SOURCE WATER PROTECTION PROGRAM
BENEFITING THE CITY OF FROSTBURG, MARYLAND
(PWSID 001-0011)

ALWI Project No. MD7S075

August 1, 2013

PREPARED FOR THE

CITY OF FROSTBURG

IN PARTIAL FULFILLMENT OF MARYLAND DEPARTMENT OF THE ENVIRONMENT IFB SOLICITATION NO. U00R1400308

ADVANCED Land and Water, Inc.
Global Environmental Solutions
7540 Main Street, Suite 7 • Sykesville, MD 21784
PHONE 410-795-4626 • FAX 410-795-4611 • www.alwi.com

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Reviewed and Approved By:	Prepared and Submitted By:
Mark W. Eisner, P.G.	**David L. Pielmeier**
President	**Operations Mgr./Sr. Scientist**

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1.0 INTRODUCTION

Advanced Land and Water, Inc. (ALWI) was engaged by the Maryland Department of the Environment (MDE) to assist 12 community groundwater systems, including the City of Frostburg (the City), in developing and implementing Source Water Protection Programs (SWPPs).

The Frostburg SWPP will help protect public health by identifying implementable measures to address existing and potential contaminant threats to groundwater supplies of safe drinking water.

1.1 REGULATORY FRAMEWORK

ALWI followed MDE's source water assessment and protection guidelines, which stem from The Safe Drinking Water Act (SDWA) of 1974 and its later amendments, which established wellhead protection programs for each state under the oversight of the U.S. Environmental Protection Agency (EPA). The 1996 Amendments to the SDWA mandated the State of Maryland to develop a Source Water Assessment Program.

The MDE Source Water Assessment Program was approved by the EPA in November 1999. The Program guidelines include recommendations for ongoing management and protection, as well as for periodic updates to reflect changes to the water system, appropriation permit and/or land uses within Source Water Protection Areas (SWPAs) as they may periodically occur.

MDE completed the initial Frostburg Source Water Assessment in 2004 (Section 1.4 and Appendix A), upon which the present groundwater SWPP effort builds. Note that in the 2004 report, SWPAs were termed "wellhead protection areas."

1.2 CONTRACTUAL CONSIDERATIONS

In September of 2011, ALWI was awarded the SWPP contract by MDE. The City's participation in the SWPP was voluntary and not a regulatory requirement under the SDWA.

Our MDE contract specifically focuses on groundwater-sourced SWPP efforts. In the case of Frostburg, the groundwater sources are confined to the Savage River watershed in Garrett County. The City water system (PWSID 001-0011) serves approximately 12,000 people and relies on both groundwater and surface water, which contribute approximately 43% and 57% of the City's water, respectively, as further discussed in Section 4.2.

Water chemistry data reported to MDE and compiled in their database, which has been provided to us, typically reflects surface water and groundwater that has been mixed and treated. Since the scope of this contract is restricted to the groundwater sources only, we briefly discuss the City's surface water source (Piney Reservoir) for the purpose of parsing water quality data, provided by both the City and MDE, to better evaluate whether specific contaminant threats display a condition of groundwater source susceptibility.

1.3 BACKGROUND PROJECT SCOPING CONSIDERATIONS

MDE determined that the City be included among the 20 statewide water systems selected for SWPP update work. We understand that Frostburg was selected and included as a water system based on the size of the population that potentially would benefit from a refocus on source water protection.

Since this contract is limited to the evaluation of groundwater sources, only wells and springs located within the Savage SWPA are assessed. However, because the water quality data provided to us are composite samples of groundwater and surface water, we briefly discuss surface water processes in the context of evaluating whether specific contaminant concerns arise from the City's groundwater sources or surface water source. In spite of our contract being groundwater-only, we also offer certain surface water-related content and recommendations for better protecting the Piney Reservoir as Appendix B.

As future phases of our work proceed, a benefit or need for a further revision to this SWPP report may arise based on MDE review comments, City preferences, citizen input or other reasons. If necessary and depending on the timeliness and relevance of such supplemental information, we will prepare a further update to this assessment, as a final contract activity.

1.4 PREVIOUS ASSESSMENT OF GROUNDWATER SOURCES

MDE prepared the 2004 source water assessment, which included its narrative support for delineation methods as then applied (Appendix A). The 2004 assessment included an analysis of the risks to source waters (both groundwater and surface water) that provide water supply to the City. The assessment included a recommendation that the City form a SWPP Steering Committee to build a consensus approach to guide ongoing protective efforts. As such, one key purpose of this SWPP is to develop and offer specific implementation guidance in consideration of changed conditions since 2004, City preferences and our overall judgment.

The 2004 MDE source water assessment has been updated for currency, drawing upon our professional experience and technical guidance from the Water Supply Program of MDE. No new sources were added to the system since the 2004 report. Notwithstanding this, source water protection is an intrinsically dynamic process. The currency of this assessment continuously is affected by new data, changing regulations and the evolving experience and professional judgment of those involved in developing and implementing this report and the recommendations herein.

1.5 GARRETT COUNTY SENSITIVE AREAS ORDINANCE

The Garrett County Sensitive Areas Ordinance (the Ordinance; Appendix C) originally was adopted on June 24, 1997, and amended May 25, 2010. The Ordinance includes a map of its applicable areas outlined in red, including the Frostburg SWPA that is subject to this effort (Appendix C).

The Ordinance provides for and applies a two-zone approach to incremental groundwater source protection. It provides for "Zone 1" delineations via 500-foot fixed radii around sources, based on a criterion established by, and for use in, Garrett County. Zone 2 areas generally are the surrounding, contributing watersheds, and these delineations generally follow applicable MDE source water delineation guidance. At the outset of this work, the map that is integral to the Ordinance included Frostburg delineations (as mapped by MDE in 2004). Chapter 2 of this report presents revisions to the existing delineations.

The Ordinance establishes requirements and prohibitions to protect community well sources from potential groundwater contamination. Largely, groundwater protections are accomplished through restrictions on incompatible land uses within SWPAs. Specifically, the Ordinance offers the following protections:

- Prohibition of both above ground and underground storage tanks from being placed within 500 feet (Zone 1) of a community water supply system well.

- Hazardous substance storage tanks located within the SWPA, but more than 500 feet from a community water supply system well, shall be placed above ground and be surrounded by a one-hundred percent catchment basin or double-walled containment and a spill protection overfill alarm.

- Uses which principally involve the manufacture, storage, use, transport, or disposal of hazardous materials or any use which involves hazardous materials in quantities greater than associated with normal household use are prohibited.

A more complete list of use restrictions is included in Appendix C. ALWI notes that presently the language of the Ordinance does not include springs; it only includes wells. As further discussed in Section 7.1, we recommend that the Ordinance be revised to include equal protection for spring sources.

2.0 SWPA DELINEATIONS

The Frostburg groundwater sources include Wells 3 and 4 as well as 31 individual springs (Figure 1). Well 4 is the only production well in service for the City. While Well 3 remains connected to the system, it has been inactive since 2006 because of pump and timer failures. According to City representatives, Well 3 is capable of delivering a yield approximating that of Well 4. Consequently, Well 3 is considered a backup source to Well 4. However, the pump and timer failures will need to be addressed, as discussed in Section 7.1.

2.1 2004 MDE SWPA DELINEATIONS

MDE completed the previous SWPA delineations in 1996 and incorporated that prior work in its 2004 report. Two protection zones were mapped, following applicable MDE source water protection delineation methodologies (Appendix A). MDE also mapped an overlapping, semi-circular "recharge area" that was judged to lie upgradient of the City springs.

The map in the Ordinance reflects the 2004 MDE delineations (Appendix C).

2.2 ALWI DELINEATION REVISIONS

ALWI reviewed the 2004 SWPA delineations for conformity to surveyed spring and well locations, present site conditions, City operational practices, Ordinance provisions and current MDE guidance.

We found that Zone 1 needed revision to reflect the surveyed source locations (Figure 1). We also found that the delineations, as shown on the Ordinance Map, did not echo the delineation methodology of the Ordinance (500-foot fixed radii around individual sources). We discussed these matters with both the City and MDE, along with the concept of protecting springs in the same manner as wells. Both the City and MDE came to agree that our revisions to the Zone 1 areas appropriately comport with the Ordinance delineation methodologies.

Accordingly, we generated such 500-foot fixed radii circles around both supply wells and each of the 31 springs (Figure 1) to comport with the intent of the Ordinance (Appendix C). We also assumed that the County would accept our recommendation that they broaden their source definition language to reference springs (in addition to wells).

The resultant Zone 1 re-delineation is generally similar in overall size and areal extent to that previously delineated by MDE using differing (i.e., computer modeling of a 10-year time-of-travel) methods. The City understands that MDE delineation guidance differs, but judged that conformance with the intent of the existing County ordinance provides the most practical means to achieve an appropriate measure of ongoing protection. This sentiment was expressed to MDE, which then approved the re-delineations.

Updates to SWPA Zone 2 were not necessary, because there has been no change to the City's overall groundwater appropriation permit since 2004.

2.3 RELATION OF DELINEATIONS TO PROTECTIVE STRATEGIES

As previously discussed in Section 1.5, the protective strategies within the Ordinance for Zone 2 generally are as robust as typically recommended and observed for Zone 1 delineations in other systems. For this reason, ALWI concluded that conservatism in overall protection was not sacrificed by the Zone 1 delineation alterations herein.

3.0 CONTAMINANT THREATS ASSESSMENT

ALWI performed a regulatory database review, field reconnaissance and limited interviews to update the 2004 inventory of potential sources of contamination within the SWPAs. Both point as well as non-point sources of contamination were considered.

3.1 STATE ENVIRONMENTAL DATABASE REVIEW

MDE provided ALWI the following environmental databases to incorporate into point-source hazard inventories:

- Municipal and Industrial Groundwater Discharge Permits (6/14/2012);
- Pesticide Dealers (1/12/2012);
- Land Restoration Program Sites (Voluntary Cleanup Program and Comprehensive Environmental Response, Compensation, and Liability Act) (1/16/2012);
- MDE Oil Control Program databases (10/14/2011);
- Supplemental database listing of solid waste facilities, wood waste disposal sites and other hazardous waste generators (2/2012); and
- Resource Conservation and Recovery Act sites (6/18/2012).

The databases helped with interpretations of groundwater susceptibility, in that the listed facilities may be generators of hazardous materials, petroleum products and/or other drinking water contaminants. Results of this review are integrated within the susceptibility discussion in Chapters 4 and 5 of this report.

3.2 FIELD RECONNAISSANCE WITHIN SWPAS

ALWI performed a visual field reconnaissance within the SWPAs on March 13, 2012, guided by City representatives. During this reconnaissance, local land use conditions were observed with emphasis on the potential use, storage and disposal practices of hazardous materials and petroleum products in the delineated SWPAs. Such conditions may have included visual evidence of present or former spills, stained or discolored ground surfaces, stressed vegetation, unusual odors or visible underground storage tank appurtenances. Adjacent and nearby properties were visually scanned to the degree practicable from public rights-of-way.

No potential point sources of contamination within the SWPAs[1] were observed during the field reconnaissance from public rights-of-way. However, City officials identified a small motorcycle shop, called D P Performance Shop, at 96 Old Beall School Road, which is located southeast of the springs and wells within the Zone 1 SWPA. The shop may act as a potential source of volatile organic compound (VOC) contamination. However, no VOCs were detected in post-treatment composite water quality samples collected between 2002 and 2011. Water quality findings are further discussed in Chapter 5. Significant land use or waste disposal changes were not observed. The municipal production wells appeared to possess good physical integrity, though no subsurface or invasive work of a confirmatory nature was performed. No confirmed sources of existing, direct contamination to the wells, springs or aquifer within the SWPAs were observed.

ALWI observed the following specific features and conditions:

- **General Set-Up and Security Provisions -** Water from the springs is collected in two concrete "reservoirs." Spring water then flows downhill to the pumping station, where it is mixed with well water, before being pumped uphill to the water supply dam near the treatment plant. We noted that well caps were securely locked in place. A locked gate, preventing unauthorized vehicles from entering the premises, secured the entrance to the well field and springhouse area.

- **Springhouse Conditions** - We noticed that some springhouses appeared to possess good physical integrity, while others had collapsed, or had been destroyed, presumably by vegetation and precipitation events. The remnants of the dilapidated springhouses (i.e., corroding sheet metal and piping) were evident during our field reconnaissance. Springhouses in disrepair may act as conduits for bacterial and other surficial contamination into both the water supply (open piping) and groundwater. As of April 29, 2013, the City secured funding from the MDE, the Community Development Block Grant (CDBG) and other local sources to fund a springhouse improvement project. The project has been organized into two phases. Phase I (already underway) will focus on rehabilitating all springhouses and pipelines that connect to the collection reservoirs. Phase II will focus on relining the reservoirs, repairing concrete infrastructure (reservoirs), rehabilitating the upper and lower pump houses and possibly installing an on-site emergency generator. System representatives hope to have Phase II solicited for bid by the end of 2013.

- **Pipeline Conditions** - Bennett, Brewer & Associates, LLC, working under contract to the City on a raw water and energy conservation project, found that large portions of the spring-water collection system are exposed above ground and broken. This reduces the quantity of water delivered to the concrete reservoirs and introduces sediment into the system. During cold periods, portions of the piping system freeze. Some pipelines get clogged or crushed,

[1] Point source hazards may remain undetected because of limitations in the methods employed (concealed visual evidence, etc.). Also, new contamination hazards may develop in the future. For these reasons, the measures employed herein for identifying contaminant hazards should be revisited periodically for the assessment to remain current.

and prevent spring water from entering pipes, contributing to increased overflow onto the ground.

- **Discolored Water Discharge** - ALWI staff observed rust-colored, possibly iron or manganese laden, water permeating from a mound/embankment in the area of the Savage River Headwater Dam Removal and Stream Restoration Project[2]. However, because this condition was not observed elsewhere, no conclusive determination of its nature or origin was available.

3.3 NON-POINT SOURCE CONTAMINATION HAZARDS AS SUGGESTED BY LAND USE

MDE guidance suggests consideration and mapping of the following land use classifications within the SWPAs: agriculture, forest, residential, industrial, commercial, public lands and mined lands. Each of these has potential implications in terms of non-point contaminant sources (e.g., septic systems outside public sewer service areas and leaking mains inside said areas).

ALWI obtained 2010 land use Geographic Information System data for the SWPA for these and other related land uses (Figure 2) from the Maryland Department of Planning. Pertinent land use acreages and percentages by SWPA are listed in Table 1. Dominant land uses within the SWPAs are forested (78%) and agricultural lands (22%) for Zone 1 and forested (81%) lands for Zone 2. Relatively small areas in Zone 2 are within low density residential, agricultural, public and commercial categories (Table 1). This information is also displayed graphically in pie chart form for SWPA Zone 1 (Figure 3) and SWPA Zone 2 (Figure 4).

Considerations of the land use review included:

- **Nitrates and Other Nutrients** - Agricultural land may be fertilized or treated with herbicides. Agricultural lands within the SWPAs may act as potential non-point sources of nutrient contamination to Piney Reservoir and the Savage SWPA sources.

- **Timbering Operations** - While this is mainly a concern for lands within the Piney Reservoir watershed, it would be beneficial to avoid timbering upgradient of the springs in the Savage SWPA, given the current state of disrepair. Intense precipitation events may permit sediment-laden stormflow from such operations to enter spring piping appurtenances. Clear cutting, in particular, may increase stream water turbidity and sedimentation, alter stream flow (and therefore reservoir) volume, and increase leaching of nutrients following cutting.

- **Interstate Route 68 & US Route 40** - Highway spills, including accidental automobile discharges along Interstate Route 68 and US Route 40, may act as non-point sources of various synthetic or volatile organic compounds.

[2] This project restored natural stream conditions to a 600 foot reach of the Savage River, where a dam was constructed to create the Savage River Reservoir, which is now unused due to the upgraded groundwater collection system (at Savage) and the replacement of the Piney Dam and Reservoir. The project was completed to improve habitat for Brook trout.

- **Potential Energy Development Plans** - ALWI obtained maps from the Garrett County website of lands leased and mineral rights sold to energy companies (Appendix D). We overlaid this information on the SWPAs and found that four acres, or roughly one percent of Zone 2 SWPA appeared to have been leased to (or owned by) Samson Resources (a natural gas exploration company). ALWI believes that it could be possible that this is an artifact of mapping imprecision and not an actual leasehold. Recent newspaper accounts suggest that active Marcellus Shale drilling applications have been withdrawn, statewide, without exception. We recommend that the City confirm this information, as it affects recommendations herein.

- **Sewer Service Areas** - MDE guidance also suggests mapping of municipal sewer service areas because property owners and occupants outside of sewer service areas may contribute to groundwater contamination differently than those on public sewer. ALWI found that the SWPAs are outside of the sewer service area. In 2004, MDE documented no more than four houses on septic systems within the SWPAs. Houses on septic systems typically entail the following specific risks and considerations from a source protection perspective:

    - Liquid petroleum products commonly are used as a heating fuel.

    - Waste (or other regulated liquids) discharges may be more likely to enter the groundwater via septic effluent.

ALWI notes that future energy resources extraction activities including, but not restricted to, natural gas operations on the aforementioned leased lands, could imperil groundwater quality and/or production based on similar occurrences reported elsewhere in the country in seemingly similar circumstances. Chapter 6 further discusses such risks (as well as from similar activities such as coal mining) and offers suggestions for their mitigation.

4.0 WATER QUALITY REVIEW AND SURFACE WATER PROCESSES

ALWI completed a review of available water quality records, integrated with other findings herein, to support an assessment of groundwater contaminant susceptibility. MDE guidance defines a threshold for regarding a water source being "susceptible" to a given contaminant as being either:

- When the concentrations exceed 50% of the Maximum Contaminant Level (MCL) for 10% or more of the documented samples for a regulated contaminant; and/or

- When a persistent but lower concentration is either increasing or appears associated with an unknown or unexpected source.

In addition to these water quality data considerations, ALWI also considered the following factors in evaluating overall susceptibility:

1. The spatial position of sources of potential contamination relative to sources and SWPAs;

2. Observed conditions of wellhead integrity and housekeeping; and

3. The natural chemical properties of the source water within contributing aquifers.

4.1 WATER QUALITY DATA REVIEW PROCEDURES

ALWI used the following step-wise procedure to complete the susceptibility assessment:

1. **Obtain MDE Water Quality Databases -** The City is required to perform water quality tests on the drinking water it produces and submit operating reports to MDE. ALWI reviewed available electronic databases of water quality analyses provided by MDE for the period 2002 to 2011. The furnished databases contain analytical records for inorganic compounds including radiological species, synthetic organic, volatile and semi-volatile organic compounds of blended water within the distribution system. Generally the absence of comprehensive analytical results of raw groundwater samples hampered correlating specific water quality findings to specific contributing sources.

2. **Review and Interpretation of MDE Water Quality Databases** - The MDE water quality database was developed as an incidence of regulatory compliance and only reflects post-treatment, composite water samples (of largely surface water) and not City raw groundwater sources. As such, this database alone could not support a conclusive finding of groundwater susceptibility.

3. **City Water Quality Records Review** - The City provided composite pre-treatment sampling results typically associated with surface water supplies (e.g., turbidity, pH, etc.) or contaminants having only a Secondary MCL (e.g., iron, manganese, etc.). For comparison purposes, the City further supplemented this information with a single raw groundwater sample from Well 4 on March 21, 2012.

4. **Segregate Surface Water and Groundwater Data** - The MDE databases and City records were analyzed to identify whether interpretive trends and results were associated with surface water sources or groundwater sources. Specific procedures included:

   - Using the flowmeter records for each source grouping, ALWI determined the percentage of water contributed from each of the major City sources (Piney Reservoir, each well, and the springs).

   - We graphed and analyzed system-wide trends for turbidity, pH and iron concentrations over time.

   - We compared the raw water sample from Well 4 to system-wide water quality data on the same date to distinguish between water of surface and groundwater origin. The parameters of turbidity, pH, and iron facilitated this comparison.

5. **Identify "Exceedance" Instances** - To identify water quality sample exceedances (as the limited raw sampling data could support), we compared each specific analytical result to published MCLs (in COMAR 26.04.01 as of September 2011). Guided by MDE and notwithstanding the above-stated concern over the limited applicability of blended analytical data from the distribution system, we judged that a concentration greater than 50% of a given MCL should be considered an "exceedance." Procedurally, this was accomplished by sorting the database by analyte and concentration.

6. **Assess Frequency and Relative Percentage of Exceedance Instances** - The number of times that a given analyte was detected in a concentration greater than 50% of its respective MCL was discerned in terms of overall frequency, percentage of total number of samples and date range of exceedance. Contaminants with results equaling or exceeding 50% of the MCL more than 10% of the time were considered *prima facie* susceptible. To the degree supported by the available data and tempered by the limited applicability of blended results from the distribution system, ALWI also considered changes in contaminant trends over time, both for those that did and did not equal or exceed 50% of the MCL more than 10% of the time.

7. **Integration** - ALWI then considered these identified exceedances in the context of the results of the contamination hazard reconnaissance to correlate water quality results to specific field observations suggestive of a condition of raw groundwater or spring water susceptibility.

4.2 WATER CONTRIBUTION AND VARIABILITY THROUGH TIME (BY SOURCE)

The City provided ALWI daily composite water quality samples (collected prior to chemical treatment) and precipitation measurements from 2011-2012, as well as monthly flow meter records from 2002-2012.

ALWI plotted the percent contribution from each source over the period 2002-2012 (Figure E1, Appendix E). On average, surface water from Piney Reservoir contributed 57%, the springs collectively contributed 38%, Well 4 furnished 5.3% and Well 3 provided 0.2%. A City representative further explained that Well 3 had a pump failure in 2006 and has not been used since.

Relative contributions from springs vary seasonally based on hydrogeological conditions, as discussed in a 2008 study by Whitman, Requardt & Associates, LLP. A decrease in water contribution from the spring sources results in increased reliance on the contribution from Piney Reservoir, particularly in the summer and fall months, as shown in Figure E1.

Moreover, the natural process of lake mixing imparts considerable variability to water quality. ALWI recommends confirmatory source-specific sampling (performed repeatedly under a range of weather conditions and at different times of year) before any quantitative susceptibility determination can be considered definitive.

4.3 SURFACE WATER MIXING AND SEASONAL TURNOVER

The 2004 MDE description of Piney Reservoir (Appendix A) suggests that it is large and deep enough to display lake-like characteristics of turnover. Cooler autumn temperatures would cause the density of the water at the surface to increase, annually. This denser water then sinks, displacing and forcing less dense water towards the surface. This process continues until the water reaches a relatively uniform temperature (Minnesota Department of Natural Resources, 2012).

Piney Reservoir chemistry varies seasonally. During summer, surface water is warmer and less dense than bottom water, establishing a thermocline that inhibits vertical mixing (i.e., summer stratification). Conversely, during autumn, the subtle temperature and density difference between surface water and bottom water allows mixing by wind in a process called lake turnover[3]. Stratification and mixing events vary year-to-year based on climate and other factors. In the case of Piney Reservoir, based on the water quality data available at the time of our assessment, turnover manifests as variability in iron concentration. This interpretation by ALWI was based on plots of combined ferrous and ferric iron concentrations, as measured in the composited, raw water, against source contribution (Figure E2).

We observed a correlation between the time period of highest total iron concentrations and the interpreted period of fall lake turnover, which would be expected for a lake in eutrophic or near-eutrophic conditions. Only in the fall does mixing return the iron and phosphate rich waters (that were isolated at depth) to the surface, where it can be captured by the City's lake intake. MDE reached a similar conclusion in 2004 (Appendix A). Ferric iron accumulates on the lake bottom in the summer, becomes reduced (and separated from the phosphate under anoxic conditions likely caused by the degradation of organic matter) and gets re-oxidized in the fall during and following turnover.

5.0 CONTAMINANT SUSCEPTIBILITY

ALWI found that the groundwater sources supplying water to the system appear susceptible to arsenic. The composite raw water, prior to chemical and physical (sedimentation and filtration) treatment, reflects elevated turbidity concentrations on an intermittent basis. The water within the distribution system reflects elevated concentrations of Disinfection Byproducts (DBPs). As supported in this Chapter, we believe that arsenic is the only one of these constituents potentially comprising a condition of raw groundwater source susceptibility.

However, we note that our findings heavily depend on limited analytical laboratory results and the pronounced seasonal overprint caused by lake turnover. Additional sampling and analysis, particularly if undertaken on a source-specific basis and repetitively throughout the year, could achieve greater assuredness.

[3] MDE used epilimnion and hypolimnion, to refer to surface and bottom water, respectively (Appendix A).

5.1 ARSENIC

Arsenic is a naturally occurring element found in rocks, soil, water and air. High arsenic concentrations tend to be associated with groundwater more than surface water sources, as high demand from groundwater sources may cause water levels to drop in response to pumping, releasing arsenic from rock formations into the well (EPA, n.d.).

A total of 12 arsenic samples were collected from 2002 to 2010, in which two samples equaled 50% of the MCL (0.005 mg/L), one in 2006 and the other in 2007. MDE officials have indicated that one of these samples was taken from the system's point of entry, while another was taken at a residence.

Arsenic is a natural component of rock formations in Western Maryland. The potential exists for arsenic to leach into the groundwater sources within the Savage SWPA, particularly for wells under increased pumping conditions. Since the system historically has experienced periods of arsenic susceptibility, the City should continue monitoring for arsenic contamination, and may benefit from testing surface water sources for arsenic separately from groundwater sources.

5.2 DISINFECTION BYPRODUCTS

DBPs form in the distribution system, as a result of mixing chlorine (used for water disinfection in the treatment system) with organic and/or inorganic matter in source water. The presence of DBP precursors is often measured using Total Organic Carbon (TOC). Individual DBPs exceed 50% of their respective MCLs, generally in half of the samples:

Contaminant	Total Samples	# Samples > 50% MCL	% Exceedance	# Samples = or > MCL
Total Trihalomethanes (TTHM)	157	73	46%	19
Total Haloacetic Acids (THAA)	157	97	62%	26

In their 2004 assessment, MDE reported that data from the Piney Reservoir indicated that most of the TOC in the reservoir was in the form of Dissolved Organic Carbon (DOC), which exhibited a consistent seasonal pattern, with concentrations lowest in spring and gradually increasing until the fall season when concentrations were highest[4]. MDE also found that DOC concentrations did not display observable trends among streams or seasons. We interpret that the high amount of organic matter (DBP precursors) in Piney Reservoir is a reflection of its eutrophic state.

[4] ALWI found that during certain years, concentrations of these DBPs were also elevated during the summer. This could be attributed to algal blooms on the lakes surface brought on by surrounding agricultural practices.

MDE hypothesized that processes within the increasingly eutrophic Piney Reservoir are producing a significant amount of DBP precursors. Upon analysis of water quality trends through time, ALWI came to support this hypothesis. Given the low percent contribution from groundwater sources and the relationship between previously noted TOC trends coinciding with suspected lake turnover trends, we believe that DBP precursors likely originate mainly from Piney Reservoir and the contributing watershed, and not from the groundwater itself. While the City is susceptible to DBP's, the groundwater likely contains few, if any, DBP precursors. Additional testing for TOC would need to be performed in samples from the wells to make this determination.

Plant operators indicated that Granular Activated Carbon (GAC) was introduced to the system in 2005, and that the entire supply was treated via GAC as of 2006. Plant operators report that the GAC helps remove iron, manganese and DBP complexes. GAC can remove DBP precursors, or adsorb the DBPs themselves. Additionally, domes were installed over the finished water reservoirs, which helped reduce the amount of chlorine needed for disinfection.

We noted a general decrease in DBP concentrations over the course of the sampling period (Figure E3). Generally, DBP concentrations were elevated above 50% of their respective MCLs for much of the year, with violations of the MCL often occurring during the summer and fall, particularly from 2002 to 2006 when the GAC treatment was not fully online.

After the 2006 sampling year, we noted a general decline not only in the concentration of both constituents, but the length of time for which they were elevated. However, despite this general decrease, the number of TTHM samples that exceeded 50% of the MCL slightly increased from 47.5% of samples (pre-GAC) to 50% of samples (post-GAC). Comparatively, the percentage of samples that exceeded 50% of the MCL for THAA decreased from 75% (pre-GAC) to 54.4% (post-GAC). Likewise, the percentage of samples that exceeded the MCLs for TTHM and THAA decreased from 20% to 4.4%, and 25% to 8.8%, respectively. Decreases in DBP formation could be attributed to changes in treatment processes at the Frostburg Water Treatment Plant.

A water sample collected by plant operators at the raw water tap on April 3, 2012 had a TOC concentration of 1.6 mg/L. However, contributions from the spring sources tend to be highest around April. TOC concentrations are expected to increase in the composite raw samples during the course of the calendar year, correlative with the relative contribution from Piney Reservoir. Raw sampling of the groundwater and surface water sources for TOC would help distinguish between the organic carbon from groundwater sources (which we expect to be minimal) and organic carbon from the likely eutrophic Piney Reservoir.

5.3 TURBIDITY

ALWI plotted the City-provided turbidity concentrations and rainfall measurements from January 2011 to March 2012 (Figure E4). We observed a strong correlation between summer and fall rainfall events and turbidity. We also compared turbidity data to Savage River stream hydrograph records, from the USGS-maintained gauge located ten miles downstream. High turbidity values were observed in the spring, associated with high stream flows, as expected

given snowmelt and low evapo-transpiration during spring rainfall events.

The available data, though sparse, do not indicate elevated groundwater source turbidity. For example, the City recorded a blended turbidity value of 0.9 Nephelometric Turbidity Unit (NTU) on March 21, 2012. The Well 4 sample from the same day had only one-sixth as much turbidity (0.16 NTU). We concluded that Well 4 does not appear to be susceptible to turbidity, and is likely not susceptible to surface water pathogens, by extrapolation. Occasional turbidity spikes at the blended filtration plant are likely of surface water origin and seem less likely to be of groundwater origin.

5.4 OTHER WATER QUALITY FINDINGS

In 2006, 29 lead samples were taken throughout the distribution system. Of the 29 samples, three exceeded the MCL of 0.015 mg/L, while 25 resulted in non-detects; only a single sample had a positive detection without exceeding the 50% MCL threshold. Additionally, none of the 29 copper samples taken throughout the system exceeded 50% of the MCL. Based on the foregoing, the system, and by extension the groundwater sources, are not susceptible to lead or copper contamination.

ALWI plotted pH values over time (Figure E5), and compared these to seasonal variability in the percent contribution from the three major water sources (Piney Reservoir, Savage Springs and Well 4). We found that the groundwater sources (pH of 6.2) are slightly acidic, and that overall system-wide pH (7.0) generally is neutral as supported by the March 21, 2012 raw groundwater sample. From that, we interpreted the following:

- **Lead and Copper** - MDE officials have indicated that lead and copper samples were collected from homes in the distribution system in compliance with Lead and Copper Rule Monitoring Requirements. For these tests, sample sites were selected to represent homes in the system with the highest potential for elevated lead, due to the presence of lead soldering predating current prohibitions. These samples were taken as first draw early morning samples, maximizing the likelihood of a positive sampling result due to extended exposure to lead and copper piping. We suspect that lead concentrations likely exceeded the MCL in samples from homes using lead soldering, and do not originate in the groundwater. Elevated lead concentrations likely are the result of leachate from residential or system piping when the water remains stagnant (such as during overnight periods when use is minimal). The neutral pH of the raw system water and the isolated instances of lead detections suggest that local residential or commercial plumbing is more likely to be the contributor of lead via leachate, as opposed to system piping.

- **Iron** - The City reported a blended, raw iron concentration of 0.08 mg/L on March 21, 2012, whereas the groundwater in Well 4 only had a concentration of 0.03 mg/L on that date. Conversely, on October 16, 2011 a blended, raw iron concentration of 0.524 mg/L was reported. Iron concentrations for the system only exceeded the secondary MCL of 0.3 mg/L in the fall, likely as a result of reservoir turnover. Consequently, the groundwater is not likely susceptible to elevated iron concentrations.

6.0 STEERING COMMITTEE INTERACTIONS

ALWI, along with our municipal planning subconsultant Advance Planning Associates, met with the Frostburg Steering Committee on Wednesday, May 30, 2012. The Steering Committee was comprised of members representing the System and its contractor, utility engineering firm Bennett, Brewer Associates.

ALWI presented a slide show summarizing the basis for then-current but still preliminary recommendations related to water quality issues and options for future planning and protection. Salient topics of discussion included:

1. **Present Effort is Limited to City Groundwater Sources** - Those in attendance understood and agreed that most of the City's water and most of its water quality risk and variability is associated with Piney Reservoir and the lake-like processes that occur within that surface water body. The meeting focused on the groundwater supply wells and springs in the Savage SWPA. At some length we discussed ongoing efforts and plans to reconstruct and otherwise improve spring infrastructure, including the need for State funding to complete those necessary efforts.

2. **Recommended Delineation Updates** - The Steering Committee discussed the updates to past SWPA delineations. Bennett Brewer Associates provided key support to this effort in the form of survey control for the spring sources, previously unavailable to support the re-delineation. We discussed how the updates were beneficial for conformance to applicable provisions of the Garrett County Sensitive Areas Ordinance and current MDE guidance, as Zone 1 of the Frostburg groundwater delineation depicted on the Ordinance map was not in conformance with the defining language of the Ordinance. It was agreed that the greatest defensibility would arise from MDE review and approval of the re-delineations; we agreed to coordinate with the agency regarding same. On October 12, 2012 MDE approved the delineations.

3. **Groundwater Susceptibility as Suggested by Water Quality Data** - We discussed data limitations supporting definitive interpretations of raw groundwater susceptibility. Many of the compliance sampling results that would form the basis of such interpretations are of blended samples. Parsing surface water effects, including variability borne of lake effects such as turnover, was central to our quantitative work on susceptibility. We identified arsenic as a possible contributor to raw groundwater susceptibility during the meeting. . Blending and filtration appears to mitigate other risks such as possible turbidity during rainfall events. Additional raw source groundwater sampling, if undertaken, could support more definitive susceptibility interpretations.

4. **Groundwater Susceptibility Arising from Land Use** - From a land use perspective, while the groundwater sources are well protected from contaminants, they could be further protected if certain potential uses of an incompatible nature were restricted or prohibited. ALWI discussed the existing Garrett County Sensitive Areas Ordinance (Appendix C), the inclusion of the existing delineation areas on the map that is a part of the Ordinance and our recommendations to Garrett County on specific revisions to the text and map (Appendix C).

In some detail we reviewed suggested prohibitions on energy resources projects (i.e., coal mining and petroleum exploration), as well as the City's hesitancy to embrace contemplated restrictions on timbering and wind energy. We agreed not to recommend timbering and wind energy restrictions.

5. **Wellhead and Spring Security** - The City plans to improve the physical integrity of spring-related appurtenances. ALWI recommends that this effort continue to be prioritized for funding, and that visible components of the groundwater source system and infrastructure be locked behind fencing.

6. **Public Workshop** - We discussed the prospect of a public workshop, and its benefit in garnering proactive buy-in regarding measures such as the revised Garrett County Ordinance. We also discussed the possibility that the existence of this Ordinance, revised or not, may not be well known to those in the Frostburg area who could potentially be affected by, and benefit from the Ordinance. Garrett County has a public participation process as a component of its administrative ordinance revision process. The City may also benefit from an informational presentation on our work, including the Ordinance, once Garrett County takes final actions on our recommendations. Steering Committee representatives supported such a presentation and stated that it could be organized as a component of a City Council meeting.

As mentioned earlier in this report, the subject SWPAs exists entirely within Garrett County jurisdiction. As a result, the SWPAs share protection under the Garrett County Sensitive Areas Ordinance with two other systems subject to this SWPP contract. These two systems are owned and operated by Garrett County and serve McHenry and Mountain Lake Park. Like the City's system, the Midland-Lonaconing-Barton water system also has portions of their SWPA within Garrett County jurisdiction, but it is not presently protected by the Ordinance.

In the course of executing our work for the Garrett County owned systems, we came to recommend ordinance revisions that would positively affect the protection of water sources controlled by the City (i.e., Savage Watershed wells and springs subject to this SWPP). Due to the applicability of revisions to the Garrett County Sensitive Areas Ordinance in the SWPAs for these Systems, the Steering Committees for each of the four related Systems came to agree to convene a joint public workshop on source water protection.

A joint workshop was held on May 15, 2013 (Appendix F) at Garrett County offices in Oakland, Maryland. The recommendations discussed at the workshop were viewed favorably by System representatives in attendance, and were taken under advisement by Garrett County.

7.0 RECOMMENDATIONS

ALWI has developed recommendations to improve overall source protection in light of the observations, analyses and interpretations presented herein.

7.1 GROUNDWATER SOURCE PROTECTION RECOMMENDATIONS

ALWI recommends the following for City groundwater sources (i.e., sources within the Savage SWPA):

1. **Repair Springhouses** - During our field reconnaissance, numerous dilapidated springhouses for active spring sources were observed. The health threats to the public at large associated with such conditions are obvious. City officials explained to ALWI that the City has applied for grant monies through the MDE for funds to repair and/or reconstruct these springhouses. It is our understanding that an agency decision is pending. Given the direct exposure that these active sources now experience, we urge MDE to consider approval of grant monies for the purpose of improving these springhouses without delay.

2. **Work with Garrett County to Revise Existing Ordinance** - Presently, there is language in the Garrett County Sensitive Areas Ordinance regarding wells, but not springs. ALWI recommends that the Ordinance be revised to include equal protection for spring sources, and that the Ordinance map be revised to reflect the new delineations for the sources within the Savage SWPA. We believe that this process will be facilitated by Garrett County's expressed plans to make similar revisions for the spring sources serving Mountain Lake Park, another system subject to this SWPP contract.

3. **Resolve Pump and Timer Failure for Well 3 -** In order to be considered a suitable backup supply source, the pump and timer issues reported for Well 3 will need to be resolved in the event that Well 4 encounters issues or need to be taken offline. The backup well should be ready to supply water the moment the primary supply well needs to be shut down.

4. **Continue Monitoring and Consider Additional Testing for Arsenic -** The City should continue monitoring for potential arsenic contamination of natural origin. EPA officials report that arsenic contamination is more likely associated with groundwater than surface water sources. The City should consider testing groundwater sources and surface water sources separately for arsenic to determine the origin of arsenic contamination, when present.

5. **Consider Surface Water Protection Strategies as Well** - Appendix B provides certain surface water protection strategies worthy of consideration and future adoption.

7.2 SYSTEM-WIDE SOURCE PROTECTION RECOMMENDATIONS

ALWI offers the following system-wide recommendations:

1. **Encourage Replacement of Lead Soldered Plumbing** - MDE officials have indicated that residential homes with the highest potential for lead and copper contamination are more susceptible due to the presence of lead soldering. These residences were tested in compliance with Lead and Copper Rule Monitoring requirements. Lead concentrations exceeded the drinking water MCL in homes that likely use lead soldered piping. Residents should consider replacing lead soldering with alternative piping, such as PVC. If such an action is not within the budget, the City should consider advising residents to undertake the following interim

measures until more holistic improvements can occur:

- **Allow water to run before use -** Water that is not constantly flowing through lead and copper piping remains stagnant, while increasing concentrations of lead and copper leach into the water. Residents should allow their water to run for a minute or two before use in the morning and when they return from work.

- **Consider buying a filter** - Many residential tap filters have been shown to help decrease concentrations of heavy metals in drinking water, including lead.

2. **Revise and Improve Natural Resource Practices -** While we agreed not to recommend timbering and wind energy restrictions during the Steering Committee Meeting (Chapter 6.0) we continue to encourage the system to abandon clear cutting in favor of a method that involves less concentrated land disturbance. When issuing timbering permits, the City/County should ensure that Best Management Practices (BMPs) are being enforced so as to minimize soil compaction and erosion of the soil surface. BMPs not only address the method of harvesting, but take terrain and water bodies into account by considering skid trail planning. Several books and field guides exist on this topic and could be further investigated by the City/County.

3. **Purchase Lands and Reduce Agricultural Practice Impact -** A review of Garrett County assessment and taxation data indicates that the City owns very little of the land that comprises the Savage SWPA. The City should consider purchasing land from landowners within the SWPA (particularly in Zone 1) to ensure that forested lands remain forested. Additionally, agricultural lands could be purchased to allow for natural, volunteer-funded or System-funded forest rehabilitation. For agricultural land, particularly in the Piney Reservoir Watershed, we recommend the City encourage appropriate County governments across the watershed to work with landowners towards re-establishing riparian buffer zones adjacent to streams in the watershed (Appendix B). Agricultural lands within the Savage SWPA are relatively sparse and system-wide nitrate concentrations do not exceed 1.5 mg/L. However, system representatives may find it beneficial to educate adjacent agricultural land owners on source protection goals, work with aforementioned land owners (and the Maryland Department of Agriculture) to develop nutrient management plans.

4. **Consider Revising Road Salt Application Procedures -** In October 2012, the Department of Transportation State Highway Administration issued new guidance for reducing the use of road salt, particularly in Sensitive Areas, which include susceptible areas (as defined by MDE) identified by the Wellhead Protection Program. In Frostburg, this would be applicable to Zone 2 of the Savage SWPA, though adoption of certain strategies could help reduce contamination of Piney Reservoir (and its tributaries) by road salt. The document states that SHA and MDE agreed that roadside receiving waters exhibiting indicators of salt contamination will be monitored and salt management practices in those areas will be assessed to determine if changes in practices and salt usage should and can be implemented. The MDE funded study by the University of Maryland Center for Environmental Science determined that salinity in the reservoir can be attributed to road salt deicing practices. Site specific plans for the Piney and Savage Protection Areas should be developed. Such plans

may include reducing salt usage, or not using salt in favor of another snow and/or ice control material. SHA also encourages placing signs to alert motorists in areas where reduced levels of deicing service may be available due to environmental concerns.

5. **Post "No Dumping" Signs Within SWPA** - The City should consider posting "No Dumping" signs at various locations within the SWPA to discourage the informal disposal of hazardous wastes and petroleum products. Similarly, the City should recon the SWPA for evidence of dumping, while removing unwanted debris and waste items.

5. **Create a Spill Notification System** - The potential exists for surficial spills to infiltrate the unconfined aquifer from which Well 4 draws its water. A spill notification system along Interstate 68 & US Route 40 would give water plant managers notice of potential contaminants that could impact drinking water quality. This would allow them ample time to design and incorporate preventative measures to reduce the impact of these spills.

8.0 REFERENCES

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