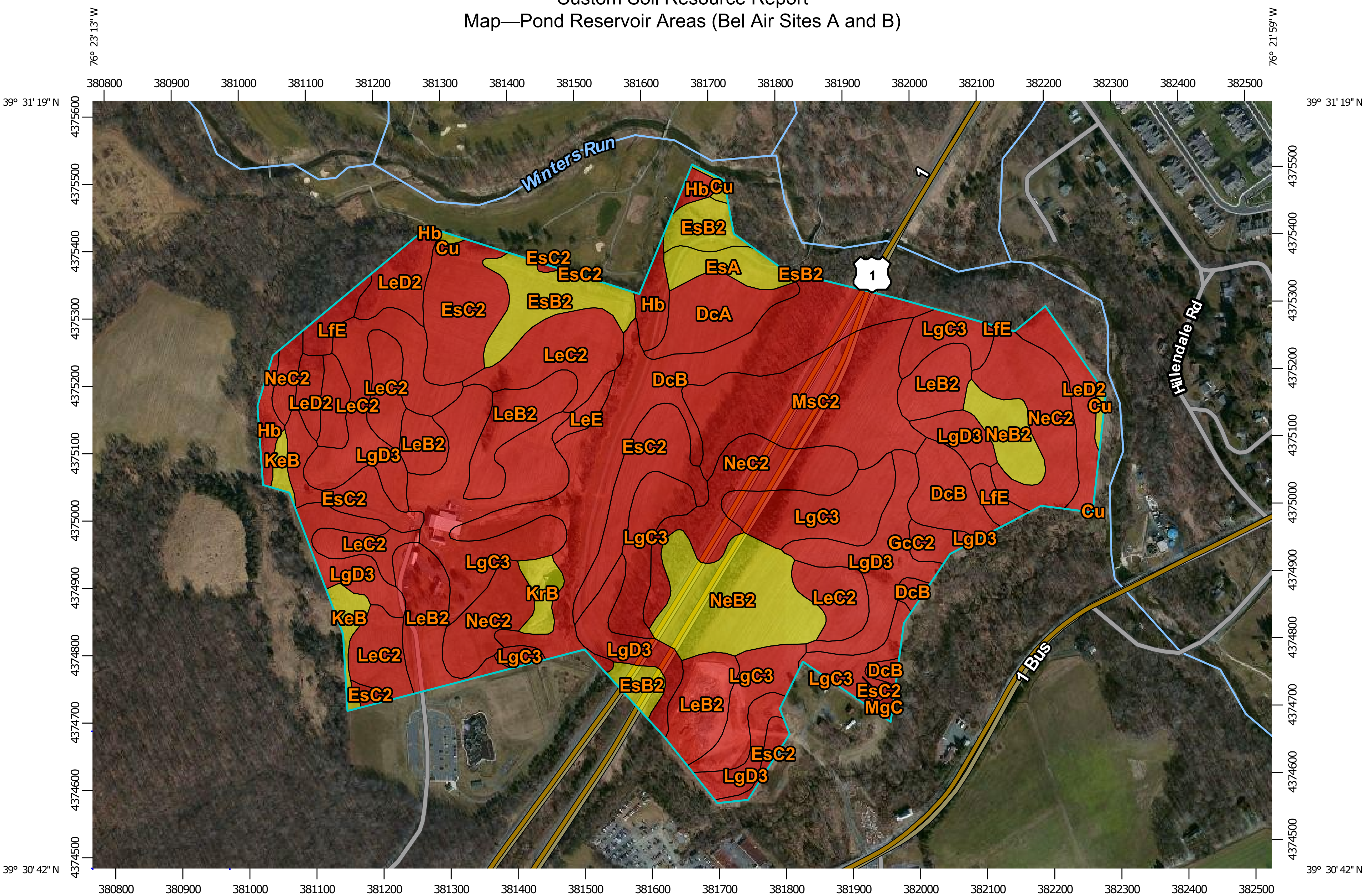
The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the specified use. "Not limited" indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. "Somewhat limited" indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. "Very limited" indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as listed for the map unit. The percent composition of each component in a particular map unit is presented to help the user better understand the percentage of each map unit that has the rating presented.

Other components with different ratings may be present in each map unit. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

Custom Soil Resource Report
Map—Pond Reservoir Areas (Bel Air Sites A and B)



Map Scale: 1:8,040 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 100, 200, 400, 600

Feet: 0, 350, 700, 1400, 2100

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- Very limited
- Somewhat limited
- Not limited
- Not rated or not available

Soil Rating Lines

- Very limited
- Somewhat limited
- Not limited
- Not rated or not available

Soil Rating Points

- Very limited
- Somewhat limited
- Not limited
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Harford County Area, Maryland
Survey Area Data: Version 6, Dec 30, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 26, 2011—Mar 2, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Tables—Pond Reservoir Areas (Bel Air Sites A and B)

Pond Reservoir Areas— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
Cu	Codorus silt loam	Somewhat limited	Codorus (85%)	Seepage (0.70)	0.6	0.3%
DcA	Delanco silt loam, 0 to 3 percent slopes	Very limited	Delanco (85%)	Seepage (1.00)	3.8	2.2%
DcB	Delanco silt loam, 3 to 8 percent slopes	Very limited	Delanco (85%)	Seepage (1.00)	19.5	11.5%
				Slope (0.32)		
EsA	Elsinboro loam, 0 to 2 percent slopes	Somewhat limited	Elsinboro (85%)	Seepage (0.70)	2.1	1.2%
			Glenelg (5%)	Seepage (0.72)		
EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	Somewhat limited	Elsinboro (85%)	Seepage (0.70)	6.7	3.9%
				Slope (0.32)		
			Glenelg (5%)	Seepage (0.72)		
				Slope (0.68)		
EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	Very limited	Elsinboro (85%)	Slope (1.00)	15.0	8.8%
				Seepage (0.70)		
			Delanco (10%)	Slope (1.00)		
				Seepage (1.00)		
			Glenelg (5%)	Slope (1.00)		
				Seepage (0.72)		
GcC2	Glenelg loam, 8 to 15 percent slopes, moderately eroded	Very limited	Glenelg (85%)	Slope (1.00)	1.0	0.6%
				Seepage (0.72)		
			Gaila (10%)	Seepage (1.00)		
				Slope (1.00)		
			Manor (5%)	Slope (1.00)		
				Seepage (1.00)		
Hb	Hatboro silt loam	Very limited	Hatboro (85%)	Seepage (1.00)	2.9	1.7%
KeB	Kelly silt loam, 3 to 8 percent slopes	Somewhat limited	Kelly (95%)	Seepage (0.46)	1.5	0.9%
				Slope (0.32)		
				Depth to bedrock (0.11)		
			WATCHUNG (5%)	Slope (0.68)		
				Seepage (0.53)		
KrB	Kinkora silt loam, 3 to 8 percent slopes	Somewhat limited	Kinkora (100%)	Seepage (0.70)	1.2	0.7%
				Slope (0.68)		
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	Very limited	Legore (85%)	Seepage (1.00)	13.5	7.9%
				Slope (0.68)		
			Gladstone (5%)	Seepage (1.00)		

Pond Reservoir Areas— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
				Slope (0.68)		
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	Very limited	Legore (85%)	Seepage (1.00)	13.7	8.0%
				Slope (1.00)		
			Montalto (10%)	Slope (1.00)		
				Seepage (0.70)		
			Gladstone (5%)	Seepage (1.00)		
				Slope (1.00)		
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	Very limited	Legore (100%)	Slope (1.00)	6.0	3.5%
				Seepage (1.00)		
LeE	Legore silt loam, 25 to 45 percent slopes	Very limited	Legore (100%)	Slope (1.00)	0.8	0.4%
				Seepage (1.00)		
LfE	Legore very stony silt loam, 25 to 45 percent slopes	Very limited	Legore (100%)	Slope (1.00)	1.9	1.1%
				Seepage (1.00)		
LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	Very limited	Legore (100%)	Slope (1.00)	23.0	13.5%
				Seepage (1.00)		
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	Very limited	Legore (100%)	Slope (1.00)	19.8	11.6%
				Seepage (1.00)		
MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	Very limited	Glenelg (50%)	Seepage (1.00)	0.2	0.1%
				Slope (1.00)		
			Manor (50%)	Seepage (1.00)		
				Slope (1.00)		
MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	Very limited	Montalto (90%)	Slope (1.00)	11.1	6.5%
				Seepage (0.12)		
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	Somewhat limited	Neshaminy, very deep over gabbro (85%)	Seepage (0.12)	10.7	6.3%
				Slope (0.08)		
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	Very limited	Neshaminy, very deep over gabbro (90%)	Slope (1.00)	15.6	9.1%
				Seepage (0.12)		
Totals for Area of Interest					**170.3**	**100.0%**

Pond Reservoir Areas— Summary by Rating Value		
Rating	**Acres in AOI**	**Percent of AOI**
Very limited	147.6	86.7%
Somewhat limited	22.7	13.3%
Totals for Area of Interest	**170.3**	**100.0%**

Rating Options—Pond Reservoir Areas (Bel Air Sites A and B)

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie. The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Subsurface Water Management, Outflow Quality (Bel Air Sites A and B)

The ratings for Subsurface Water Management, Outflow Quality are based on the soil properties that affect the capacity of the soil to convey surface and subsurface water and on the properties that affect water quality. The properties that affect the conveyance and water quality include salinity, sodicity, soil reaction, soil taxonomic great group placement, gypsum content, shrink-swell potential, soil saturation, and surface erosion.

The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the specified use. "Not limited" indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. "Somewhat limited" indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. "Very limited" indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor water quality can be expected.

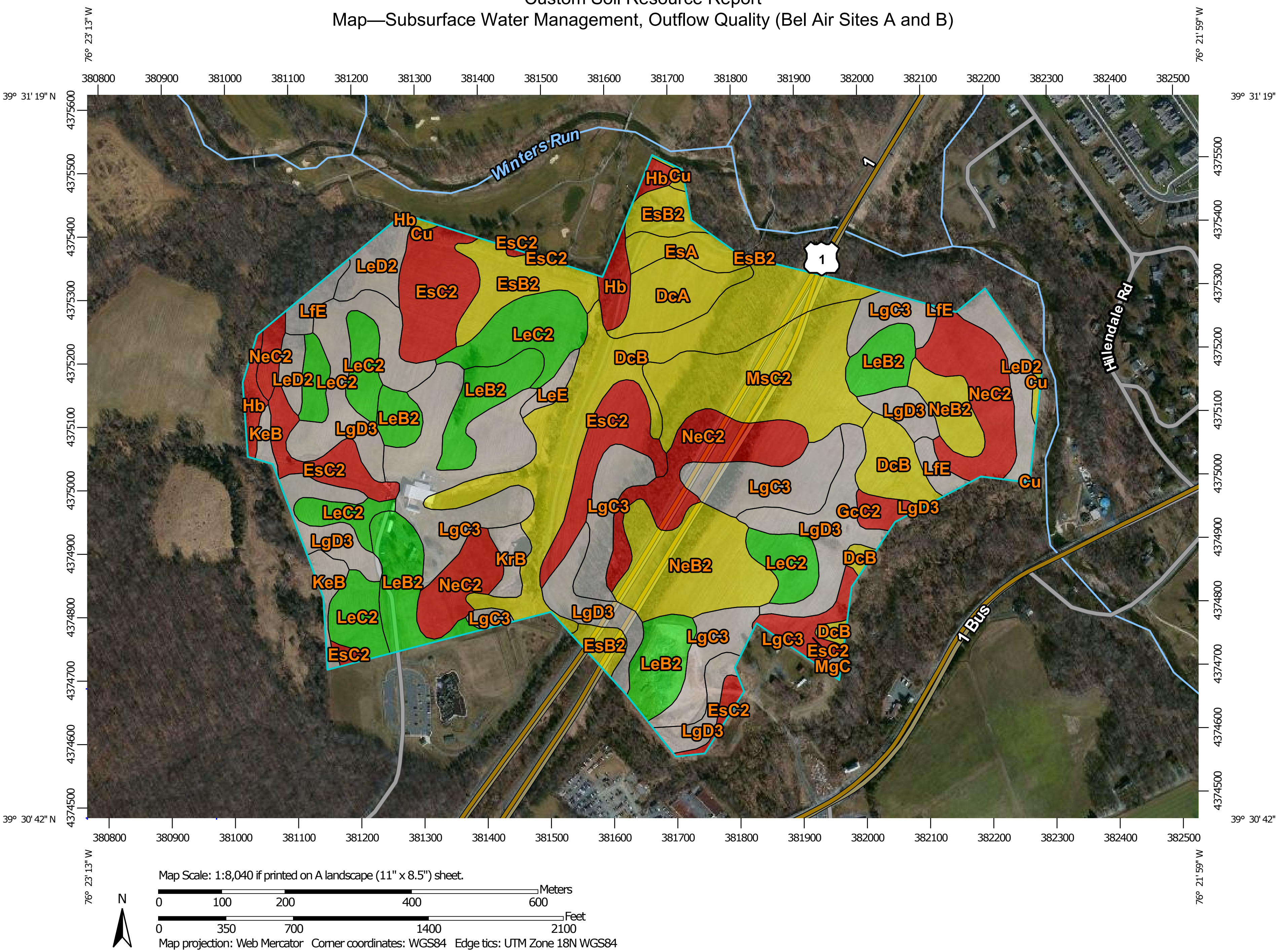
Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as that listed for the map unit. The percent composition of each component in a particular map unit is given so that the user will realize the percentage of each map unit that has the specified rating.

A map unit may have other components with different ratings. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

Custom Soil Resource Report

Map—Subsurface Water Management, Outflow Quality (Bel Air Sites A and B)



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- Very limited
- Somewhat limited
- Not limited
- Not rated or not available

Soil Rating Lines
- Very limited
- Somewhat limited
- Not limited
- Not rated or not available

Soil Rating Points
- Very limited
- Somewhat limited
- Not limited
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Harford County Area, Maryland
Survey Area Data: Version 6, Dec 30, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 26, 2011—Mar 2, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Tables—Subsurface Water Management, Outflow Quality (Bel Air Sites A and B)

Subsurface Water Management, Outflow Quality— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
Cu	Codorus silt loam	Somewhat limited	Codorus (85%)	Pesticide and nutrient movement (0.99)	0.6	0.3%
DcA	Delanco silt loam, 0 to 3 percent slopes	Somewhat limited	Delanco (85%)	Pesticide and nutrient movement (0.99)	3.8	2.2%
			Elsinboro (15%)	Pesticide and nutrient movement (0.22)		
DcB	Delanco silt loam, 3 to 8 percent slopes	Somewhat limited	Delanco (85%)	Pesticide and nutrient movement (0.99)	19.5	11.5%
				Water Erosion (0.36)		
			Elsinboro (15%)	Water Erosion (0.85)		
				Pesticide and nutrient movement (0.22)		
EsA	Elsinboro loam, 0 to 2 percent slopes	Somewhat limited	Elsinboro (85%)	Pesticide and nutrient movement (0.22)	2.1	1.2%
			Delanco, Piedmont (10%)	Pesticide and nutrient movement (0.99)		
			Glenelg (5%)	Pesticide and nutrient movement (0.00)		
EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	Somewhat limited	Elsinboro (85%)	Water Erosion (0.85)	6.7	3.9%
				Pesticide and nutrient movement (0.22)		
			Delanco (10%)	Pesticide and nutrient movement (0.99)		
				Water Erosion (0.36)		

Subsurface Water Management, Outflow Quality— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)	Acres in AOI	Percent of AOI
			Glenelg (5%)	Water Erosion (0.23)		
				Pesticide and nutrient movement (0.00)		
EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	Very limited	Elsinboro (85%)	Water Erosion (1.00)	15.0	8.8%
				Pesticide and nutrient movement (0.22)		
			Delanco (10%)	Water Erosion (1.00)		
				Pesticide and nutrient movement (0.99)		
			Glenelg (5%)	Water Erosion (1.00)		
				Pesticide and nutrient movement (0.00)		
GcC2	Glenelg loam, 8 to 15 percent slopes, moderately eroded	Very limited	Glenelg (85%)	Water Erosion (1.00)	1.0	0.6%
				Pesticide and nutrient movement (0.00)		
			Gaila (10%)	Water Erosion (1.00)		
				Pesticide and nutrient movement (0.22)		
			Manor (5%)	Water Erosion (1.00)		
				Pesticide and nutrient movement (0.22)		
Hb	Hatboro silt loam	Very limited	Hatboro (85%)	Pesticide and nutrient movement (1.00)	2.9	1.7%
KeB	Kelly silt loam, 3 to 8 percent slopes	Not Rated	Kelly (95%)		1.5	0.9%
			WATCHUNG (5%)			
KrB	Kinkora silt loam, 3 to 8 percent slopes	Not Rated	Kinkora (100%)		1.2	0.7%

Subsurface Water Management, Outflow Quality— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)	Acres in AOI	Percent of AOI
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	Not limited	Legore (85%)		13.5	7.9%
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	Not limited	Legore (85%)		13.7	8.0%
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	Not Rated	Legore (100%)		6.0	3.5%
LeE	Legore silt loam, 25 to 45 percent slopes	Not Rated	Legore (100%)		0.8	0.4%
LfE	Legore very stony silt loam, 25 to 45 percent slopes	Not Rated	Legore (100%)		1.9	1.1%
LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	Not Rated	Legore (100%)		23.0	13.5%
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	Not Rated	Legore (100%)		19.8	11.6%
MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	Not Rated	Glenelg (50%)		0.2	0.1%
			Manor (50%)			
MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	Somewhat limited	Montalto (90%)	Water Erosion (0.94)	11.1	6.5%
				Pesticide and nutrient movement (0.00)		
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	Somewhat limited	Neshaminy, very deep over gabbro (85%)	Water Erosion (0.12)	10.7	6.3%
				Pesticide and nutrient movement (0.00)		
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	Very limited	Neshaminy, very deep over gabbro (90%)	Water Erosion (1.00)	15.6	9.1%

Subsurface Water Management, Outflow Quality— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
				Pesticide and nutrient movement (0.00)		
Totals for Area of Interest					**170.3**	**100.0%**

Subsurface Water Management, Outflow Quality— Summary by Rating Value		
Rating	**Acres in AOI**	**Percent of AOI**
Not Rated	54.3	31.9%
Somewhat limited	54.4	32.0%
Very limited	34.4	20.2%
Not limited	27.1	15.9%
Null or Not Rated	54.3	31.9%
Totals for Area of Interest	**170.3**	**100.0%**

Rating Options—Subsurface Water Management, Outflow Quality (Bel Air Sites A and B)

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie. The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Subsurface Water Management, System Installation (Bel Air Sites A and B)

The ratings for Subsurface Water Management, System Installation are based on the soil properties that affect the capacity of the soil to be drained and on the properties that affect excavation and construction costs. The properties that affect the subsurface system installation include depth to a water table, ponding, flooding, slope, depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, slope, clay content, excavation stability, and the amount and size of rock fragments.

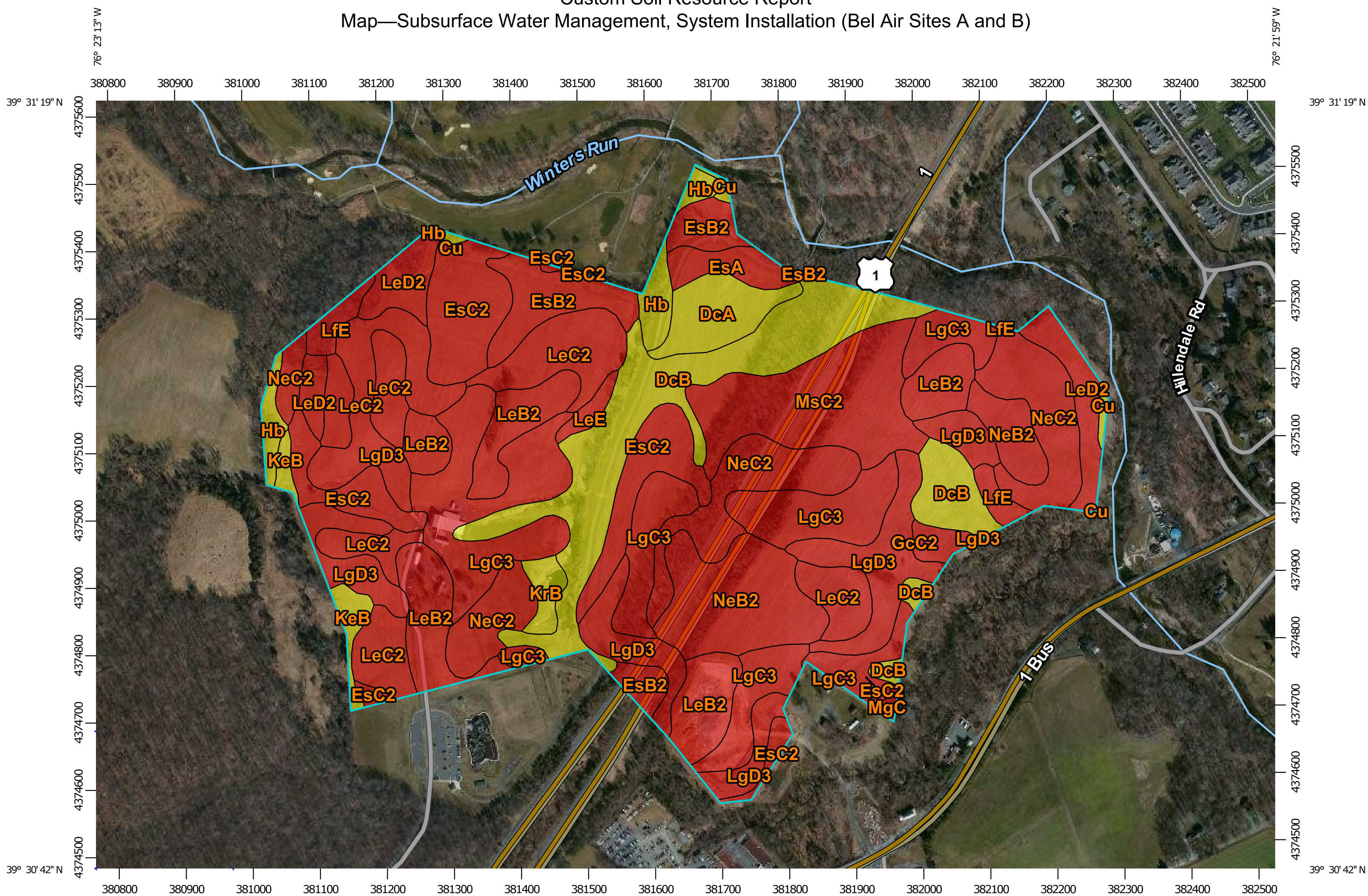
The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the specified use. "Not limited" indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. "Somewhat limited" indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. "Very limited" indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures.

Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as that listed for the map unit. The percent composition of each component in a particular map unit is given so that the user will realize the percentage of each map unit that has the specified rating.

A map unit may have other components with different ratings. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

Map—Subsurface Water Management, System Installation (Bel Air Sites A and B)



Map Scale: 1:8,040 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 350 700 1400 2100

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

Very limited

Somewhat limited

Not limited

Not rated or not available

Soil Rating Lines

Very limited

Somewhat limited

Not limited

Not rated or not available

Soil Rating Points

Very limited

Somewhat limited

Not limited

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Harford County Area, Maryland
Survey Area Data: Version 6, Dec 30, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 26, 2011—Mar 2, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Tables—Subsurface Water Management, System Installation (Bel Air Sites A and B)

Subsurface Water Management, System Installation— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
Cu	Codorus silt loam	Somewhat limited	Codorus (85%)	Unstable excavation walls (0.01)	0.6	0.3%
			Hatboro (15%)	Unstable excavation walls (0.01)		
DcA	Delanco silt loam, 0 to 3 percent slopes	Somewhat limited	Delanco (85%)	Unstable excavation walls (0.01)	3.8	2.2%
DcB	Delanco silt loam, 3 to 8 percent slopes	Somewhat limited	Delanco (85%)	Unstable excavation walls (0.01)	19.5	11.5%
EsA	Elsinboro loam, 0 to 2 percent slopes	Very limited	Elsinboro (85%)	Drainage not required (1.00)	2.1	1.2%
				Unstable excavation walls (0.01)		
			Glenelg (5%)	Drainage not required (1.00)		
				Unstable excavation walls (0.01)		
EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	Very limited	Elsinboro (85%)	Drainage not required (1.00)	6.7	3.9%
				Unstable excavation walls (0.01)		
			Glenelg (5%)	Drainage not required (1.00)		
				Unstable excavation walls (0.01)		
EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	Very limited	Elsinboro (85%)	Drainage not required (1.00)	15.0	8.8%
				Slope (0.61)		
				Unstable excavation walls (0.01)		
			Glenelg (5%)	Drainage not required (1.00)		
				Slope (0.78)		
				Unstable excavation walls (0.01)		

Subsurface Water Management, System Installation— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
GcC2	Glenelg loam, 8 to 15 percent slopes, moderately eroded	Very limited	Glenelg (85%)	Drainage not required (1.00)	1.0	0.6%
				Slope (0.78)		
				Unstable excavation walls (0.01)		
			Gaila (10%)	Drainage not required (1.00)		
				Slope (0.78)		
				Unstable excavation walls (0.01)		
			Manor (5%)	Drainage not required (1.00)		
				Slope (0.78)		
				Unstable excavation walls (0.01)		
Hb	Hatboro silt loam	Somewhat limited	Hatboro (85%)	Unstable excavation walls (0.01)	2.9	1.7%
			Codorus (15%)	Unstable excavation walls (0.01)		
KeB	Kelly silt loam, 3 to 8 percent slopes	Somewhat limited	Kelly (95%)	Unstable excavation walls (0.51)	1.5	0.9%
			WATCHUNG (5%)	Clay content (0.31)		
				Unstable excavation walls (0.01)		
KrB	Kinkora silt loam, 3 to 8 percent slopes	Somewhat limited	Kinkora (100%)	Unstable excavation walls (0.01)	1.2	0.7%
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	Very limited	Legore (85%)	Drainage not required (1.00)	13.5	7.9%
				Unstable excavation walls (0.01)		
			Montalto (10%)	Drainage not required (1.00)		
				Unstable excavation walls (0.01)		
			Gladstone (5%)	Drainage not required (1.00)		
				Unstable excavation walls (0.01)		

Subsurface Water Management, System Installation— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	Very limited	Legore (85%)	Drainage not required (1.00)	13.7	8.0%
				Slope (0.61)		
				Unstable excavation walls (0.01)		
			Montalto (10%)	Drainage not required (1.00)		
				Slope (0.61)		
				Unstable excavation walls (0.01)		
			Gladstone (5%)	Drainage not required (1.00)		
				Slope (0.61)		
				Unstable excavation walls (0.01)		
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	Very limited	Legore (100%)	Drainage not required (1.00)	6.0	3.5%
				Slope (1.00)		
				Unstable excavation walls (0.01)		
LeE	Legore silt loam, 25 to 45 percent slopes	Very limited	Legore (100%)	Drainage not required (1.00)	0.8	0.4%
				Slope (1.00)		
				Unstable excavation walls (0.01)		
LfE	Legore very stony silt loam, 25 to 45 percent slopes	Very limited	Legore (100%)	Drainage not required (1.00)	1.9	1.1%
				Slope (1.00)		
				Unstable excavation walls (0.01)		
LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	Very limited	Legore (100%)	Drainage not required (1.00)	23.0	13.5%
				Slope (0.78)		
				Unstable excavation walls (0.01)		
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	Very limited	Legore (100%)	Drainage not required (1.00)	19.8	11.6%
				Slope (1.00)		
				Unstable excavation walls (0.01)		

Subsurface Water Management, System Installation— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	Very limited	Glenelg (50%)	Drainage not required (1.00)	0.2	0.1%
				Slope (0.22)		
				Unstable excavation walls (0.01)		
			Manor (50%)	Drainage not required (1.00)		
				Slope (0.22)		
				Unstable excavation walls (0.01)		
MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	Very limited	Montalto (90%)	Drainage not required (1.00)	11.1	6.5%
				Slope (0.61)		
				Unstable excavation walls (0.01)		
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	Very limited	Neshaminy, very deep over gabbro (85%)	Drainage not required (1.00)	10.7	6.3%
				Unstable excavation walls (0.01)		
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	Very limited	Neshaminy, very deep over gabbro (90%)	Drainage not required (1.00)	15.6	9.1%
				Slope (0.78)		
				Unstable excavation walls (0.01)		
Totals for Area of Interest					**170.3**	**100.0%**

Subsurface Water Management, System Installation— Summary by Rating Value		
Rating	**Acres in AOI**	**Percent of AOI**
Very limited	140.8	82.7%
Somewhat limited	29.5	17.3%
Totals for Area of Interest	**170.3**	**100.0%**

Rating Options—Subsurface Water Management, System Installation (Bel Air Sites A and B)

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie. The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Subsurface Water Management, System Performance (Bel Air Sites A and B)

The ratings for Subsurface Water Management, System Performance are based on the soil properties that affect the capacity of the soil to be drained. The properties that affect the subsurface system performance include depth to a water table, salinity, flooding, sodicity, sand content, soil reaction, hydraulic conductivity, soil density, gypsum content, and subsidence.

The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the specified use. "Not limited" indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. "Somewhat limited" indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected.

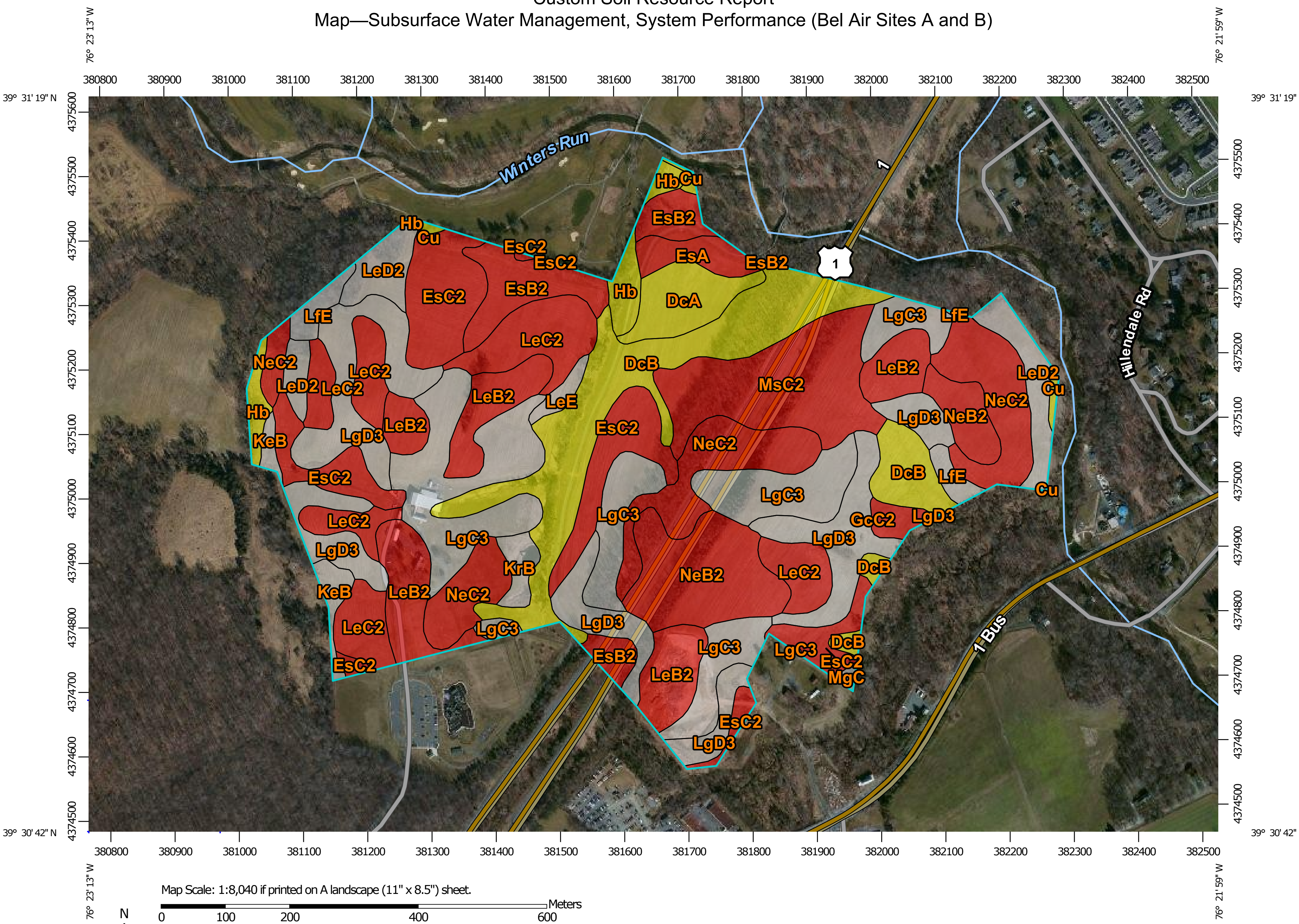
"Very limited" indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance can be expected.

Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as that listed for the map unit. The percent composition of each component in a particular map unit is given so that the user will realize the percentage of each map unit that has the specified rating.

A map unit may have other components with different ratings. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

Map—Subsurface Water Management, System Performance (Bel Air Sites A and B)



Map Scale: 1:8,040 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 100, 200, 400, 600

Feet: 0, 350, 700, 1400, 2100

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

Very limited

Somewhat limited

Not limited

Not rated or not available

Soil Rating Lines

Very limited

Somewhat limited

Not limited

Not rated or not available

Soil Rating Points

Very limited

Somewhat limited

Not limited

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Harford County Area, Maryland
Survey Area Data: Version 6, Dec 30, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 26, 2011—Mar 2, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Tables—Subsurface Water Management, System Performance (Bel Air Sites A and B)

Subsurface Water Management, System Performance— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
Cu	Codorus silt loam	Somewhat limited	Codorus (85%)	Occasional flooding (0.40)	0.6	0.3%
			Hatboro (15%)	Slow water movement (0.75)		
				Frequent or very frequent flooding (0.70)		
				Dense layer (0.34)		
DcA	Delanco silt loam, 0 to 3 percent slopes	Somewhat limited	Delanco (85%)	Clogging of tiles with sand (0.78)	3.8	2.2%
				Slow water movement (0.03)		
DcB	Delanco silt loam, 3 to 8 percent slopes	Somewhat limited	Delanco (85%)	Clogging of tiles with sand (0.78)	19.5	11.5%
				Slow water movement (0.03)		
EsA	Elsinboro loam, 0 to 2 percent slopes	Very limited	Elsinboro (85%)	Drainage not required (1.00)	2.1	1.2%
			Glenelg (5%)	Drainage not required (1.00)		
EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	Very limited	Elsinboro (85%)	Drainage not required (1.00)	6.7	3.9%
			Glenelg (5%)	Drainage not required (1.00)		
EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	Very limited	Elsinboro (85%)	Drainage not required (1.00)	15.0	8.8%
			Glenelg (5%)	Drainage not required (1.00)		
GcC2	Glenelg loam, 8 to 15 percent slopes, moderately eroded	Very limited	Glenelg (85%)	Drainage not required (1.00)	1.0	0.6%
			Gaila (10%)	Drainage not required (1.00)		
				Clogging of tiles with sand (0.24)		
			Manor (5%)	Drainage not required (1.00)		

Subsurface Water Management, System Performance— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
				Clogging of tiles with sand (0.44)		
Hb	Hatboro silt loam	Somewhat limited	Hatboro (85%)	Slow water movement (0.75)	2.9	1.7%
				Frequent or very frequent flooding (0.70)		
				Dense layer (0.34)		
			Codorus (15%)	Occasional flooding (0.40)		
KeB	Kelly silt loam, 3 to 8 percent slopes	Not rated	Kelly (95%)		1.5	0.9%
			WATCHUNG (5%)			
KrB	Kinkora silt loam, 3 to 8 percent slopes	Not rated	Kinkora (100%)		1.2	0.7%
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	Very limited	Legore (85%)	Drainage not required (1.00)	13.5	7.9%
				Slow water movement (0.75)		
				Dense layer (0.31)		
			Montalto (10%)	Drainage not required (1.00)		
				Dense layer (1.00)		
			Gladstone (5%)	Drainage not required (1.00)		
				Clogging of tiles with sand (0.30)		
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	Very limited	Legore (85%)	Drainage not required (1.00)	13.7	8.0%
				Slow water movement (0.75)		
				Dense layer (0.31)		
			Montalto (10%)	Drainage not required (1.00)		
				Dense layer (1.00)		
			Gladstone (5%)	Drainage not required (1.00)		

Subsurface Water Management, System Performance— Summary by Map Unit — Harford County Area, Maryland (MD600)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
				Clogging of tiles with sand (0.30)		
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	Not rated	Legore (100%)		6.0	3.5%
LeE	Legore silt loam, 25 to 45 percent slopes	Not rated	Legore (100%)		0.8	0.4%
LfE	Legore very stony silt loam, 25 to 45 percent slopes	Not rated	Legore (100%)		1.9	1.1%
LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	Not rated	Legore (100%)		23.0	13.5%
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	Not rated	Legore (100%)		19.8	11.6%
MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	Not rated	Glenelg (50%)		0.2	0.1%
			Manor (50%)			
MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	Very limited	Montalto (90%)	Drainage not required (1.00)	11.1	6.5%
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	Very limited	Neshaminy, very deep over gabbro (85%)	Drainage not required (1.00)	10.7	6.3%
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	Very limited	Neshaminy, very deep over gabbro (90%)	Drainage not required (1.00)	15.6	9.1%
Totals for Area of Interest					**170.3**	**100.0%**

Subsurface Water Management, System Performance— Summary by Rating Value		
Rating	**Acres in AOI**	**Percent of AOI**
Very limited	89.2	52.4%
Somewhat limited	26.8	15.7%

Subsurface Water Management, System Performance— Summary by Rating Value		
Rating	**Acres in AOI**	**Percent of AOI**
Null or Not Rated	54.3	31.9%
Totals for Area of Interest	**170.3**	**100.0%**

Rating Options—Subsurface Water Management, System Performance (Bel Air Sites A and B)

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie. The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Appendix D

Test Pit Logs

TEST PIT LOG

Gannett Fleming
ENGINEERS AND PLANNERS

Date Started: 8/6/14		Test Pit No.: TP-1
Date Finished: 8/6/14		Sheet 1 of 1
Total Depth of Pit: 12'		Line & Station:
Inspector: W. ROBIN	Project: VAAW - Evaluation of Reservoir, Bel Air	Offset:
Photographic Log: Yes ☑ No ☐	Excavation Contractor: HILLIS-CARNES	N Coordinate:
Groundwater Observations: NONE	Operator: DON STONE	E Coordinate:
	Excavation Equipment: TAKEUCHI, TB135	Surface Elevation:

Depth (Ft.)	Sample No.	Legend	Description of Materials	Remarks
0 - 8"			0 - 8": TOPSOIL	
8" - 4'	S1	SM	8" - 4': Silty SAND with boulders and gravel (SM), brown, moist, medium size (FILL)	START 9:35 AM Boulders, up to 18" long
4' - 12'	S2	SM	4' - 12': Silty SAND (SM), light brown, very fine, micasceous, occasional boulders. SAPROLITE ESPECIALLY AT LOWER REGION occasional cemented sand	
			BOTTOM @ 12'	STOPPED @ 10:17

Remarks:
- PHOTOS: 3905 thru 3907
- Performed infiltration test adjacent to TP-1
- land currently a farm.
- See test pit location plan
- 2' wide test pit (bucket width)

TEST PIT LOG

Gannett Fleming
ENGINEERS AND PLANNERS

Date Started: 8/6/14		Test Pit No.: TP-2
Date Finished: 8/6/14		Sheet of
Total Depth of Pit: 12'		Line & Station:
Inspector: W. ROBIN	Project: VAAW-EVALUATION OF RESERVOIR, BEL AIR	Offset:
Photographic Log: Yes ☑ No ☐	Excavation Contractor: Hillis-CARNES	N Coordinate:
Groundwater Observations: NONE	Operator: DON STONE	E Coordinate:
	Excavation Equipment: TEKEUCHI, TB 135	Surface Elevation:

Depth (Ft.)	Sample No.	Legend	Description of Materials	Remarks
0 – 1			0 – 11" TOPSOIL	Start @ 1:30pm
1 – 4	S1	mh/cl	11" – 4' (Fill) Elastic SILT (mh) and lean clay (Cl), light brown, moist, occasional gravel.	
4 – 8	S2	sm	4' – 8' (Fill): Silty SAND with Gravel (sm), light br., moist	
8 – 12	S3	sm	Silty SAND (sm), tan, moist, very fine, saprolitic, micasceous, partially cemented sand, occasional sandstone fragments, medium size green to variated, tan, orange black and green.	Residual small Boulder (quartz) at 10'±
12			BOTTOM @ 12'	Completed excavation 2:14 pm

Remarks: Photos: 3924 to 3926
– See test pit location plan
– 2' wide test pit

3936-37

TEST PIT LOG

Gannett Fleming
ENGINEERS AND PLANNERS

Date Started: 8/6/14	Project: VAAW-EVALUATION OF RESERVOIR, BEL AIR	Test Pit No.: TP-3
Date Finished: 8/6/14		Sheet 1 of 1
Total Depth of Pit: 12'		Line & Station:
Inspector: W. ROBIN		Offset:
Photographic Log: Yes ☑ No ☐	Excavation Contractor: Hillis-CARNES	N Coordinate:
Groundwater Observations: NONE	Operator: DON STONE	E Coordinate:
	Excavation Equipment: TAKEUCHI, TB135	Surface Elevation:

Depth (Ft.)	Sample No.	Legend	Description of Materials	Remarks
			0 – 8": TOPSOIL	Start @ 2:42pm
1	S1		8"–6': (FILL): Sandy SILT (ML) and Silty and Silty SAND with Gravel (SM), brown to lt. brown.	Gravel and boulders (small) present, boulders include angular and subrounded rock fragments (Angular rock fragments–Schist)
3			– schist boulders at 3.5'± (up to 8" long)	
5				
7			6' to 8': Rock fragments with Sand, Gray rocks, lt. br. Sand, moist (Fill)	
9	S2 S3		8' to 12': Silty SAND (SM) tan to variated tan, pink, and brown, occasional cemented sand, saprolitic	Residual
11			Partially decomposed rock fragments at 11.5' to 12'	
12			BOTTOM @ 12' ~~3938-42~~	Excavation completed at 3:30pm

Remarks: – Test pits 2' wide
– Photos: 3938-42
– See test pit location plan

TEST PIT LOG

Gannett Fleming
ENGINEERS AND PLANNERS

Date Started: 8/6/14		Test Pit No.: TP-4
Date Finished: 8/6/14		Sheet 1 of 1
Total Depth of Pit: 12'		Line & Station:
Inspector: W. ROBIN	Project: VAAW - EVALUATION OF RESERVOIR, BEL AIR	Offset:
Photographic Log: Yes ☒ No ☐	Excavation Contractor: HILLIS - CARNES	N Coordinate:
Groundwater Observations	Operator: DON STONE	E Coordinate:
NONE	Excavation Equipment: TAKEUCHI, TB135	Surface Elevation:

Depth (Ft.)	Sample No.	Legend	Description of Materials	Remarks
0'-1'			0'-1' TOPSOIL	
1'-5'	S1	ml	1'-5' SILT with Sand (ml), light brown, moist	Started at 11:16 am
5' to	S2	sm	5' to 12': Silty SAND (sm), light brown and tan, moist, very fine	
	S3 (8'±)			
	S4 (10'±)			
5	S5 (11.5'±)		SAPROLITIC ESPECIALLY AT LOWER REGION	Rock fragments and SANDSTONE @ 11.5'±
			BOTTOM @ 12'	

Remarks:

- 12:05 pm - Track came off excavator while excavating TP-4.
- land is currently a farm
- excavator track partially reinstalled (mechanic to come repair)
- See test pit location plan

Date Started: 8/6/14	**TEST PIT LOG**	Test Pit No.: TP-5
Date Finished: 8/6/14	Gannett Fleming ENGINEERS AND PLANNERS	Sheet 1 of 1
Total Depth of Pit: 12'		Line & Station:
Inspector: W.ROBIN	Project: VAAW-EVALUATION OF RESERVOIR, BEL AIR	Offset:
Photographic Log: Yes ☑ No ☐	Excavation Contractor: Hillis-Carnes	N Coordinate:
Groundwater Observations	Operator: DON STONE	E Coordinate:
NONE	Excavation Equipment: Takeuchi, TB 135	Surface Elevation:

Depth (Ft.)	Sample No.	Legend	Description of Materials	Remarks
			0 - 1.5' : TOPSOIL	Start at 3:41 PM
1.5' - 2'	S1	ml	1.5' to 7.5' : (FILL) SILT with Gravel and boulders (ml), brown to light brown, moist	
5' - 6'	S2			
7.5 - 8'	S3	ml	7.5' to 8.5' : Sandy SILT (ml), lt br, moist, micasceous	
8' - 9'	S4			
		sm	8.5' to 9' : Silty SAND (sm), light brown, moist fine to very fine	
9' - 10'	S5	sm	9'-12' : Silty SAND (sm), variated tan, light brown, black and white, moist, fine to very fine, saprolitic. Rock fragments from 11' Gravel to boulder size.	
10' - 11'	S6			
			BOTTOM @ 12'	

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

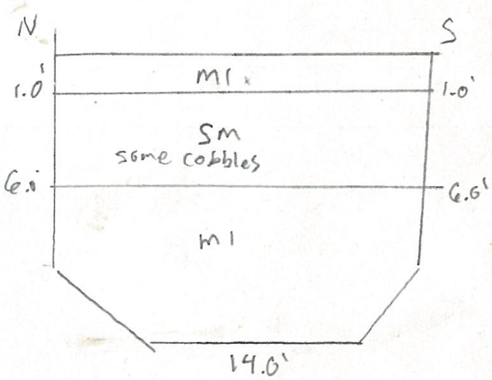
Remarks:
- width of excavation 2'
- See test pit location plan

Gannett Fleming
ENGINEERS AND PLANNERS

TEST PIT LOG

TEST PIT NO. TP-6	PROJECT/LOCATION Bel Air Reservoir
PROJECT NO.	GEOLOGIST/ENGINEER G. Braun
DATE STARTED 9-5-14	EXCAVATION CONTRACTOR Jeff Barton / JW MDAW
DATE FINISHED 9-5-14	OPERATOR JW
	EXCAVATION EQUIPMENT Case Extendahoe
	PHOTOGRAPHIC LOG ☐ YES ☐ NO
	SURFACE ELEVATION
	GROUNDWATER OBSERVATIONS (Date, Time, Level) None

DEPTH	SAMPLE NO. & TYPE	DESCRIPTION OF MATERIALS (Density, Consistency or Rock Hardness; Color; Classification; etc. . . .)	USCS	PID FID	REMARKS
1.0'	S-1	0-1.0': Sandy silt, (ml), dark brown, moist, (topsoil)	ml		
6.0'	S-2	1.0'-6.0': Silty Sand w/ [illegible], (sm), light brown, moist, homogenous, residual. some Cobbles throughout, angular to subrounded, 4" to 6", gneiss	Sm		
14.0'	S-3	6.0'-14.0': Silt w/ sand, (ml), reddish brown, moist, hogenous, little subangular gravel throughout, 1.0" or less in size.	ml		



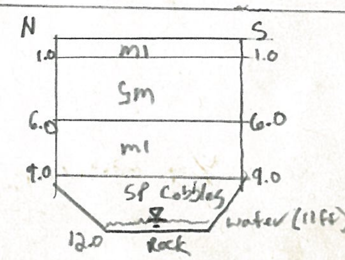
GENERAL REMARKS TP-6: Dim. 16' x 2.5' x 14'

TEST PIT NO. TP-6
SHEET 1 OF 1

Gannett Fleming
ENGINEERS AND PLANNERS

TEST PIT LOG

TEST PIT NO.	TP-7
PROJECT NO.	
DATE STARTED	9-5-14
DATE FINISHED	9-5-14
PROJECT/LOCATION	Bel Air Res. MD
GEOLOGIST/ENGINEER	G. Braun
EXCAVATION CONTRACTOR	MD Am. Water
OPERATOR	Jeff Barton / JW
EXCAVATION EQUIPMENT	Case Extendahoe
PHOTOGRAPHIC LOG ☐ YES ☐ NO	
SURFACE ELEVATION	
GROUNDWATER OBSERVATIONS (Date, Time, Level)	at 11ft @ time of Excavation

DEPTH	SAMPLE NO. & TYPE	DESCRIPTION OF MATERIALS (Density, Consistency or Rock Hardness; Color; Classification; etc. . . .)	USCS	PID FID	REMARKS
1.0	S-1	Silt w/sand, (ml), brown, dry, homogenous 1.0 w/gravel	ml		Topsoil
6.0	S-2	Sandy Silt, (Sm), light brown, moist, homogenous, ·gravel subrounded 3in max size 6.0	Sm		
9.0	S-3	Sandysilt, (ml), reddish brown, moist, homogenous 9.0	ml		
12.0	S-4	Poorly graded sand w/gravel, (SP), light brown, moist to wet, homogenous, Mica, Cobbles throughout, subrounded, 8inches max. ·cobbles Schist 12.0	SP		~11.0 ft water visible water ponding in bottom
		Rock (bedrock)			

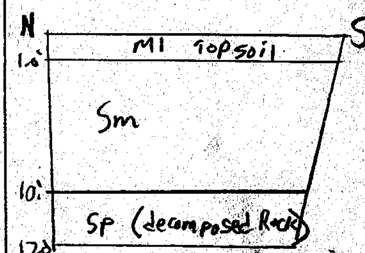
GENERAL REMARKS 2.5 ft x 14 ft x 12.0 ft

TEST PIT NO. TP-7
SHEET 1 OF 1

Gannett Fleming
ENGINEERS AND PLANNERS

TEST PIT LOG

TEST PIT NO. TP-8	PROJECT/LOCATION Bel Air Reservoir MD Am Water
PROJECT NO.	GEOLOGIST/ENGINEER G. Braun
DATE STARTED 9-5-14	EXCAVATION CONTRACTOR MD Am Water
DATE FINISHED 9-5-14	OPERATOR Jeff Barton / JW
	EXCAVATION EQUIPMENT Case Extendahoe
	PHOTOGRAPHIC LOG ☐ YES ☐ NO
	SURFACE ELEVATION
	GROUNDWATER OBSERVATIONS (Date, Time, Level) N/A

DEPTH	SAMPLE NO. & TYPE	DESCRIPTION OF MATERIALS (Density, Consistency or Rock Hardness; Color; Classification; etc. . . .)	USCS	PID FID	REMARKS
1.0	S-1	Silt w/sand, (ml), brown, dry, homogenous w/gravel 1.0	ml		
10.0	S-2	Silty Sand, (Sm), reddish brown, moist, homogenous 10.0	Sm		
12.0	S-3	Poorly graded sand w/gravel, (sp), gray and brown, moist (decomposed gneiss) Cobbles (gneiss) max size 8 to 9 inches 12.0			

GENERAL REMARKS 12 ft deep x ~14 ft long x 2.5' wide

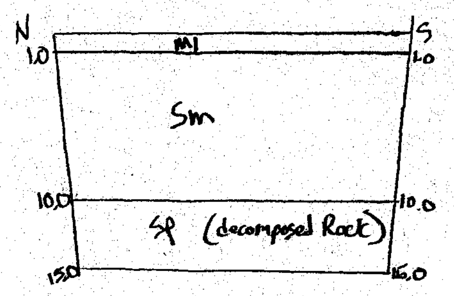
TEST PIT NO. 8
SHEET 1 OF 1

Gannett Fleming
ENGINEERS AND PLANNERS

TEST PIT LOG

TEST PIT NO.	TP-9
PROJECT NO.	
DATE STARTED	9-5-14
DATE FINISHED	9-5-14
PROJECT/LOCATION	Bel Air Reservoir MD
GEOLOGIST/ENGINEER	G. Braun
EXCAVATION CONTRACTOR	MD Am Water
OPERATOR	Jeff Barton / SW
EXCAVATION EQUIPMENT	Case Extendahoe
PHOTOGRAPHIC LOG	☑ YES ☐ NO
SURFACE ELEVATION	
GROUNDWATER OBSERVATIONS (Date, Time, Level)	N/A

DEPTH	SAMPLE NO. & TYPE	DESCRIPTION OF MATERIALS (Density, Consistency or Rock Hardness; Color; Classification; etc. . . .)	USCS	PID FID	REMARKS
1.0	S-1	Silt, Brown, moist, Topsoil	Ml		Topsoil
	S-2	Silty Sand w/ gravel, (Sm) reddish brown, moist, homogenous; gravel less than 2 inches	Sm		
10.0		10.0			
		Poorly graded Sand w/ gravel, (SP), gray to brown, moist, decomposed gneiss	SP		
15.0	S-3	15.0			



GENERAL REMARKS 15.0 ft deep x 12 ft long x 2.5 ft wide

TEST PIT NO. 9

SHEET 1 OF 1

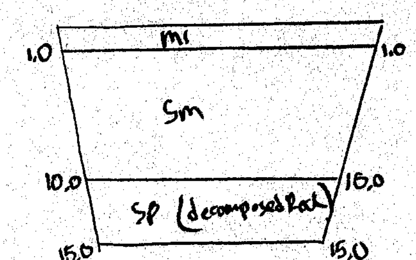
Gannett Fleming
ENGINEERS AND PLANNERS

TEST PIT LOG

PROJECT/LOCATION	Bel Air Reservoir MD
GEOLOGIST/ENGINEER	G. Braun
EXCAVATION CONTRACTOR	MD Am Water
OPERATOR	Jeff Barton / JW
EXCAVATION EQUIPMENT	Case Extendahoe
PHOTOGRAPHIC LOG	☐ YES ☐ NO
SURFACE ELEVATION	
GROUNDWATER OBSERVATIONS (Date, Time, Level)	N/A

TEST PIT NO. TP-10
PROJECT NO.
DATE STARTED 9-5-14
DATE FINISHED 9-5-14

DEPTH	SAMPLE NO. & TYPE	DESCRIPTION OF MATERIALS (Density, Consistency or Rock Hardness; Color; Classification; etc. . . .)	USCS	PID FID	REMARKS
1.0	S-1	Silt, (ml), brown, dry, (Topsoil)			
	S-2	Silty Sand w/gravel, (sm), reddish brown, moist, homogerous • Cobbles max size 6 inches			
10.0		10.0			
	S-3	Poorly graded sand w/gravel, (SP), gray and brown, moist (decomposed gneiss) Cobbles (gneiss) max size 6 inches			
15.0		15.0			

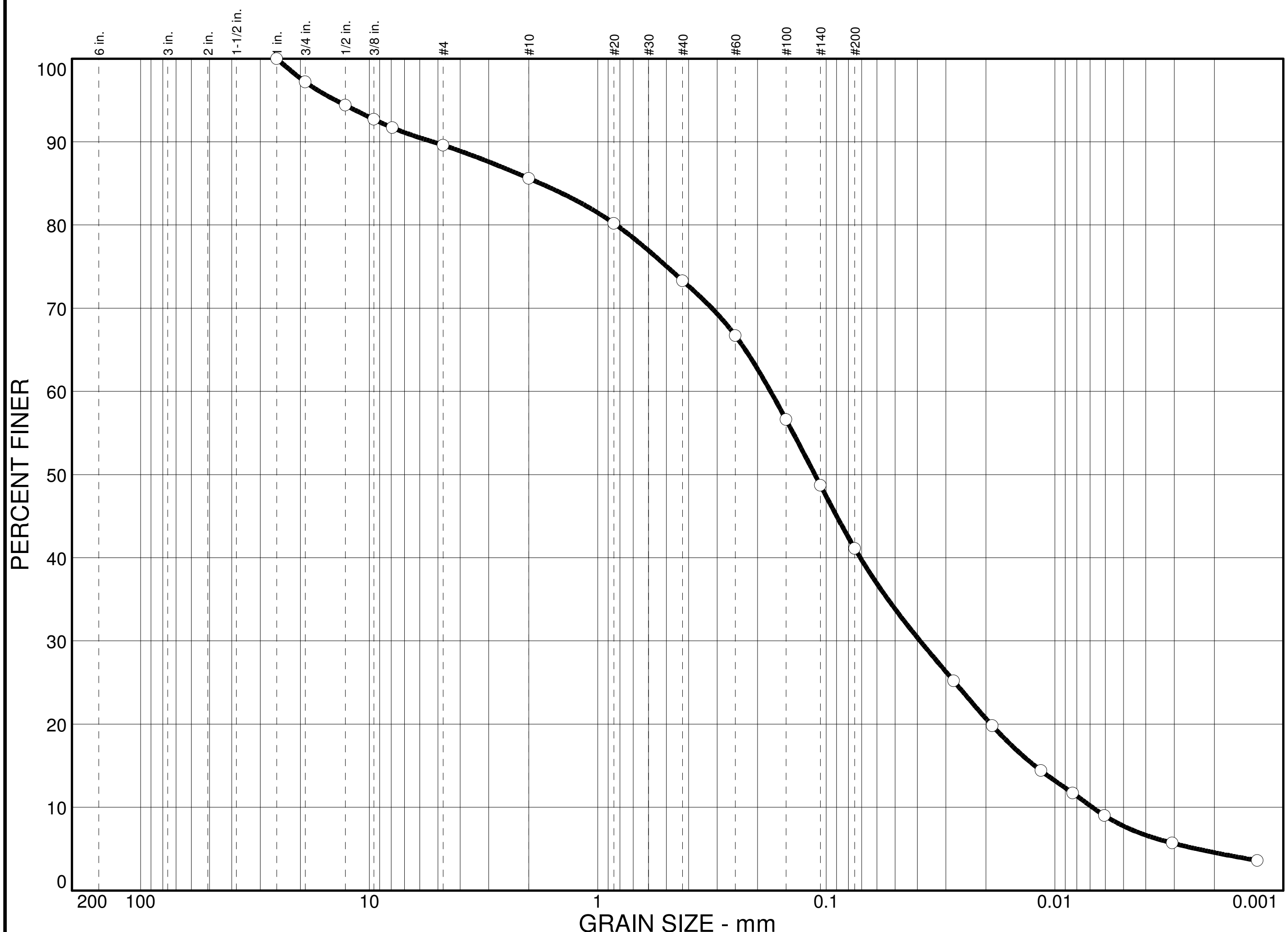


GENERAL REMARKS 15 ft deep 12 ft long

TEST PIT NO. 10
SHEET 1 OF 1

Appendix E
Lab Test Results

Particle Size Distribution Report



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	10.4	48.5	33.4	7.7

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	N/P	N/P	1.78	0.175	0.112	0.0389	0.0123	0.0069	1.26	25.56

MATERIAL DESCRIPTION	USCS	AASHTO
○ Brown silty SAND	SM	

Project No. 059267 **Client:** Maryland American Water

Project: Bel Air Reservoir

○ **Source:** Boring No.: TP-1 **Sample No.:** S-1 **Elev./Depth:** 2.5' - 12.0'

Gannett Fleming
ENGINEERS AND PLANNERS

Remarks:

○ Date:August 18, 2014

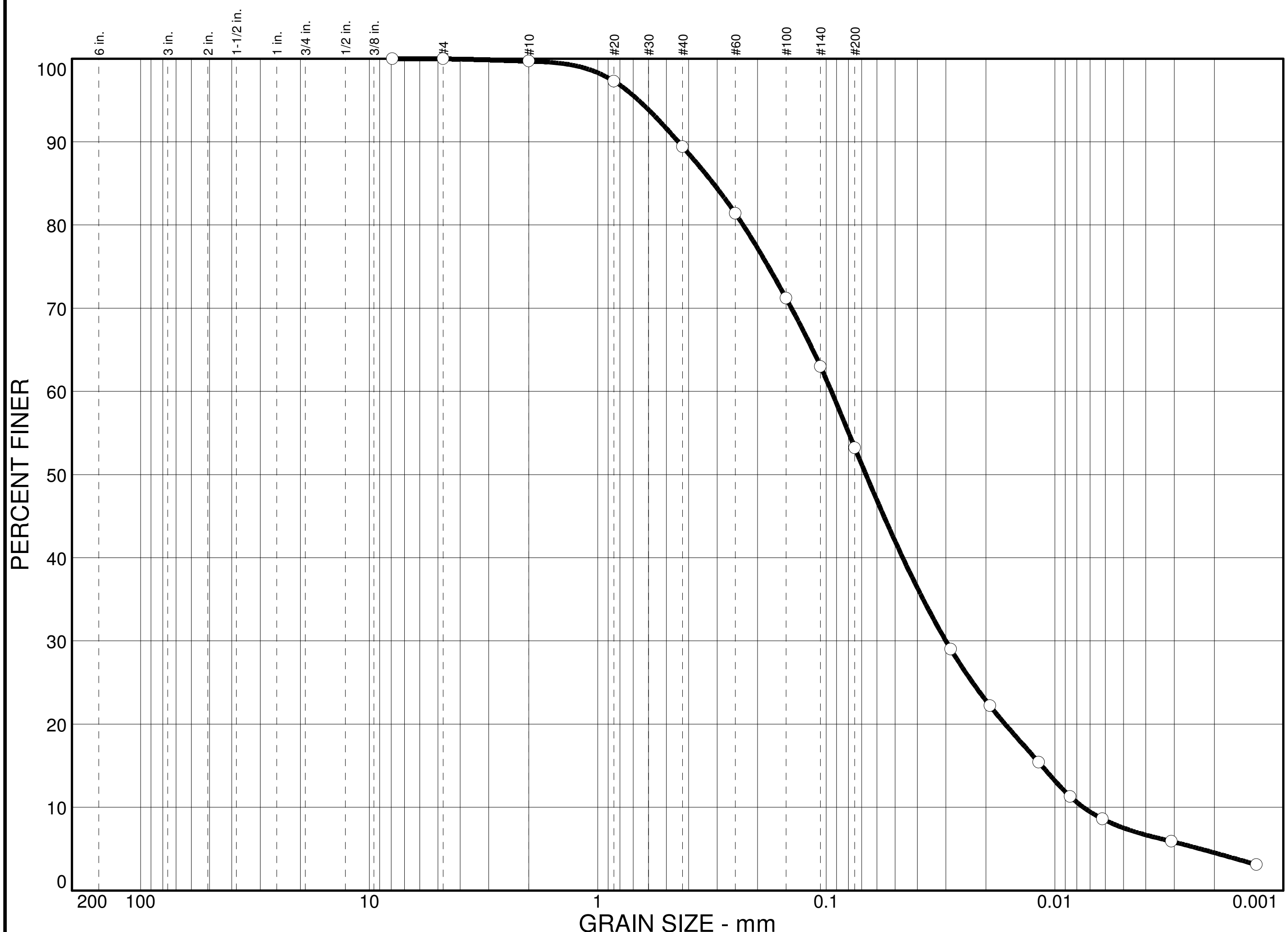
Nat. Water Content: 28.7 %

W.O.# 1

Tested By: KAA

Figure

Particle Size Distribution Report



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	46.8	45.7	7.5

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	N/P	N/P	0.312	0.0949	0.0671	0.0300	0.0114	0.0075	1.26	12.66

	MATERIAL DESCRIPTION	USCS	AASHTO
○	Brown sandy SILT	ML	

Project No. 059267 **Client:** Maryland American Water

Project: Bel Air Reservoir

○ **Source:** Boring No.: TP-4 **Sample No.:** S - 2 **Elev./Depth:** 5.0' - 12.0'

Gannett Fleming
ENGINEERS AND PLANNERS

Remarks:

○ Date:August 18, 2014

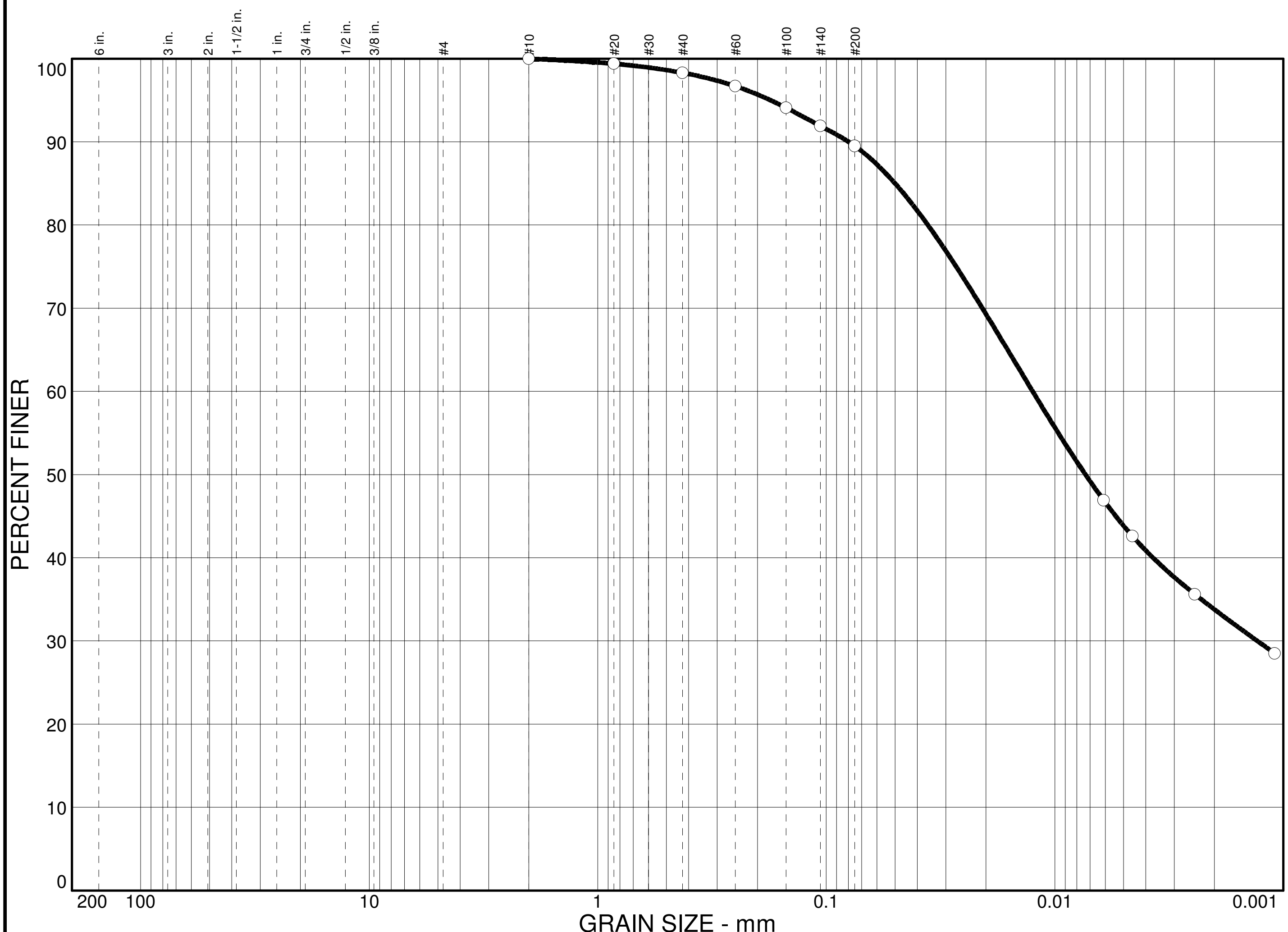
Nat. Water Content: 24.9 %

W.O.# 1

Tested By: KAA

Figure

Particle Size Distribution Report



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	10.5	45.7	43.8

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	52	33	0.0500	0.0125	0.0073	0.0013				

MATERIAL DESCRIPTION	USCS	AASHTO
○ Brown elastic SILT	MH	

Project No. 059267 **Client:** Maryland American Water

Project: Bel Air Reservoir Site A

○ **Source:** Boring No.: TP-6 **Sample No.:** Bag **Elev./Depth:** 0.0' - 6.0'

Gannett Fleming
ENGINEERS AND PLANNERS

Remarks:

○ Date:September 17, 2014

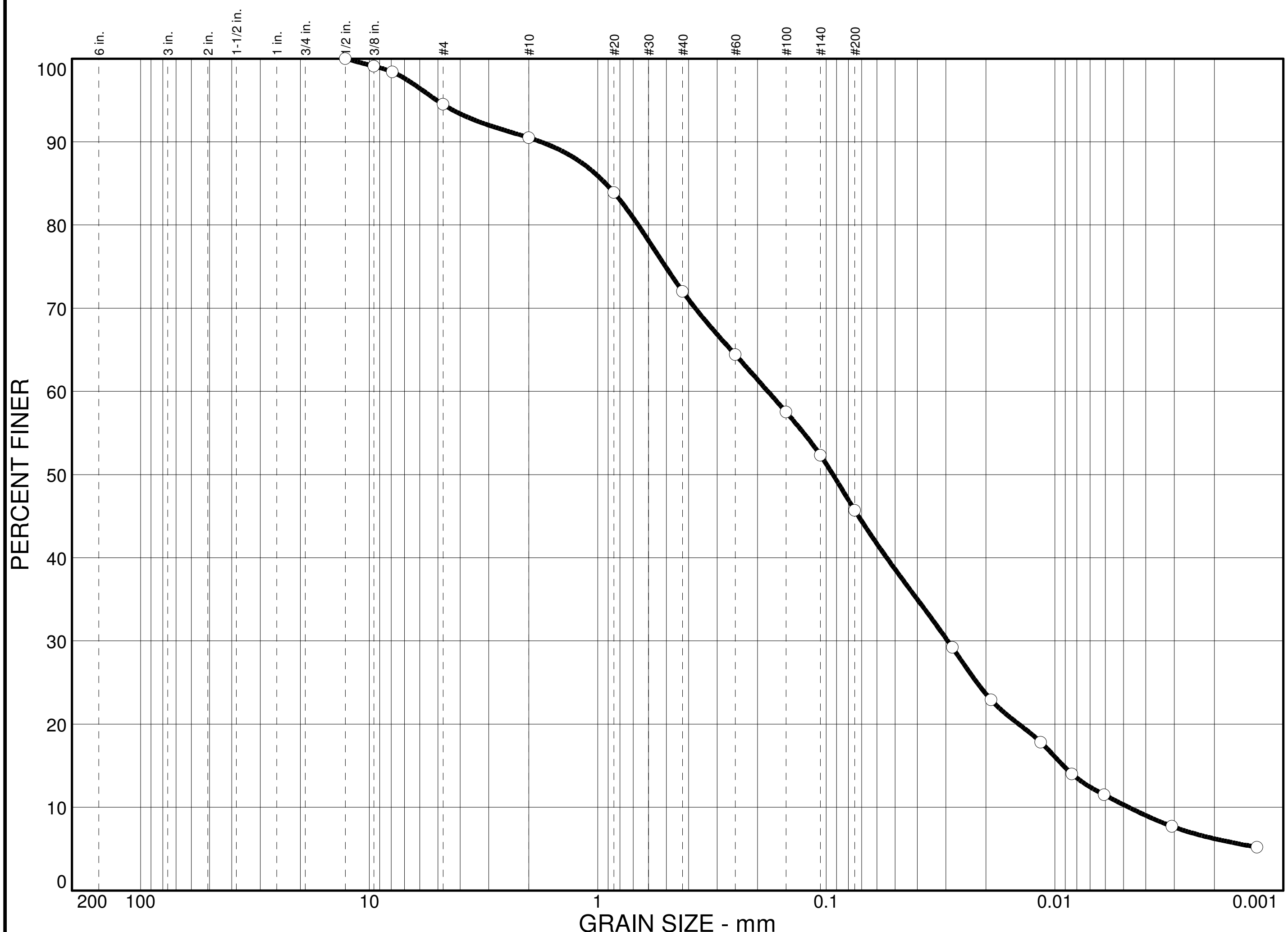
Nat.Water Content: 33.1 %

W.O.# 2

Tested By: KAA

Figure

Particle Size Distribution Report



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	5.5	48.8	35.4	10.3

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	N/P	N/P	0.924	0.180	0.0935	0.0294	0.0092	0.0048	1.01	37.93

	MATERIAL DESCRIPTION	USCS	AASHTO
○	Brown silty SAND	SM	

Project No. 059267 **Client:** Maryland American Water

Project: Bel Air Reservoir Site A

○ **Source:** Boring No.: TP-8 **Sample No.:** Bag **Elev./Depth:** 0.0' - 6.0'

Remarks:

○ Date:September 17, 2014

Nat.Water Content:26.3 %

W.O.# 2

Tested By: KAA

Gannett Fleming
ENGINEERS AND PLANNERS

Figure

Appendix F

Infiltration Test Results

A

Against back of trench

PENNSYLVANIA STORMWATER BEST MANAGEMENT PRACTICES (BMP)
DOUBLE-RING INFILTROMETER TEST RESULTS

Project: Bel Air Reservoir
Test Location: Bel Air PA TP-1
Tested by: G. Braun / C. Schriner
Data: 8-6-14

Water Source: GF Soil Lab
Ground Cover: Farm Field
Depth to Seasonal High Water Table:
Depth to Test: 6 ft

Final Average Infiltration Rate: ______ In./hr.

Falling Head Double Ring Apparatus:

	Ring Diameter		Height Of Ring	
Inner Ring:	6	In.		In.
Outer Ring:	12	In.		In.
Penetration of Rings in Ground:	2	In.		

Weather: Overcast

Temperature: 75 °F

Presoak: ***	Start	End	Water Drop		Reading Interval	
1	11:36am	12:06pm	4 3/8"	< 2 in.	30	min.
2	12:06pm	12 36	4 5/8"	(> 2 in.) circled	30	min.

No seepage @ outer ring
No seepage

*** Water drop was less than 2-inches in the hole at the end of the final 30-minute presoak? Yes, (<2"), use 30 minute interval; No, (>2"), use 10 minute interval.

Reading No.		Time (hr : min)	Time Interval (min) (Elapsed Time) (min)	Infiltration Readings Inner Ring: Water Drop (Fraction) (in)	Infiltration Readings Inner Ring: Water Drop (Decimal) (in)	Incremental Infiltration Rate (in/min)	Incremental Infiltration Rate * (in/hr)	Remarks
1	Start:	12:36		15/16	0.938			No seepage Rings refilled after each reading is taken
	End:	12:46	(10)					
2	Start:	12:46		1 5/8	1.625			No Seepage Rings refilled after each reading is taken
	End:	12:56	(10)					
3	Start:	12:56		1 7/8	1.875			No seepage Rings refilled after each reading is taken
	End:	1:06	(10)					
4	Start:	1:06		1 5/8	1.625			No Seepage Rings refilled after each reading is taken
	End:	1:16	(10)					
5	Start:	1:16		1 7/8	1.875			No Seepage Rings refilled after each reading is taken
	End:	1:26	(10)					
6	Start:	1:26		1 7/8	1.875			NO SEEPAGE Rings refilled after each reading is taken
	End:	1:36	(10)					
7	Start:	1:36		1 7/8	1.875			NO SEEPAGE Rings refilled after each reading is taken
	End:	1:46	(10)					
8	Start:	1:46		1 7/8	1.875			No Seep Rings refilled after each reading is taken
	End:	1:56	(10)					

*Calculation is performed for each water level drop. Infiltration Rate = (Drop in water level / Time interval) x (conversion (60 min / hr))

B

No seepage on ledge Near edge of ledge

PENNSYLVANIA STORMWATER BEST MANAGEMENT PRACTICES (BMP)
DOUBLE-RING INFILTROMETER TEST RESULTS

Project: Bel Air Reservoir
Test Location: Bel Air, MD TP-1
Tested by: G. Braun / C. Schriver
Data: 8-6-14

Water Source: GF Soils Lab
Ground Cover: Farm Field
Depth to Seasonal High Water Table:
Depth to Test: 6.0 ft

Final Average Infiltration Rate: ______ In./hr.

Falling Head Double Ring Apparatus:

	Ring Diameter	Height Of Ring
Inner Ring:	6 In.	In.
Outer Ring:	12 In.	In.
Penetration of Rings in Ground:	2 In.	

Weather: Overcast

Presoak: ***	Start	End	Water Drop		Reading Interval	
1	11:38am	12:08pm	3" 11/16"	< 2 in.	30	min.
2	12:08pm	12:38	3" 1/8"	(> 2 in.) circled	30	min.

Temperature: 75 °F No seepage at outer ring / No seepage at outer ring

*** Water drop was less than 2-inches in the hole at the end of the final 30-minute presoak? Yes, (<2"), use 30 minute interval; No, (>2"), use 10 minute interval.

Reading No.		Time (hr : min)	Time Interval (min) (Elapsed Time) (min)	Infiltration Readings Inner Ring: Water Drop (Fraction) (in)	Infiltration Readings Inner Ring: Water Drop (Decimal) (in)	Incremental Infiltration Rate (in/min)	Incremental Infiltration Rate * (in/hr)	Remarks
1	Start:	12:38		15/16	0.938			No seepage. Rings refilled after each reading is taken
	End:	12:48	(10)					
2	Start:	12:48		1 1/16	1.063			No seepage. Rings refilled after each reading is taken
	End:	12:58	(10)					
3	Start:	12:58		15/16	0.938			No seepage. Rings refilled after each reading is taken
	End:	1:08	(10)					
4	Start:	1:08		1 1/16	1.063			No seep. Rings refilled after each reading is taken
	End:	1:18	(10)					
5	Start:	1:18		1.0	1.0			No seepage. Rings refilled after each reading is taken
	End:	1:28	(10)					
6	Start:	1:28		1 1/8	1.125			No seep. Rings refilled after each reading is taken
	End:	1:38	(10)					
7	Start:	1:38		1 1/16	1.0625			No seep. Rings refilled after each reading is taken
	End:	1:48	(10)					
8	Start:	1:48		1 1/8	1.125			No seep. Rings refilled after each reading is taken
	End:	1:58	(10)					

*Calculation is performed for each water level drop. Infiltration Rate = (Drop in water level / Time interval) x (conversion (60 min / hr))

A

Against Slope

PENNSYLVANIA STORMWATER BEST MANAGEMENT PRACTICES (BMP)
DOUBLE-RING INFILTROMETER TEST RESULTS

Project: Bel Air Reservoir
Test Location: Bel Air MD TP-4
Tested by: G. Braun / C. Schriner
Data: 8-6-14

Water Source: GF Soils lab
Ground Cover: Farm Field
Depth to Seasonal High Water Table:
Depth to Test: 5 ft

Final Average Infiltration Rate: In./hr.

Falling Head Double Ring Apparatus:

	Ring Diameter	Height Of Ring
Inner Ring:	6 In.	In.
Outer Ring:	12 In.	In.

Penetration of Rings in Ground: 2 In.

Weather: Partly cloudy

Presoak: ***	Start	End	Water Drop		Reading Interval	
1	2:20pm	2:50pm	1" 6/8	(< 2 in.) circled	30	min.
2	2:50pm	3:20pm	1.5"	> 2 in.	30	min.

Temperature: 80 °F

No Seepage
No Seepage

*** Water drop was less than 2-inches in the hole at the end of the final 30-minute presoak? Yes, (<2"), use 30 minute interval; No, (>2"), use 10 minute interval.

Reading No.		Time (hr : min)	Time Interval (min) (Elapsed Time) (min)	Infiltration Readings Inner Ring: Water Drop (Fraction) (in)	Infiltration Readings Inner Ring: Water Drop (Decimal) (in)	Incremental Infiltration Rate (in/min)	Incremental Infiltration Rate * (in/hr)	Remarks
1	Start:	3:20pm		1 1/2	1.50			NO SEEPAGE Rings refilled after each reading is taken
	End:	3:50pm	(30)					
2	Start:	3:50pm		1 1/2	1.50			No Seepage Rings refilled after each reading is taken
	End:	4:20pm	(30)					
3	Start:	4:20pm		1 9/16	1.56			No Seepage Rings refilled after each reading is taken
	End:	4:50pm	(30)					
4	Start:	4:50pm		1 11/16	1.688			No Seepage Rings refilled after each reading is taken
	End:	5:20pm	(30)					
5	Start:							Rings refilled after each reading is taken
	End:		( )					
6	Start:							Rings refilled after each reading is taken
	End:		( )					
7	Start:							Rings refilled after each reading is taken
	End:		( )					
8	Start:							Rings refilled after each reading is taken
	End:		( )					

*Calculation is performed for each water level drop. Infiltration Rate = (Drop in water level / Time interval) x (conversion (60 min / hr))

B

Near edge w/ ledge

PENNSYLVANIA STORMWATER BEST MANAGEMENT PRACTICES (BMP)
DOUBLE-RING INFILTROMETER TEST RESULTS

Project: Bel Air Reservoir
Test Location: Bel Air MD TP-4
Tested by: G. Braun / C. Schriner
Data: 8-6-14

Water Source: GF Soils lab
Ground Cover: Farm Field
Depth to Seasonal High Water Table:
Depth to Test: 5 ft

Final Average Infiltration Rate: ______ In./hr.

Falling Head Double Ring Apparatus:

	Ring Diameter	Height Of Ring
Inner Ring:	6 In.	In.
Outer Ring:	12 In.	In.

Penetration of Rings in Ground: 2 in In.

Weather: partly Cloudy

Presoak: ***	Start	End	Water Drop		Reading Interval
1	2:19	2:49	7/8"	(<2 in.) circled	30 min.
2	2:49	3:19	9/16"	> 2 in.	30 min.

Temperature: 80 °F

No Seepage
No Seepage

*** Water drop was less than 2-inches in the hole at the end of the final 30-minute presoak? Yes, (<2"), use 30 minute interval; No, (>2"), use 10 minute interval.

Reading No.		Time (hr : min)	Time Interval (min) (Elapsed Time) (min)	Infiltration Readings Inner Ring: Water Drop (Fraction) (in)	Infiltration Readings Inner Ring: Water Drop (Decimal) (in)	Incremental Infiltration Rate (in/min)	Incremental Infiltration Rate * (in/hr)	Remarks
1	Start:	3:19		11/16	0.688			No SEEPAGE Rings refilled after each reading is taken
	End:	3:49	(30)					
2	Start:	3:49		9/16	0.563			No Seepage Rings refilled after each reading is taken
	End:	4:19	(30)					
3	Start:	4:19		10/16	0.625			No Seepage Rings refilled after each reading is taken
	End:	4:49	(30)					
4	Start:	4:49		9/16	0.563			No Seepage Rings refilled after each reading is taken
	End:	5:19	(30)					
5	Start:							Rings refilled after each reading is taken
	End:		( )					
6	Start:							Rings refilled after each reading is taken
	End:		( )					
7	Start:							Rings refilled after each reading is taken
	End:		( )					
8	Start:							Rings refilled after each reading is taken
	End:		( )					

*Calculation is performed for each water level drop. Infiltration Rate = (Drop in water level / Time interval) x (conversion (60 min / hr))

Next to ledge of bench

A

PENNSYLVANIA STORMWATER BEST MANAGEMENT PRACTICES (BMP)
DOUBLE-RING INFILTROMETER TEST RESULTS

Project: Bel Air Reservoir Site A
Test Location: Bel Air MP TP-6
Tested by: G. Braun
Data: 9-5-14

Water Source: GF Soil Lab
Ground Cover: Farm Field
Depth to Seasonal High Water Table:
Depth to Test: 6.0 ft

Final Average Infiltration Rate: In./hr.

Falling Head Double Ring Apparatus:

	Ring Diameter	Height Of Ring
Inner Ring:	6 In.	In.
Outer Ring:	12 In.	In.

Penetration of Rings in Ground: 2 In.

Weather: Cloudy, humid, foggy

Presoak: ***	Start	End	Water Drop		Reading Interval
1	9:05	9:35	empty	< 2 in.	30 min.
2	9:35	10:05	empty	(> 2 in.)	30 min.

Temperature: 75 °F

No seepage at outer ring
Some seepage at outer ring
Seepage on ledge wall below bench from surface seepage of outer ring

*** Water drop was less than 2-inches in the hole at the end of the final 30-minute presoak? Yes, (<2"), use 30 minute interval; No, (>2"), use 10 minute interval.

Reading No.		Time (hr : min)	Time Interval (min) (Elapsed Time) (min)	Infiltration Readings Inner Ring: Water Drop (Fraction) (in)	Infiltration Readings Inner Ring: Water Drop (Decimal) (in)	Incremental Infiltration Rate (in/min)	Incremental Infiltration Rate * (in/hr)	Remarks
1	Start:	10:05		2 5/8 ~~2.625~~	2.625			Rings refilled after each reading is taken
	End:	10:15	(10)					
2	Start:	10:15		3 1/4	3.25			Rings refilled after each reading is taken
	End:	10:25	(10)					
3	Start:	10:25		3 1/4	3.25			Seepage outer ring Rings refilled after each reading is taken
	End:	10:35	(10)					
4	Start:	10:35		3 3/32	3.0937			Seepage outer ring Rings refilled after each reading is taken
	End:	10:45	(10)					
5	Start:	10:45		3 1/4	3.25			Seepage outer ring Rings refilled after each reading is taken
	End:	10:55	(10)					
6	Start:	10:55		3 3/32	3.0937			Seepage outer ring Rings refilled after each reading is taken
	End:	11:05	(10)					
7	Start:	11:05		3 1/4	3.25			Seepage outer ring Rings refilled after each reading is taken
	End:	11:15	(10)					
8	Start:	11:15		3/4	3.25			Seepage Rings refilled after each reading is taken
	End:	11:25	(10)					

*Calculation is performed for each water level drop. Infiltration Rate = (Drop in water level / Time interval) x (conversion (60 min / hr))

Next to end of Bench (exit)

B

PENNSYLVANIA STORMWATER BEST MANAGEMENT PRACTICES (BMP)
DOUBLE-RING INFILTROMETER TEST RESULTS

Project: Bel Air Reservoir Site A
Test Location: Bel Air MD TP-6
Tested by: G. Braun
Data: 9-5-14

Water Source: GF Soil Lab
Ground Cover: Farm Field
Depth to Seasonal High Water Table:
Depth to Test: 6.0 ft

Final Average Infiltration Rate: In./hr.

Falling Head Double Ring Apparatus:

	Ring Diameter		Height Of Ring	
Inner Ring:	6	In.		In.
Outer Ring:	12	In.		In.

Penetration of Rings in Ground: 2 In.

Weather: Cloudy, humid, foggy

Temperature: 75 °F

Presoak: ***		Start	End	Water Drop		Reading Interval	
	1	9:09	9:39	3 in	(< 2 in.)	30	min.
	2	9:39	10:09	1/8	> 2 in.	30	min.

Seepage initially then stopped w/soil

No Seepage

*** Water drop was less than 2-inches in the hole at the end of the final 30-minute presoak? Yes, (<2"), use 30 minute interval. No, (>2"), use 10 minute interval.

Reading No.		Time (hr : min)	Time Interval (min) (Elapsed Time) (min)	Infiltration Readings Inner Ring: Water Drop (Fraction) (in)	Infiltration Readings Inner Ring: Water Drop (Decimal) (in)	Incremental Infiltration Rate (in/min)	Incremental Infiltration Rate * (in/hr)	Remarks
1	Start:	10:09		1/16	0.0625			No Seepage Rings refilled after each reading is taken
	End:	10:39	(30)					
2	Start:	10:39		1/16	0.0625			No Seep Rings refilled after each reading is taken
	End:	11:09	(30)					
3	Start:	11:09		1/16	0.0625			No Seep Rings refilled after each reading is taken
	End:	11:39	(30)					
4	Start:	11:39		1/8	0.125			No Seep Rings refilled after each reading is taken
	End:	12:09	(30)					
5	Start:							Rings refilled after each reading is taken
	End:		( )					
6	Start:							Rings refilled after each reading is taken
	End:		( )					
7	Start:							Rings refilled after each reading is taken
	End:		( )					
8	Start:							Rings refilled after each reading is taken
	End:		( )					

*Calculation is performed for each water level drop. Infiltration Rate = (Drop in water level / Time interval) x (conversion (60 min / hr))

A

Near ledge of bench

PENNSYLVANIA STORMWATER BEST MANAGEMENT PRACTICES (BMP)
DOUBLE-RING INFILTROMETER TEST RESULTS

Project: BelAir Reservoir MD AM. Water SiteA

Test Location: BelAir MD TP-8

Tested by: G. Brown

Data: 9-5-14

Water Source: GF Lab / MD Am Water

Ground Cover: Farm

Depth to Seasonal High Water Table:

Depth to Test: 6.0

Final Average Infiltration Rate: ______ In./hr.

Falling Head Double Ring Apparatus:

	Ring Diameter	Height Of Ring
Inner Ring:	6 In.	In.
Outer Ring:	12 In.	In.

Penetration of Rings in Ground: 2 In.

Weather: Sunny 90° humid

Presoak: ***	Start	End	Water Drop		Reading Interval	
1	1:20	1:50	3/8 in	(< 2 in.) circled	30	min.
2	1:50	2:20	3/8 in	> 2 in.	30	min.

Temperature: 90 °F No Seepage

No Seep

*** Water drop was less than 2-inches in the hole at the end of the final 30-minute presoak? Yes, (<2"), use 30 minute interval. No, (>2"), use 10 minute interval.

Reading No.		Time (hr : min)	Time Interval (min) (Elapsed Time) (min)	Infiltration Readings Inner Ring: Water Drop (Fraction) (in)	Water Drop (Decimal) (in)	Incremental Infiltration Rate (in/min)	Incremental Infiltration Rate * (in/hr)	Remarks
1	Start:	2:20		5/16	0.3125			No Seep Rings refilled after each reading is taken
	End:	2:50	(30)					
2	Start:	2:50		5/16	0.3125			No Seep Rings refilled after each reading is taken
	End:	3:20	(30)					
3	Start:	3:20		5/16	0.3125			No Seep Rings refilled after each reading is taken
	End:	3:50	(30)					
4	Start:	3:50		5/16	0.3125			No Seep Rings refilled after each reading is taken
	End:	4:20	(30)					
5	Start:							Rings refilled after each reading is taken
	End:		( )					
6	Start:							Rings refilled after each reading is taken
	End:		( )					
7	Start:							Rings refilled after each reading is taken
	End:		( )					
8	Start:							Rings refilled after each reading is taken
	End:		( )					

*Calculation is performed for each water level drop. Infiltration Rate = (Drop in water level / Time interval) x (conversion (60 min / hr))

B

Near end of trench (exit)

PENNSYLVANIA STORMWATER BEST MANAGEMENT PRACTICES (BMP)
DOUBLE-RING INFILTROMETER TEST RESULTS

Project: Bel Air MD Am Water Site A
Test Location: Bel Air MD TP-8
Tested by: G. Brown
Data: 9-5-14

Water Source: GF lab / MD Am Water
Ground Cover: Farm
Depth to Seasonal High Water Table:
Depth to Test:

Final Average Infiltration Rate: In./hr.

Falling Head Double Ring Apparatus:

	Ring Diameter	Height Of Ring
Inner Ring:	6 In.	In.
Outer Ring:	12 In.	In.

Penetration of Rings in Ground: 2 In.

Weather: Sunny Humid

Temperature: 90 °F

Presoak: ***	Start	End	Water Drop		Reading Interval
1	1:25	1:55	7/16 in	(<2 in.) circled	30 min.
2	1:55	2:25	1/8 in	> 2 in.	30 min.

No Seepage
No Seep

*** Water drop was less than 2-inches in the hole at the end of the final 30-minute presoak? Yes, (<2"), use 30 minute interval; No, (>2"), use 10 minute interval.

Reading No.		Time (hr : min)	Time Interval (min) (Elapsed Time) (min)	Infiltration Readings Inner Ring Water Drop (Fraction) (in)	Infiltration Readings Inner Ring Water Drop (Decimal) (in)	Incremental Infiltration Rate (in/min)	Incremental Infiltration Rate * (in/hr)	Remarks
1	Start:	2:25		1/16	0.0625			No Seep Rings refilled after each reading is taken
	End:	2:55	(30)					
2	Start:	2:55		3/32	0.09375			No Seep Rings refilled after each reading is taken
	End:	3:25	(30)					
3	Start:	3:25		3/32	0.09375			No Seep Rings refilled after each reading is taken
	End:	3:55	(30)					
4	Start:	3:55		3/32	0.09375			No Seep Rings refilled after each reading is taken
	End:	4:25	(30)					
5	Start:							Rings refilled after each reading is taken
	End:		( )					
6	Start:							Rings refilled after each reading is taken
	End:		( )					
7	Start:							Rings refilled after each reading is taken
	End:		( )					
8	Start:							Rings refilled after each reading is taken
	End:		( )					

*Calculation is performed for each water level drop. Infiltration Rate = (Drop in water level / Time interval) x (conversion (60 min / hr))

Appendix G

Environmental Review and Study

Attachment 1
Bel Air, MD - Study Area

Scale: For Illustrative Purposes Only

U.S. Fish and Wildlife Service

National Wetlands Inventory

Aug 13, 2014

Wetlands

- Freshwater Emergent
- Freshwater Forested/Shrub
- Estuarine and Marine Deepwater
- Estuarine and Marine
- Freshwater Pond
- Lake
- Riverine
- Other

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

User Remarks:

U.S. Fish and Wildlife Service

National Wetlands Inventory

Aug 13, 2014

Wetlands

- Freshwater Emergent
- Freshwater Forested/Shrub
- Estuarine and Marine Deepwater
- Estuarine and Marine
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- Riverine
- Other

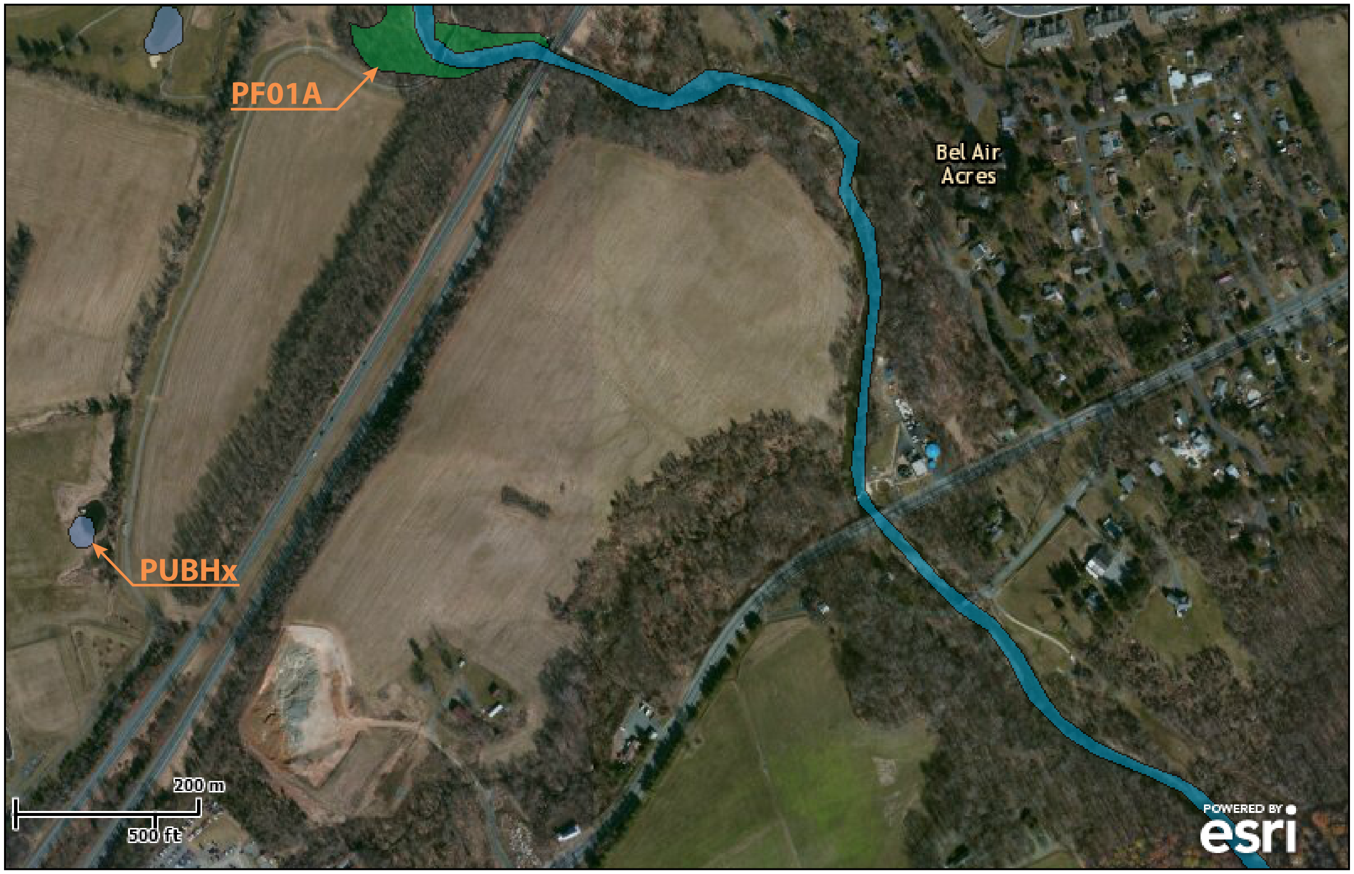
This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

User Remarks:

U.S. Fish and Wildlife Service

National Wetlands Inventory

Aug 13, 2014



Wetlands

- Freshwater Emergent
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- Estuarine and Marine Deepwater
- Estuarine and Marine
- Freshwater Pond
- Lake
- Riverine
- Other

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

User Remarks:

GANNETT FLEMING, INC.
P.O. Box 67100
Harrisburg, PA 17106-7100

Location:
207 Senate Avenue
Camp Hill, PA 17011

Office: (717) 763-7211
Fax: (717) 763-8150
www.gannettfleming.com

August 27, 2014

Lori Byrne
DNR Wildlife & Heritage Service
580 Taylor Avenue
Tawes Office Bldg E-1
Annapolis, MD 21401

MAILED 8/27/14
Certified 7013 2250 0000 4345 7922

RE: Request for Environmental Review
The Maryland American Water Company
Bel Air Reservoir Feasibility Study
Bel Air, Harford County, Maryland

Dear Ms. Byrne:

Gannett Fleming, Inc. (Gannett Fleming) is requesting an environmental review of a project located on the east and west sides of the Bel Air Bypass (US Route 1) approximately 1 mile south of its intersection with MD Route 24 in Bel Air, Harford County, Maryland (39.517203 N, 76.375215 W). Gannett Fleming was retained by the Maryland American Water Company (MAWC) to evaluate the feasibility of creating an off-stream raw water storage reservoir that would provide the Town of Bel Air with drinking water during dry periods. This project is currently in a conceptual design phase with field reconnaissance and preliminary engineering studies to occur in the near future. To support permitting, we are requesting an environmental review to determine if any species of concern occur within or in close proximity to the study area. Please refer to **Figure 1** for the USGS topographic map of the study area. **Figure 2** provides an aerial photograph of the project study area.

The Bel Air water system is supplied primarily by Winters Run. The Maryland Department of the Environment (MDE) regulates the Harford County water treatment plant, operated by the MAWC. When stream flow falls below the minimum pass-by flow stipulated by the MDE, water should not be withdrawn from Winters Run. During such times historically, Harford County has allowed the MAWC system to continue operating to meet system demands. However, since Harford County expects the Bel Air water supply to experience long-term supply shortfalls, alternative water supply systems are being evaluated. Gannett Fleming is evaluating the feasibility of building a reservoir in an off-stream agricultural area adjacent to Winters Run to store water from Winters Run during periods of high flow. The reservoir would provide Bel Air with water when water levels in Winters Run fall below MDE withdraw limits.

August 27, 2014

Please provide Gannett Fleming with an official response letter regarding any species of concern within or in close proximity to the study area. We would appreciate an expedited environmental review, if possible. Please contact me at (717) 763-7211, extension 2914, with any questions or requests for additional information. Thank you for your cooperation; we look forward to working with you on this project.

Very truly yours,

Danielle Iuliucci
Environmental Scientist

Attachments

Copies Furnished (electronically): S. Liskovich, GF Project Manager
D. Graff, GF Sr. Environmental Scientist
File

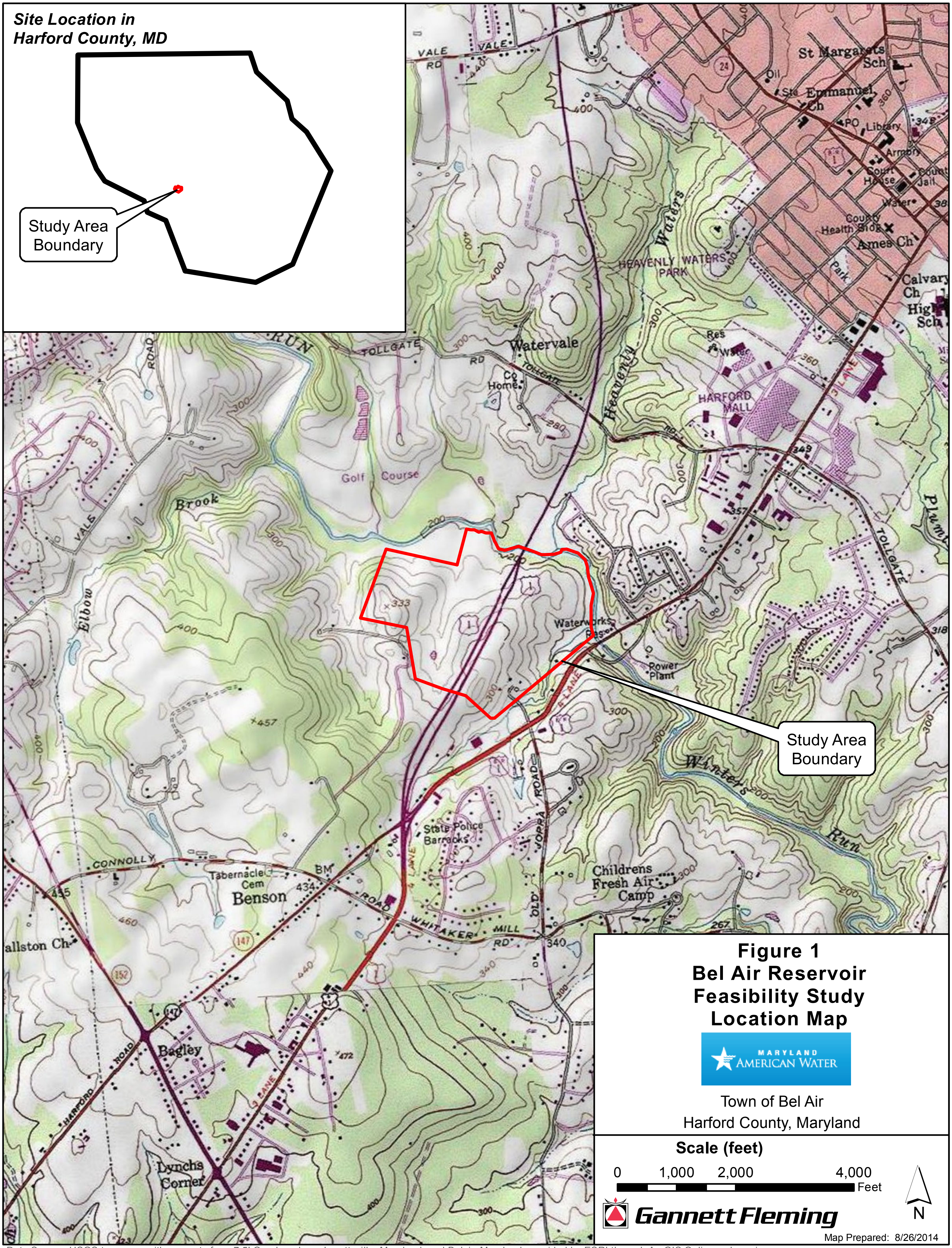

Figure 1
Bel Air Reservoir Feasibility Study Location Map

Town of Bel Air
Harford County, Maryland

Data Source: USGS topo map with excerpts from 7.5' Quadrangles - Jarrettsville, Maryland, and Belair, Maryland, provided by ESRI through ArcGIS Online webservice.

Figure 2
Bel Air Reservoir
Feasibility Study
Aerial Location Map

MARYLAND AMERICAN WATER

Town of Bel Air
Harford County, Maryland

Gannett Fleming

Data Source: Aerial imagery map provided by ESRI through ArcGIS Online webservice.

GANNETT FLEMING, INC.
P.O. Box 67100
Harrisburg, PA 17106-7100

Location:
207 Senate Avenue
Camp Hill, PA 17011

Office: (717) 763-7211
Fax: (717) 763-8150
www.gannettfleming.com

August 27, 2014

US Fish and Wildlife Service
Chesapeake Bay Ecological Services Field Office
177 Admiral Cochrane Drive
Annapolis, MD 21401

SUBMITTED ELECTRONICALLY
8/27/14

RE: Project Review Request
The Maryland American Water Company
Bel Air Reservoir Feasibility Study
Bel Air, Harford County, Maryland

To whom it may concern:

Gannett Fleming, Inc. (Gannett Fleming) is requesting a project review from the US Fish and Wildlife Service's Chesapeake Bay Ecological Services Field Office for a project located on the east and west sides of the Bel Air Bypass (US Route 1) approximately 1 mile south of its intersection with MD Route 24 in Bel Air, Harford County, Maryland (39.517203 N, 76.375215 W). Gannett Fleming was retained by the Maryland American Water Company (MAWC) to evaluate the feasibility of creating an off-stream raw water storage reservoir that would provide the Town of Bel Air with drinking water during dry periods. This project is currently in a conceptual design phase with field reconnaissance and preliminary engineering studies to occur in the near future. To support permitting, we are requesting a project review to determine if any species of concern occur within or in close proximity to the study area.

Gannett Fleming was retained by the Maryland American Water Company (MAWC) to evaluate the feasibility of creating an off-stream raw water storage reservoir that would provide the Town of Bel Air with drinking water during dry periods. This project is currently in a conceptual design phase with field reconnaissance and preliminary engineering studies to occur in the near future. The Bel Air water system is supplied primarily by Winters Run. The Maryland Department of the Environment (MDE) regulates the Harford County water treatment plant, operated by the MAWC.

The Bel Air water system is supplied primarily by Winters Run. The Maryland Department of the Environment (MDE) regulates the Harford County water treatment plant, operated by the MAWC. When stream flow falls below the minimum pass-by flow stipulated by the MDE, water should not be withdrawn from Winters Run. During such times historically, Harford County has allowed the MAWC system to continue operating to meet system demands. However, since Harford County expects the Bel Air water supply to experience long-term supply shortfalls, alternative water supply systems are being evaluated. Gannett Fleming is evaluating the feasibility of building a reservoir in an off-stream agricultural area adjacent to Winters Run to store water from Winters Run during periods of high flow. The reservoir would provide Bel Air with water when water levels in Winters Run fall below MDE withdraw limits.

The Information, Planning, and Conservation (IPaC) System indicated that no listed species, critical habitats, or national wildlife refuges were found within the vicinity of the proposed project. The IPaC System identified 13 migratory birds of concern that may be impacted. Three (3) National Wetlands Inventory wetland types were identified within the project study area, including freshwater forested/shrub wetland (PFO1A), freshwater pond (PUBHx), and riverine (R2UBH). Please refer to **Attachment 1** for the USGS topographic map of the study area. **Attachment 2** provides an aerial photograph of the project study area and **Attachment 3** provides the IPaC System Trust Resources List.

Please provide Gannett Fleming with an official response letter regarding any species of concern within or in close proximity to the study area as well as any conservation measures that should be implemented. We would appreciate an expedited review, if possible. Please contact me at (717) 763-7211, extension 2914, with any questions or requests for additional information. Thank you for your cooperation; we look forward to working with you on this project.

Very truly yours,

Danielle Iuliucci
Environmental Scientist

Attachments

Copies Furnished (electronically): S. Liskovich, GF Project Manager
D. Graff, GF Sr. Environmental Scientist
S. Smith, GF Environmental Scientist
File

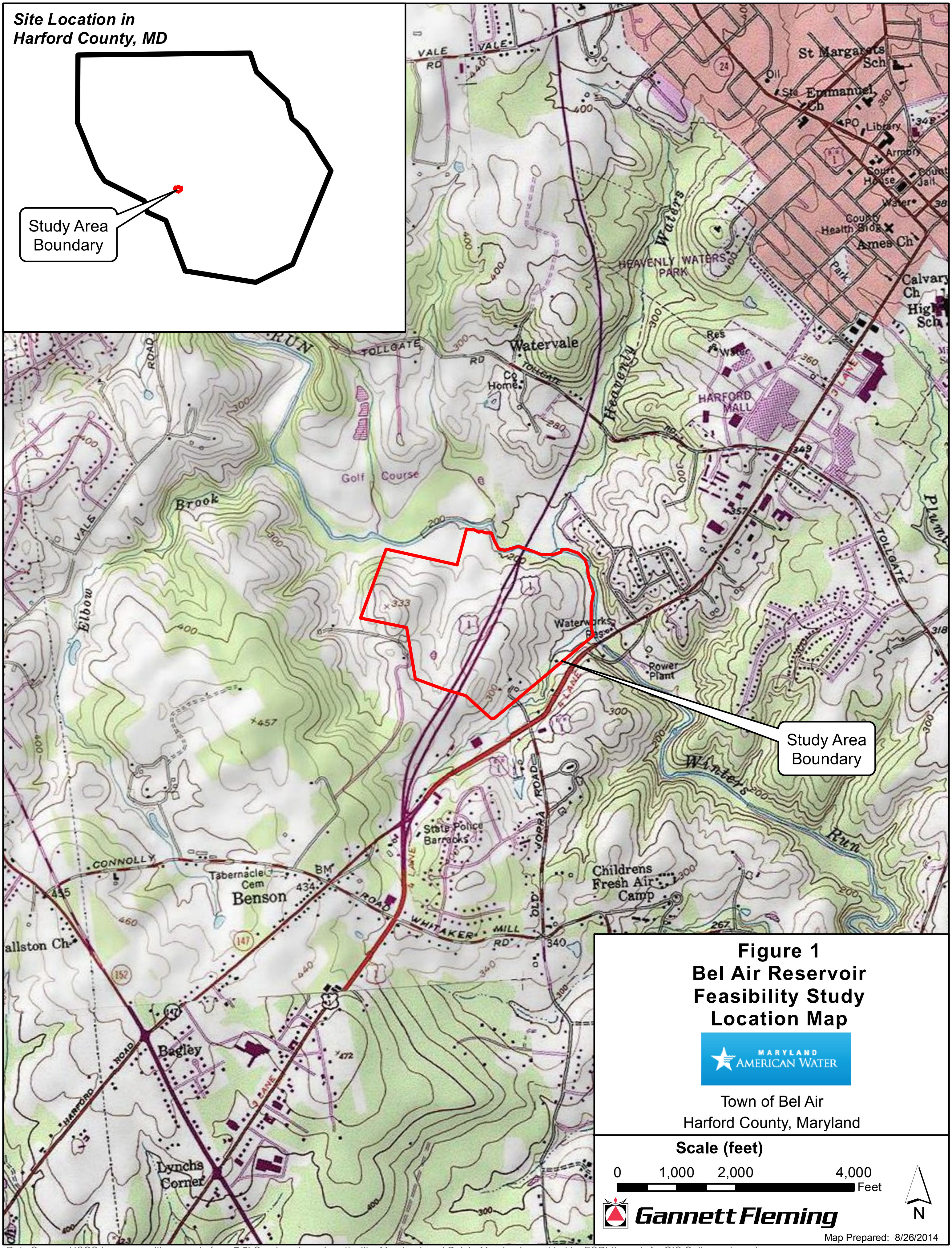

Figure 1
Bel Air Reservoir Feasibility Study Location Map

MARYLAND AMERICAN WATER

Town of Bel Air

Harford County, Maryland

Scale (feet)

0 1,000 2,000 4,000 Feet

N

Gannett Fleming

Map Prepared: 8/26/2014

Data Source: USGS topo map with excerpts from 7.5' Quadrangles - Jarrettsville, Maryland, and Belair, Maryland, provided by ESRI through ArcGIS Online webservice.

Figure 2
Bel Air Reservoir
Feasibility Study
Aerial Location Map

MARYLAND AMERICAN WATER

Town of Bel Air
Harford County, Maryland

Scale (feet)
0 500 1,000 2,000 Feet

N

Gannett Fleming

Map Prepared: 8/26/2014

Data Source: Aerial imagery map provided by ESRI through ArcGIS Online webservice.

U.S. Fish and Wildlife Service

Trust Resources List

This resource list is to be used for planning purposes only — it is not an official species list.

Endangered Species Act species list information for your project is available online and listed below for the following FWS Field Offices:

Chesapeake Bay Ecological Services Field Office
177 ADMIRAL COCHRANE DRIVE
ANNAPOLIS, MD 21401
(410) 573-4599

Project Name:

Bel Air Reservoir Feasibility Study

U.S. Fish and Wildlife Service

Trust Resources List

Project Location Map:

Project Counties:

Harford, MD

Geographic coordinates (Open Geospatial Consortium Well-Known Text, NAD83):

MULTIPOLYGON (((-76.3774704 39.519473, -76.376612 39.5211613, -76.3759469 39.5208799, -76.3750885 39.5208634, -76.3745736 39.519953, -76.3732217 39.5201185, -76.3722776 39.5197047, -76.3702177 39.5198206, -76.3695739 39.5194399, -76.3692306 39.5187281, -76.3691877 39.5180329, -76.3690804 39.5174039, -76.3693808 39.5162783, -76.3690589 39.5156161, -76.3757069 39.5123041, -76.3772133 39.5133644, -76.3801487 39.5142417, -76.3804985 39.5165925, -76.383288 39.5171884, -76.3815724 39.5204824, -76.3774704 39.519473)))

U.S. Fish and Wildlife Service

Trust Resources List

Project Type:

Dam

Endangered Species Act Species List ([USFWS Endangered Species Program](#)).

There are no listed species found within the vicinity of your project.

Critical habitats within your project area:

There are no critical habitats within your project area.

FWS National Wildlife Refuges ([USFWS National Wildlife Refuges Program](#)).

There are no refuges found within the vicinity of your project.

FWS Migratory Birds ([USFWS Migratory Bird Program](#)).

The protection of birds is regulated by the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA). Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the U.S. Fish and Wildlife Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)). The MBTA has no provision for allowing take of migratory birds that may be unintentionally killed or injured by otherwise lawful activities. For more information regarding these Acts see http://www.fws.gov/migratorybirds/RegulationsandPolicies.html.

All project proponents are responsible for complying with the appropriate regulations protecting birds when planning and developing a project. To meet these conservation obligations, proponents should identify potential or existing project-related impacts to migratory birds and their habitat and develop and implement conservation measures that avoid, minimize, or compensate for these impacts. The Service's Birds of Conservation Concern (2008) report identifies species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become listed under the Endangered Species Act as amended (16 U.S.C 1531 et seq.).

For information about Birds of Conservation Concern, go to http://www.fws.gov/migratorybirds/CurrentBirdIssues/Management/BCC.html.

Trust Resources List

Migratory birds of concern that may be affected by your project:

There are **13** birds on your Migratory birds of concern list. The Division of Migratory Bird Management is in the process of populating migratory bird data with an estimated completion time of Fall 2014; therefore, the list below may not include all the migratory birds of concern in your project area at this time. While this information is being populated, please contact the Field Office for information about migratory birds in your project area.

Species Name	Bird of Conservation Concern (BCC)	Species Profile	Seasonal Occurrence in Project Area
American bittern (*Botaurus lentiginosus*)	Yes	species info	Wintering
Bald eagle (*Haliaeetus leucocephalus*)	Yes	species info	Year-round
Black-billed Cuckoo (*Coccyzus erythropthalmus*)	Yes	species info	Breeding
cerulean warbler (*Dendroica cerulea*)	Yes	species info	Breeding
Golden-Winged Warbler (*Vermivora chrysoptera*)	Yes	species info	Breeding
Least Bittern (*Ixobrychus exilis*)	Yes	species info	Breeding
Marbled Godwit (*Limosa fedoa*)	Yes	species info	Wintering
Pied-billed Grebe (*Podilymbus podiceps*)	Yes	species info	Breeding
Purple Sandpiper (*Calidris maritima*)	Yes	species info	Wintering
Rusty Blackbird (*Euphagus carolinus*)	Yes	species info	Wintering
Short-billed Dowitcher (*Limnodromus griseus*)	Yes	species info	Wintering
Wood Thrush (*Hylocichla mustelina*)	Yes	species info	Breeding
Worm eating Warbler (*Helmitheros vermivorum*)	Yes	species info	Breeding

Trust Resources List

NWI Wetlands (USFWS National Wetlands Inventory).

The U.S. Fish and Wildlife Service is the principal Federal agency that provides information on the extent and status of wetlands in the U.S., via the National Wetlands Inventory Program (NWI). In addition to impacts to wetlands within your immediate project area, wetlands outside of your project area may need to be considered in any evaluation of project impacts, due to the hydrologic nature of wetlands (for example, project activities may affect local hydrology within, and outside of, your immediate project area). It may be helpful to refer to the USFWS National Wetland Inventory website. The designated FWS office can also assist you. Impacts to wetlands and other aquatic habitats from your project may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal Statutes. Project Proponents should discuss the relationship of these requirements to their project with the Regulatory Program of the appropriate U.S. Army Corps of Engineers District.

Data Limitations, Exclusions and Precautions

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery and/or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Exclusions - Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Precautions - Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

The following wetland types intersect your project area in one or more locations:

Wetland Types	NWI Classification Code	Total Acres
Freshwater Forested/Shrub Wetland	PFO1A	1.7732
Freshwater Pond	PUBHx	0.1999
Riverine	R2UBH	61.948

United States Department of the Interior
U.S. Fish & Wildlife Service
Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, MD 21401
410/573 4575

Online Certification Letter

Today's date: September 22, 2014

Project: The Maryland American Water Company
Bel Air Reservoir Feasibility Study
Bel Air, Harford County, Maryland

Dear Applicant for online certification:

Thank you for using the U.S. Fish and Wildlife Service (Service) Chesapeake Bay Field Office online project review process. By printing this letter in conjunction with your project review package, you are certifying that you have completed the online project review process for the referenced project in accordance with all instructions provided, using the best available information to reach your conclusions. This letter, and the enclosed project review package, completes the review of your project in accordance with the Endangered Species Act of 1973 (16 U.S.C. 1531-1544, 87 Stat. 884), as amended (ESA).This letter also provides information for your project review under the National Environmental Policy Act of 1969 (P.L. 91-190, 42 U.S.C. 4321-4347, 83 Stat. 852), as amended. A copy of this letter and the project review package must be submitted to this office for this certification to be valid. This letter and the project review package will be maintained in our records.

Based on this information and in accordance with section 7 of the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.), we certify that except for occasional transient individuals, no federally proposed or listed endangered or threatened species are known to exist within the project area. Therefore, no Biological Assessment or further section 7 consultation with the U.S. Fish and Wildlife Service is required. Should project plans change, or if additional information on the distribution of listed or proposed species becomes available, this determination may be reconsidered.

This response relates only to federally protected threatened or endangered species under our jurisdiction. For additional information on threatened or endangered species in Maryland, you should contact the Maryland Wildlife and Heritage Division at (410) 260-8540. For information in Delaware you should contact the Delaware Natural Heritage and Endangered Species Program, at (302) 653-2880. For information in the District of Columbia, you should contact the National Park Service at (202) 535-1739.

The U.S. Fish and Wildlife Service also works with other Federal agencies and states to minimize loss of wetlands, reduce impacts to fish and migratory birds, including bald eagles, and restore habitat for wildlife. Information on these conservation issues and how development projects can avoid affecting these resources can be found on our website (www.fws.gov/chesapeakebay)

We appreciate the opportunity to provide information relative to fish and wildlife issues, and thank you for your interest in these resources. If you have any questions or need further assistance, please contact Chesapeake Bay Field Office Threatened and Endangered Species program at (410) 573-4527.

Sincerely,

Genevieve LaRouche
Field Supervisor

September 17, 2014

Danielle Iuliucci
Gannett Fleming, Inc.
PO Box 67100
Harrisburg, PA 17106-7100

RE: Environmental Review for The American Water Company, Bel Air Reservoir Feasibility Study, Bel Air, US Route 1, Winters Run, Harford County, MD.

Dear Ms. Iuliucci:

The Wildlife and Heritage Service has determined that there are no State or Federal records for rare, threatened or endangered species within the boundaries of the project site as delineated. As a result, we have no specific comments or requirements pertaining to protection measures at this time. This statement should not be interpreted however as meaning that rare, threatened or endangered species are not in fact present. If appropriate habitat is available, certain species could be present without documentation because adequate surveys have not been conducted.

Thank you for allowing us the opportunity to review this project. If you should have any further questions regarding this information, please contact me at (410) 260-8573.

Sincerely,

Lori A. Byrne,
Environmental Review Coordinator
Wildlife and Heritage Service
MD Dept. of Natural Resources

ER# 2014.1333.ha

Gannett Fleming

GANNETT FLEMING, INC.
P.O. Box 67100
Harrisburg, PA 17106-7100

Location:
207 Senate Avenue
Camp Hill, PA 17011

Office: (717) 763-7211
Fax: (717) 763-8150
www.gannettfleming.com

August 27, 2014

Maryland Historical Trust
Project Review and Compliance
Attn: Beth Cole
100 Community Place
Crownsville, MD 21032

MAILED 8/27/14
Certified 7013 2250 0000 4345 7939

RE: Request for Maryland Historical Trust Review
The Maryland American Water Company
Bel Air Reservoir Feasibility Study
Bel Air, Harford County, Maryland

Dear Ms. Cole:

Gannett Fleming, Inc. (Gannett Fleming) is requesting a review from the Maryland Historical Trust of a project located on the east and west sides of the Bel Air Bypass (US Route 1) approximately 1 mile south of its intersection with MD Route 24 in Bel Air, Harford County, Maryland (39.517203 N, 76.375215 W). Gannett Fleming was retained by the Maryland American Water Company (MAWC) to evaluate the feasibility of creating an off-stream raw water storage reservoir that would provide the Town of Bel Air with drinking water during dry periods. This project is currently in a conceptual design phase with field reconnaissance and preliminary engineering studies to occur in the near future. To support permitting, we are requesting this review to determine if any historic or archeological properties occur within or in close proximity to the study area. Please refer to **Figure 1** for the USGS topographic map of the study area. **Figure 2** provides an aerial photograph of the project study area and **Figure 3** provides a photo location map with attached photo log depicting site conditions. The Project Review Form is also attached.

The Bel Air water system is supplied primarily by Winters Run. The Maryland Department of the Environment (MDE) regulates the Harford County water treatment plant, operated by the MAWC. When stream flow falls below the minimum pass-by flow stipulated by the MDE, water should not be withdrawn from Winters Run. During such times historically, Harford County has allowed the MAWC system to continue operating to meet system demands. However, since Harford County expects the Bel Air water supply to experience long-term supply shortfalls, alternative water supply systems are being evaluated. Gannett Fleming is evaluating the feasibility of building a reservoir in an off-stream agricultural area adjacent to Winters Run to store water from Winters Run during periods of high flow. The reservoir would provide Bel Air with water when water levels in Winters Run fall below MDE withdraw limits.

Gannett Fleming will coordinate with the MDE regarding permits for Surface Water Withdrawal, Dam Safety, Wetlands and Waterways Construction, and Water and Sewerage, the US Army Corps of Engineers regarding Wetlands and Waterways Construction permits, and the Maryland Department of Natural Resources regarding Forest Conservation permits.

Current and past land use within the project area consists of sloping agricultural fields, buildings, and a pond; the project area is bordered by streams. Proposed land use is a water storage reservoir that would supply the Town of Bel Air. There are four (4) structures within and adjacent to the project study area, including an old stone springhouse, a bridge over Winters Run, Edgeley Grove Farm House and Barn, and an old barn. The springhouse may be impacted depending on the final reservoir location, configuration, and size, but the remaining structures will not be disturbed. See the attached photo log for photographs of these structures.

Please provide Gannett Fleming with an official response letter regarding any historic or archeological properties within or in close proximity to the study area. We would appreciate an expedited project review, if possible. Please contact me at (717) 763-7211, extension 2914, with any questions or requests for additional information. Thank you for your cooperation; we look forward to working with you on this project.

Very truly yours,

Danielle Iuliucci
Environmental Scientist

Attachments

Copies Furnished (electronically): S. Liskovich, GF Project Manager
D. Graff, GF Sr. Environmental Scientist
File

MARYLAND HISTORICAL TRUST

PROJECT REVIEW FORM

Request for Comments from the Maryland Historical Trust/ MDSHPO on State and Federal Undertakings

MHT USE ONLY	
Date Received:	Log Number:

Project Name	Bel Air Reservoir Feasibility Study	County	Harford

Primary Contact:

Contact Name	Danielle Iuliucci	Company/Agency	Gannett Fleming, Inc.		
Mailing Address	P.O. Box 67100				
City	Harrisburg	State	Pennsylvania	Zip	17106-7100
Email	diuliucci@gfnet.com	Phone Number	+1 (717) 763-7211	Ext.	2914

Project Location:

Address	Bel Air Bypass			City/Vicinity	Town of Bel Air
Coordinates (if known): Latitude	39.517203	Longitude	-76.375215	Waterway	Winters Run

Project Description:

List federal and state sources of funding, permits, or other assistance (e.g. Bond Bill Loan of 2013, Chapter #; HUD/ CDBG; MDE/COE permit; etc.).	Agency Type	Agency/Program/Permit Name	Project/Permit/Tracking Number (if applicable)
	State	Maryland Department of the Environment	Permits pending
	Federal	US Army Corps of Engineers	Permit(s) pending

This project includes (check all applicable): ☒ New Construction ☐ Demolition ☐ Remodeling/Rehabilitation

☐ State or Federal Rehabilitation Tax Credits ☒ Excavation/Ground Disturbance ☒ Shoreline/Waterways/Wetlands

Other\Additional Description:

Known Historic Properties:

This project involves properties (check all applicable): ☐ Listed in the National Register ☐ Subject to an easement held by MHT

☐ Included in the Maryland Inventory of Historic Properties ☐ Designated historic by a local government

☐ Previously subject to archeological investigations

Property\District\Report Name

Attachments:

All attachments are required. Incomplete submittals may result in delays or be returned without comment.

☒ Aerial photograph or USGS Quad Map section with location and boundaries of project clearly marked.

☒ Project Description, Scope of Work, Site Plan, and\or Construction Drawings.

☒ Photographs (print or digital) showing the project site including images of all buildings and structures.

☒ Description of past and present land uses in project area (wooded, mined, developed, agricultural uses, etc).

MHT Determination:

☐ There are **NO HISTORIC PROPERTIES** in the area of potential effect

☐ The project will have **NO EFFECT** on historic properties

☐ The project will have **NO ADVERSE EFFECT** on historic properties

☐ The project will have **NO ADVERSE EFFECT WITH CONDITIONS**

☐ The project will have **ADVERSE EFFECTS** on historic properties

☐ **MHT REQUESTS ADDITIONAL INFORMATION**

MHT Reviewer: Date:

Submit printed copy of form and all attachments by mail to: Beth Cole, MHT, 100 Community Place, Crownsville, MD 21032

Revised 6/21/2013

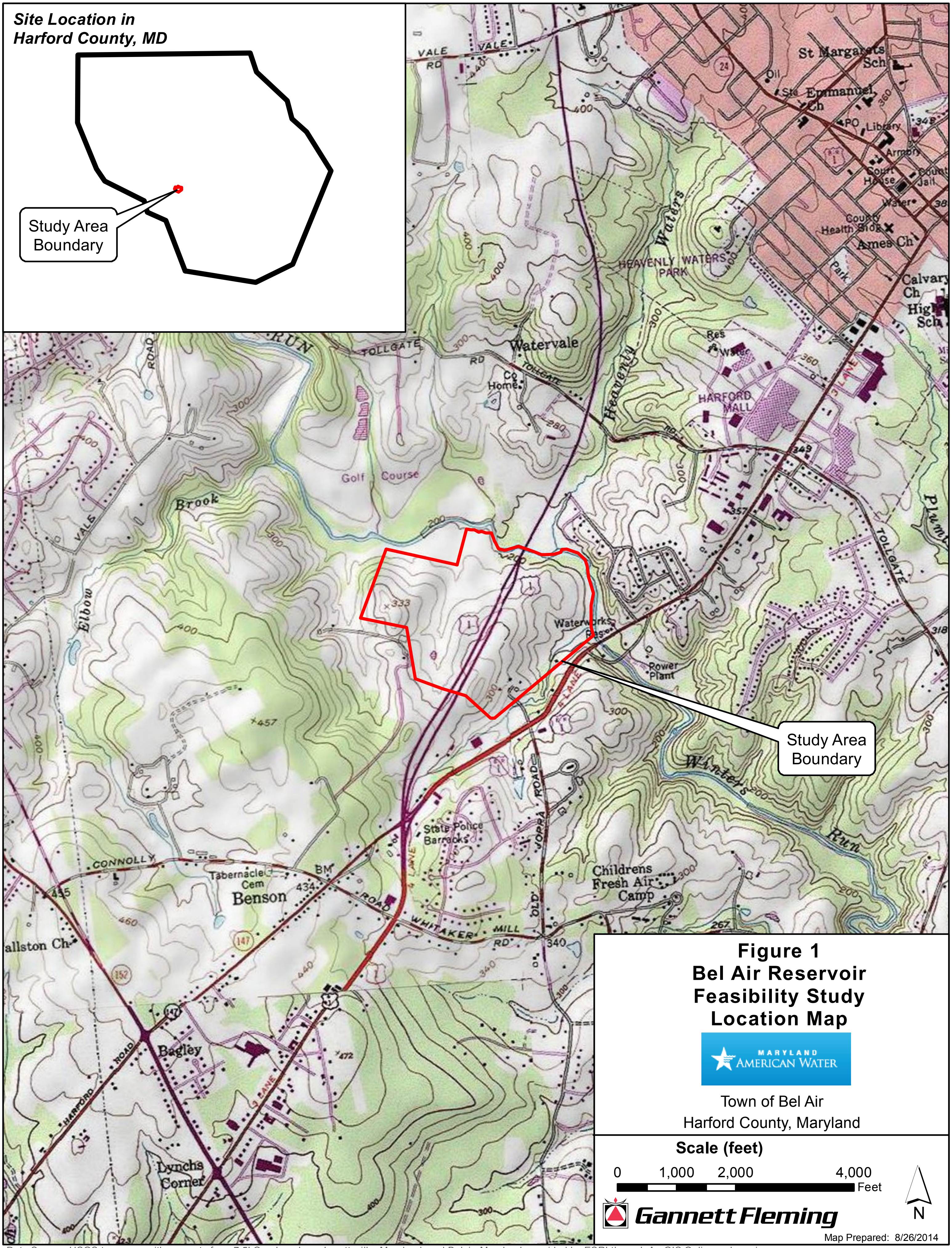

Figure 1
Bel Air Reservoir
Feasibility Study
Location Map

Town of Bel Air
Harford County, Maryland

Data Source: USGS topo map with excerpts from 7.5' Quadrangles - Jarrettsville, Maryland, and Belair, Maryland, provided by ESRI through ArcGIS Online webservice.

Figure 2
Bel Air Reservoir
Feasibility Study
Aerial Location Map

MARYLAND AMERICAN WATER

Town of Bel Air
Harford County, Maryland

Gannett Fleming

Map Prepared: 8/26/2014

Data Source: Aerial imagery map provided by ESRI through ArcGIS Online webservice.

Figure 3
Bel Air Reservoir
Feasibility Study
Photo Location Map

MARYLAND AMERICAN WATER

Town of Bel Air
Harford County, Maryland

Gannett Fleming

Map Prepared: 8/26/2014

Data Source: Aerial imagery map provided by ESRI through ArcGIS Online webservice.

1. Old stone springhouse.
View is south.

2. Old stone springhouse, back view.
View is east.

3. Annie's Playground. View is southwest; playground will not be impacted.

4. Ephemeral stream, unnamed tributary to Winters Run. View is north.

5. Bridge over Winters Run. View is northwest; bridge will not be impacted.

6. Entry to bridge over Winters Run.
View is north; bridge will not be impacted.

7. Edgeley Grove Farm House.
View is northwest; house will not be impacted.

8. Edgeley Grove Farm Barn.
View is north; barn will not be impacted.

9. Edgeley Grove Farm.
View is south.

10. Rock and top soil borrow pit.
View is west.

11. Old barn.
View is south; barn will not be impacted.

12. Old barn.
View is east; barn will not be impacted.

MARYLAND
AMERICAN WATER

Gannett Fleming

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