pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

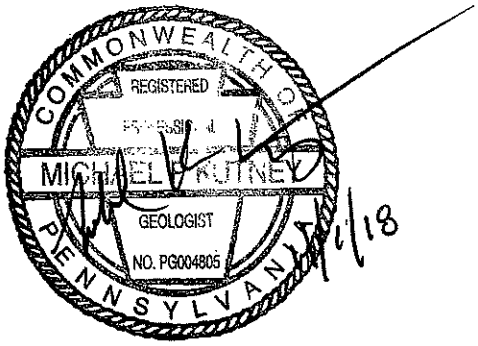
**MEMO**

**TO:** File

**FROM:** Michael Kutney, P.G., Chief
Permitting and Technical Services

**DATE:** 11.1.2018

**RE:** NHCS Blasting Review




## Introduction

Upon further review of information, the Pennsylvania Department of Environmental Protection (Department) has determined that the blasting plan for reclamation submitted by New Hope Crushed Stone & Lime Co., Inc. (NHCS or New Hope) for its quarry in Solebury Township will not impact the Furlong Fault in a manner that prevents NHCS from restoring the hydrologic balance to the permit-approved post mining water elevation.

## Background

Approximately 2,100 linear feet of highwall remains to be reclaimed at NHCS' quarry in Solebury Township. The east wall of the quarry comprises approximately 1,800 feet of the 2,100 remaining feet of highwall needing reclamation.

Throughout the reclamation process, the Department has been regularly sharing information with Solebury Township and Solebury School. There is also a website, accessible to the public, on which information and documents are posted. See, https://www.dep.pa.gov/About/Regional/SoutheastRegion/Community%20Information/Pages/New-Hope-Crushed-Stone.aspx

On May 30, 2018 NHCS submitted a blast plan for reclamation of the east wall. The plan was reviewed by Ross Klock, Blasting Inspector for the Department.

On June 7, 2018, the Department via an inspection report approved NHCS' blasting plan to reclaim the east wall.

However, after further consideration and at the request of Solebury School, the Department requested additional information regarding blasting through portions of the Furlong Fault in letters dated July 12, 2018 and July 23, 2018.

In a letter dated July 12, 2018, the Department required NHCS to "delineate the Furlong Fault Line on the Updated Reclamation Map and the cross Sections." The Department also required NHCS to explain that "there will be no additional adverse hydraulic effects to the Furlong Fault from drilling and blasting at or near the Fault."

On July 23, 2018, the Department sent NHCS an additional letter clarifying the language in paragraph 3 of the July 12, 2018 letter. In the July 23, 2018 letter, the Department advised NHCS that "[a]t the time the Department approved the blast plan/design for the reclamation of the East Wall, it was with the understanding that the drilling and blasting would be conducted in such a manner as to prevent any additional adverse hydrologic effects to the Furlong Fault Line and the current prevailing hydrologic balance at or near the Fault." The Department required NHCS to "provide supplemental information demonstrating that conducting reclamation drilling and blasting will not impact the Furlong Fault in a manner that prevents NHCS from restoring the hydrologic balance to the permit-approved post mining water elevation."

The July 23, 2018 letter also required NHCS to provide a "revised 'Reclamation Update Map' that delineates the Furlong Fault Line and the associated Cross Sections. In addition, New Hope shall include the following wording as Note no. 3 on the revised 'Reclamation Update Map': 'Drilling and blasting will not impact the Furlong Fault in a manner that prevents NHCS from restoring the hydrologic balance to the permit-approved post mining water elevation.'"

On August 13, 2018, NHCS responded to the Department's request for more information. In the August 13, 2018 submission, EarthRes Group, Inc., (EarthRes) on behalf of NHCS, provided an analysis that claims the fault relationship along the east wall of the quarry creates a barrier to groundwater flow to the quarry. The Department shared this information with Solebury School. In its response, EarthRes stated, "The post mining water level of the quarry will be dictated by the elevation of the water outfall and the rock level in the eastern wall. The current and proposed final benches will be similar in elevation. Therefore, reclamation activities in the area of the Furlong Fault will not prevent NHCS from restoring the hydrologic balance to the permit-approved post mining water elevation."

On September 4, 2018, Solebury School sent a letter to the Department expressing its concerns regarding the proposed reclamation blasting, and NHCS' August 13th response. The Department reached out to the School's technical expert, Michael Byle, on October 1, 2018 to ask if the School had any additional data or analysis to share. Mr. Byle indicated that the School did not, and that the School was primarily using the data and analysis in the permit file as well as NHCS' August 13, 2018 submission.

**Current Furlong Fault Conditions**

The Furlong Fault strikes approximately parallel to the east wall of the quarry. The fault places Triassic aged red shales and siltstones in contact with the Cambrian-Ordovician aged carbonates that are mined in the quarry. Approximately 1,300 feet of the fault has already been mined through on the east wall. Referencing the Reclamation Update map dated August 6, 2016,

updated August 13, 2018, the fault is mined from approximately 250 feet south of Reclamation Stake #23 to approximately Reclamation Stake #16. Approximately 150 feet north of Reclamation Stake #16, the fault is exposed in the quarry wall at approximately 110' MSL, near the ground surface. The fault has been mined out to deeper depths farther south along the east wall. The lowest point the fault has been mined is approximately 39' MSL about 125 feet south of Reclamation Stake #23. The ground surface in this area is approximately 110' MSL. These areas of the fault were previously mined out below 102' MSL prior to the hearing that resulted in the July 31, 2014 Adjudication where the Board included findings of fact that the Fault is a barrier to groundwater flow.

**June 7, 2018 - Approved Reclamation via Blasting**

Under the June 7, 2018 approved reclamation plan (reference Reclamation Update map and cross-sections), most of blasting that could affect the Furlong Fault is located between Reclamation Stakes #17 and #15, a length of approximately 600 feet. South of Reclamation Stake #15, the fault is already mined below the reclamation grades, therefore little to no blasting would occur through the fault. Refer to Cross-sections B-B' and C-C' on the Reclamation Update Map. South of Reclamation Stake #15, proposed blasting does not shoot through the fault.

Along Cross-section A-A' (Around Reclamation Stakes #17 & #16) blasting would remove rock and expose the fault at elevations 95-100' MSL (Approx.). This constitutes a length of approximately 300 feet.

Along Cross-Section B-B' (south of Reclamation Stake #15), blasting would be required to remove rock to an elevation of about 60' MSL. In this area, the Furlong Fault is already mined out to this depth. This constitutes a length of approximately 300 feet.

South of Cross-section B-B' to C-C', little blasting if any would occur along the fault. The fault is exposed at an elevation of approximately 60'MSL.

From Reclamation Stake #23 south, reclamation will be achieved via backfill. In this area, the fault is already mined out to approximately 39' MSL.

**Discussion**

Per the Department's January 29, 2016 letter, it is tasked with overseeing the abatement of a public nuisance caused by the lowering of the groundwater around the New Hope quarry as quickly as possible. This is being accomplished through reclamation and the cessation of mining at the New Hope Quarry. As detailed in its January 29, 2016 letter, the Department requires regular updates from NHCS to keep reclamation on schedule. The planned date for reclamation of the highwall to be complete is March 2019. Once all the highwalls are reclaimed, the quarry can completely fill with water, abating the nuisance caused by the lowered groundwater elevations around the quarry.

On page 3 of its September 4, 2018 letter, Solebury School stated that, *"[f]urther damage to the Fault will cause significant loss of both groundwater and pool water once the quarry is allowed to fill with water, which may very well cause irreparable harm: the groundwater will not be able to return to pre-mining levels and Solebury School will have no recourse to prevent sinkholes from continuing to suddenly open on its campus."*

*The School also stated on page 3 of its September 4, 2018 letter:*

*"In light of these irrefutable facts and potentially calamitous consequences, Solebury School believes that NHCS must be required to perform reclamation without any drilling or blasting of the fault (regardless of any potential increased expense or inconvenience to NHCS). If the Department determines that reclamation cannot be completed while completely protecting the Fault from blasting, Solebury School requests that the Department minimize blasting of the Fault to the greatest extent possible, and in any event, prohibit blasting below 102' MSL. Limiting blasting of the Fault to above 102' MSL will help reduce the risk of significant groundwater and quarry pit water loss. Based on the information available, Solebury School's experts believe that reclamation can be completed with this limitation in place, although doing so may require a reduction of the bench height and/or an increase in the planned slope angle along the stretch of the east wall where the Fault is exposed."*

NHCS, through EarthRes, provided information that the fault itself is not a barrier to groundwater flow, but instead it is the relationship of the impermeable shale to the more permeable carbonate that creates the barrier. Therefore, planned reclamation activities will not prevent NHCS from restoring the hydrologic balance to the permit-approved post mining water elevation.

After reviewing EarthRes' information and conclusions, the Department also conducted its own analysis of the hydrologic consequences of the currently approved reclamation plan from the view point that the fault is a barrier to groundwater flow. The Department used water monitoring data from 2006 to present, the 2010 Fault Study and quarterly monitoring reports submitted by NHCS from 2009 to present to determine if NHCS' proposed blasting will impact the Furlong Fault in a manner that prevents NHCS from restoring the hydrologic balance to the permit-approved post mining water elevation. Based upon its analysis of that information, the Department concluded that the proposed blasting will not prevent NHCS from restoring the hydrologic balance to the permit-approved post mining water elevation.

**Department's Analysis**

In 2010, EarthRes provided a report that demonstrated the Furlong Fault did not transmit groundwater from out of the Primrose Creek basin. Page 11 of the report states, "Based on the water budgets, measured Fault flows, published data and direct observation, there is no justification for extending the recharge area of the Fault to out of basin areas." The Department agrees with this position. The Fault Study was reviewed by Solebury Township's

hydrogeologist at the time, and he concurred with the findings in the report. However, the report focuses on transmitting groundwater in and out of the basin *along strike* of the fault. It does not address groundwater moving *across strike* (transmitting groundwater from the carbonate to the shale, and from the shale to the carbonate). Blasting through the fault could only conceivably cause a change in the ability to move water across strike, since the blasting would only take place over a few hundred feet. The Furlong Fault constitutes a regional scale feature that extends for several miles. Blasting would have to occur over the length of the fault (several miles) to affect groundwater transmission along strike.

As established in the 2010 Fault Study, since groundwater is not expected to be transmitted in or out of the Primrose Creek basin, the water to bring the quarry lake up to its expected post-mining elevation of 98' MSL must come from within the Primrose Creek basin. The monitoring wells in and around the quarry's east side (near the fault) are the best indicator of the water availability around the fault.

**Monitoring Well Data**

As shown on the 2018 Groundwater Contour Map, monitoring wells MW-6, MW-7A and MW-8 are in the northeastern area of the mining permit. MW-6 is located approximately 400' from the quarry pit. This well intercepts the carbonate rock mined in the quarry. The collar of this well is located approximately 400 feet west of the Furlong Fault. The well collar elevation is 177.66' MSL. The groundwater elevation in MW-6 is consistently around 110' MSL, fluctuating 5-10 feet higher or lower, so groundwater is approximately 60 to 70 feet below the ground surface.

MW-7A is located in the carbonate rock on the upper benches within the pit. Historically the groundwater elevation in the well is around -20' MSL, fluctuating about 20 feet higher or lower. Since early 2018 there has been an upward trend in the groundwater elevations in MW-7A. It is unclear if this is a result of the pit filling with water or increased precipitation, or a combination of the two. The collar of this well is located approximately 250 feet west of the Furlong Fault. The well collar elevation is 146.81' MSL, so groundwater is approximately 140 to 180 feet below the ground surface.

MW-8 is located approximately 150 feet east of the quarry pit. MW-8, which intercepts the carbonate fluctuates between 92 – 125' MSL. Since early 2017 there has been a slight upward trend in the groundwater elevations in MW-7A. Again, it is unclear if this is a result of the pit filling with water or increased precipitation, or a combination of the two. The well collar elevation is 143.66' MSL, so groundwater is approximately 20 to 50 feet below the ground surface.

Monitoring wells MW-1 and MW-2 are located east of the pit, approximately 1,100 feet west of the fault. These wells are entirely in the red shale. Over the last 12 years, these wells have had groundwater elevations of 91' MSL, fluctuating only 2 feet higher or lower. The well collar elevation is 101.25' MSL, so groundwater is approximately 10 feet below the ground surface.

The PECO well nest south of the quarry, installed to investigate the hydrologic connectivity between the quarry and the Aquetong Spring via the Furlong Fault, is a well nest consisting of three nested wells- shallow, intermediate, and deep. The wells were monitored from February 2010 until June 2015. It is located approximately 400 feet south of the quarry pit. The PECO shallow well has groundwater elevations between 101 – 120' MSL. The well collar elevation is 137.78' MSL, meaning the depths to water in the shallow well are 17 to 26 feet below the ground surface. The shallow well is only drilled in the red shale. It is also approximately 500 feet from where the Furlong Fault is breached down to 39' MSL.

The intermediate well is constructed to intercept the fault zone itself. The intermediate groundwater elevations range from 87 to 112' MSL. The deep well is constructed to monitor the carbonate 120 feet below the fault. The groundwater elevations in the deep well mimic those in the intermediate well. Groundwater in the intermediate and deep wells nests is 25 to 50 feet below the ground surface.

**Monitoring Well Analysis**

The permit-approved post-mining water elevation for the quarry lake is 98' MSL. MW-6, MW-8 and the PECO shallow well have groundwater elevations all above 98' MSL. Groundwater elevations in MW-7A are low (-20' MSL) and clearly affected by mining.

MW-6 and MW-8 are completed entirely in the carbonate, while the PECO shallow well is drilled entirely in the red shale. As detailed in the section above, groundwater elevations on the west side of the Furlong Fault (in MW-6 and MW-8) and relatively close to the quarry pit are regularly above 98' MSL. Groundwater elevations in the red shale (PECO wells) on the east side of the fault are above 98' MSL. Given the groundwater elevations in these wells, it is probable that the permit-approved post-mining water elevation of 98' MSL can be achieved.

Since the permit-approved post-mining water elevation is expected to be achieved, the next question is: What effect, if any, will the currently approved reclamation plan have on the post-mining water level at the quarry?

In the northern part of the east wall, near MW-6 and MW-8, the Furlong Fault is relatively unaffected by mining. The groundwater elevations in these wells behaves similarly, although MW-8 fluctuates a bit more than MW-6. MW-8 is finished in the same carbonate unit as MW-6. The carbonate unit controls the groundwater elevation in this area. As discussed earlier, groundwater elevations in MW-8 may have begun to rise, but it is too early to be sure. These wells are close to the open quarry pit and completed in the carbonate unit being mined. Over the last 12 years groundwater elevations in these wells have consistently remained at elevations at or above the expected permit-approved post-mining elevation of 98' MSL. The June 7, 2018 blasting plan would impact the fault only to elevations of 95-100 MSL, which is within the range of expected post-mining water elevations. The elevation of the remaining quarry rim will be approximately 110' MSL in this area. Based on the Reclamation Update Map and cross-sections provided by EarthRes, the top 15 feet of the quarry wall will be composed of the red shale, which

is much less conductive than the carbonate unit. The groundwater elevations in the carbonate are at desirable post-mining elevations. Based on this information the Department concludes that exposing the quarry lake to the red shale will not result in lower post-mining water elevations.

Midway along the east wall the Furlong Fault is mined out to approximately 70' MSL. On the Reclamation Update Map, this is the section south of cross section B-B'. Based on the cross-sections, approximately 35 feet of the red shale is exposed in the quarry as a result of the fault being mined out at this location. Groundwater elevations in MW-1 and MW-2 are consistently at 91' MSL plus or minus a couple of feet. Additionally, in the area of the wells, the groundwater is 10 feet below the ground surface. No leakage to the quarry as a result of the fault being breached is apparent in this region because the groundwater elevations are 20 feet higher than the daylighted fault. Also based on dozens of inspections, these walls do not visibly weep groundwater. Therefore, in this area, the groundwater elevations are controlled by the hydraulic head in the red shale instead of the Furlong Fault.

In the southern part of the east wall, we can look to the PECO well nest for guidance about the controlling influence on groundwater. The PECO well nest is approximately 500 feet south from where the Furlong Fault is mined out to 39' MSL. Groundwater in the PECO shallow well (completed only in the red shale) is near the ground surface, 17-26 feet below the ground surface. The groundwater elevations in the shallow well range between 101-120' MSL. The fault is breached 60 to 80 feet below the groundwater elevations in this area. The PECO shallow well is closer than MW-1 and MW-2 to the fault but its groundwater elevations are higher. As in the middle portion of the east wall, the groundwater in this area is controlled by the red shale and not the Furlong Fault. The breached fault near the shallow PECO well is not prohibiting groundwater from returning to shallow near-surface conditions. The PECO shallow well has groundwater elevations above the expected permit-approved post-mining water elevation.

The intermediate and deep well nests are instructive as well. The intermediate PECO well is constructed to monitor only the fault zone, from 25' MSL down to 10' MSL. The PECO intermediate well groundwater elevations range from 87 to 112' MSL. This range brackets the expected permit-approved post-mining elevation of 98' MSL.

The PECO deep well is constructed to monitor the carbonate 120 feet below the fault, at elevation of -97' to -111' MSL. The groundwater elevations in the deep well mimic those in the intermediate well. Groundwater in the intermediate and deep wells nests is 25 to 50 feet below the ground surface.

The fact that the well intercepting only the fault and the deeper well respond similarly to each other indicates that they are in hydraulic communication with each other. They are part of the same hydrologic unit. Therefore, *the fault zone is controlled by the hydraulic head in the carbonate, not in the hydraulic head in the red shale.* Reclamation blasting will take place almost exclusively in the red shale and have no effect on the hydraulic head in the carbonate (and by extension no effect on the fault). However, allowing the quarry (carbonate) to refill with water will affect the water levels in the fault zone (they will rise). Therefore, the most important

thing to do to raise the groundwater elevation in the area around the quarry is to allow the quarry to refill with water.

Based upon the analysis of this data and information, the June 7, 2018 blasting plan will not impact the Furlong Fault in a manner that prevents NHCS from restoring the hydrologic balance to the permit-approved post mining water elevation.

**Conclusions**

In the northern part of the east wall, groundwater elevations are controlled by the carbonate unit as demonstrated by the groundwater elevations in MW-6 and MW-8. In the middle part of the east wall, little additional blasting is required. The Furlong Fault is mined out to 70' MSL, but groundwater elevations remain 20 feet higher. In the southern part of the east wall little additional blasting is required. Groundwater elevations there remain near the surface despite the Furlong Fault being mined down to 39' MSL. Data from the PECO well nest suggest that the carbonate unit is controlling the groundwater elevations in the fault zone. This reinforces the interpretation of the relationship of MW-6 and MW-8. There is groundwater at desirable elevations surrounding the Furlong Fault, throughout the length of the quarry's east wall. The hydrology is available in the basin to fill the quarry lake to expected post-mining elevations under the currently approved reclamation plan.

The Department authorizes NHCS to proceed with the June 7, 2018 blasting and reclamation plans for the following reasons:

1. The currently approved blasting through the Furlong Fault is limited to that only required to achieve reclamation.
2. Blasting approximately 600 feet of the Furlong Fault at elevations above where it is already mined out minimizes disturbances to the prevailing hydrologic balance.
3. Based on the available data and information, there is no reason to think that blasting at elevations above where the fault has already been mined will affect the post-mining water elevations.
4. Blasting will not occur at depths along the Furlong Fault greater than those already mined out.