ALPHA
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Geology
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Remediation
Water Supply

June 18, 2012

Kevin Franke
The LA Group
40 Long Alley
Saratoga Springs, NY 12866

Re: Windham Mt. Sporting Club
Hydrogeologic Evaluation

Dear Kevin:

This letter was prepared by Alpha Geoscience (Alpha), at your request, to address concerns that the New York City Department of Environmental Protection (DEP) has raised regarding potential storm water and hydrogeologic impacts resulting from the proposed Windham Mountain Sporting Club (WMSC). The WMSC is a residential development proposed on the lower elevations of a 465 acre property on Cave Mountain, adjacent to, and east of, the Windham Mountain Ski Center in Windham, NY. The DEP concerns were provided in two letters from Cynthia Garcia (DEP) to Ms. Maureen Anshanslin (Chair of the Town of Windham Planning Board) that are dated November 11, 2009 and April 30, 2012. These letters presented DEP's comments on the project and the WMSC DEIS for the Lead Agency.

It is our understanding from a review of the DEP letters that the DEP is concerned that road cuts and storm water control structures associated with the WMSC development will "drastically" and "radically" alter the existing shallow subsurface flow (interflow) and shallow concentrated surface water flow at the site. The DEP feels that these changes will result in higher volumes of water being discharged to the receiving streams resulting in degradation of downstream channels, an increase in soil erosion rates, greater turbidity levels in surface water, decreased soil moisture content on the slopes below the development, and flooding of property and public infrastructure downstream from the project. The DEP did not identify any particular water courses or stream segments that they believed would be drastically affected by the WMSC development. Alpha evaluated the DEP concerns by conducting site reconnaissance, reviewing pertinent technical articles addressing the hydrology of the site area, and drawing on Alpha's experience with similar developments in the area. Mr. Steven Trader, CPG of Alpha and I performed a site reconnaissance on May 24, 2012 and made hydrogeologic observations of water features along many of the logging roads and existing access

roads within the property of the proposed WMSC. We also made observations of existing road cuts and storm water control features in the development west of, and adjacent to, Ski Windham, and in the Copper Ridge development downslope, and adjacent to, the WMSC property. The purpose of these visits was to document existing conditions in established and new residential developments on Cave Mountain and compare them to the conditions on the undeveloped WMSC property (the site).

The following sections of this letter describe the existing hydrogeologic conditions at the site and the conditions at the nearby residential developments as they pertain to interflow and shallow concentrated surface flow. A discussion of the potential effects on interflow and shallow concentrated flow at the site due to the proposed road cuts and storm water control features is then presented.

Existing Site Conditions

The geology of Cave Mountain is very typical of the Catskills. It is underlain by fractured sedimentary rocks dipping slightly to the southwest, and the bedrock is comprised of repeated cycles (from base to top) of conglomerate, sandstone, siltstone and shale. Bedrock is exposed, or is very near the surface, across much of the upper slopes at the site (above approximately 1900 ft elevation). The intermediate slopes of the mountain (approximately 1,650 ft to 1,900 ft elev.) are covered by thin glacial till over bedrock. The till is comprised of an unsorted mixture of clay, silt, sand, gravel, cobbles and boulders and has a relatively low permeability. The lower and gentler slope of the mountain along the Batavia Kill Valley (below approximately 1650' elevation) is underlain by permeable sand and gravel (stratified drift).

The hydrogeology of the site is also typical of the Catskills. The bulk of the site lies in what Heisig (1998) refers to as an "unchanneled area" (Heisig, P.M., 1998, *Water Resources of the Batavia Kill Basin at Windham, Greene County, New York*, USGS Water Resources Investigation Report 98-4036, Troy, NY). Heisig states "The lack of channel development in unchanneled areas/valley areas, precludes surface flow to the local valley stream, thus, nearly all water in these areas becomes recharge for the local valley aquifer." Heisig (1998) observed a "stair- step pattern of alternating subsurface flow and surface discharge" on the hillside of Cave Mountain during wet conditions in April of 1991. This same pattern was observed by Alpha personnel on May 24, 2012 during the site reconnaissance. Significant precipitation events had occurred just days before the Alpha site visit. National Weather Service rain gauges at nearby Cairo and East Jewett received 1.44 inches and 1.49 inches of rainfall, respectively during May 22-23. Alpha observed this stair-step pattern of surface and shallow subsurface flow above an elevation of approximately 1,900 ft within the central portion of the site. Minimal to no flow was observed downslope from this elevation within the "unchanneled zone". Nearly all of the surface flow below approximately 1,900 ft elevation within the central

portion of the site had infiltrated into more permeable deposits within the till or, eventually, into the permeable stratified drift deposits on the lower slope.

Logging roads are present throughout the site. The main logging that is used to provide access into the site is locally known as Upper Panorama Lane. Most of this access road is located on the west side of the drainage divide that crosses the central portion of the site. Water bars have been installed at intervals of approximately 75-100 ft along Upper Panorama Lane. These water bars cut diagonally across the roads and convey water across the road from the small swale on the upslope side. Numerous interflow seeps were observed on the upslope (road cut) side of this logging road. These seeps were typically slope break seeps or contact seeps occurring between till and sandstone beds or ledges. Above the switchback on Upper Panorama Lane, water from these seeps ran down the logging road for some distance, crossed the roads via water bars, flowed downhill for some distance, only to seep back into the ground before reaching the section of Upper Panorama Lane below the switchback. The flow through individual water bars was typically less than two gallons per minute (gpm) as estimated visually. Many of the water bars showed no flow at all. The lower slopes of the site showed no water flow, except for approximately one gpm in a small ditch crossing the section of Upper Panorama Lane above the gate on Panorama Lane. No flow was observed in the roadside ditches along the length of Panorama Lane itself, which is the entrance to the site from County Route 12 (South St.). These observations were made less than two days after a precipitation event of approximately 1.5 inches.

A relatively open meadow is present along the drainage divide that runs through the central portion of the site, southeast and uphill from the Upper Panorama Lane switchback. The meadow also extends east of the divide for some distance and is located upgradient from the recent Copper Ridge development (discussed below). The meadow area is downhill from several logging roads. No surface water features, rills or gullies were observed within the meadow. Occasional seeps were observed in the meadow at small bedrock outcrops; however, this seepage infiltrated the subsurface immediately downslope from these outcrops.

Conditions at Existing Developments

Alpha personnel visited the residential development on the west side of Ski Windham to observe the surface water and interflow patterns associated with that area. That development has been in place for many years and has numerous established road cuts. The development also has some recent and unfinished road construction in the higher elevations (above 2,400 ft elevation) that had cuts into till and bedrock. Minor seepage (interflow) was observed in several of the new road cuts in till and in bedrock along the unfinished road at the uppermost extent of the development. Water from these seeps flowed at approximately one to two gpm in the gravel-lined ditch along the uphill side of the

unfinished road for approximately 200 ft and then re-entered the subsurface (Attachment, Photos 1 and 2).

Directly downslope from this location, minor seepage from fissile shale in a rock cut was observed near the top of a chair lift. This is an indication that sufficient seepage and infiltration was present to maintain soil moisture downslope from an existing road cut. Water also reappeared in the same ditch further down the road where the ditch ran directly on the top of bedrock and flowed at approximately one gpm until a portion of it re-entered the subsurface and a portion entered a storm water drainage pipe. A relatively new storm water pond was observed downslope of the unfinished road and at an elevation of approximately 2,360 ft. The water level in the pond was very low and there was no drainage in or out of this pond on May 24, which was less than two days after the recent precipitation events (Attachment, Photo 3).

Further downhill, along the Club Road switchbacks of the mature portion of the western development area, road cuts and ditches were observed, but none had any flow. The inter-lot areas were well vegetated with grass and woods. There was evidence of recent and historical seepage in the grassy areas and along the top of a massive sandstone outcrop within the roadside ditch at approximately 2000 ft elevation. This is another indication that there is sufficient seepage to maintain soil moisture downslope from numerous road cuts in the development. At the base of the development, near the existing Enclave condominiums (~1,640 ft elev.), the roadside gravel lined ditch was flowing at approximately 2 gpm. Water was clear in all of the road side ditches of this development, even in the unfinished portions at the higher elevations.

The Copper Ridge development is located directly downhill from the WMSC site. There are several small road cuts along the uppermost (southern) portion of the unfinished access road. Very minor seepage from one of the road cuts was noted. This seepage resulted in a trickle of water in the adjacent roadside ditch; however, it did not flow very far before infiltrating the subsurface beneath the ditch. No seepage was noted from the road cuts in the unimproved westward extension of the access road, and no water was flowing in the adjacent ditch. A contour hugging, somewhat linear, pond which is several hundred feet long, was noted downhill from an existing model home in Copper Ridge. This pond is apparently a storm water retention structure. There was a trickle of water discharging from this pond down a rock lined swale at the pond's open western end on May 24, 2012, and there were cattails and wetland type vegetation growing on its banks. The discharge apparently seeped back into the subsurface as there was no flow observed along South Street downhill from this location.

Discussion of Observations

The existing hydrogeologic conditions at the WMSC site are similar to the conditions at the existing development west of Ski Windham. Both sites have road cuts with active seepage from till and bedrock. This seepage infiltrates the shallow subsurface and pops back out further downslope, only to infiltrate again; however, the development west of Ski Windham is located in what Heisig (1998) refers to as a "channeled area" where most of the overland flow and interflow enters local streams. This condition is similar to that in the western and southeastern portions of the WMSC site. Much of the central portion of the WMSC site is in the "unchanneled area" where nearly all water becomes recharge for the valley aquifer.

The existing network of logging roads with road cuts has not significantly changed characteristics of the central, unchanneled part of the WMSC site from its "pristine" condition. The only difference is that the interflow likely pops out to the surface more frequently now than prior to the installation of the logging roads. The end result is the same: nearly all of the overland flow and interflow becomes recharge for the local valley aquifer.

It is Alpha's understanding that the system of water bars on Upper Panorama Lane was installed approximately three years ago. Prior to the installation of the water bars, most of the runoff apparently ran along ruts in the logging roads, with some of the water crossing the roads at random intervals and some of it infiltrating along the roads. A ripped out corrugated metal culvert pipe was noted alongside a portion of Upper Panorama Lane at an elevation of approximately 1,950 ft and a short distance below the switchback. This culvert apparently discharged to a rocky swale extending downhill. It was apparent that this culvert at one time received a large amount of the runoff from the central portion of the site when it was operable. The swale ended a few hundred feet down hill despite the apparent concentration of storm water flow at this location. No discernible erosional gully or rills were observed further downhill from this feature along Panorama Lane east-southeast of the gate. It is apparent that the storm water flow from this culvert infiltrated the unconsolidated sediments, consistent with Heisig's classification of the areas as "unchanneled area".

Future Conditions/Recommendations

A system of rock lined conveyances with velocity reducing features and storm water retention ponds is appropriate in handling interflow intercepted by road cuts at the site. This system has been shown to work at the development west of Ski Windham and is in place at Copper Ridge downhill from the WMSC site. The capability of the shallow fractured bedrock and thin till cover to allow re-infiltration of seepage (interflow) and surface water is clearly demonstrated at the site as no flow was observed in the swales and ditches further downhill from the site two days after significant precipitation

events. The only way this is possible is if most of the surface flow from the central portion of the site recharged the valley aquifer.

The presence of road cuts and the use of swales, ditches and storm water ponds will not "drastically" or "radically" change the volume of surface water entering streams and leaving the site. Interflow intercepted by these structures will continue to infiltrate the subsurface during and after storm events, just as it does within the ditches, swales, and storm water ponds of the existing developments nearby. It is true that a portion of the runoff could leave the site faster than at present, given the conversion of landscape to roads, buildings, and lawns; however, the use of velocity reducing structures will allow infiltration to continue to occur along the conveyances, thus eliminating any substantial increase in the discharge rate.

Erosion rates at the site are not expected to increase; on the contrary, maintenance of the properties and storm water control features will likely reduce erosion rates from the site. The existing conditions of the logging roads and water bars indicate that some erosion is taking place within the water bars. The sediment mobilized from this erosion does not travel very far downgradient during and after storm events. This is because the seepage and runoff from the central portion of the site infiltrates the subsurface soon after crossing the logging roads and does not reach tributaries of the Batavia Kill via surface flow.

All of the surface water flows observed during the site visit were clear (not turbid) at the WMSC site, as well as the nearby developments, which also contained rock lined ditches and fresh road cuts in bedrock and till. This was observed during the site reconnaissance of May 24, which was 2 days after approximately 1.5 inches of rain fell on the site. The presence of non-turbid waters at the WMSC site and nearby developments is consistent with the conclusions in the DEP's own 2007 study entitled "Schoharie Watershed Turbidity Reduction Report: Evaluation of Watershed Management Programs". That study determined that the vast majority of turbidity was caused by in-channel erosion, not landscape erosion. Even if the entire Schoharie watershed (which includes the Batavia Kill) were hypothetically converted to "pristine" forested conditions (i.e., no development whatsoever), the study concluded that the reduction in sediment yield at the Shandaken Tunnel outlet would be only 2-5%. Furthermore, the study concluded that the number of days during the year that the Shandaken Tunnel outfall exceeded turbidity requirements under these "pristine" conditions would be reduced by only 2.5 days. Given these conclusions, it follows that development of the proposed WMSC could not possibly have any noticeable effect on turbidity levels in the watershed.

Storm water conveyances such as rock lined swales present at nearby developments are apparently capable of handling storm water runoff as well as the interflow intercepted by road cuts and not resulting in excess turbidity. Conventional, properly designed storm water conveyance and control structures such as rock lined swales and bioretention areas at the proposed WMSC development also

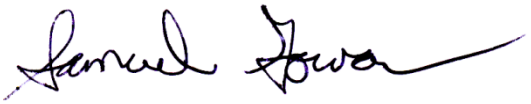
will be capable of handling interflow intercepted by road cuts. The infiltration of intercepted interflow will continue to occur at similar rates as under present conditions, though perhaps at different locations along the flow path downslope than at present; consequently, the temporary interception of interflow by roadcuts will result in no increase in flow at the surface water discharge points.

Soil moisture will not be decreased on the slopes downhill from the development. Soil moisture on these slopes is dependent upon precipitation and interflow from contiguous uphill sources. All of the seepage from road cuts will not be diverted off site because a large portion of it will continue to infiltrate through the base of the storm water control structures, as it does in the development west of Ski Windham and at Copper Ridge, directly downslope from the WMSC site. Infiltration from direct precipitation on the slopes downhill from the site will increase concomitant with any presumed reduction of interflow from uphill sources.

It is highly unlikely that construction of WMSC will increase downstream flooding of property and infrastructure, given the fact that the lower slopes of the site are underlain by permeable stratified drift. Properly constructed storm water control features will continue to allow intercepted seepage from road cuts to infiltrate the subsurface and recharge the valley aquifer.

Please contact me, or Steven Trader, if you have any questions on this matter.

Sincerely,
Alpha Geoscience



Samuel W. Gowan, PhD, CPG
Geologist

cc: Dan Ruzow, Whiteman Osterman & Hanna, LLP

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PHOTO 1: Water flowing in rock lined ditch (1-2 gpm) along unfinished road in the development west of Ski Windham at approximately 2,500 ft elevation.

PHOTO 2: All of the flow seen in Photo 1 has infiltrated the subsurface by approximately 200 feet from where the flow originated.

PHOTO 3: Low water level in retention pond on May 24, 2012, down slope from Photos 1 and 2, with no overflow or discharge two days after 1.5 inches of precipitation.