



## Meliora Design

---

October 24, 2017

Mark P. Thompson, Esq.  
Lamb McErlane PC  
24 E. Market Street  
PO Box 565  
West Chester, PA 19381

**RE: Stormwater Management Review of Planned Development Plan for Crebilly Farm**

Dear Mr. Thompson:

Meliora Design has reviewed the plans and documentation related to the Crebilly Farm Proposed Development in Westtown Township, Chester County, including the following documents prepared on behalf of the applicant:

1. Conditional Use Subdivision Plan for Crebilly Farm, Westtown Township, Chester County, Pennsylvania for Toll PA XVIII, L.P. prepared by ESE Consultants, Inc. dated 10/07/2016, Plan Sheets 1 through 45.
2. Conditional Use Subdivision Plan for Crebilly Farm, Westtown Township, Chester County, Pennsylvania for Toll PA XVII, L.P. prepared by ESE Consultants, Inc. dated 10/07/2016, last revised 12/08/2016, Sheets 1-4D, 5-23, and 44A-45 of 45.
3. Stormwater Management Narrative for Crebilly Farm, prepared by ESE Consultants, Inc. dated October 2016, last Revised December 2016.
4. Report of Preliminary Geotechnical Exploration for Crebilly Farm, Westtown Township, Chester County, Pennsylvania, prepared by Geo-Technology Associates, Inc. dated August 2016.
5. Exploration Location Plan for Crebilly Farm, prepared by Geo-Technology Associates, Inc. dated August 2016.

We have also reviewed various supporting documents including the following:

1. Chapter 144: Stormwater Management of the Code of the Township of Westtown, Pennsylvania.
2. Soil resource map generated by the United States Department of Agriculture
3. Response Letter, prepared by ESE Consultants, dated 01/31/2017, RE: Conditional Use Application for Crebilly Tract Development.

We have reviewed these materials specifically for issues related to stormwater management and site development, including potential downstream water quality and stormwater impacts.

## **Overview of Existing Site Conditions**

The project is shown on the Conditional Use Subdivision Plan as a 322.36 acre development comprised of many parcels. A majority of the existing slope of the site is generally from northeast to south west, with a high point of approximately Elevation 385 feet in the northeast corner of the site, to a low point of approximately Elevation 255 feet in the southeast corner by Radley Run. Most of the property drains to Radley Run or its tributaries and wetlands. Radley Run, classified as a Warm water Fishery (WWF) per Chapter 93 of the Pennsylvania Code, is listed as an impaired stream per Section 303(d) list. Radley Run is subject to the Pollutant Reduction Plan requirements of the Township's MS4 program.

Radley Run crosses the southeast corner of the parcel from east to west. A tributary of Radley Run extends diagonally from the northeast corner of the site to the southeast where it joins with Radley Run. Between these two stream segments are two major "fingers" of tributaries and wetlands that also run diagonally from east to west, reflecting the rolling topography of the site. The proposed development is located between these "fingers" of streams and wetlands.

An eastern portion of the site slopes toward the east to a tributary of Chester Creek, but it appears that this area will be redirected towards Radley Run after development.

There are areas of steep slopes and very steep slopes on the site. The existing land use is dominated by crop farming and an equestrian facility, and about 75% of the site is underlain by well-drained "B" and "C" soils of high agricultural value. It should be noted, however, that the approximate remaining 25% of soils are "D" or dual classified "B/D" and "C/D" soils, which have little infiltration capacity due to the presence of a water table within 24 inches of the surface. While not detailed on the Overall Existing Resources and Site Analysis Map, there are many trees of unknown caliper that will be removed for the proposed development.

## **Overview of Proposed Development**

The primary components of the proposed conditions include:

- The construction of 317 new residences, including 117 townhomes and 200 single family homes, with associated driveways, service walks, and impervious allowance
- Nine (9) infiltration basins
- Four (4) effluent disposal areas
- Circulation roadways
- Existing roadway improvements

The total post-development impervious area (as estimated from Appendix 5 of the Stormwater Management Narrative) is 50.44 acres, or approximately 15.6%. It is notable that 5.26 acres of this impervious area will not be captured by a proposed stormwater management basin. Additional areas will be converted to highly compacted lawn areas. The proposed development includes nine stormwater basins of significant depth and excavation, with very steep sides.

## **Conditional Use and the Importance of Stormwater Management**

We have numerous specific concerns related to the proposed development and stormwater management system, as discussed in later sections of this letter, and it is our opinion based on the information provided that the project as proposed will adversely impact the water quality of local

waterways including Radley Run and its tributaries, Brandywine Creek, and Chester Creek and its tributaries.

With regards to **§170-2009 Conditional Uses**

- We do not believe that sufficient information has been provided to meet the requirement of **§170-904.A.(3)(c)[1]** regarding *“Guidance for stormwater management shall use the most current best management practices such as those promulgated by the Pennsylvania Department of Environmental Protection”*. The information provided does not support that the proposed stormwater system will provide infiltration or protect water quality.
- We do not believe that sufficient information has been provided to meet the requirement of **§170-904.A.(3)(c)[2]** regarding *“The applicant shall be required to submit ... credible evidence .... satisfactory to demonstrate long-term feasibility of required groundwater infiltration.”*
- It is also our opinion that the proposed project fails to meet design standards as described in **§170-905.A.(2)** requiring that *“the finished topography of the site shall adequately facilitate the proposed development without excessive earthmoving, tree clearance, or destruction of natural amenities. Natural features such as lakes, streams, and wooded slopes shall be preserved and incorporated...”*.

Further, we do not believe that sufficient detail has been provided that demonstrates the proposed development can reasonably meet many requirements outlined in **Chapter 144 Stormwater Management** of the Westtown Township code. Specific concerns regarding Chapter 144 are described later in this letter.

Since a majority of proposed project is immediately upstream of the Lower Brandywine Creek, which is designated a **Scenic River by the Lower Brandywine Scenic Rivers Act**, it is imperative that the site design and stormwater management systems provide adequate stormwater management and protect existing water quality. Additionally, no assurances are provided in the preliminary design that will protect existing wetlands on the site.

Further, a portion of the site drains to a tributary of Chester Creek, a waterbody that has seen significant degradation and therefore has a higher level of protection under the **Act 167 Stormwater Management Plan for Chester Creek Watershed**. The portion of the Crebilly Farm site in the Chester Creek Watershed has a required release rate where post-development peak discharges for **all design storms must not exceed 50% of the predevelopment peak discharges** for all design storms. Given that the land use proposed on this portion of the site contains high density townhouses (carriage homes) and no stormwater management practices are proposed in this portion of the site, **we are assuming that this area will be redirected to Radley Run**, but this cannot be confirmed from the provided materials.

**Potential Water Quality Impacts from the Proposed Project**

The quality and health of the receiving wetlands and streams will be directly and immediately impacted by the proposed development and its stormwater management system. Potential and anticipated water quality impacts as a result of the inadequate stormwater management as shown include:

- **Increases in the volume and frequency of stormwater discharge** from the project, adversely impacting the downstream channel geomorphology. Increases in stormwater runoff volumes will alter the frequency of bankfull or high flow conditions. This will result in streambank erosion and the downcutting or incising of the stream channel. Pools and riffles that support aquatic communities will be lost. Eroded stream-bank material will contribute to downstream

sediment pollution, and to the temporary deposition of sediment along the stream bottom. This will adversely impact the benthic aquatic community. Radley Run is currently impaired from stormwater.

- **Disconnection of the stream channel from the associated floodplain and wetlands.** As the stream channel becomes incised from increases in stormflow discharge, the channel bottom is lowered, the channel side slopes are increased, and it is more difficult for flood flows in large storms to reach the floodplain. This increases downstream flooding by “disconnecting” floodplain areas and funneling higher stormwater flows at higher velocities downstream, increasing flood damage.
- **Disconnection of the stream channel from the associated wetlands.** Once the channel has become incised and undercut, it is also disconnected from adjacent wetland areas. These wetland areas then quickly dry out after a storm has passed and wetland water flows too quickly from the wetland to the deeper incised channel.
- **Reduction in stream baseflow.** Unless the proposed project maintains the volume of groundwater recharge that currently occurs, there will be a decrease in the baseflow to the wetlands and stream. A decrease in baseflow directly impacts water quality in both streams and wetlands.
- **Alterations in stream temperature that will adversely impact instream water quality and aquatic health.** The discharge of runoff from the newly created impervious areas and compacted landscapes will alter the instream water temperature, as runoff from very hot or very cold impervious surfaces is discharged to the wetlands. Alterations in stream temperature of just a few degrees directly impact the instream fungal and bacterial communities as well as sensitive species, directly impacting the aquatic community and food chain.
- **Alterations to the chemical properties from stormwater discharges** based on the proximity of proposed stormwater effluent areas to both stormwater infiltration practices and headwaters to streams and wetlands. On-site sewage treatment is widely known to be the major cause of nutrient pollution.

We specifically list these problems created by inadequate stormwater management because it is our opinion that the proposed stormwater management system for Crebilly Farm is inadequate, and will result in the above-mentioned impacts to downstream properties.

### **Overview of Proposed Stormwater Management**

The proposed stormwater management system includes nine basins, as shown on Sheet 3 of 45 Overall Lot Layout, Plan A/Proposed Development Crebilly Farm. The Conditional Use Stormwater Narrative, October 2016 and revised December 2016, indicates that “**Infiltration is proposed in all basins**”, and “**the post-construction total runoff volume shall not exceed the pre-development runoff volume for all storms equal to or less than the two-year**”. In order to achieve this, the basins must function as infiltration basins.

We note that the Stormwater Management Narrative contains only preliminary information on design of stormwater management basin design. No detailed stormwater plans or profiles are provided. Detailed infiltration test information at each proposed infiltration basin has not been provided. No detailed stormwater conveyance plans or profiles have been provided. We also note that there is no Erosion and Sedimentation Report with supporting calculations included in the available documentation.

We also note that the plans fail to present critical information in a clear and comprehensive manner to allow for detailed review. For example:

- Sheet 1 of 2 Preliminary Drainage Area Plan and Sheet 2 of 2 Post Developed Drainage Area Plan dated 2016/10/07 prepared by ESE Consultants, Inc., which are the final two pages of the Stormwater Management Narrative have been reduced to fit on an 8.5" x 11" sheet of paper at **poor quality and are not legible.**
- Further, these two drainage plans do not appear in the resubmitted Stormwater Management Narrative, revised December 2016.
- The **test boring locations and test pit locations are not located on any plan that shows the proposed basins**, nor is testing information provided on the plans.
- The test boring locations and test pit locations provided on the Exploration Location Plan prepared by Geo-Technology Associates to accompany the Report of Preliminary Geotechnical Exploration, **does not show proposed basin locations and shows an inconsistent development layout with the layout proposed in the Conditional Use Subdivision Plan set.**
- The plans are **lacking basic information to comprehensively review** the proposed development for compliance with Westtown Township and PaDEP requirements.

No detailed design, plan, profiles, or conveyance for the proposed infiltration systems has been provided. The Stormwater Management Narrative states that *"The Stormwater Management Plan described herein has been designed according to the following publications and criteria: Chapter 144, Stormwater Management of the Township of Westtown Ordinance, adopted by the BOS 12-16-2013..., Pennsylvania Stormwater Best Management Practices Manual Final Draft April 2006, 'Urban Hydrology for Small Watersheds' (Technical Release No. 55), published by the United States Department of Agriculture, Soil Conservation Service, dated 1986."* Data and information provided does not support this statement.

### Stormwater Management Comments

Detailed stormwater plans, details, profiles, and conveyance have not been provided, and so a detailed review cannot be done, however, the proposed design has a number of deficiencies and will fail to meet township and state stormwater management requirements.

1. **The proposed project will not provide adequate stormwater volume management through infiltration as proposed, and the provided Report of Preliminary Geotechnical-Exploration is inadequate.** There are nine (9) proposed infiltration basins, however, the provided site data and design information does not support that the basins will provide infiltration:
  - General placement of infiltration practices in low-lying areas adjacent to existing streambanks and wetlands is not ideal and is not likely to provide adequate infiltration given groundwater conditions and seasonal high water.
  - No testing or infiltration data is provided in the vicinity of Basins A-4, A-9 or A-10.
  - Basins A-9 and A-10 are in areas of Seasonal-High Water Table as mapped by the applicant.
  - An infiltration rate the vicinity of Basin A-1 had "no discernable movement" indicating that this location may not infiltrate.
  - Another test near A-1 encountered high groundwater.

- In Basins A-6 and A-7, the perc tests are more than 10 feet above the proposed basin bottom, and not representative of conditions.
  - The bottom of Basin A-7 is lower than the rock that was encountered in the nearest test pit, in violation of PaDEP requirements.
  - The bottom of Basin A-2 is close to rock, in violation of PaDEP requirements.
2. **The site is well suited to stormwater infiltration, but the proposed site design and stormwater management system will eliminate meaningful stormwater infiltration opportunities. Instead, the design proposes to site most of the infiltration basins in low-lying areas along stream beds and wetlands such that these stormwater systems that will fail to manage the increase in stormwater volumes.** The development area is primarily underlain by well-draining “B” and “C” soils, which are suited to infiltration. As such, the site is very suitable for infiltrating stormwater practices. However, the majority of the infiltration basins have been placed in other areas that are not suitable for infiltration. Further, the project proposes significant removal of the existing soil for construction of the deeply excavated basins. Soil infiltration suitability generally diminishes with depth as the well-draining agricultural soils are removed.
  3. **The proposed project has not demonstrated that it will provide adequate volume control as proposed.** The calculations provided to demonstrate volume control contain a weighted averaging technique which is not in compliance with regulations.
  4. **No stormwater management appears to be provided for the downslope area of the eastern townhouse cluster.** It is unclear how stormwater management is proposed for the disturbance associated with the townhouses at the east of the site along Route 202. This area is particularly notable given that it is in the Chester Creek Watershed, requiring a 50% Peak Rate Reduction from pre-development peak rates for all design storms.
  5. **Extensive cut and fill will alter soil conditions and the site’s hydrologic response to rainfall.** The proposed layout and grading indicate extensive areas of cut and fill placement throughout the development area. Even where lawn is established after development, the hydrologic response of the soils will be altered and additional runoff will be generated.
  6. **The creation of steep slopes, and the discharge of stormwater onto steep slopes will cause erosion and sediment discharge.** Most notably, there extensive lengths of very steep along the sides of the basins are likely to erode and discharge sediment. These areas will be difficult to maintain in a healthy vegetated cover.

#### **Specific Concerns Regarding Westtown Township Code Chapter 144. Stormwater Management**

This preliminary design does not demonstrate that “*public health, safety and general welfare, property and water quality*” will be protected, as required by §144-103. Further, the applicant has not demonstrated general understanding of the stormwater management requirements outlined in Chapter 144 of the Westtown Township code, and the applicant has not demonstrated general consistency with the protocols written in the Pennsylvania Stormwater Best Management Practices Manual, as required by §144-306.K.(4). This following items contain specific sections of the code, followed by commentary of how the applicant has failed to demonstrate compliance.

§144-305.I. *Weighted averaging of runoff coefficients shall not be used for manual computations or input data for water quality and runoff calculations.*

§144-309.G. *Weighted averaging of runoff coefficients shall not be used for manual computations or input data for water quality and runoff calculations.*

The applicant appears to have used weighted averaging for curve number (CN) values for both pre-development conditions and post-development conditions. These calculations are provided by the applicant in the Stormwater Management Narrative for Crebilly Farm, Appendix 4 and Appendix 5.

§144-306.J. *Infiltration BMPs shall be selected based on suitability of soils and site conditions and shall be constructed on soils that have the following characteristics*

- (1) *A minimum depth of 24 inches between the bottom of the BMP and the top of the limiting zone.*
- (2) *An infiltration rate sufficient rate sufficient to accept additional stormwater volume and drain completely as determined by field tests conducted by the applicant.*

Based on preliminary results, there are limitations regarding subsurface soils, infiltration feasibility, high groundwater, seasonal high water, proximity to water bodies, and potential for a perched water table.

Results from soil testing and interpretations in the Report of Preliminary Geotechnical Exploration note, "surficial fine-grained soils could impact the design and construction of the proposed [stormwater management] facilities." This concern has not been adequately addressed in the stormwater management design.

All proposed infiltration basins are either directly along or near waterways or wetlands. These low-lying areas contain soils and conditions not appropriate for stormwater infiltration. Five of the proposed nine infiltration basins are sited on soils with hydrologic soil group (HSG) B/D or C/D as mapped by the United States Department of Agriculture. The National Engineering Handbook (Part 630 Hydrology, Chapter 7) describes that these dual hydrologic soil groups are "certain wet soils placed in group D based solely on the presence of a water table within 24 inches of the surface even though the saturated hydraulic conductivity may be favorable for water transmission." These basins are not likely to meet this requirement of a minimum depth of 24 inches to a limiting zone of groundwater.

It should be noted that no infiltration tests were reported near basins A-9 or A-10 at the northwest side of the site, which raises concern due to the siting of these two basins directly on the stream bank which is likely to impact infiltration feasibility.

Further, the Report of Preliminary Geotechnical Exploration explicitly notes, "infiltration is not considered practical in the areas near test pits TP-4 and TP-10 due to shallow limiting zone and/or lower infiltration rates," yet despite this, Basin A-1 is proposed in the area of TP-10.

Additionally, the Report of Preliminary Geotechnical Exploration notes, "Groundwater was observed at 11 of the exploration locations at depths ranging from 4.4 to 12.0 feet below the ground surface... The observed water levels in the higher areas of the site are likely perched water trapped in sandy lenses over dense weathered rock. Water levels encountered in the exploration locations in the low lying areas

are considered to be the seasonal water table.” Soil conditions, infiltration feasibility, and groundwater are concerns have not been addressed in the engineering design of stormwater management practices.

§144-306.K. All infiltration practices shall:

- (3) Be consistent with the protocols written in the Pennsylvania Stormwater Best Management Practices Manual, December 2006 or latest version thereof.

The proposed stormwater management consists of only infiltration basins, which is just one type of best management practice (BMP). It does not appear that the design engineer has given any consideration to non-structural BMPs, or any other structural BMP other than infiltration basins. Especially given the numerous natural water resources on the site, it is recommended that non-structural BMPs are considered in the design process.

Based on preliminary information, it does not appear that the proposed infiltration basins can adequately manage the stormwater generated from the proposed development in keeping with the guidance on loading ratios as described in the Pennsylvania Stormwater Best Management Practices Manual. The manual recommends for infiltration systems that a maximum impervious loading ratio should be 5:1 (relating impervious drainage area to infiltration area). Using the provided calculations in Appendix 5 and Appendix 6 of the Stormwater Management Narrative, every basin exceeds this loading ratio requirement, some by extravagant amounts. The design has not adequately demonstrated that stormwater can safely be conveyed and managed by these infiltration systems. The impervious areas to each basin and basin footprint used for this comment are provided in the following table:

Area	Impervious On-lot (ac)	Impervious ROW (ac)	Total On-Site Impervious (ac)	Basin Footprint (sf)	Basin Footprint (ac)	Impervious LR (unitless)
Source	Appendix 5, Stormwater Management Narrative	Appendix 5, Stormwater Management Narrative	Sum of Previous two Columns	Appendix 6, Stormwater Management Narrative	Conversion from sf to ac from previous column	Total On-Site Impervious Area / Basin Footprint
Basin A1	5.55	2.98	8.53	11,640	0.27	32
Basin A2	1.81	0.81	2.62	950	0.02	120
Basin A4	0.96	0.42	1.38	1,100	0.03	55
Basin A5	1.95	1.83	3.78	11,650	0.27	14
Basin A6	7.76	4.61	12.37	40,940	0.94	13
Basin A7	4.06	2.23	6.29	38,450	0.88	7
Basin A8	2.08	2.03	4.11	15,600	0.36	11
Basin A9	1.6	0.67	2.27	8,300	0.19	12
Basin A10	2.75	1.08	3.83	4,860	0.11	34



§144-308. The applicant shall comply with the following peak flow rate control requirements for all regulated activities... that are not located in the Chester Creek watershed.

A. Post-construction peak flow rates from any regulated activity shall not exceed the predevelopment peak flow rates as shown for each of the design storms specified in Table 308.1

H. Regulated activities located within the Chester Creek watershed shall achieve the applicable peak flow release rate control requirements presented in the approved PA Act 167 for that watershed in Table 308.2...

§144-309.D.(3) The following additional ground cover assumptions shall apply to regulated activities within the Chester Creek Watershed:

(b) For the purposes of predevelopment flow rate determination, undeveloped land shall be considered as "meadow" good condition, type "B" soils, (RCN=58, Rational "C"=0.12) unless the natural ground cover generates a lower curve number or Rational "C" value (i.e., forest).

The applicant did not correctly apply the CN value of 58 associated with meadow, good condition, B soils to the predevelopment POI C-1 contributing to the Chester Creek Watershed, as required by this section of the code. The calculations provided in the Stormwater Management Narrative, Appendix 4 for pre-developed POI C-1 includes 5.05 acres of meadow, good condition, C soils (CN=71) and 0.05 acres of meadow, good condition, D soils (CN=78). When the applicant follows the code and applies the correct CN value, it will result in a reduced value for pre-development peak rate runoff. Further, post-development peak rate runoff must be reduced to 50% of the pre-development rate per §144-308.H. and the Chester-Creek Watershed Release Rate Map.

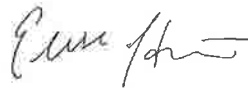
### Summary

The plans lack essential information including detailed information on stormwater management. However, the preliminary information that is provided proposes a site design and stormwater system that will create significant disturbance in the project area, with a stormwater system that will fail to manage the increase in runoff volume and rate, fail to recharge groundwater, and unquestionably will adversely impact the downstream water quality of receiving streams and wetlands.

Sincerely,



Michele C. Adams, PE, LEED AP  
President, Meliora Design



Elise Hunter, EIT  
Water Resources Designer, Meliora Design

# Meliora Design

Civil, Water Resources, and Structural Engineering

Meliora (mel/ee/or/ah): Latin for "always better"

## Michele C. W. Adams, PE , LEED AP, Principal/Founder

For over 30 years, Michele Adams' work has encompassed environmentally sensitive site design and sustainable water resources engineering. With a focus on sustainability and regenerative design, her work includes both planning and engineering design for cities, urban and suburban restoration projects, campuses, research facilities, commercial, industrial and residential installations, parks, recreation centers, public facilities, non-profit headquarters, and environmental education centers. In all her work, Michele seeks to combine sound engineering science with an understanding of natural systems.

Michele has been designing low impact development and green infrastructure projects for nearly three decades, with successful installations of rain gardens, porous pavements, green roofs, and restorative landscapes dating back to the mid-1980s. She has extensive built experience in virtually every type of "best management practice," from bioretention and streetscape landscape measures, to water harvesting and reuse, to retrofitting traditional detention basins in the suburban environment to promote infiltration and evapotranspiration. Many of her projects encompass a holistic approach to water management and ecological restoration, recognizing that water in all its forms is a resource, and that a system approach to site design is often the most sustainable and cost-effective design. She has provided engineering design for multiple LEED certified projects, including several LEED Platinum and SITES pilot projects.

Michele was one of the principal authors of the Pennsylvania Stormwater Best Management Practices Manual and the award-winning NYC Department of Parks and Recreation High Performance Landscape Guidelines, as well as several other stormwater and LID manuals throughout the country. She served on the U.S. Green Building Council's Technical Advisory Group for Sustainable Sites, working to develop the Rainwater Management credits for LEED V4, and serves on American Rivers Science and Technical Advisory Committee. In 2011, Michele co-authored with Donald Watson *Design for Flooding: Architecture, Landscape, and Urban Design for Resilience to Climate Change* (Wiley Publishing), which presents best practices and lessons to create buildings and communities that are more resilient in the face of climate change.

### Expert Analysis and Comment within Past Five Years

- **2009 - 2014 City of Philadelphia Long Term Control Plan, Monitoring Plan;** on behalf of Natural Resources Defense Council, review and development of recommendations for

### Years of Experience: 30+

#### Areas of Expertise

- Water Resources Engineering, Planning, Policy Review and Recommendations
- Civil/Site Engineering
- Green Infrastructure Planning and Design
- Watershed Management Planning
- Integrated Resource Management Planning
- Sustainable Stormwater Planning and Design Analysis
- Site Design for LEED and SITES Criteria
- Sustainability and LID Manual Development
- Alternative Wastewater Systems
- Stream Daylighting and Restoration
- Water Balance Analysis
- Hydrologic and Hydraulic Modeling
- Water Quality Modeling and Monitoring
- Development Impact Review and Analysis
- Stormwater Plan Review
- Expert Testimony
- Regulatory Review and Comment

#### Education

- B.S., Civil Engineering, The Pennsylvania State University, University Park, PA, 1984
- Graduate Coursework, Water Resource Engineering, Villanova University, Villanova, PA, 1997-2001

#### Registrations

- Professional Engineer: DE, NY, MD, PA and VA
- LEED Accredited Professional

#### Affiliations

- U.S. Green Building Council, Sustainable Sites Technical Advisory Group, Stormwater Expert
- Member, American Rivers Science and Technical Advisory Committee
- Member, American Society of Civil Engineers,
- Environmental Water Resources Institute
- Member, American Water Resources Association

#### Guest Lecturer

Drexel University, Pennsylvania State University, Philadelphia University, Temple University, and University of Pennsylvania

**Publications:** Available upon request

LTCP Monitoring Plan in compliance with PaDEP permit and EPA agreement.

- **2014 Pa Chapter 78 Proposed Regulation Changes;** on behalf of Earthjustice, review and preparation of comments.
- **2012 New York State Draft SGEIS and Draft SPDES Permit for High Volume Hydraulic Fracturing;** on behalf of Natural Resources Defense Council, review and technical recommendations related to hydraulic fracturing.
- **2011 Delaware River Basin Commission Oil Proposed Oil and Gas and Hydraulic Fracturing Regulations;** on behalf of Delaware Riverkeeper Network, technical review and analysis of DRBC Draft regulations for Hearing.
- **2011 Pennsylvania Environmental Regulations for Oil and Gas Industry and Hydraulic Fracturing;** on behalf of Delaware Riverkeeper Network, review, comment and testimony related to Pennsylvania water quality impacts and regulatory needs.
- **2009/2012 Pennsylvania Turnpike Expansion Project;** on behalf on National Park Service Valley Forge National Park and Valley Creek Coalition. Expert services related to review and comment of stormwater design and impacts on water quality and stream conditions.
- **2009/2012 City of Philadelphia Long Term Control Plan;** on behalf of Natural Resources Defense Council and PennFuture; review of technical reports, policy documents, and draft permit conditions on issues related to stormwater management, water quality, stream health, and compliance with Clean Water Act and EPA Long term Control Policy.
- **2010 City of Chattanooga MS4 Permit –** For City of Chattanooga, providing technical guidance for incorporation of stormwater measures to address and restore impaired streams and meet TMDL requirements. Training sessions for municipal officials and program development.

## Select Relevant Experience

**High Performance Landscapes, New York City Parks and Recreation –** Ms. Adams served as one of five authors in development of the New York City's High Performance Landscapes document, specifically addressing the water issues within the document. This publication is the third in a series that began with High Performance Buildings, and is providing the framework for sustainability in NYC parks and public spaces.

## Philadelphia Zoological Society, Philadelphia, PA

Multiple projects including:

- **Master Plan –** Development of sustainable stormwater recommendations for the Zoo Master Plan, with a focus on stormwater measures integrated into the Zoo's landscape to address flooding problems and reducing stormwater fees.
- **KidZooU –** Design of an integrated water system, including elements that provide educational opportunities, including green roofs, porous paths, rain gardens, and cisterns for toilet needs.
- **Treetop Trails –** Design of water and drainage utilities for the Zoo's new elevated chutes outside between trees for primates to explore.
- **Tiger Lot Green Infrastructure Retrofit**

**Low Impact Design Manual and Stormwater Program, Chattanooga, TN –** For the City of Chattanooga, which is required by permit to implement Low Impact Development to address the problems of impaired streams, developing a Manual, stormwater permit review/approval process, and supporting zoning and planning materials to successfully implement a "green infrastructure" approach in all new and redevelopment projects.

**Lake George Low Impact Development Certification Program and Manual, Lake George, NY –** Development of the basis and criteria for a new certification program, which will be used to promote low impact development for residential and commercial sites in the Lake George area.

**Three Groves Ecovillage, West Grove, PA –** Site Design for a zero-energy residential community that includes housing units, a community food garden, community building, and a natural pool. Stormwater measures include porous pavements, rain gardens, stream buffers, and reuse, and wastewater will be discharged to a land application system.

# Meliora Design

Civil, Water Resources, and Structural Engineering

Meliora (mel/ee/or/ah): Latin for "always better"

**Stroud Water Research Center Environmental Education Center, Avondale, PA** – For one of the nation’s premier water research and education facilities, sustainable site design engineering related to “living within the water budget”. Design elements include rain gardens, water cisterns and reuse, a green roof, permitting for a wetlands wastewater system, and riparian buffers. The site is quantified to maintain a “water balance” and achieved LEED Platinum certification.

**City of Philadelphia Water Department, Tacony Creek Green Infrastructure, Philadelphia, PA** – Providing stormwater design for green street infrastructure projects within the Tacony Creek Park. The design included numerous bioretention areas within existing lawn, playfields, and adjacent to park gateway areas, and 4,500 LF of new high-level sewers and utility coordination.

**Wilmington Green Infrastructure Planning and Design, Wilmington, DE** – Evaluation and identification of potential “green infrastructure” locations within urban neighborhoods to capture stormwater and improve neighborhood conditions with increased green space, tree canopy, and recreational facilities. Also designed a pilot stormwater tree trench system that is replicable throughout the city.

**Fire Engine 38, Philadelphia, PA** – Sustainable stormwater and site design for a LEED Silver certified facility for the Philadelphia Fire Department whose elements include bioretention areas and a green roof.

**Longwood Gardens Stormwater Analysis and Design, Kennett Square, PA** – Stormwater site analysis for a large portion of the Longwood Gardens property to identify stormwater opportunity areas and repair erosion issues. Designed green stormwater infrastructure and retentive grading designs for areas identified in the stormwater analysis.

**U.S. Botanic Garden Bartholdi Park, Washington, D.C.** – Design of stormwater management measures in the landscape and along streetscapes to serve as demonstration sites, as well as to comply with the new Federal Regulations for stormwater-management as part of Section 438 of the Energy Independence and Security Act. The project is a Sustainable Sites Initiative pilot project.

**Green Streets Design and Philadelphia Green Streets Manual** – Led a team of design professionals in the design of a “complete” street for an urban neighborhood, including two design charrettes with regulatory and design professionals from various city and state agencies. Currently incorporating the design guidelines for the stormwater components into the City’s “Green Streets Manual”. Several streetscapes and intersections have been constructed to include stormwater management along with pedestrian access, multiple users, and increased green space.

**University of Pennsylvania Shoemaker Green, Philadelphia, PA** – Provided stormwater design for a highly-utilized new passive green open space to include formal rain garden planting areas and a cistern for reuse, which lead to a 49% reduction in impervious surfaces on the site. The project will be certified and is a pilot project under the Sustainable Sites Initiative.

**Mann Center for the Performing Arts Site Improvements, Philadelphia, PA** – Provided full-civil site services for improvements to the unique music venue in the heart of Fairmont Park. Stormwater management improvements include bioretention and an infiltration trench.

**Acme Market – Heat Island and Stormwater Management Improvements, Wilmington, DE** – Urban retrofit of the existing Acme Parking lot in Wilmington. The design includes several bioretention systems and tree trenches with subsurface infiltration beds to capture roof runoff and parking lot runoff, as well as provide site greening. The project was funded through the Urban Heat Island Grant from the U.S. Forest Service.

**Drexel University Stormwater Master Plan, Philadelphia, PA** – Development of a campus-wide Stormwater Master Plan which will serve as a blueprint to facilitate future development outlined in the Master Plan, as well as addressing present stormwater concerns. The Plan will integrate sustainable stormwater measures into the existing campus layout and landscape, while establishing stormwater policy to guide future development.

**Woodlands Cemetery Site Improvements, Philadelphia, PA** – Utility design for stormwater and wastewater for the historic Mansion and the Stable buildings. The stormwater improvements will prevent future damage to the historic structures, as well as contribute to the sustainability goals and initiatives outlined by the City of Philadelphia.

# Meliora Design

Civil, Water Resources, and Structural Engineering

*Meliora (mel/ee/or/ah): Latin for "always better"*

**Panther Hollow Watershed Restoration and Green Infrastructure Pilot Projects, Pittsburgh, PA** – For an ultra-urban watershed, development of a restoration plan to restore stream baseflow and health. Efforts include hydrologic modeling of the natural and existing conditions, using WinSLAMM, and design of pilot projects to capture street runoff and restore impacted landscapes.

**Purdue University Site and Stormwater Improvements at the Mackey Football Fields and Ross-Ade Stadium Parking Lot, West Lafayette, IN** – Design of nearly 3 acres of infiltration beds located beneath the Purdue Boilmaker's football practice fields to manage stormwater for the upper campus athletic complex. At the Ross-Ade Stadium, design of bioretention systems to pre-treat runoff from the parking lot and bordering roadways, a drainage area of nearly 6 acres, before the system connects to the infiltration beds under the adjacent football practice fields.

**Technical Review of Philadelphia Green City, Clean Waters Plan** – Ms. Adams and Dr. Robert Traver of Villanova University were engaged to provide an independent technical review and recommendations for the City of Philadelphia Green City, Clean Waters program. Various technical and policy recommendations were incorporated into the plan and the final permit.

**Review and Comments DNREC Draft Stormwater Regulation** – For a coalition of environmental advocacy and conservation organizations, Ms. Adams was engaged to review and provide comments on the DNREC's 2012 Proposed 5101 Sediment and Stormwater Regulations.

**Peer Review for EPA Stormwater Program** – Ms. Adams has served as a technical peer reviewer for various technical documents and material in support of EPA's evolving stormwater policies.

**Oxford Library, Oxford, PA** – Sustainable site design and engineering for a library addition to an urban library that includes porous pavers, rain gardens, and public outdoor gathering spaces to promote environmental education.

**Upper Merion Township, Community Recreation Center, King of Prussia, PA** – Provided site/civil services for a repurposed and expanded building and site improvement project. Located within the floodplain of a Schuylkill River tributary and within the township trails and woodland park system, the project included a parking lot retrofit of existing standard asphalt parking to add several large porous parking lots with subsurface infiltration beds, addressing runoff and mitigating erosion from upstream residential areas.

**Greening and Stormwater Retrofits for Urban Schoolyards, Parks, and Streets in Philadelphia** – For multiple locations in the City of Philadelphia, green infrastructure retrofits to capture stormwater and improve communities through stormwater tree trenches, bioretention gardens, porous pavements and playgrounds, reuse cisterns, and other measures. Built projects include three schools, two recreation centers, several parks and urban food gardens, and multiple streetscapes and public sites. Over twenty impervious acres have been "captured", and two projects are featured at <http://vimeo.com/13844085> and <http://vimeo.com/15231400>.

**Stormwater Management for Green and Public Properties, City of Philadelphia** – Developed concept stormwater designs for the City of Philadelphia public properties. The stormwater and landscape designs are intended to reduce impacts to the City's combined sewer system, provide economic cost savings, and promote green infrastructure. Projects have included parks, schools, recreation facilities, and "green streets". A number of projects have been documented through construction and are being (or have been) built.

**Allegheny Riverfront Urban Green Infrastructure, Pittsburgh, PA** – Design of "green infrastructure" along an urban waterfront redevelopment area to capture stormwater in an area that is both a brownfield site and a floodplain, with a goal of habitat restoration along the waterfront for native fish species.

**North 3rd Street Corridor Sustainable Affordable Housing Plan, Philadelphia, PA** – With Pennsylvania Horticultural Society, developed guidelines and tools for sustainable affordable urban housing, including stormwater and water reuse measures to reduce combined sewer overflows and meet City of Philadelphia "green infrastructure" requirements.

**Wiki Watershed "Model My Watershed"** – For Stroud Water Research Center under funding from the National Science Foundation, technical support for the development of an educational watershed modeling tool for students

# Meliora Design

Civil, Water Resources, and Structural Engineering

*Meliora (mel/ee/or/ah): Latin for "always better"*

and watershed groups. The tool allows students to evaluate the impacts of development on the water "balance" and watershed health. Students can then evaluate alternative designs and see the impacts on groundwater restoration, stream health, and water quality (<http://www.wikiwatershed.org/model-my-watershed.aspx>).

**Marcellus Shale Impacts, Pennsylvania and New York** – For various environmental advocacy groups (NRDC, Earthjustice, Riverkeeper, and others), providing technical expertise for comment and litigation related to the Marcellus Shale natural gas drilling industry, with regards to stormwater, wastewater, and surface water quality.

**University of Pennsylvania Locust Walk Repaving Project, Philadelphia, PA** – Site and stormwater management design for repaving of the 3600 and 3800-3900 blocks of Locust Walk, a highly utilized path for Penn students and faculty. This effort has primarily involved addressing issues related to PWD requirements and policies for stormwater, utility right-of- ways, utility replacement and repair, and the challenges presented by existing policies and requirements.

**Waterview Recreation Center, Philadelphia PA** – For an existing urban recreation center, design of "green infrastructure" stormwater elements to improve community amenities and reduce combined sewer overflows. Elements include stormwater tree trenches, stormwater planter boxes, and porous concrete sidewalks. This project has recently been the subject of a GreenTreks video on stormwater.

**Bureau of Laboratory Services Green Streets Project, Philadelphia, PA** – Engineering design of structural stormwater planter boxes outside of a Philadelphia Water Department water testing facility in Northeast Philadelphia. These planter boxes were designed with the safety of pedestrians in mind and to accommodate vehicles parking in the adjacent parallel parking spaces.

**Drexel University Perelman Plaza, Philadelphia, PA** – Designed stormwater management improvements for a pedestrian plaza within a former city street. Permitting challenges included maximizing stormwater management and impervious area disconnection within a utility right-of-way. A follow-up research project designed and executed by Drexel Faculty seeks to quantify the volume reduction achieved at this site, and apply for stormwater management credit at a future Drexel project.

**Springside Chestnut Hill Academy's New Lower School and Site Improvements Project, Philadelphia, PA** – Currently providing Project Management and full site civil engineering services for the proposed Lower School at the pre-k through 12 Institute. Meliora is designing sustainable, demonstrative, and cost-effective stormwater management features that include porous parking and paths, rain gardens, cisterns for re-use, and other elements of outdoor learning all while giving emphasis on bringing the "fingers" of the adjacent woods into the campus.

**William Penn Charter School Master Plan, Philadelphia, PA** – Providing site engineering and planning services as part of a larger Campus Master Planning effort. Meliora is developing recommendations that meet William Penn Charter's goals for sustainability, while providing a cost-effective approach to future growth, utility needs, and permitting. As part of the Master Plan, Meliora and the design team have developed Guiding Principles for Sustainability and Integrated Stormwater Practices recommendations, including naturalizing the campus landscape to work more like the forest it once was and stormwater management measures at different scales. The Master Plan will serve as a touchstone in guiding future projects and decisions, including the re-zoning of the campus from residential to institutional.

## Expert Testimony within Past Ten Years

Ms. Adams has provided expert testimony on behalf of various environmental organizations on issues related to stormwater management, water quality, stream health, and flooding. Representative cases include:

- **2017 Clean Air Council vs Commonwealth of Pennsylvania, Department of Environmental Protection and Sunoco Mariner East II Pipeline Project, EHB Docket No 2017-009-L**; Provided technical expertise and testimony regarding stormwater and erosion and sediment control impacts on water quality.
- **2017 Bradley and Amy Simon vs Commonwealth of Pennsylvania, Department of Environmental Protection and Sunoco Mariner East II Pipeline Project, EHB Docket No 2017-019**; Provided technical expertise regarding stormwater and erosion and sediment control impacts on water quality in HQ streams and ponds.

# Meliora Design

Civil, Water Resources, and Structural Engineering

Meliora (mel/ee/or/ah): Latin for "always better"

- **2017 Nesbitt Comments to FERC regarding Atlantic Sunrise Pipeline proposed location and alternates.** Provided technical expertise and reports evaluating the anticipated water quality impacts of the Atlantic Pipeline East proposed route through the Nesbitt property. FERC required that the pipeline alternate route be selected.
- **2014 Citizen's for Pennsylvania's Future (PennFuture) vs. Commonwealth of Pennsylvania, Department of Environmental Protection and Upper Gwynedd Township, EHB Docket No 2013-105-L;** Provided technical expertise and recommendations for Settlement and improvements related to Pennsylvania's MS4 program requirements.
- On behalf of **Beaver Valley Conservancy (2014-2016);** Provided technical support and testimony against the Conditional Use approval of Woodlawn Trustees planned development in Concord Township Delaware County. Property will now be placed in conservation.
- **Citizen's for Pennsylvania Future vs. City of Pittsburgh;** Pennsylvania Environmental Hearing Board mediation regarding stormwater management and MS4 requirements. 2014
- **Delaware Riverkeeper Network vs Tennessee Pipeline;** Pennsylvania Environmental Hearing Board. Expert witness on behalf of Delaware Riverkeeper Network on issues related to pipeline impacts on water quality, stormwater, erosion and sediment control, and soil compaction. 2013
- **Blue Mountain Preservation Association vs Alpine Development Rose Resorts,** Pennsylvania Environmental Hearing Board, 2011
- **Koziell and Perrini vs. Madison Township,** Lackawanna Court of Common Pleas, 2010
- **West Vincent Zoning Hearing Board, Flather Property, 2010.** Testimony on behalf of Green Valleys Association and PennFuture related to impacts of water quality on variance request for stream buffer and wetland setback requirements.
- **West Pikeland Zoning Hearing Board;** 2010 Testimony on behalf of Green Valley Association related to impacts of water quality and stream health on variance requests to environmental ordinances.
- **Tim and Jamie Lake vs. The Hankin Group;** 2009/2011 Court of Common Pleas Chester County; Expert witness on stormwater design and flooding.
- **Crum Creek Neighbors vs. DEP, et al;** 2008-2009 Pennsylvania Environmental hearing Board; Expert witness on stormwater design review and impacts on flooding and water quality.
- **Glenhardie Condominium vs. Realen Associates;** Appeal of NPDES Post-construction Stormwater Management Permit; 2008 Expert witness on behalf of Glenhardie related to stormwater design and flooding. Permit was withdrawn.

## Previous Experience

For ten years prior to forming Meliora (1997 – 2007), Ms. Adams was a Principal Engineer with Cahill Associates, where she successfully directed and participated in all aspects of a number of projects.

**Pennsylvania Stormwater Best Management Practices Manual, Pennsylvania DEP –** Co-author of State Manual describing structural and non-structural BMPs, Control Guidelines, calculation methodologies, and specifications, including a volume-based approach to stormwater.

**Northern Federation of Communities Sustainable Water Resource Plan, PA –** Development of a watershed plan to evaluate all anticipated aspects of water, wastewater, and stormwater impacts from planned growth, and to prevent adverse impacts to groundwater supply and stream health. A GIS based tool was developed to identify areas that could support growth, and areas that should be protected by zoning.

**University of North Carolina, Environmental and Stormwater Master Plan, Chapel Hill, NC –** Environmental master planning for sustainable water approach to address large university expansion plan. Recognized by Sierra Club as a "Top Ten Building Better II" project.

**National Forest Service, Grey Towers National Monument, Milford, PA –** Sustainable site design for historic gardens, including various stormwater measures integrated with on-site water and wastewater systems.

# Meliora Design

Civil, Water Resources, and Structural Engineering

Meliora (mel/ee/or/ah): Latin for "always better"

**Western Pennsylvania Girls Scouts, Camp Wastewater System, Bruceton Mills, WV** – For new Camp and Nature Center located in the mountains, development of a zero-energy, low-disturbance wastewater system for facility wastewater needs, and a supporting water re-use system.

**Washington National Cathedral, Washington, DC** – Restorative stormwater measures for Cathedral site and woods, including various infiltration measures (at source of runoff), infiltration for road system, channel stabilization, etc. and infiltration trenches integrated into new outdoor amphitheater.

**Mill Creek Community Garden and Clark Park Urban Stormwater Projects, Philadelphia, PA** – Design of urban stormwater systems that collect runoff from City streets and infiltrate/manage water in urban green spaces such as community gardens and new basketball courts.

**Cusano Center at John Heinz National Wildlife Refuge, Tinicum, PA** – Sustainable site design for educational center, including various stormwater elements and permitting for a Living Machine wastewater system.

**Springbrook Low Impact Development, Lebanon County, PA** – Design of full LID stormwater system for 247 residential units in karst area, including over 120 individual stormwater systems (vegetated infiltration beds, infiltration trenches, rain gardens, porous pavements, etc.).

**Ford Rouge Sustainable Stormwater Management, Dearborn, MI** – Stormwater planning and design for major industrial facility re-development (Porous pavement, bioretention swales, vegetated systems).

*From 1990 through 1997, Ms. Adams was a Project Engineer and Project Manager at Roy F. Weston, Inc. Concept Engineering Division.*

**Stormwater and Wastewater Analysis, Design and Permitting** – Ms. Adams developed and implemented stormwater management and sampling programs at over fifty industrial, commercial, and military facilities throughout the United States. For a variety of watershed studies, Ms. Adams conducted hydrologic and hydraulic modeling using various mathematical computer models, including EPA SWMM, and COE HEC models. Ms. Adams performed floodway analysis studies on a number of rivers and streams, and conducted mixing zone studies relating to receiving stream capabilities, mixing zones, and NPDES permitted discharges using the U.S. EPA mathematical computer model CORMIX. Analysis for water bodies included streams, estuarine systems and coastal waters. Ms. Adams also developed wastewater treatment, and sludge drying and handling manuals for small system wastewater treatment operations.

## Publications

**Design for Flooding** – Architecture, Landscape, and Urban Design for Resilience to Climate Change, By Donald Watson and Michele Adams, Wiley Publishing, 2010.

**High Performance Landscape Guidelines** – 21st Century Parks for NYC, New York City Parks Department and NYC Design Trust, 2011.

**Porous Asphalt Pavement** – 20 Years and Still Working, Michele Adams, Stormwater Magazine, May/June 2003.