



Pumping, Monitoring and Mitigation Plan (PMMP)

for

**Town of Hamilton Well 14
Stone Eden Well
Hamilton, Virginia**

Prepared for:

Mayor Ray Whitbey
Town of Hamilton

Prepared by:

TRIAD Engineering, Inc.
210 N. 21st Street
Purcellville, Virginia 20132

Date: October 15, 2007

TRIAD Project # 05-07-0092

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1.0 INTRODUCTION

TRIAD Engineering, Inc. is pleased to present the following pumping, monitoring and mitigation plan (PMMP) on behalf of our client, the Town of Hamilton. This PMMP has been specifically prepared for Well 14, which is situated on a 1.36 acre parcel just outside of the Town of Hamilton limits (PIN 454-20-8349) and is shown on Figure 1. This PMMP describes the anticipated pumping rates, monitoring methods for the supply well and select off site wells, and includes mitigation strategies to be initiated in the event that any offsite well is deemed to be negatively impacted due to groundwater withdrawal from Well 14. The monitoring section of the plan has been developed to address the groundwater monitoring requirements of Section 6.240, G., I., J., and K. of the Loudoun County Facility Standards Manual (FSM).

Well 14 will withdraw in excess of 10,000 gallons per day and is therefore subject to hydrogeologic study requirements of the Loudoun County Facility Standards Manual (Section 6.240). The Town of Hamilton has requested a waiver of Hydrogeologic Study Requirements and this PMMP has been prepared to address monitoring and mitigation concerns expressed by the Loudoun County Department of Building and Development in correspondence dated September 12, 2007. A similar request was made by the Virginia Department of Health Office of Water Programs in correspondence dated September 18, 2007. Copies of this correspondence have been provided in Appendix A. To satisfy these requests the Town of Hamilton is pleased to submit this PMMP which addresses plans for pumping, monitoring and mitigation for Well 14. With the approval of this PMMP the Town of Hamilton understands that the Hydrogeologic Study Requirements as outlined in FSM Section 6.240 will be waived.

2.0 PUMPING

Well 14, also known as the Stone Eden Well, was completed on October 21, 2000 by Valley Drilling Corporation. The well was completed to a depth of 420 feet where an air lift yield of 400 gallons per minute (gpm) was recorded. The well was constructed with 8-inch diameter casing set to a depth of 126 feet. Water bearing zones were noted from 240 feet to 360 feet. A well completion report for Well 14 has been included as Appendix B. Well 14 underwent 48-hour pump testing on December 10, 2000. The well was pumped for 48 hours with a final recorded pumping rate of 350 gpm. Pump test data sheets have been provided in Appendix B, along with a drawdown and recovery graph. Based on the pump test data, the Virginia Health Department Office of Water Programs (ODW) has determined a safe yield of 280,000 gallons per day from this well as documented on the Department of Health Engineering Sheet included as Appendix B.

Pumping of the well will occur on demand from the existing water treatment facility and will not exceed 280,000 gallons in any single day. The projected demand is estimated to be approximately 120,000 gallons per day with minimal increases from new connections over time. While the Town of Hamilton does not expect to withdrawal the entire safe yield of the well (280,000 gpd) at this time, it does wish to obtain approval to utilize the

full capacity of this well (production at a maximum of 350 gpm for a maximum of 800 minutes per day) as a supply resource for future groundwater withdrawal demand.

The Town of Hamilton operates a public water utility that currently serves approximately 700 customers, who average approximately 164 gallons per day (gpd) per equivalent residential connection (ERC). The addition of the elementary school to the system will result in an anticipated increase in demand of 5,000 gallons per day. Assuming a 5,000 gpd demand for the school, the anticipated typical withdrawal rate is expected to be in the range of 120,000 gpd. Supporting calculations have been provided below.

700 customers	@ 164 gpd	=	114,800 gpd
Elementary School	@ 5000 gpd	=	<u>5,000 gpd</u>
	Subtotal		119,800 gpd

- The average daily withdrawal is estimated to be 120,000 gallons per day.
- The average monthly withdrawal is estimated to be 3,600,000 gallons per month. Monthly fluctuations would not be expected to exceed 20%, or 720,000 gallons, during any given month of the year.
- The maximum withdrawal for a one day period is 280,000 gallons per day. (Such a withdrawal could occur during an emergency situation involving equipment failure or fire. Also the Town's water storage tanks require internal inspection every three years and require flushing and immediate refilling.)

The anticipated daily withdrawal from Well 14 (120,000 gpd) represents 43% of the determined safe yield for the well and 24% of the 48-hr pump test yield.

3.0 HYDROGEOLOGIC SETTING

To better understand the hydrogeologic setting of the site, TRIAD personnel reviewed available geologic mapping, performed a fracture trace analysis of the site and larger site area, reviewed a hydrogeologic report generated from work on a nearby subdivision and reviewed available well log data from the Loudoun County Health Department. The available well logs obtained from Health Department Files provided useful information with regard to off site well construction including depth of identified water bearing zones. Site reconnaissance was also performed to evaluate landscape positions with respect to neighboring properties and Well 14.

The subject property drains towards the west and storm water enters an unnamed tributary of Crooked Run which is located approximately 250 feet west of the subject site. Another small unnamed tributary drains westward just south of Well 14. An attempt to approximate general groundwater flow direction has been made based solely on landscape position and is shown in Figure 2.

Geologic mapping obtained from the Loudoun County Geologic GIS Office indicates that the site is underlain by the Marshall Metagranite (Ymb). Geologic mapping of the site has been provided as Figure 3. The Marshall Metagranite is a Proterozoic age gneiss and lies within the Blue Ridge Physiographic Province. Descriptions from boring logs obtained from the nearby area suggest the presence of moderately well foliated, quartz feldspar-biotite gneiss. A diabase intrusion is mapped west of the site and is noted to be trending in a north-south direction.

3.1 Fracture Fabric Evaluation

The fracture trace mapping utilized stereoscopic analysis of aerial photographs to identify traces, or lineaments, indicative of zones of fracture concentration. Stereo pairs of aerial photographs were obtained with leaf off conditions at a scale of 1:24,000, dated April 12, 1982 and at a scale of 1:12,000, dated December 30, 1998. The 1982 photography provided coverage of much of the site area prior to significant development. Zones of fracture concentration can often create transmissive conditions which can be important in determining potential impact from high yield wells. The development of this PMMP has taken into account the hydrogeologic implications of the results of the fracture trace analysis. Results of the fracture trace mapping were also compared with mapped lineaments on the adjacent Saddle Ridge Subdivision prepared by others.

Mapped fracture traces or lineaments identified during this study are shown in Figure 4. The orientations of the mapped lineaments were evaluated and orientation measurements were utilized to prepare a compass rose which is depicted as Figure 5. The mapped lineaments were found to have two dominant orientations with the first orientation trending north northeast and a second trending north northwest. A prominent lineament, with a northeast trend was mapped across the central portion of the well lot. A second prominent lineament was also mapped just west of the well lot, which trends in a general north northwest orientation.

3.2 Available Hydrogeologic Reports

TRIAD reviewed the Detailed Hydrogeologic Report prepared by others for the Saddle Ridge Subdivision. The report which is dated December 2000 was obtained from the Loudoun County Department of Building and Development. The report included pump testing results generated during the aquifer testing of 19 wells within the Subdivision. The findings of the report suggested that several wells appeared to have experienced interference, or impact, during the completion of Well 14. Five (5) wells that were noted within the report were FRA-28, FRA-30, FRA-2-1, FRA-32 and FRA 5-1. Some of these wells were noted to be sluggish during recovery, and some were noted to have experienced drawdown in the range of 3 to 10 feet. A copy of pump test graphics for these wells has been provided in Appendix C. An artesian well was also noted within the report to have had potential to contribute to well interference. The wells that were identified to have experienced interference were generally located in the northern portion of the Saddle Ridge Subdivision which lies just south of Route 709. Well 14 is situated approximately 400 feet north of Route 709.

The report provided useful information with regard to observed well yield and general groundwater availability within the site area. Nineteen wells were completed and observed to have air lift yields ranging from 2-75 gallons per minute with an average air lift yield of 29 gpm. No dry wells were reported to have been completed. Of the five wells that were noted to have experienced interference their respective yields were 5, 50, 25, 10 and 50 gpm. Compared to published well yield data for similar bedrock lithology, the air lift yield measurements noted during the completion of wells within the Saddle Ridge Development appear to be above average. The Interpretative Guide to Geology and Groundwater in Loudoun County (Department of Environmental Resources, Loudoun County, Virginia, 1993) indicates that the average groundwater yield for Marshall Formation (gneiss complex) is 16.7 gpm. While offsite conditions may vary, the bedrock geology mapping suggest similar lithology underlying Well 14 and in the nearby vicinity.

4.0 GROUNDWATER MONITORING

4.1 Background

This monitoring plan has been developed to provide meaningful data towards evaluating any potential impact to offsite wells during the planned use of Well 14. Wells for off site monitoring have been selected based on an assessment of the hydrogeologic setting, proximity to Well 14, and well interference data obtained from an adjacent hydrogeologic study. A monitoring regime has been designed with specific monitoring intervals to correspond with relatively stable use. Monitoring data, including both depth-to-water measurements and withdrawal rates from Well 14, will be evaluated to determine baseline conditions and to aid in identifying any potential off site impact. If withdrawal rates are observed to increase sharply above anticipated use, the monitoring intervals will need to be re-evaluated.

4.2 Potential Contaminant Sources

To develop an adequate monitoring plan, an assessment of the site and site area was performed to determine the presence of any potential contaminant sources that could impact the site well or perhaps other nearby wells. This assessment was conducted by reviewing data from the Loudoun County GIS Office and by requesting a search of local, State and Federal Regulatory databases by Environmental Data Resources, Inc. (EDR). A map has been prepared with the Loudoun County GIS data which indicates potential contaminant sources within proximity to Well 14. Based on our review of this data, these sources appear to be limited to septic fields. A potential contaminant threat map has been provided as Figure 7. The EDR report did not identify any mapped sites within the EDR defined search radius. A limited number of orphan sites, which do not have adequate address information for accurate mapping were identified, but those sites do not appear to be proximal to the site. The EDR Report is provided as Appendix D.

4.3 Recommended Groundwater Monitoring Locations

In selecting wells to be included within the monitoring program, an attempt has been made to identify wells that may be more likely to experience impact, if any, from the withdrawal of groundwater from Well 14. A map was prepared that shows existing wells within a ½ mile radius of Well 14 which is presented in Appendix E. A review of well logs proximal to the site was conducted at the Loudoun County Health Department and 36 well completion reports were obtained and reviewed. A map showing the location of the 36 wells has also been provided in Appendix E, along with a tabular summary of the well data. Wells that are located within a 1000-foot radius of Well 14 were each evaluated based on their location with respect to Well 14 and on the depth and number of their reported water-bearing zones. The most proximal wells to Well 14 that were identified by this investigation lie within the Saddle Ridge Subdivision, with the closest well being approximately 450 feet away.

Thirteen (13) of the wells located within 1000 feet of Well 14 have been selected as proposed monitoring wells. Each of the 13 wells is representative of a single property parcel. The proposed monitoring wells are shown on Figure 6 and available details regarding the well construction and water bearing zones for these wells has been provided in Table 1 below.

While nearby wells are not located in every direction from Well 14, the identified wells together provide good spatial coverage for most of the surrounding area. These selected wells are believed to provide good locations for monitoring data that are expected to be generally representative of the bedrock aquifer conditions underlying the site; however, use of the wells will depend on obtaining permission from landowners to regularly access their wells. Each well owner will be contacted by the client to determine if they wish to have their well monitored.

Table 1
Proposed Monitoring Wells

Well #	Parcel Identification Number	Well Yield (gpm)	Total Depth (feet)	Depth to Bedrock (feet)	Static Water Level (feet)	Water-Bearing Depths (feet)**
1	419253590**	NA	NA	NA	NA	NA
2	419260463	30	200	10	30	134
3	419159786	12	500	10	12	460
4	419157282	50	380	20	30	180 (2), 365 (48)
5	419155183	30	400	10	12	190 (4), 360 (26)
6	419153482	30	275	10	30	253
7	419150980	50	250	8	0	225
8	454108379	20	250	8	30	222
9	454105978	60	383	50	30	381
10	454104178	15	300	50	30	278
11	454102078	25	50	25	25	275
12	454297930	15	380	25	2	365
13	454302227	15	260	51	40	235

Note: NA: Not Available; * Values are given in feet below the ground surface, numbers in parentheses are estimated flow at each given depth. **: Loudoun County Mapping System indicates that a well is located on this parcel; however, data for this well were not found during review of Health department records.

4.4 Installation of Monitoring Equipment

Existing private residential supply wells will be utilized for monitoring of potential impacts from Well 14. Owners of selected wells will be contacted with requests for permission to use their wells for long-term monitoring. Formal, legal agreements for access to each well will be presented to each owner of the selected wells. A signed agreement from the well owner will be required before including the well into the monitoring program.

Water levels in the wells will be measured and recorded by dedicated automatic pressure transducers (probes). Attempts will be made to a collect manual depth-to-water measurement from each well just before installation of the probe. The downhole equipment will consist of In Situ brand Level Troll Pressure transducers or equivalent, with approximately 100 feet of vented cable. The probes will be suspended from the top of the well casing, or to the well cap. Attempts will be made to install the monitoring equipment so that the well caps will not have to be removed for data collection. However, depending on the well cap construction, the cap may need to be removed temporarily to access the underlying pressure transducer cable connection.

After installation, the well will be shocked with chlorine, as per VDH guidelines for new wells, so as to guard against the potential for any bacterial contamination from the installation of the down well equipment. Coordination with the well owner will be necessary to purge the well adequately after shocking. Data will be retrieved from the data logger electronically through the cable connection, which will be fitted just beneath the well cap. While the well cap may have to be temporarily removed to retrieve data,

no down well equipment will be used following the initial equipment installation. In the event of equipment failure, the probe may have to be retrieved and re-installed which would again require chlorination procedures. We assume that groundwater quality sampling will utilize flow from existing exterior taps.

4.5 Monitoring Intervals, Sampling and Reporting

TRIAD Engineering recommends the following monitoring schedule for the 13 proposed monitoring well locations.

- Background monitoring of the well array will be conducted for at least 30 days prior to the start-up of pumping in Well 14. During this period, insitu transducer probes will be utilized to collect water level data at 15-minute intervals within the selected monitoring wells. Each monitor well site will be visited on a weekly basis to download the collected data. These data will be used to aid in establishing “normal” fluctuation in water levels in the monitoring wells.
- The background monitoring will also include an evaluation of water quality. Initially each well will be sampled and analyzed for the “Loudoun County Suite of parameters”. This analytical parameter list has been included as Appendix F. Groundwater quality will also be evaluated by field instrumentation for the following parameters: ph, specific conductivity, turbidity and temperature.
- Water level measurements will continue to be monitored at the 15-minute frequency for 30 days after withdrawal from Well 14 begins. Again, the water level data will be downloaded weekly from the monitoring locations. Field instrumentation will be used to evaluate ph, specific conductivity, turbidity, and temperature at approximately 30 days following start up of the pumping of Well 14.

Discharge data from Well 14 will be closely monitored and recorded by Town of Hamilton officials or assigned contractors. The discharge readings will be collected daily for the first 30 days that Well 14 is online.

- Following the first 30 days of well production, a review of the data will be made to determine if any significant impacts on water levels can be detected. The findings of this review will be provided to the Loudoun County Building and Development office. The report will include a general assessment of the monitoring program and a quantification and professional assessment of impacts to monitoring wells, if any, are observed.
- Following the first 30 days of monitoring, water level measurements will continue to be collected from the monitor wells, but will be collected at 6 hours intervals. The data will be downloaded on a monthly basis from each monitor well location. Field instrumentation will also be used to evaluate ph, specific conductivity, turbidity and temperature monthly for the first three months. Following the first

quarter the monitoring of field parameters will occur once per quarter. Following the first quarter of monitoring, discharge measurements will be collected from Well 14 on a weekly basis.

- Data obtained during the first quarter of monitoring will be analyzed and documented within a quarterly report which will be prepared for submittal to the Loudoun County Building and Development Office. The report will provide all monitoring data for the first quarter, including water production, as well as a professional assessment of impacts to monitoring well water levels, if any are observed.
- This monitoring program will continue for two years from the time of pumping startup at Well 14. At the end of the two year monitoring period the Town of Hamilton will submit a final groundwater monitoring report to the Loudoun County Building and Development Office. The final report will include all data collected during the program, as well as a professional opinion, supported by a detailed hydrogeological analysis, as to the nature and extent of apparent impacts if any, to the neighboring residential supply wells. The report will include a recommendation of whether additional monitoring beyond the planned two year interval appears warranted.

The following chart provides a tabulated summary of the proposed monitoring schedule.

Table 2
Monitor Locations, Sampling Parameters with Intervals and Reports

Monitoring Location	Analytical Parameters with Sampling Intervals	Water Level Gauging	Well 14 Discharge Measurements
Selected Monitor Wells: MW1 (PIN 419253590) MW2 (PIN 419260463) MW3 (PIN 419159786) MW4 (PIN 419157282) MW5 (PIN 419155183) MW6 (PIN 419153482) MW7 (PIN 419150980) MW8 (PIN 454108379) MW9 (PIN 454105978) MW10 (PIN 454104178) MW11 (PIN 454102078) MW12 (PIN 454297930) MW13 (PIN 454302227)	Wells sampled for Loudoun County Parameter Suite <i>(interval – Single background event)</i> Turbidity, pH, Specific Conductivity, and Temperature with field instrumentation <i>(interval - background event, then every 30 days for first quarter, then quarterly for 2 years)</i>	Data collection with electronic data loggers <i>(interval - 15 minute collection intervals during both 30 day background and during first 30 days of Well Operation, then at 6 hour intervals for 2 years)</i>	Discharge measurements recorded manually <i>(interval - daily collection during background and during first quarter, then weekly thereafter for 2 years)</i>
Reports: Report documenting first 30 days of well operation. Quarterly reports for 1 st , 2 nd , 3 rd , 4 th , 5 th , 6 th , and 7 th quarters Comprehensive Report documenting 2 years of monitoring			

4.6 Sampling Quality Assurance and Quality Control

The groundwater sampling program will follow generally accepted professional methods and standards for field sampling and quality assurance. All sample containers will be prepared by a certified laboratory or equipment vendor. Personnel performing sampling will wear clean Latex gloves at each sample location to prevent any potential cross contamination. All samples collected for laboratory analysis will be transported under chain-of-custody documentation.

5.0 EVALUATION OF THE IMPACT TO GROUNDWATER AND SURFACE WATER RESOURCES

This PMMP has involved the review of available geologic mapping, well completion reports, a hydrogeologic report generated for a nearby subdivision, and completion of a fracture trace analysis in order to grasp a better understanding of the hydrogeology of the site. The site is underlain by a crystalline bedrock aquifer that is generally found to be well fractured. Such an aquifer system is capable of supplying relatively high yields of water to groundwater wells. In fact, based on a review of 36 well completion reports during this study, the average reported air lift yield was found to be 26.8 gallons per minute. Of these 36 wells only five were reported to have yields less than 10 gpm.

Aquifer testing performed by others within the nearby Saddle Brook subdivision indicated relatively minimal drawdown in the majority of the tested wells and most were found to recover in a reasonable timeframe.

Based on the bedrock aquifer characteristics noted within this assessment, specifically highly fractured rock supporting relatively high yielding wells, the withdrawal of groundwater from Well 14 is not expected to significantly impact regional groundwater resources. While some impact may occur to proximal wells, it is not expected that the impact will be significant. This PPMP includes a groundwater monitoring plan which will utilize select monitor wells within 1000 feet of the site to monitor for the occurrence of any impact to the wells.

A tributary of Crooked Run lies approximately 250 west of Well 14. This small stream is fed by a considerable drainage area which lies within an upgradient position with respect to Well 14. Groundwater withdrawal is not anticipated to significantly impact this stream and surface water monitoring has not been included within this PMMP.

6.0 INVESTIGATION/MITIGATION MEASURES

6.1 Off-site Well Investigation/Mitigation

The objective of the monitoring program is to detect significant adverse impacts (i.e., drawdown) to private off-site supply wells in the vicinity of Well 14. Data generated by

the site's PMMP will be utilized to monitor for any potential offsite impact and to aid in determining the potential source of impact to any off site well. The monitoring program will use background data collected prior to the operation of Well 14 to aid in identifying normal groundwater level fluctuations within the monitor wells. At any time during the monitoring period if a statistically significant change in groundwater levels is observed in the data an attempt will be made to determine if that change appears to be a result of groundwater withdrawal from Well 14. This assessment will be made by the Town of Hamilton's Groundwater Consultant. The Town of Hamilton will notify the Loudon County Building and Development Office upon identifying any such condition. The frequency of water level monitoring on the specific well in question would be increased to 15 minute intervals to enable a better assessment of water level fluctuation in the monitor well and to determine the potential source of impact to the monitor well.

A licensed well and pump installer will be retained by the Town of Hamilton to physically inspect any well that appears to be impacted due to the operation of Well 14. The inspection will consist of an evaluation of the well and pump equipment to determine if it appears to be functioning properly. If the pump submergence is not adequate for normal system operation, the technician will determine if the pump can be lowered and will provide his report to the Town of Hamilton. If deemed possible, lowering of the pump would likely be the first step toward mitigating impact to any well. If lowering of the pump were unsuccessful, well rehabilitation efforts (deepening or reaming of the well) and/or new well installation would be considered. The Town of Hamilton will work diligently to provide water supply to any offsite well that is deemed to have been critically impacted by the usage of Well 14. If necessary repairs to the system are identified that appear to be due to normal wear and usage, and are not deemed to be due to the use of Well 14, the well owner will be provided with the findings and recommendations of the well and pump technician.