To: Harry Martin
From: Anthony H. Fleming, Licensed Professional Geologist
Re: Hearst Park Landscape and Hydrology

July 17, 2016

Dear Mr. Martin:
In response to your request, I offer the following observations regarding the topography, geology, and hydrology at Hearst Park and vicinity, based on a review of historical topographic maps, geologic maps, and my own observations of the area dating from when I compiled the Washington West geologic quadrangle.

1. The time frame of my analysis is from the Civil War to the present. I looked at topographic maps from 1861, 1892, 1901, 1917, 1945, 1956, 1965, 1994, and 2014.

2. The recreational field sits directly over the filled headwaters of Melvin Hazen Branch (figure 1). The stream originally bifurcated into two main ravines at about the western end of present-day Springland Lane. Both of these ravines now lie beneath the rec field.

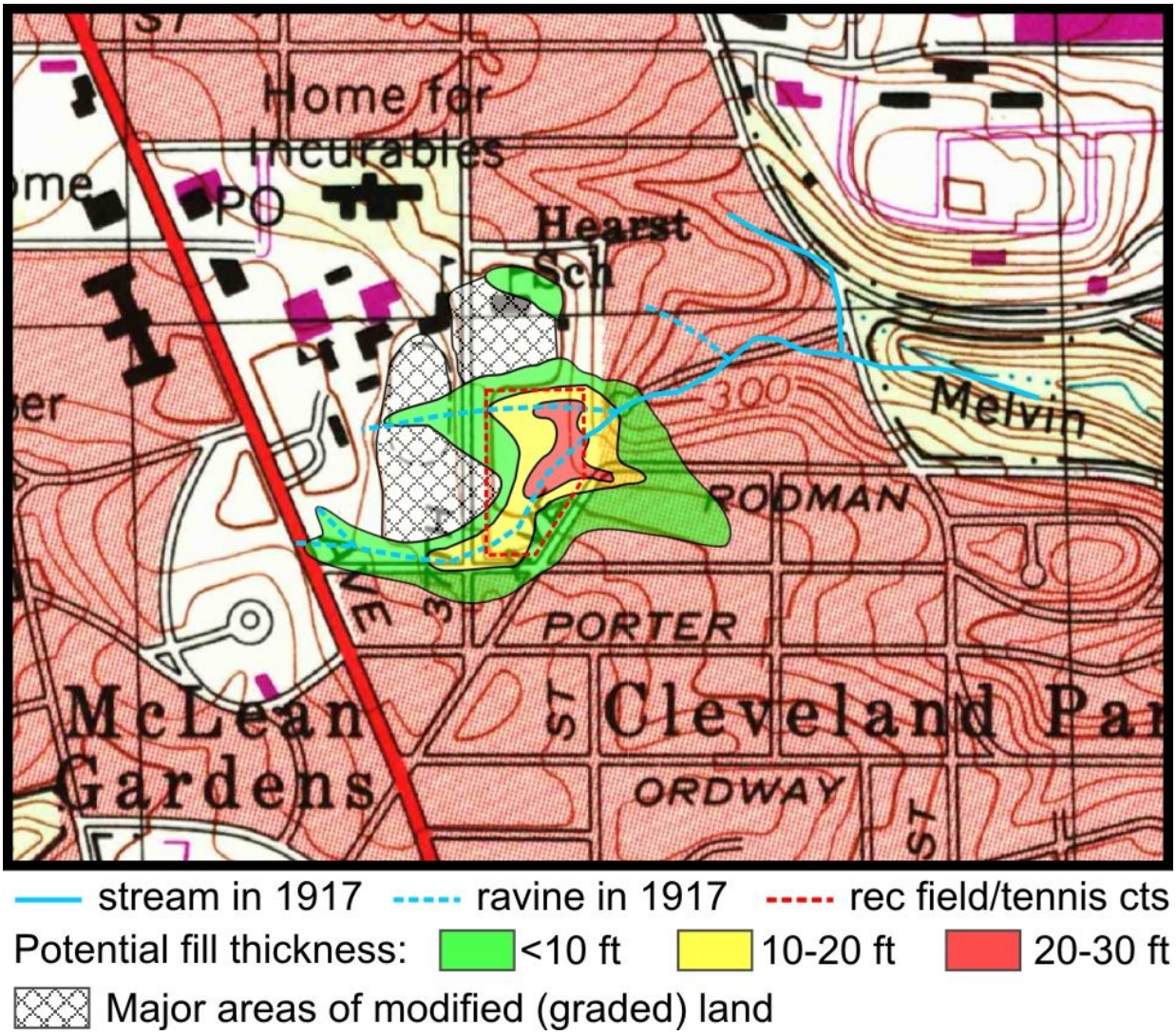

Figure 1. Historical locations of headwaters ravines and potential thickness of artificial fill at Hearst park. Estimated from USGS topographic maps published in 1917 and 1965.

The longer and deeper of the two ravines lies under the southern part of the field and the tennis courts; a shallower ravine more or less follows the north edge of the field, with the hill that bounds this side of the field more or less corresponding to the former ravine wall. There appears to be 30 or more feet of artificial fill over the deepest parts of the ravines, based on a comparison of 1917 and 1965 topographic contours.

3. The maps from 1861, 1892, 1901, and 1917 indicate minimal human modification of the landscape at Hearst during this period, with the ravines being rather pronounced features on all of these maps. The recreational field and Hearst School/playground first appear on the 1945 topo (the next available map after 1917), as does 37th Street (figure 2). The two branches of the ravine have been completely filled in to create the field, and the spur ridge to the north (separating this drainage from the "Upton Street branch", another Melvin Hazen tributary) leveled off for the school and playground. It is entirely plausible that the field was created in conjunction with the opening of Hearst School in the early 1930's, but without additional maps or aerial photos for the intervening years, all that can be said for sure is that the ravines were filled between 1917 and 1945. This is important for trying to understand what kind of infrastructure may (or may not) have been installed to convey the springs, streams, and associated stormwater under the field. On a related note, the Sidwell Friends athletic fields west of 37th St. were created between 1945 and 1956, resulting in another major episode of grading and hydrologic disturbance in the watershed just above Hearst. No significant changes to local topography are evident on any subsequent maps.

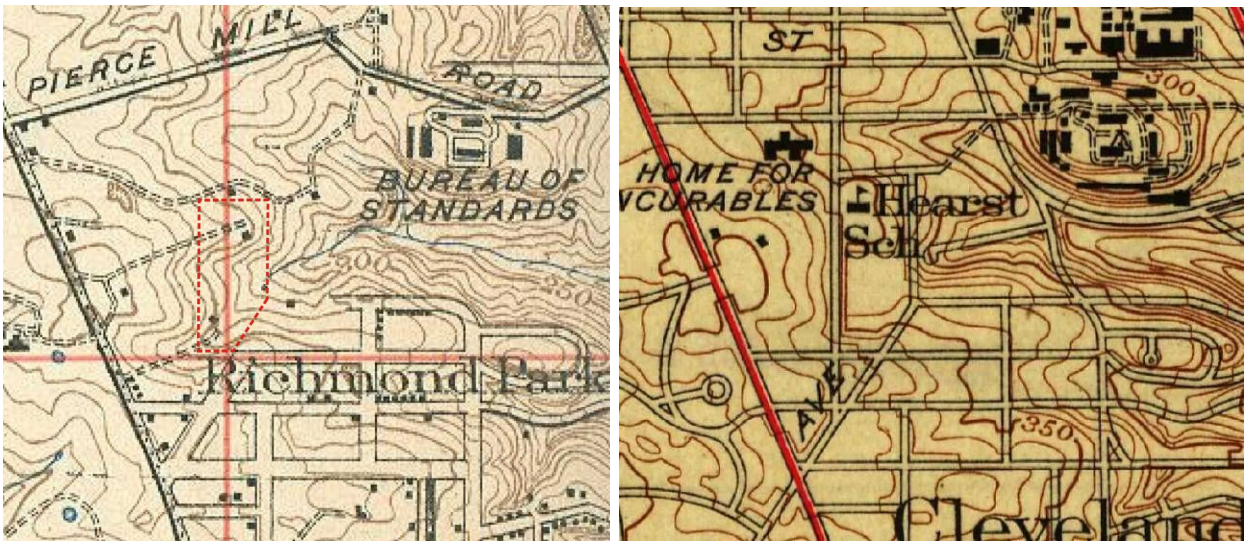

Figure 2. The original ravine topography of the site (outlined in red) is still evident on the 1917 topographic map of Washington, D.C. (left). Both ravines extend west into the Sidwell Friends campus. By 1945 (right), the ravines have been filled in and replaced by the flat expanse of the Hearst rec field and playground. Contour interval is 10 feet on both maps.

4. In the absence of a detailed subsurface investigation, it is impossible to know exactly what was used to fill in the ravines to make the rec field, but in many similar situations from that era, artificial fill in other ravines typically consists of native soil scraped off adjacent ridges (consistent with the leveling of the spur ridge where the school and playground sit) mixed with various kinds of construction and demolition debris like bricks, lumber, coal cinders, vegetation, etc. Because its physical and engineering properties at any given place are generally poorly known and likely to be laterally and vertically variable, artificial fill as a rule poses a significant problem for load-bearing structures. The degree of compaction (how thoroughly the fill was compacted by machinery when emplaced) is also unknown, and is a particularly serious engineering question: if the fill was minimally compacted or contained

organic material (wood, vegetation, etc) that degrades over time, then ongoing settlement and lack of strength will be major issues. For all these reasons, artificial fill poses major engineering challenges, and placement of a major load bearing structure (e.g., a building, swimming pool, etc.) generally will require an extensive geotechnical investigation involving a significant amount of test drilling and analysis of subsurface conditions to evaluate bearing conditions. Such an investigation may determine that major remediation is needed to support a structure, i.e., removal of some or all of the existing fill and its replacement by more structurally suitable material.

5. There probably were multiple springs along these ravines, just as there are today along Springland Lane and many other Rock Creek tributaries. The different iterations of topo maps show perennial streams extending up the ravines to various locations. The 1861 Boschke map shows a stream extending up the southern ravine (under the tennis courts/Quebec St) nearly to Rockville Pike — the farthest headward extent of a stream shown on any of the maps I reviewed. Later maps show streams starting at various places lower down the ravines. In reality, the positions of springs and the extent of flowing streams may have varied seasonally. In any case, filling the ravines did not make the springs go away: they are still there.

6. Local geology and topography ultimately control the locations and volumes of springs, and Hearst is very favorably situated for springs on both counts. In fact, it is not hard to imagine the site could have potentially hosted a line of historical springs along the contact between the thick river terrace gravel that caps the Wisconsin Avenue Ridge (a significant spring maker all along the avenue) and the underlying bedrock; further, the rec field lies within a major, bowl-like topographic concavity that could be expected to focus groundwater flow inward toward the field. Geologic maps from 1901 and 1994 indicate that this contact lies at an elevation between 340 feet (south side of the rec field) and 350 feet (north side)--in other words, at or just below the current elevation of the field. Water discharging from springs today presumably seeps into the fill under the field, and some of it may be conveyed by (80 year old) infrastructure to the head of Springland Lane or beyond. The presence of springs at or just beneath the field helps explain its seasonal wetness. It should also be noted that the outfall of Melvin Hazen Branch, just below Reno Road, produces a large volume of water, presumably representing the combined discharge of springs around Springland Lane, Hearst, and the Upton Street ravine.

7. The likely presence of groundwater discharge further complicates the geotechnical conditions below the site, and could reasonably be expected to decrease the stability and bearing strength of the fill and create other kinds of problems from seepage forces, piping, and related phenomena. A considerable volume of surface runoff also appears to drain towards the site. Thus, key questions are: whether any drainage infrastructure was installed at the time the park was created; its composition and durability over 80 years; how much of the ground water discharge around the site is captured by said infrastructure; and whether it is appropriately sized to handle the runoff from a now-thoroughly urbanized environment. On the last point, it might be noted that in the mid 1910's, the setting of the Sidwell Friends campus was described as "…buttressed to the south and west by grand estates and cloaked to the east by woodlands that fell away almost uninterruptedly toward Reno Road and Connecticut Avenue…" (MacKaye and Mackaye, 1983), i.e., a relatively natural landscape that would have generated far less runoff than it does now.

8. Finally, the potential presence of a Civil War encampment makes perfect sense: this is one of at least two large, reliable springs near Fort Reno (Cleveland Park Spring is the other), ergo, it may have served as a water supply for the fort or at least was strategic enough to warrant an encampment. Prior to the advent of a public water system, springs emanating from the sandy and gravelly strata that cap the Wisconsin Ave ridge were the

major source of water for Georgetown, other early NW neighborhoods (including Cleveland Park), and various estates. No doubt the Hearst/Springland Lane springs were too. Clearing of trees by the Union army was very common around forts and encampments, not so much for firewood or lumber, but for visibility, to detect Confederate spies attempting to sneak behind Union lines via ravines and other wooded areas. That's why so many extant forests in and around Washington (c.f., most of Rock Creek Park, NatureServe, 2015) sprouted shortly after 1865. Thus, it is quite possible some or all of the forest around the Hearst ravines may have been cleared at that time as well.

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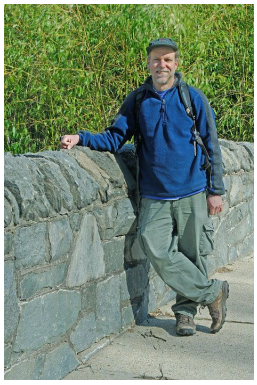
U.S. Geological Survey, 2014, Washington West Quadrangle, scale 1:24,000.
http://store.usgs.gov/b2c_usgs/usgs/maplocator/(xcm=r3standardpitrex_prd&layout=6_1_61_48&uiarea=2&ctype=areaDetails&carea=%24ROOT)/.do

Fleming Bio



Tony Fleming grew up in Cleveland Park, across from his alma mater, John Eaton School, and later attended Sidwell Friends School. After completing the available science classes at Sidwell, Tony conducted an independent study of water quality in local streams during his senior year, which further stimulated his interest in both water resources and DC area geology. He graduated magna cum laude with a degree in geology from Beloit College, where both his senior thesis and a year of independent study were focused on the geology of Rock Creek Park. He went on to receive graduate degrees in geology and water resources management from the University of Wisconsin-Madison. He has worked for government agencies, conservation organizations, and as a private geologist on a wide range of topics, including geologic mapping, geological hazards, ground water availability and contamination, and the relationship between geology and natural communities. He is the author of several major geological studies and publications on the greater DC area, including the modern geological maps of the District and the City of Alexandria. He is credited with the discovery of the Rock Creek Fault, a first order tectonic structure with miles of displacement and several periods of motion, and is a contributor to the Arlington County Natural Heritage Resources Inventory—the first of its kind in a major urban area. He is a coauthor of the forthcoming 'Technical Guide to the Natural Communities of Rock Creek Park' and has led field trips in the local area for groups as different as the Geological Society of Washington, local planning and natural resource professionals, and native plant associations. He was the keynote speaker at the 2006 DC-Maryland Native Plant Society Annual Conference on the "Geology-Botany Connection"; his talk, entitled "From Gondwanaland to Georgetown", illuminated how the geologic history of the Potomac Valley has affected regional ecology, and was followed by a popular field trip in Rock Creek Park called "Subway to Subduction". He is also an expert on local building stones and on the role of geology in Civil War defenses around Washington.

Tony has resided in the Great Lakes region for more than 25 years, where he works as a glacial geologist/hydrogeologist, and in the emerging field of natural-areas geology. He returns periodically to the Washington area to continue his professional research on various aspects of regional geology. He credits his lifelong career in geology to frequent childhood expeditions to nearby Tregaron and Klingle Valley, which led to an early interest in rocks, water, and all things nature.

CURRICULUM VITA

Name and Address: Anthony H Fleming, 2275 E 300 S Albion, IN 46701
Qualifications: Licensed Professional Geologist
Education:

B.A.	Geology, Beloit College, 1979, magna cum laude
M.S.	Geology & Geophysics, University of Wisconsin-Madison, 1986
M.S.	Water Resources Management, University of Wisconsin-Madison, 1986

Academic Advisor (B.A.): Henry Woodard
Field Term: Fleming, Anthony, 1978. The geology of Rock Creek Park and vicinity, Washington, D.C.

B.A.. Thesis: Fleming, Anthony, 1979. Stratigraphy and origin of the Glenarm Series, central Appalachian Piedmont. Beloit College, Beloit, Wisconsin

Academic Advisor (M.S.): David Mickelson (glacial geology and hydrogeology)

M.S. Thesis: Fleming, Anthony, 1986. The determination of joint system characteristics from azimuthal resistivity surveys. The University of Wisconsin, Madison, Wisconsin

Water Resources Management Practicum: Delevan Lake: A recovery and management study

Current Professional Appointments:

Independent consulting geologist, 1998-present. Providing expert technical assistance on a wide range of land and water resources issues to clients in government, industry, the non-profit sector, and the general public. Specialties include geologic education and website content development, glacial geology and landscape interpretation, ground water quality protection, sustainable ground-water development, subsurface interpretation, wetland hydrology and ecology, floodplain issues, and the role of geology and ground water in conservation and natural communities. I emphasize presenting complex earth-science issues and information in ways understandable to non-technical audiences.

Adjunct Professor, Geosciences, Indiana-Purdue University Fort Wayne (IPFW), 2015-

Other Professional Appointments:

Geologist, Indiana Geological Survey, Indiana University-Bloomington, 1988-1997. Directed the survey's northeastern regional office at Fort Wayne, specializing in glacial geology, wetlands, ground water protection and availability, and public outreach related to these and other geoscience-based issues. Managed several comprehensive county- and regional-scale ground-water studies. Developed statewide hydrogeologic index to evaluate the sensitivity of ground water to contamination from agricultural chemicals as part of the state pesticide management plan. Author of many geologic maps, technical articles on geoscience topics in peer-reviewed publications, as well as non-technical reports aimed at elected officials, state and local agency staff, the media, and the general public. Gave dozens of presentations to such diverse audiences as local Chambers of Commerce, conservation groups, soil scientists, and health and planning authorities.

Natural Resources Planner, Dane County Plan Commission, Madison Wisconsin, 1987-1988. Assessed environmental impact of active and abandoned solid waste sites. Assisted with the development of countywide recycling plan and ground-water management and protection plan.

Water Resources Specialist, Wisconsin Department of Natural Resources, 1986-1987. Evaluated and managed geological, water usage, and construction data for high capacity wells. Assisted with revisions to the Wisconsin well code. Carried out inspections of high capacity wells and pump installations for compliance with the Wisconsin well code. Developed program guidelines and authored operations manual.

Professional Society Memberships:

Geological Society of America
Indiana Academy of Science
Professional Geologists of Indiana
Maryland-DC Native Plant Society
Indiana Native Plant and Wildflower Society

Short Courses:

"Practical Field Identification of Wetland and Other Plants of Northeastern Indiana", Little River Wetlands Project, Fort Wayne, IN 2015

"Remote Sensing Applications to Hydrogeology" National Ground Water Association, Boston, MA, 1987

"Radon and Other Radionucleiides in Ground Water," National Ground Water Association, Dublin, OH, 1986.

HONORS AND DISTINCTIONS

Magna Cum Laude graduate, 1979, Beloit College, Beloit, WI
Stanley A. Tyler Award for student teaching, 1985-1986, Univ. of Wisconsin, Madison, WI
Volunteer for Science Award, 1991, US Geological Survey, Reston, VA

SELECTED RECENT ACTIVITIES

City of Alexandria, VA. Produce comprehensive online geologic atlas as part of the city's natural heritage resources inventory and flora project. Includes the first modern, large-scale geologic maps of the city. Investigate prehistoric and modern landslides and geologic hazards and their implications for land-use management

Indiana Geological Survey, Bloomington, IN. Develop content for web-based geologic atlases for Marion County (Indianapolis) and Allen County (Fort Wayne); produce Quaternary geologic maps of parts of northeastern Indiana

ACRES Land Trust, northeastern Indiana. Lead interpretive hikes at preserves; develop interpretive signage; inventory geologic, floristic, ecological, and other natural features at preserves; assess properties for acquisition; develop template for preserve management plans; produce preserve management plans for several of the organization's most significant and heavily utilized preserves

Town of Huntertown, Allen County, IN (with M.C. Wheeler & Sons Well Drilling, Columbia City, IN). Identified and developed a new 5,000-gpm public wellfield for the town using detailed aquifer mapping, water level analysis, test drilling, borehole geophysics, and pump testing.

Little River Wetlands Project, Fort Wayne, IN. Lead interpretive hikes for public at preserves. Develop web-based interpretive guide to geology and natural history of Eagle Marsh. Lead interpretive hikes at preserves for public and volunteers. Provide research, expertise, and

field trips for Federal interagency task force on Asian carp management. Developed background materials for Indiana Academy of Science bioblitz. Invasive vegetation removal

Indiana Master Naturalists, Allen County, Indiana. Instructor and field trip leader

The Nature Conservancy-Indiana Chapter. Assess hydrogeologic conditions at wetland preserves and suggest management strategies

Cleveland Park Historical Society and Tregaron Conservancy, Washington, D.C. Lead educational field trips on the role of geology in local natural history, culture, and settlement patterns, and seismic risk

PUBLISHED MAPS, PAPERS, AND WEB GUIDES

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Fleming, A.H., 1996, Characteristics of fine-grained soils and glacial deposits in northeastern Indiana for on-site waste disposal systems. Indiana University-Purdue University Fort Wayne Office of Continuing Education.

Unpublished Reports, Maps, Presentations, and Field Trips by A.H. Fleming

2014. Quaternary Geologic Maps of the Leesburg and North Webster 7.5-minute quadrangles, Indiana. Submitted to the US Geological Survey in fulfillment of STATEMAP grant G12AC20237.

2012. Quaternary Geologic Maps of the Nappanee West, Nappanee East, Milford, and Lake Wawasee 7.5-minute quadrangles, Indiana. Submitted to the US Geological Survey in fulfillment of STATEMAP grant G11AC20237.

2012. Natural History of the upper Wabash Valley. Field trip for the Tippecanoe Audubon Society,

Sept. 8, 2012.

2012. Map of the Huntertown 7.5-Minute Quadrangle Showing the Extent, Thickness, and Other Characteristics of the Deep Glacial Aquifer. Prepared for DLZ Engineering and the Town of Huntertown, IN.

2011. Hydrogeology of the Gellar Ditch (upper Eel River) watershed, Allen County, Indiana. Prepared for Engineering Resources and the Town of Huntertown.

2010. Report on the Results of Test Drilling and aquifer characteristics at the Byron Hospital Campus. Prepared for the Town of Huntertown, IN.

2008. Geology of Rock Creek Park, Washington, D.C. Prepared for Nature Serve, Technical Field Guide to the Natural Communities of the National Capital Region.

2008. Hydrogeologic Observations at the Proposed Greenview Landfill Site and Vicinity, Fountain County, Indiana. Prepared for Concerned Citizens of Fountain County.

2008. Geologic Atlas of the City of Alexandria, VA, v.1. Prepared for the Alexandria Division of Parks Planning, 130 pp, plus 6 plates.

2008. Assessment of current and historical ground-water levels on the north side of Lake Wawasee, Kosciusko County, Indiana. Prepared for Peter Nicholas and the Wawasee Area Conservancy Foundation.

2008. Geology and Fossils of Hathaway Gorge, Wabash County. Field Trip for North Manchester Public Schools on behalf of ACRES Land Trust, September 27, 2008.

2007. Geologic history of northeastern Indiana in relation to natural communities: Presented to the Tippecanoe Audubon Society.

2007. Geology of northern Virginia and its bearing on the distribution of native plant communities: Presented to the Virginia Native Plant Society-Potowmack Chapter.

2007. Geology of Allen County-Website content. Prepared for the Indiana Geological Survey.

2006. Subway to Subduction: Field trip to the urban geology of southern Rock Creek Park, Washington, D.C. Arranged for the Maryland-DC Native Plant Society 2006 Annual Conference.

2006. Hydrogeology of Jack Mountain and Vicinity, West Virginia, and Analysis of Impacts of the Proposed Liberty Gap Wind Project. Prepared for Friends of Beautiful Pendleton County (FOBPC).

2006. Inventory of Geological Features of Arlington County, Virginia: Arlington County Natural Heritage Resources Inventory, Arlington County Department of Parks and Recreation. 89 pp plus 22 maps (see http://www.arlingtonva.us/departments/parksrecreation/documents/file76445.pdf and http://www.arlingtonva.us/departments/ParksRecreation/documents/nhri.ppt.

2006. Hydrogeology of Green Spring Garden Park, Fairfax County, Virginia. Prepared for the Virginia Native Plant Society and Fairfax County Park Authority. 14 pp. plus maps and figures.

2006. From Gondwanaland to Georgetown: A travelogue of geological features of the Potomac River Gorge and the National Capital Region Park System, and their bearing on ecological communities and modern urban issues. Keynote presentation to the 2006 annual meeting of the Maryland-DC Native Plant Society, October 14, 2006, Shady Grove, MD.

2005. Hydrogeology of Barcroft Park, Arlington County, Virginia. Prepared for Arlington County Department of Parks and Recreation. 22 pp. plus maps and figures.

2005. Water table map of the Lake Wawasee basin. Prepared for the Wawasee Area Conservancy Foundation. Scale 1:24,000,

2005. Water table characteristics in the Lake Wawasee basin. Prepared for the Wawasee Area Conservancy Foundation. 9 pp.

2004. Geology of Fort Dupont Park, Washington, D.C, Prepared for the Maryland-DC Native Plant Society and the National Park Service, 5 pp.

2004. Hydrogeologic setting of a proposed confined animal feeding operation near Lake Wawasee, Indiana. Prepared for the Wawasee Area Conservancy Foundation. 7 pp. plus maps and figures.

2004. Hydrogeologic considerations at Piney Branch Bog, Charles County, Maryland. Prepared for the Maryland Chapter of The Nature Conservancy. 8 pp. plus maps and figures.

2004. Hydrogeology of Araby Bog, Charles County, Maryland. Prepared for the Maryland Native Plant Society and the Araby-Mason Springs Association. 6 pp. plus maps and figures.

2003. Water quality issues in organic certification. Technical paper posted on the Independent Organic Inspectors Association website.

1998. Evaluation of long-term ground-water availability in Aboite Township, Allen County, Indiana. Prepared for Jefferson Environmental Association. 5 pp.

1998. Hydrogeological evaluation of a proposed wellfield in Jefferson Township, Whitley County, Indiana. Prepared for Jefferson Environmental Association. 8 pp.

1998, Atlas of Hydrogeologic Settings of Lagrange County, Indiana, prepared for the Lagrange County Health Department, 109 pp. plus 20 maps and plates. Scale 1:100,000.

1998. Impact of proposed artificial drainage on forest hydrology of Pike Lumber Co. lands, Miami and Howard County. Prepared for Pike Lumber Company. 4 pp.

1997. Stream stage and shallow ground-water levels in the Pigeon River watershed upstream of Mongo Millpond, Lagrange County, Indiana. Indiana Geological Survey Memorandum Report. 4 pp plus figures.

1995. Geological map of Chestnut Woods and vicinity, Pendleton County, WV. Prepared for the Chestnut Woods Association. Scale 1:12,000.

1988. Ground water primer for Chestnut Woods partners, Pendleton County, WV. Prepared for the Chestnut Woods Association. 12 pp, plus maps and figures.