BETHLEHEM AUTHORITY
IMPROVED FOREST MANAGEMENT PROJECT

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Blue Source LLC

Project Title	Bethlehem Authority IFM
Version	1.1
Date of Issue	March 18, 2013
Prepared By	Blue Source LLC
Contact	3165 E. Millrock Drive, Ste 340, Holladay, UT, 84121

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PROJECT DETAILS

1.1 Summary Description of the Project

The Bethlehem Authority Improved Forest Management Project Area ("Project Area") is a 17,591-acre split-parcel situated in Monroe County and Carbon County, Pennsylvania. The Project Area has been put under a 60-year term conservation easement with The Nature Conservancy (TNC) with the intention of conserving the property and managing its forest resources sustainably into perpetuity. The Project Area has ecological, scientific, educational and aesthetic value in its present state as a natural area that has not been subject to development or severe exploitation.

The Project Area is comprised of primarily native forest types characteristic of the region and surrounds the headwaters of Tunkhannock Creek and Wild Creek that flow into the Delaware Basin. Interspersed with the hardwood forests are significant stands of mixed conifers and special habitat types including wetlands that provided habitat for a multitude of rare species and natural communities.

The project will extend the rotation age of the timber resource on the property by approximately 70 years compared to Common Practice, thereby reducing carbon emissions and increasing carbon sequestration. The project activity will employ a sustainable level of harvesting, as specified in the FSC compliant management plan required by the conservation easement, and will facilitate improvements in the overall health of the forest.

While executing this carbon stock enhancing harvest strategy, management practices will vary to some degree based on the unique ecological features of the Wild Creek and Tunkhannock tracts.

Within the Wild Creek Tract, management will be tailored for species diversity with primary target species of red oak, white oak, chestnut oak, red maple and white pine. The age structure, which is currently over-weighted in the two main age classes (90-120 and 60-75 years), will be better distributed through regeneration in appropriate areas to create vigorous young stands of early successional habitat while other stands are thinned and allowed to mature. The tract's plantations will be managed to optimal stocking for improved health, better growth and extended rotations. The deer herd will be controlled via increased hunting to allow the slow establishment of advanced oak regeneration, creating conditions where shelterwood management will successfully regenerate the oak forests. As healthy stands are allowed to mature and overstocked stands are thinned to control species and spacing, the property should experience forest stocking of increasing volume and value. Once these management goals are achieved, the Authority intends to continue to manage the forest under a long rotation harvest regime designed to sustain the forest's health and promote the ecosystem services it provides.

The Tunkhannock tract will be managed to promote healthy and expanding populations of rare, threatened, and endangered species, while encouraging increased carbon stocks. Black cherry, red maple, sugar maple, red oak, white oak, white pine and red spruce will be targeted species in the upland areas for value growth and regeneration and the percent stocking of beech will be reduced over time. The future forest will have a more diverse age class and species mix where portions of the current northern hardwood forest of 100-120 yr old stands will be successfully regenerated. Forest growth in terms of timber value and carbon capture will both be accelerated

through (1) thinnings to control species and spacing, and (2) successful regeneration to overcome pressure from deer browse and competing vegetation which currently preclude new age classes of seedling establishment. The minor component of conifer plantations will be managed for growth and carbon capture where they remain healthy and considered for conversion to native forest where they fall into decline.

1.2 Sectoral Scope and Project Type

The Project is within sectoral scope 14; Agriculture, Forestry and Other Land Use (AFOLU). The AFOLU project category is Improved Forest Management, Extended Rotation Age (IFM ERA) and the methodology applied is VM0003 v1.1. The Project is an individual project.

1.3 Project Proponent

Project Proponent: Bethlehem Authority ("the Authority")

- Stephen Repasch | srepasch@bethlehem-pa.gov

1.4 Other Entities Involved in the Project

Project Developer Blue Source LLC

- Blue Source is responsible for the coordination, management, and development of the Bethlehem Authority IFM project. Following validation and verification, Blue Source will assume responsibility for all forest modeling and carbon calculations pertinent to the project. Throughout the project crediting period, Blue Source will oversee the reporting and upkeep of all project activities on behalf of the Bethlehem Authority.
- Contact: Jeff Cole | jcole@bluesource.com

Easement Holder/Forest Advisor The Nature Conservancy (TNC), Pennsylvania

- TNC holds and manages the Bethlehem Authority conservation easement, oversaw the drafting of the forest management plan to be utilized in the execution of the Bethlehem Authority IFM project and provided FSC certification. Throughout the crediting period TNC, in conjunction with WMS, will supervise or directly carry out all forest management, inventory, and monitoring activities within the project area.
- Contact: Josh Parrish | josh_parrish@tnc.org

Forest Advisor Woodlands Management Services LLC (WMS)

- WMS designed the forest inventory process utilized for the Bethlehem Authority IFM project and conducted onsite forest measurements. Throughout the crediting period WMS, in conjunction with TNC, will supervise or directly carry out all forest management, inventory, and monitoring activities within the project area. WMS will also establish a network of permanent inventory plots throughout the project area in order to facilitate future project inventory updates.
- Contact: Robin Wildermuth | wms1@hughes.net

Modeling Consultants Spatial Informatics Group (SIG)

- SIG executed all forest carbon modeling for the project and completed the associated carbon calculations. Following validation and verification SIG will have no further responsibilities in relation to the project.
- Contact: Charles Kerchner | ckerchner@sig-gis.com

Verification Entity Rainforest Alliance

- The Rainforest Alliance is the VCS approved VVB responsible for verifying the Bethlehem Authority IFM project.
- Contact: Lawson Henderson | lhenderson@ra.org

1.5 Project Start Date

The Project Start Date is represented by the conveyance of the term conservation easement on April 14, 2011.

[*The conservation easement is provided separately for validation and verification purposes*]

1.6 Project Crediting Period

The project has a 100-year crediting period. This time horizon coincides with both the completion of a full timber rotation under the IFM ERA forest management plan. The crediting period start date took place on May 29, 2012 in conjunction with the official issuance of Forest Stewardship Council (FSC) certification. The Project crediting period end date is May 29, 2112.

[*The letter conferring FSC certification is provided separately for validation and verification purposes*]

1.7 Project Scale and Estimated GHG Emission Reductions or Removals

Project	17,590.7 acres
Large project	N/A

Years	Estimated GHG emission reductions or removals (tCO_2e) before risk deduction	Estimated GHG emission reductions or removals (tCO_2e) after 10% risk deduction
2012	24,474	22,027
2013	38,760	34,884
2014	35,883	32,295
2015	35,883	32,295
2016	35,883	32,295
2017	35,883	32,295
2018	35,883	32,295
2019	35,883	32,295

2020	35,883	32,295
2021	35,883	32,295
2022	30,635	27,571
2023	30,259	27,233
2024	30,237	27,213
2025	30,237	27,213
2026	30,237	27,213
2027	30,237	27,213
2028	30,237	27,213
2029	30,237	27,213
2030	30,237	27,213
2031	30,237	27,213
2032	21,943	19,749
2033	19,020	17,118
2034	21,677	19,509
2035	21,676	19,509
2036	21,676	19,509
2037	21,676	19,509
2038	21,676	19,509
2039	21,676	19,509
2040	21,676	19,509
2041	21,676	19,509
2042	-43,733	-
2043	54,889	10,041
2044	10,150	9,135
2045	10,150	9,135
2046	10,150	9,135
2047	10,150	9,135
2048	10,150	9,135
2049	10,150	9,135
2050	3,855	3,470
Total estimated ERs	943,370	849,033
Total number of crediting years (credits are not issued in all 100 years of the crediting period due to Long Term Average requirement[1])	39	39
Average annual ERs	24,189	21,770

[1] See the VCS Long-Term Average Calculation Guidance document in the *VCS Methodology Documents* folder that can be found in the validation and verification materials provided separately

1.8 Description of the Project Activity

The project will extend the rotation length on the property by approximately 70 years compared to Common Practice and shift to an irregular shelterwood method in which some legacy trees are retained indefinitely for biodiversity value (Lindenmayer et al. 2012[2]). Shelterwood harvesting (also an even-aged method with distinct rotation periods) both releases advanced regeneration and regenerates new cohorts. This will result in the average age of harvested trees increasing from *45* years in the baseline to *70 to > 100* years in the project scenario, depending on whether the harvested tree 1) regenerated immediately following the last harvest, 2) was advanced regeneration released by the last harvest, or 3) is a legacy tree persistently from a regeneration event two or more harvests previously. The combined effect of this extension of rotation age is enhanced long term carbon storage and thus greenhouse gas emissions reductions.

The Common Practice harvesting approach on forests comparable to the project area consists of 30-year commercial clear cut (Kelty and D'Amato 1006[3]) and patch cut based rotations focused on the removal of merchantable trees.

The project will instead adopt a 100-year rotation, heavily dependent upon a two-staged, group selection based, shelterwood harvest system. This silvicultural approach entails an initial harvest entry approximately 10 years prior to a second and final entry for overstory removal. The concept is to establish or advance desirable seedlings (regeneration) through an initial harvest entry that typically removes the poletimber (mid-story) along with a moderate percentage of the overstory, leaving residual basal areas averaging 50 square feet per acre. Once regeneration reaches adequate stocking of a desirable composition (10 years) a final removal occurs, removing the majority of the residual overstory. To promote diversity, 5 to 20 square feet of basal area is retained over one or more rotations, resulting in predominantly even-aged stands containing scattered remnant older trees, with a diversity of stand ages across the patch mosaic at landscape scales.

As different stands across the project area are in different stages of maturity, timing of harvest entries will vary. For example, a patch of young oak saplings found in the Mixed Oak – Low Stocking strata of the Tunkhannock tract might not be harvested until the final years of the project period, while a mature, 90-year-old Hardwood stand in the Wild Creek tract will likely be harvested in the early decades of the project activity. This mixed age distribution across the property allows the entire project area to undergo a full (two-stage) harvest cycle by the conclusion of the 100-year crediting period, in compliance with the requirements of the VCS AFOLU Requirements (v.3) document.

The network of streams and wetlands that span the Wild Creek and Tunkhannock parcels will be carefully maintained throughout the life of the project. Details on specific management practices that will be implemented to this end are included in the Project Forest Management Plan.

To improve understanding of forest growth and stocking, the total project area was stratified using three criteria: (1) forest community type; (2) stocking level; and (3) anticipated future management treatments. Ultimately the forest was broken into eight stratum including: Mixed Oak

[2] D.B. Lindenmayer (2012). A major shift to the retention approach for forestry can help resolve some global forest sustainability issues. Conservation Letters. doi: 10.1111/j.1755-263X.2012.00257.x

[3] Matthew J. Kelty and Anthony W. D'Amato. (2006). *Historical Perspective on Diameter-Limit Cutting in Northeastern Forests*. Department of Natural Resources Conservation, University of Massachusetts, Amherst, MA

(high and low stocking), Natural Conifers (high and low stocking), Hardwood (high and low stocking), Plantations, and Scrub. High stocked Mixed Oak, High stocked Natural Conifers, and High stocked Hardwoods were the largest strata in terms of total acreage. Strata 4 and 6 currently represent zero acres, but will grow in the future as stands from other stratum will eventually cycle through these strata.

Stratification Breakdown	
Stratum	Acreage
1 Mixed Oak - High Stock	11,508.2
2 Mixed Oak - Low Stock	944.3
3 Natural Conifers - High Stock	1,907.7
4 Natural Conifers - Low Stock	0
5 Hardwoods - High Stock	1,636.5
6 Hardwoods - Low Stock	0
7 Plantation	1,007.6
8 Scrub - Low	586.4
Total Forested Project Acreage	17,590.7
BA Working Woodlands Property	22,536.1
Non-Project Acreage	4,945.4

The project activity is enabled by the conveyance of a 60-year conservation easement to TNC that commits the Authority to improving overall environmental health on the Bethlehem property by protecting, conserving, and maintaining its natural resources. The signing of the easement marks the Project Start Date and ensures that forest management practices will not conflict with the ecological well being of the property. Though the project crediting period continues for 40 years following the conclusion of the easement, the Bethlehem Project Forest Management Plan is designed as a perpetual system and management will be carried out in accordance with the plan's goal for the entire 100 year project life.

The project activity will employ a sustainable level of harvesting as specified in the FSC compliant management plan required by the conservation easement, and will facilitate improvements in the overall health of the forest. In compliance with a final requirement of the easement, the Project Area acquired FSC certification on May 29, 2012.

A more detailed description of harvest practices are outlined in the Project Forest Management Plan.

[*The Forest Management Plan is provided separately for validation and verification purposes*]

1.9 Project Location

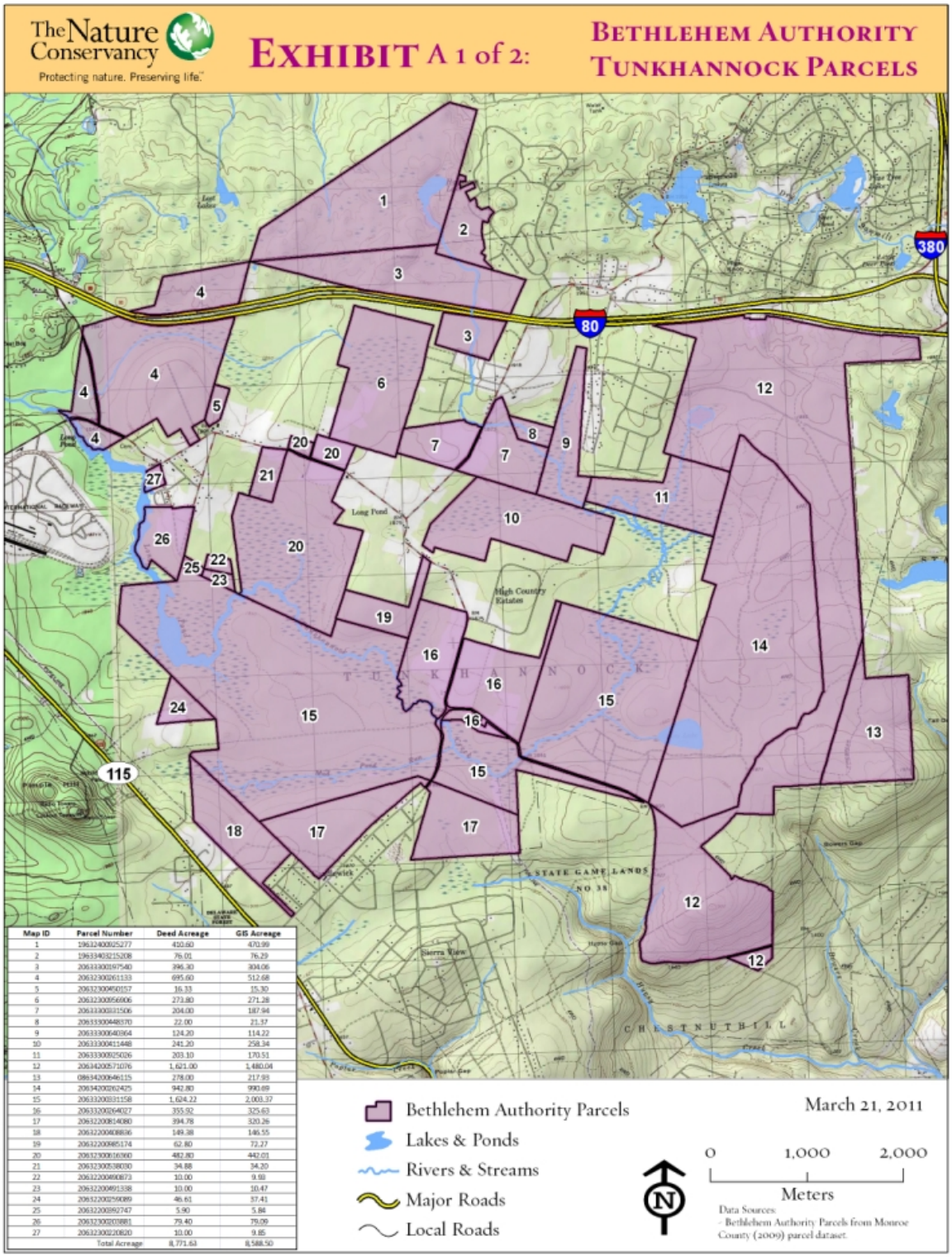
The Project Area is located in Monroe and Carbon County, Pennsylvania and is comprised of two semi-contiguous areas of land parcels. The 'Tunkhannock Parcels' are situated in Monroe

County, bordering Interstate 80. These are identified in Exhibit A 1 of 2 with Map ID's 1 through 27. The second is the 'Wild Creek Parcels' which straddle the Monroe and Carbon Country borders (See Exhibit A, 2 of 2), bordering Interstate 476. These land parcels are identified as with Map ID's 1 thru 44. Each individual land parcel also has a unique Parcel identification number (PIN).

The Tunkhannock Parcels in the Project area represent a total acreage of approximately 4,653 acres and are bisected by the Tunkhannock Creek. The Wild Creek Parcels in the Project area represent a total acreage of approximately 12,938 acres and are bisected by the Wild Creek.

Exhibit B shows the proximity of the Tunkhannock and Wild Creek Parcels.

[*KMZ files, with the associated KML component provided separately for validation and verification purposes*]



Map ID	Parcel Number	Deed Acreage	GIS Acreage
1	19632400025277	410.60	470.99
2	19633400215208	76.01	76.29
3	20633300197540	396.30	304.06
4	20632300261133	695.60	512.68
5	20632300450157	16.33	15.30
6	20632300566006	273.80	271.28
7	20633300331506	204.00	187.94
8	20633300448370	22.00	21.37
9	20633300640364	124.20	114.22
10	20633300411448	241.20	258.34
11	20633300925026	203.10	170.51
12	20634200571076	1,621.00	1,480.04
13	08634200646115	278.00	217.93
14	20634200262425	942.80	990.69
15	20633200331158	1,624.22	2,003.37
16	20633200264027	355.92	325.63
17	20632200814080	394.78	320.26
18	20632200408816	149.38	146.55
19	20632200985174	62.80	72.27
20	20632300616900	482.80	442.01
21	20632300538030	34.88	34.20
22	20632200490873	10.00	9.93
23	20632200491338	10.00	10.47
24	20632200259089	46.61	57.41
25	20632200892747	5.90	5.84
26	20632300203881	79.40	79.09
27	20632300220820	10.00	9.85
	Total Acreage	8,771.63	8,588.50

Tunkhannock Stratification Map (4,653 acres)

0 0.5 1 2 3 4 Miles

Strata Legend

- 1 Mixed Oak - High Stock
- 2 Mixed Oak - Low Stock
- 3 Natural Conifers - High Stock
- 5 Hardwoods - High Stock
- 6 Hardwoods - Low Stock
- 7 Plantations
- 8 Scrub - Low Stock

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EXHIBIT A 2 of 2: BETHLEHEM AUTHORITY WILD CREEK PARCELS

Monroe County 2009 Parcels

Map ID	Parcel Number	Deed Acreage	GIS Acreage
1	13621901064000	0.68	0.70
2	13621901054827	0.55	0.57
3	13621901054735	0.55	0.56
4	13621900140920	22.54	22.08
5	13620900954279	118.47	108.24
6	13620900924845	120.00	141.93
7	13621900003603	19.00	20.11
8	13621800091510	35.28	34.71
9	13620800765765	1,300.00	2,148.58
10	13631000106064	33.00	18.13
Monroe County Total Acreage:		1,650.07	2,495.62

Carbon County 2011 Parcels

Map ID	PIN	Parcel ID	Deed Acreage	GIS Acreage
11	5279479755	12-51-A5	None Listed	648.00
12	5370897058	12-51-A6	None Listed	536.81
13	5360601371	23-51-A1INLIEU	None Listed	1,014.71
14	5299984701	23-51-A3	None Listed	29.33
15	5289356237	24-51-A3,4	None Listed	666.82
16	5298843769	24-51-A1	None Listed	1,061.64
17	5279013304	13-51-A1INLIEU	None Listed	317.74
18	None Listed	--WATER	None Listed	265.24
19	5278302412	14-56-A1	None Listed	1,131.49
20	5277962504	15-56-A31	None Listed	9.19
21	5267753322	26-56-A35	None Listed	918.07
22	5267753322	26-56-A35	None Listed	437.19
23	5267753322	26-56-A35	None Listed	1.41
24	5267898650	25-56-B1	None Listed	309.83
25	5267791856	25-56-B2	None Listed	69.25
26	5268602355	25-51-A4	None Listed	30.47
27	5268418912	25-51-A3INLIEU	482.00	503.51
28	5268449125	25-51-A2	None Listed	425.40
29	5268652869	25-51-A1	None Listed	146.81
30	5268251620	25-51-A5INLIEU	None Listed	52.56
31	None Listed	38-51-A1.01	204.51	204.71
32	None Listed	38-51-A1.02	40.04	39.76
33	5258416613	38-51-A4INLIEU	None Listed	708.66
34	5258025243	52-51-A8	None Listed	149.83
35	5248955806	51-51-A8.01	None Listed	154.88
36	5258097691	37-51-A6INLIEU	293.00	381.50
37	5258750282	37-51-A1	None Listed	376.26
38	5258475479	37-51-A7.04	None Listed	14.21
39	5258578547	37-51-A4	None Listed	287.60
40	5258770445	37-51-A3	None Listed	30.49
41	5258777268	37-51-A2INLIEU	None Listed	25.39
42	5259402080	37-51-A7	None Listed	244.11
43	5259920832	37-51-A9	None Listed	54.25
44	5276772476	15-56-A11	None Listed	56.62
Carbon County Total Acreage:			1,019.55	11,303.71
Monroe County Total Acreage:			1,650.07	2,495.62
Grand Total Acreage:			2,669.62	13,799.32

Bethlehem Authority Parcels
Lakes & Ponds
Rivers & Streams
Major Roads
Local Roads
Secondary Roads

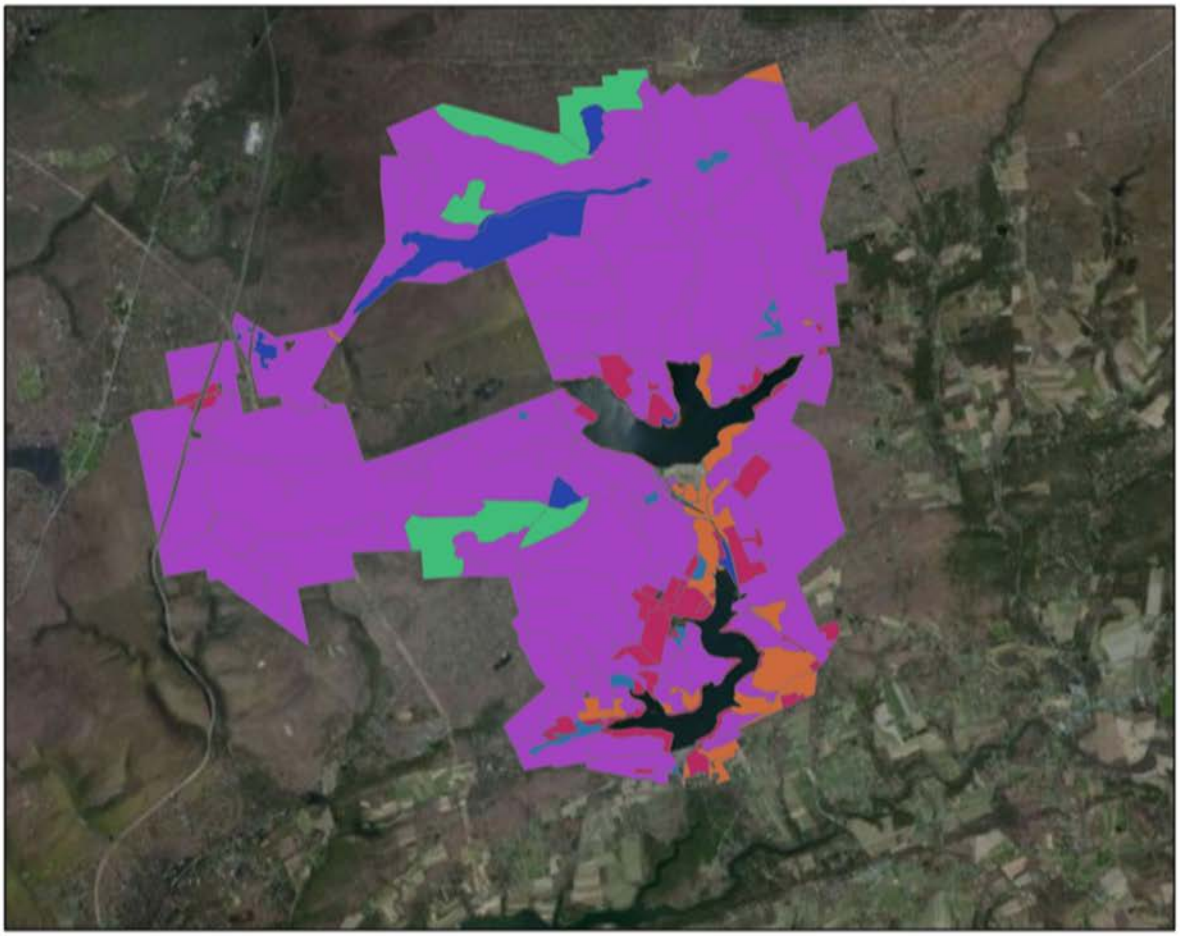
March 29, 2011

0 1,000 2,000
Meters

Data Sources:
- Bethlehem Authority parcels from Carbon County (2011) and Monroe County (2009) parcel datasets.

*NOTE: Carbon County 2011 Parcel dataset is missing a number of deed acreages, and three PIN numbers.

Wild Creek Stratification Map (12,938 acres)



Strata Legend

0 0.5 1 2 3 4 Miles

- 1 Mixed Oak - High Stock
- 2 Mixed Oak - Low Stock
- 3 Natural Conifers - High Stock
- 5 Hardwoods - High Stock
- 6 Hardwoods - Low Stock
- 7 Plantations
- 8 Scrub - Low Stock

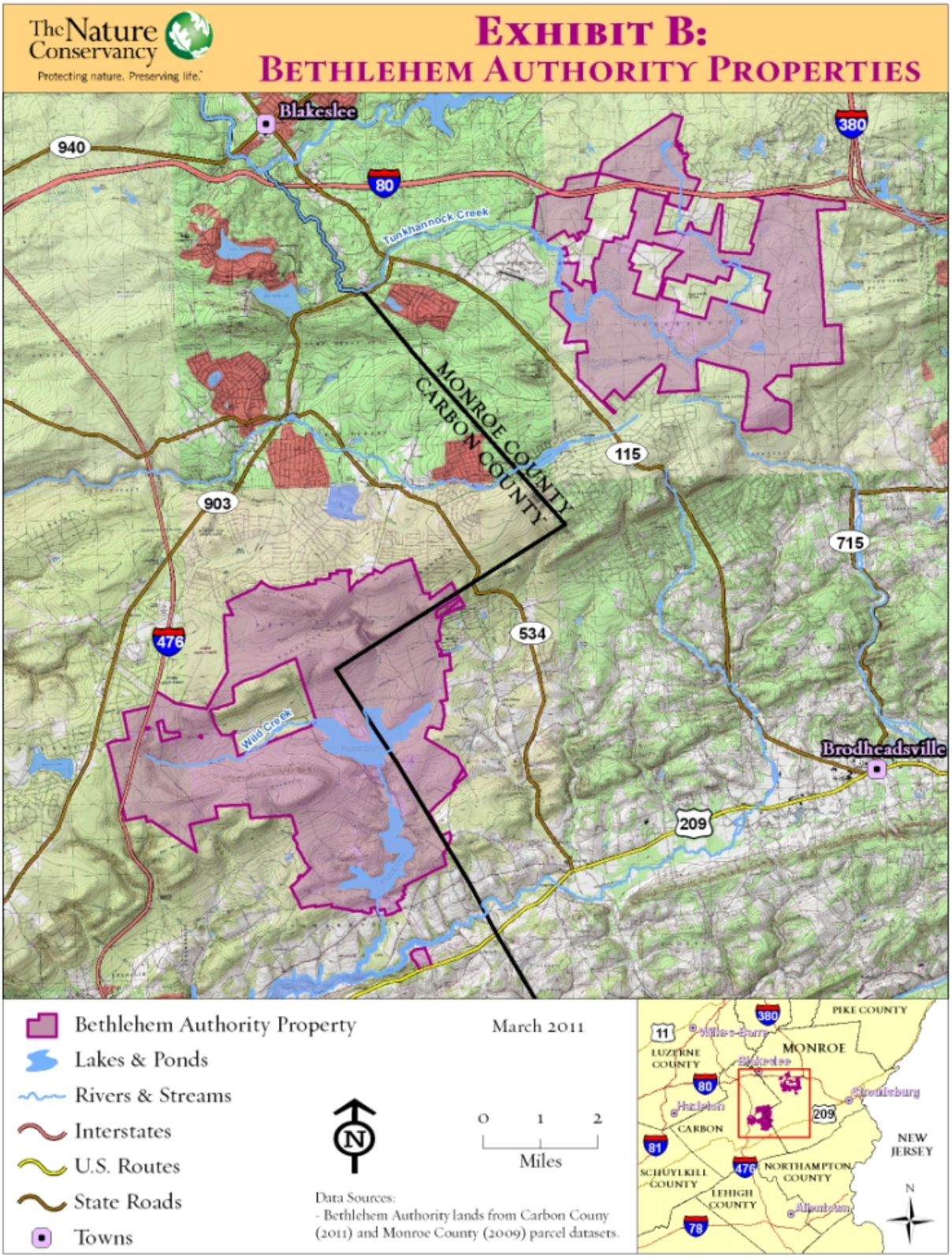

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EXHIBIT B:
BETHLEHEM AUTHORITY PROPERTIES
Blakeslee
940
80
380
Tunkhannock Creek
MONROE COUNTY
CARBON COUNTY
115
903
715
534
476
Wild Creek
Brodheadsville
209
Bethlehem Authority Property
Lakes & Ponds
Rivers & Streams
Interstates
U.S. Routes
State Roads
Towns
March 2011
N
0 1 2
Miles
Data Sources:
- Bethlehem Authority lands from Carbon County (2011) and Monroe County (2009) parcel datasets.
PIKE COUNTY
11
Wilkes-Barre
LUZERNE COUNTY
MONROE
Stroudsburg
Hazleton
CARBON
81
NEW JERSEY
SCHUYLKILL COUNTY
NORTHAMPTON COUNTY
LEHIGH COUNTY
Allentown
78
N

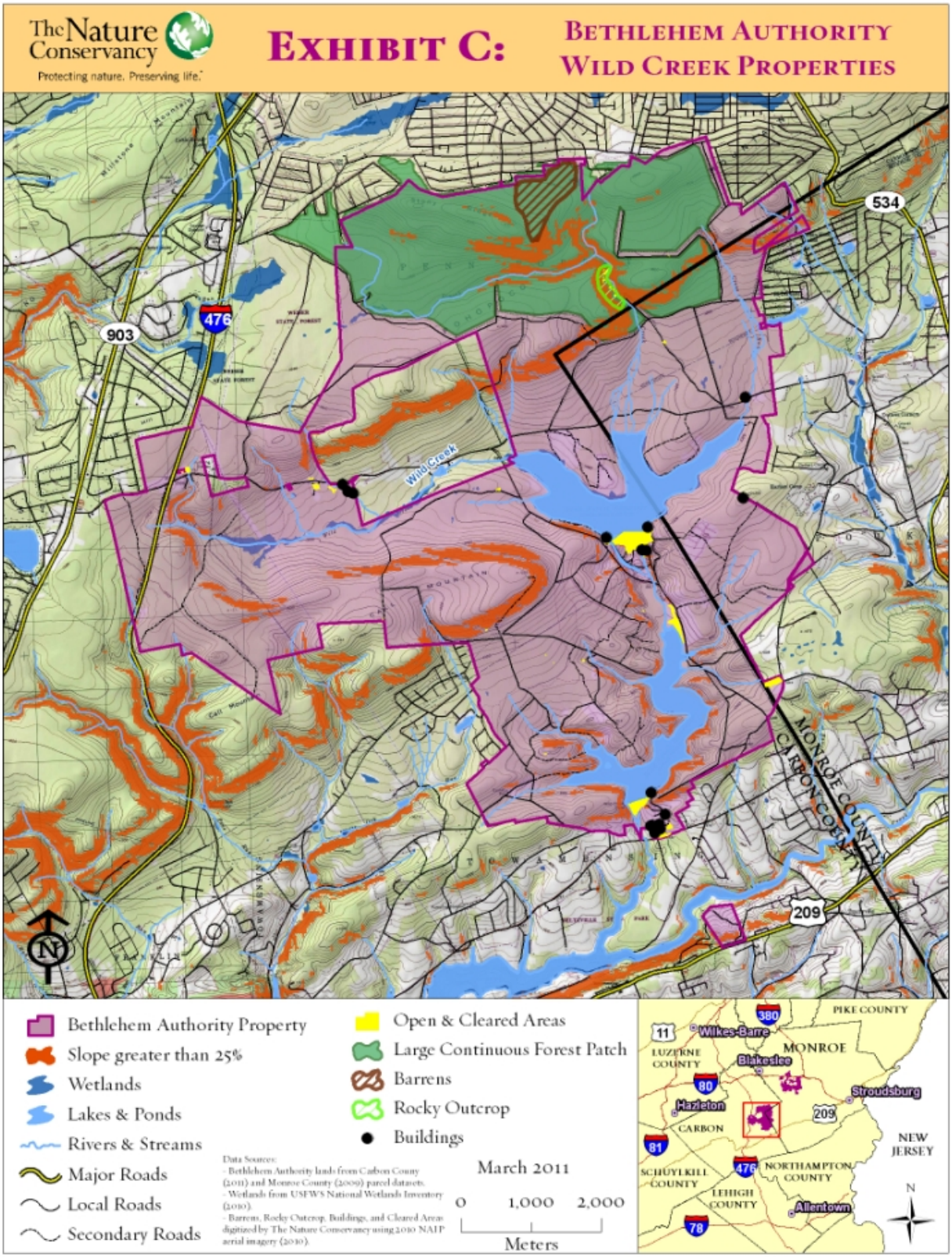
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EXHIBIT C:
BETHLEHEM AUTHORITY
WILD CREEK PROPERTIES
534
476
903
209
Wild Creek
MONROE COUNTY
CARBON COUNTY
Bethlehem Authority Property
Slope greater than 25%
Wetlands
Lakes & Ponds
Rivers & Streams
Major Roads
Local Roads
Secondary Roads
Open & Cleared Areas
Large Continuous Forest Patch
Barrens
Rocky Outcrop
Buildings
Data Sources:
- Bethlehem Authority lands from Carbon County (2011) and Monroe County (2009) parcel datasets.
- Wetlands from USFWS National Wetlands Inventory (2010).
- Barrens, Rocky Outcrop, Buildings, and Cleared Areas digitized by The Nature Conservancy using 2010 NAIP aerial imagery (2010).
March 2011
0 1,000 2,000
Meters
PIKE COUNTY
Wilkes-Barre
LUZERNE COUNTY
MONROE
Blakeslee
Stroudsburg
Hazleton
CARBON
NEW JERSEY
SCHUYLKILL COUNTY
NORTHAMPTON COUNTY
LEHIGH COUNTY
Allentown
N

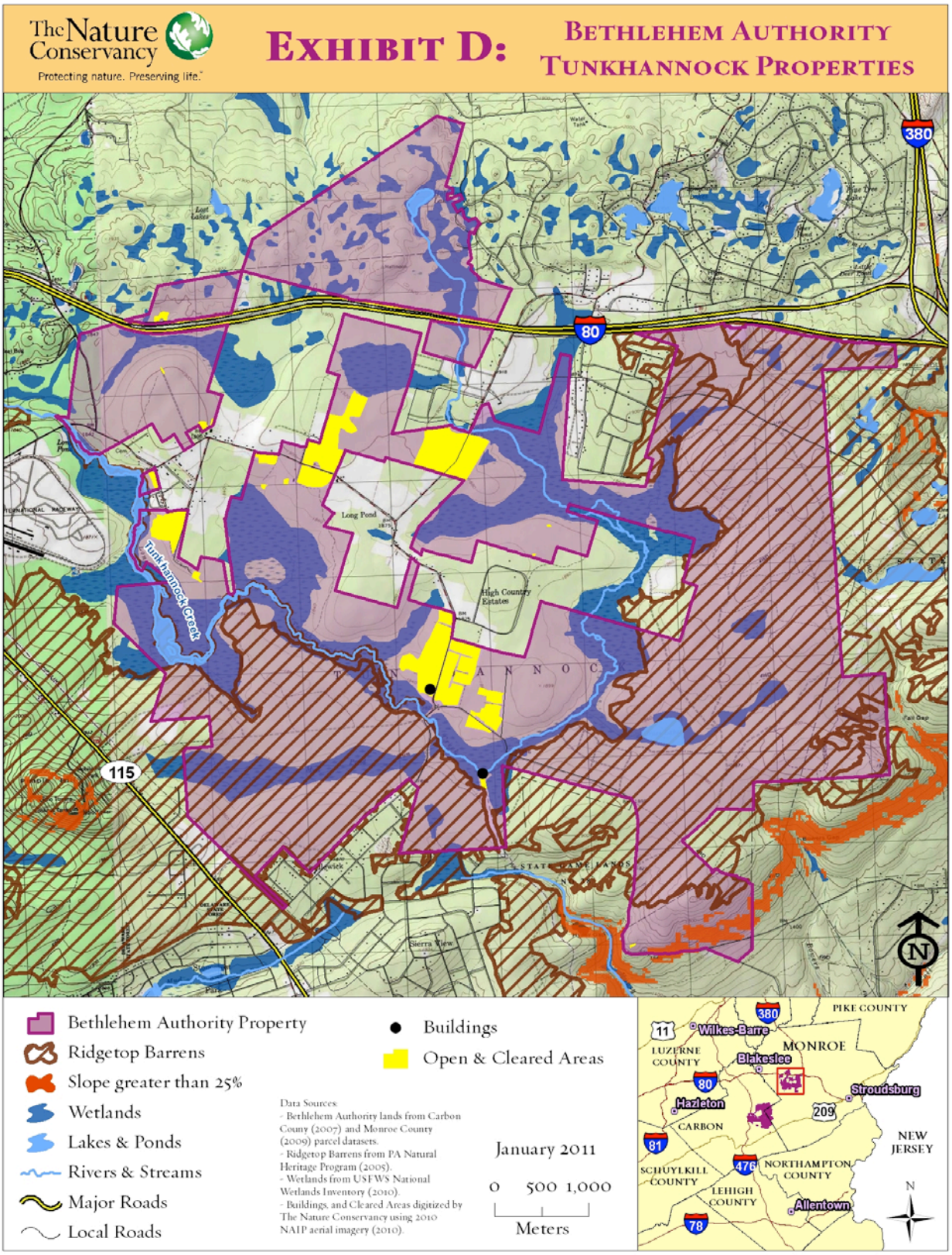
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EXHIBIT D:
BETHLEHEM AUTHORITY TUNKHANNOCK PROPERTIES
380
80
115
Tunkhannock Creek
Long Pond
High Country Estates
Bethlehem Authority Property
Ridgetop Barrens
Slope greater than 25%
Wetlands
Lakes & Ponds
Rivers & Streams
Major Roads
Local Roads
Buildings
Open & Cleared Areas
Data Sources:
- Bethlehem Authority lands from Carbon County (2007) and Monroe County (2009) parcel datasets.
- Ridgetop Barrens from PA Natural Heritage Program (2005).
- Wetlands from USFWS National Wetlands Inventory (2010).
- Buildings, and Cleared Areas digitized by The Nature Conservancy using 2010 NAIP aerial imagery (2010).
January 2011
0 500 1,000
Meters
PIKE COUNTY
Wilkes-Barre
LUZERNE COUNTY
MONROE
Blakeslee
Stroudsburg
Hazleton
CARBON
NEW JERSEY
SCHUYLKILL COUNTY
NORTHAMPTON COUNTY
LEHIGH COUNTY
Allentown
N

1.10 Conditions Prior to Project Initiation

The Project Area has been owned by the Authority for over 50 years but has had only three management plans prepared. The first plan was composed in 1988 for the Wild Creek portion of the project area, while the second and third plans were composed in 1991 and 2005 for the Tunkhannock tract. Despite the existence of these plans, the associated management prescriptions were not followed and actual harvest levels were significantly below plan projections.

The forest communities that have persisted in the Wild Creek and Tunkhannock tracts prior to project initiation have been quite different despite their relatively close proximity. The following two sections describe the general conditions on each tract and demonstrate that the project has not been implemented to generate GHG emissions for the purpose of their subsequent reduction, removal or destruction.

Wild Creek

The Wild Creek tract is predominantly a dry oak forest community type with two main age classes; an older age class of 90-120 year old stands and a younger age class of 50-65 year old stands. A dry oak species mix is the dominant forest community, with lesser amounts of mixed white pine, hemlock and hardwood stands along the drainages. Approximately 5% of the total forested acreage is in 50-75 year old conifer plantations. Over the past 20 years there has been very little harvesting on the tract and the Wild Creek forest stands have continued to mature and grow toward conditions of full stocking.

All compartments have good to very good stocking with generally good canopy health other than scattered ice damage on the ridges. Several of the plantations are showing signs of overcrowding, stress and shrinking live crown ratios. The age of the forest has led to a deficiency of large trees across many of the compartments, especially in the central and western side of the property and at higher elevation where fires and poor soils have limited tree size.

Regeneration is variable across the Wild Creek tract with areas of well-developed mixed oak, white pine and red maple regeneration and other areas where competing vegetation, deer browse pressure and low light conditions have severely limited understory development. These areas should respond to well executed regeneration harvests or any natural disturbance with acceptable regeneration and recovery without the use of deer fencing. The understory in these areas is also providing much more developed forest structure and better wildlife habitat features.

No timber value analysis has been conducted on the Wild Creek tract in more than 20 years, but the trees growing in the mature oak and white pine stands could provide significant timber revenues in the near term if Common Practice management were pursued.

Tunkhannock

The Tunkhannock Tract is a diverse mix of upland northern hardwood forests north and west of Tunkhannock Creek, palustrine hemlock, spruce and hardwood forests adjoining the creek bottom and dry oak and barrens communities south and east of Tunkhannock Creek. Several of the stands in the north and west portions of the tract are 90-120 years old, while the predominant

stand age-class on the rest of the forest ranges from 60-90 years. Forest composition generally exhibits good stocking and diversity. While there has been a higher level of harvesting and more canopy mortality in select beech stands due to beech bark disease, adequate growing stocks still remain to provide suitable options for future management. Species evenness in the north and west portions of the tract are in the fair range owing to the dominance of beech, red maple and cherry in the overstory. These compartments score well for the presence of large trees and large snags owing to the combination of older age classes, fast growing cherry and red maple, and the impact of beech bark disease and ice damage on tree mortality. The southern and eastern areas of the tract have smaller tree size and fewer large snags, but these are areas dominated by barrens communities and young forest stands created by fire history.

Deer browse impact has been higher on the Tunkhannock tract than the Wild Creek tract and there are additional regeneration issues with competing vegetation (hayscented fern and beech brush). There is a reasonable presence of seedlings and saplings but poor stocking of desirable seedlings as many areas in the northern hardwood forests are predominantly beech suckers. The southern and eastern portions of the tract have a better component of red maple and mixed oak, but many of these stands have a younger age structure and have not entered the period of maximum seed production.

1.11 Compliance with Laws, Statutes and Other Regulatory Frameworks

All baseline and project activities comply with all Pennsylvania and US laws and regulations governing forested areas. Further, the conservation easement requires that the Project Area adhere to all relevant local, regional and national laws, statutes and regulatory frameworks.

The following laws and regulations are of relevance to the project:

- Pennsylvania's Conservation District Law Act 217 - enacted May 15, 1945 as amended April 30, 1986.
- Endangered Species Act of 1973 – US Fish and Wildlife
- Federal Water Pollution Control Act, Title 33—Navigation and Navigable Waters, chapter 26—Water Pollution Prevention and Control
- Carbon & Monroe Conservative District Erosion and Sediment Pollution Control Plan Review Fee Schedule Policy
- The General Assembly of Pennsylvania House Bill 262 Prescribed Fire
- The General Assembly of Pennsylvania House Bill 2735 Prescribed Fire
- The Clean Streams Law P.L 1987, Act 394 of 1937, as amended
- Fire and Panic Act - Act of 1927, P.L. 465, no. 299

[*Additional laws pertinent to the project are listed in Appendix-I of the Bethlehem Authority Management plan, provided separately for validation and verification purposes*]

[*An attestation of compliance with all local and federal laws and regulations is provided separately for validation and verification purposes*]

1.12 Ownership and Other Programs

1.12.1 Right of Use

Right of use has been supplied as a supplementary document to the PDD in the form of a title affidavit for the Project Area.

[*The title affidavit is provided separately for validation and verification purposes*]

1.12.2 Emissions Trading Programs and Other Binding Limits

The Project is not subject to any required binding limits on GHG emissions, and will not be used for compliance with an emissions trading program.

1.12.3 Participation under Other GHG Programs

The Project has neither been registered nor sought registration under any other GHG program.

1.12.4 Other Forms of Environmental Credit

The Project neither has nor intends to generate any other form of GHG related environmental credit for GHG emission reductions or removals claimed under the VCS Program; therefore no such credit has been or will be cancelled from the relevant program. This is the first instance of this Project claiming GHG environmental credits.

1.12.5 Projects Rejected by Other GHG Programs

The Project has not been by rejected by any other GHG programs.

1.13 Additional Information Relevant to the Project

Eligibility Criteria

N/A. This is an individual project.

Leakage Management

The applicability conditions of VM0003 and the VCS standard prohibit any *activity shifting leakage* as result of the implementation of an IFM project. As the Bethlehem Project Area is the only working forestland owned/managed by BA, this requirement is automatically met. *Market effects leakage* is calculated based on a comparison of the percentage of merchantable timber per acre on the project site compared to other forests within the region (See section 3.3 for a detailed description of all leakage calculations). *Market effects leakage* will be re-assed at each verification but does not require additional specific leakage management activities.

Commercially Sensitive Information

None of the contents of this PDD are considered commercially sensitive information. However, elements of the supporting documentation or reference material provided separately to this PDD may be considered confidential such as financial models. These will be provided for validation and verification purposes.

Further Information

N/A

2 APPLICATION OF METHODOLOGY

2.1 Title and Reference of Methodology

VCS methodology:

VM003 Methodology for Improved Forest Management through Extension of Rotation Age

Version 1.1, Sectoral Scope 14

2.2 Applicability of Methodology

Applicability Condition (Section 4 of the Methodology)	**Bethlehem Authority**
Forest management in both baseline and projects cases involve harvesting techniques such as clear cuts, patch cuts, seed tree, continuous thinning or group selection practices.	The Baseline Scenario employs clear and patch cuts. The project scenario involves a group selection based, two-stage shelterwood system.
Forests which are unmanaged, or managed by individual tree selection, in the baseline case are not eligible under this methodology.	Individual tree selection is not practiced in the Baseline Scenario.
Forests must be certified by the FSC by the start of the project crediting period	The Bethlehem Authority Project Area achieved FSC certification on May 29, 2012
Project proponents must define the minimum project length in their project description document	The Project Crediting Period is stated as 100 years in section 1.6 of this PD.
The project must not encompass managed peat forests and the proportion of wetlands are not expected to change as part of the project	The Project Area does not encompass peat forests to be managed, and the proportion of wetlands are not expected to change as part of the project.
Project proponents must have a projection of management practices in both with and without project scenarios	Project scenario and baseline management activities are recorded in this PD in section 1.8 and 2.4 respectively.

If fire is used as part of forest management then fire control measures, such as installation of fire-breaks or back-burning, shall be taken to ensure fire does not spread outside the project boundary – that is, no biomass burning shall be permitted to occur beyond the project boundary due to forest management activities.	Any time controlled burns are employed in forest management activities, firebreaks will be installed or a back burning approach will be taken.
There may be no leakage through activity shifting to other lands owned or managed by project participants outside the bounds of the VCS carbon project	Bethlehem Authority does not manage or own any other working timberlands outside of the bounds of the VCS carbon project area, so no activity shifting leakage is possible. The Bethlehem Authority does own 4,945.4 acres not incorporated in the Project Area, but these acres represent farmland, water bodies, and ecologically sensitive areas of the property that will not be subject to any harvest activity and therefore should not be considered susceptible to activity shifting leakage.

2.3 Project Boundary

Selection of Carbon Pools:

Carbon Pool	**Selected**	**Justification/Explanation of Choice**
Above Ground Biomass	YES	Major carbon pool subjected to the project activity
Below Ground	YES	Below ground biomass stock is expected to increase due to the implementation of the VCS IFM project activity. Belowground biomass subsequent to harvest is not assessed with the conservation assumption of immediate emission.
Deadwood	YES	The standing deadwood pool will be included and estimated in both the baseline and with project cases. The dead wood will represent less than 50% of total

		carbon volume on the site in any given modeled year. The lying deadwood pool is excluded.
Litter	NO	*De minimis* as a result of rotation extension
Soil Organic Carbon	NO	*De minimis* as a result of rotation extension
Wood Products	YES	This stock may increase or decrease due to the implementation of the project activity

Source		Gas	Included?	Justification/Explanation
Baseline	Burning of Biomass	CO_2	NO	Excluded in the protocol
		CH_4	NO	Per VM0003, "estimation of CH4 emissions is based on the carbon stock loss from biomass burning during forest management is based on the biomass of logging slash burned." Burning of logging slash is not employed in the baseline scenario.
		N_2O	NO	Excluded in the protocol
		Other	N/A	N/A
Project	Burning of Biomass	CO_2	NO	Excluded in the protocol
		CH_4	NO	Burning of logging slash is not employed in the project scenario.
		N_2O	NO	Excluded in the protocol
		Other	N/A	N/A

Per VM0003 and the guidance of the Executive Board of the CDM, emissions caused by combustion of fossil fuels and through the use of fertilizers are considered insignificant and not considered here.

2.4 Baseline Scenario

Per section 6 of VM0003, credible alternatives to the proposed VCS project activity must be identified and a single baseline forest management scenario must be selected from amongst them.

To this end, four possible land-use scenarios were evaluated and approved as accurate by an independent Certified Pennsylvania Forester:

1. Historic Scenario: continuation of the pre-project forest management
2. Legal Scenario: legal requirements for forest management in the region
3. Common Practice Scenario: common practice forest management in the region
4. Project Activity Scenario: forest management as modelled under the project but in the absence of registration as an IFM project activity

1. Historic Scenario

In the case of the Bethlehem project, moderate timber harvest activity was practice on the project area prior to the IFM project's initiation. Few timber sale management records for the property can be found. The two sale documents that do exist indicate that the timber activities over the last three decades delivered below average market returns:

Historical Scenario Activity Summary*

Tract	Year	Stratum	Treatment	Acres	Mbf	Tons Pulp	Dollars	Contractor
Tunkhannock	1981	5	Selective		212	-	$3,431	Berger Lbr
Tunkhannock	1983	5	Integrated Thin		165	510	$5,256	Timberline
Tunkhannock	1983	5	Integrated Thin		116	266	$3,196	Timberline
Tunkhannock	1983	5	Selective	49	116	445	$2,678	Timberline
Tunkhannock	1984	5	Selective	123	422	2545	$17,014	Yeakley
Tunkhannock	1985	5	Clearcut	21	292	682	$18,055	Little Lbr
Wild Creek	1987	1	Selective	25	48	180	$3,200	Sincavage
Wild Creek	1990	1	Selective	80	242	1246	$18,400	Berger Lbr
Wild Creek	1991	1	Integrated Thin	33	13	75	$955	City/Berger
Wild Creek	1991	3	Integrated Thin	36	30.4	125	$2,233	City/Berger
Wild Creek	1991	1	Timber Stand Improvement	100	-	-	($42,000)	Greenshadow
Wild Creek	1992	1	Timber Stand Improvement	12	-	-		Greenshadow
Wild Creek	1992	1	Timber Stand Improvement	34	-	-		Robbins
Wild Creek	1992	1	Timber Stand Improvement	14	-	-		Robbins
Wild Creek	1992	1	Timber Stand Improvement	7	-	-		Greenshadow
Wild Creek	1992	1	Timber Stand Improvement	142	-	-		Robbins/ABC
Wild Creek	1992	7	Timber Stand Improvement	3	-	-	($61,355)	Greenshadow
Wild Creek	1992	7	Timber Stand Improvement	1	-	-		Greenshadow
Wild Creek	1992	7	Timber Stand Improvement	11	-	-		Greenshadow
Wild Creek	1992	1	Timber Stand Improvement	12	-	-		Greenshadow
Wild Creek	1992	7	Timber Stand Improvement	3	-	-		Greenshadow
Wild Creek	1993	7	Timber Stand Improvement	8	-	-		ABC Tree Serv
Wild Creek	1993	7	Timber Stand Improvement	8	-	-	($48,750)	ABC Tree Serv
Wild Creek	1993	1	Timber Stand Improvement	29	-	-		ABC Tree Serv
Wild Creek	1994	7 (9%), 1 (91%)	Timber Stand Improvement	110	-	-	($41,140)	
Wild Creek	1995	7 (9%), 1 (91%)	Timber Stand Improvement	140	-	-	($50,750)	
Wild Creek	1996	7 (9%), 1 (91%)	Timber Stand Improvement	140	-	-	($50,260)	
Wild Creek	1997	7 (9%), 1 (91%)	Timber Stand Improvement	146	-	-	($44,055)	
Wild Creek	1998	7 (9%), 1 (91%)	Timber Stand Improvement	147	-	-	($45,996)	
Both Tracts	1999-2006		Commercial Activety Curtaile	-	-	-	-	
Tunkhannock	2007	5	Shelterwood	154	272	3810	$26,785	
Tunkhannock	2008		Shelterwood	15	14	280	$2,800	Walter Logging
Tunkhannock	2009		Shelterwood	66	67	3360	$22,879	Glatfelter PW
Wild Creek	2010	7	Integrated Thin	50	220**	3637**	$29,150	Walter Logging
Tunkhannock	2011		Shelterwood	83	100	3500	$43,200	Walter Logging
						Total revenue	**($185,074)**	

* From notes and prescriptions in 1991 AFC Plan and Records of Removals from Stephen Repasch, Executive Director of the Bethlehem Authority.
** Volumes were assumed from cruise at 25% sawtimber and 75% pulpwood. All went to pulpmill to address supply issues.
Note - Records were unavailable for all blank cells.

Historical forest practices on the property resulted in a net loss of $185,074 in total revenue vs. positive average market returns. Because it delivers below average market returns, the Historic Scenario (Scenario 1) is excluded from selection a*s Baseline Scenarios per*. VM0003 p.9.

[Timber sale management records provided separately for validation and verification purposes]

2. Legal Scenario
3. Common Practice Scenario

Because the Common Practice Scenario complies with all laws and regulations, it serves as the Legal Scenario as well. This is also appropriate given that legal requirements alone do not constitute a forest management regime, and that the Common Practice Scenario represents the most likely legal forest management alternative to the Project Activity.

The Legal/Common Practice Scenario consists of *commercial clear cuts* **(**Kelty and D'Amato 2006[3]) down to an 8 inch diameter limit, with a matrix of complete patch cuts opportunistically interspersed amongst the greater harvest area, on a 30-year rotation. This is widely used type of clear cutting, not to be confused with a "regeneration clear cut" in which all stems regardless of size are cut to prepare a new seedbed. The diameter-limited commercial clear cut is also fundamentally different from any type of single-tree (i.e. Individual Tree) selection harvest, in which only individual trees are selected to achieve a desired residual structure, or a high-grading operation in which only those stems above a 10 to 16 inch diameter **(**Kelty and D'Amato 2006[3]) and of high commercial value are cut. Commercial clear cutting with a low diameter limit, as modeled in our baseline, is also widely used in eastern North America to protect and release advanced regeneration.

The predominance of this management approach is supported by a report on the effects of timber harvest practices in Pennsylvania produced by Dr. James Finley[4] (from the Penn State School of Forestry), along with two USDA publications on destructive forest practices in the Northeast (Kenefic & Nyland 2005[5], Fajvan 2006[5]). The nature of common practice in the area surrounding Bethlehem was further confirmed through discussions with Dave Jackson, Regional Forest Resources Educator for Penn State Cooperative Extension, and Nick Lylo from the DCNR Bureau of Forestry. Ultimately, a formal attestation of the project's proposed common practice scenario was provided by a Certified Pennsylvania Forester. The attestation confirms that the proposed common practice scenario accurately reflects regional standards for:

1) Harvest rotations
2) Harvest methods
3) Species harvested and planted
4) No harvest zones
5) Riparian management areas
6) Areas of steep slope or unstable soils
7) Maximum patch cut areas
8) Financial pressures
9) Legal requirements

Additionally, it should be noted that the project lies within the procurement area (wood basket) of 56 logging and sawmill companies. A significant wood pellet manufacturing plant has started operations in Palmerton and provides a market for wood chips. Craftmaster and Glatfelter provide additional markets for pulpwood or low-grade material. Higher value timber products go into grade lumber, flooring, veneer, and construction lumber and will typically find markets either regionally in northeast PA, or will be exported as far as Canada (or the Far East in the case of top quality hardwood logs). In concert, these factors lead to persistent demand for timber products and provide a strong financial incentive for short-cycle stand entry.

[*Third party attestation by Certified Forester, Bob Hobbes, provided separately for verification and validation purposes*]

[4] James C. Finley and Steven P. Jones (1997). The Effects of Timber Harvesting on Pennsylvania Forest Sustainability. The Center for Rural Pennsylvania. University Park, PA

[5] Laura S. Kenefic and Ralph D. Nyland (2005). *Diameter-Limit Cutting and Silviculture in Northeastern Forests: A Primer for Landowners, Practitioners, and Policymakers*. USDA Forest Service. Newtontown Square, PA

If forest management regulations are readily enforced, as they are in Pennsylvania, VM0003 requires that the Legal Baseline be selected as the most plausible Baseline Scenario (for evaluation against Scenario 4 – see "Additionality" section below). Therefore the Legal / Common Practice Baseline was selected.

This scenario was modeled by clear cutting all harvested forest stands down to a minimum DBH of 8 inches every 30 years. While the maximum tree age maintained by this approach will be approximately 40 to 50 years (8 inch residual stems are 10 to 20 years old) the rotation period between harvests is 30 years. The opportunistically interspersed patch cuts, that would be nested within the commercial clear cuts in reality, are omitted from the model as a measure of conservatism. This omission is a conservative, as more carbon is maintained in the forest in our modeled baseline scenario than would be in reality.

4. Project Activity Scenario: forest management as modelled under the project but in the absence of registration as an IFM project activity

The 100-year timber rotation modeled in the project scenario sacrifices short-term profits for improved forest health and a host of ecological benefits (see aditionality section below for detail). As result of this, project scenario activities in the absence of carbon credit revenue provided by VCS IFM registration provide financial returns considerably lower than the Legal/Common Practice Baseline scenario.

2.5 Additionality

Per Step 2 of the VM0003 Baseline Analysis process, the CDM "Tool for the demonstration and assessment of aditionality" (Version 5.2.1) must be used to compare the Project Activity (Scenario 4 above) to the Legal / Common Practice (Scenario 2 & 3 above) -- the baseline scenario identified in Step 1 of the VM0003 Baseline analysis process. If a financial analysis or a demonstration of barriers does not lead to the preclusion of the project scenario then the project shall be considered non-additional.

Tool Step 1: Identification of alternatives to the project activity

This alternative (i.e. the Legal / Common Practice Scenario) was selected as described in the preceding section.

Tool Step 2: Investment analysis

Tool Sub-step 2a&b. Determine appropriate analysis method and Identify a financial indicator

Option II, "Investment comparison," based on Net Present Value (NPV) was selected as the most appropriate analysis method for the additionality section of the PD because it is the method most commonly used by forest managers/investors in the region. This was confirmed by Bob Hobbes, the third party forester who completed the common practice attestation for the project.

Investment comparison provides a strait forward mechanism for selecting between competing capital deployment strategies, while the NPV indicator allows for a clear understanding of present and future cash flows.

Tool Sub-step 2c&d. Calculation and comparison of financial indicators and sensitivity analysis

Data on stumpage prices for pulp and timber was retrieved through a request to the Penn State Extension covering the Southeastern region of Pennsylvania since 1992. Stumpage price trends were adjusted for inflation using data from the consumer price index. An average stumpage price for hardwoods as well as softwood was calculated and weighted based on the unique harvest mix by volume of timber species from the property analysed including both timber tracks, Wild Creek and Tunkhannock. The property's hardwood timber species mix consisted of 57% oak species, 11% cherry, 1% ash, 23 % maple, and 8% other hardwoods. Hardwoods made up 67% of the timber while softwoods contributed another 36% of the timber. For this unique timber mix, the real stumpage prices adjusted for inflation fell by an average of -1.1% per year from 1992-2012 (Figure 1 (b)). This decrease in real stumpage prices from a 20-year dataset was projected into the future for the next 100 years. The average 2012 stumpage price for the property's hardwood and softwood mix was $329 per thousand board feet (mbf) and $72 per mbf, respectively. As the local estimates consider around 54% of the current timber in the pallet/tie log class at an estimated stumpage price of $69 per mbf, the adjusted average stumpage value for all qualities and hardwood species equalled $189 per mbf.

Hardwood pulpwood was converted from cubic feet to green short tons at a rate of 51 pounds/cubic foot based on the average density of hardwoods in the Northeast (USDA 2008). An average pulp stumpage price at $2 per green short ton in 2012 based on Pennsylvania-specific data from Penn State Extension was assumed.

To account for a reversion value of the property, hardwood and softwood timber and pulp volumes were computed over 100 years for the baseline and project scenario (Figure 2). In order to assign a value to the property for a given point in time, the standing timber volumes were multiplied with the stumpage prices described above equalling $189 and $72 per mbf for hard- and softwoods, respectively, as well as $2 per green ton of pulp wood.

Management costs, estimated at $50 per mbf, were obtained from property management staff. The property has a good internal road network which would not create any extraordinary costs of access or infrastructure beyond what would be included in the management costs. The real discount rate was set at 5% resulting in a nominal discount rate of around 7.5% which is a conservative estimate as it is only slightly above the average 10-year US Treasury rate since 1992 of 4.93% and would therefore include a very low risk premium. If timber management costs would exceed stumpage prices due to inflation and stumpage price dynamics, no timber sale was assumed for the given year. Comparably, pulp sales were only assumed if timber sales would occur at a given year.

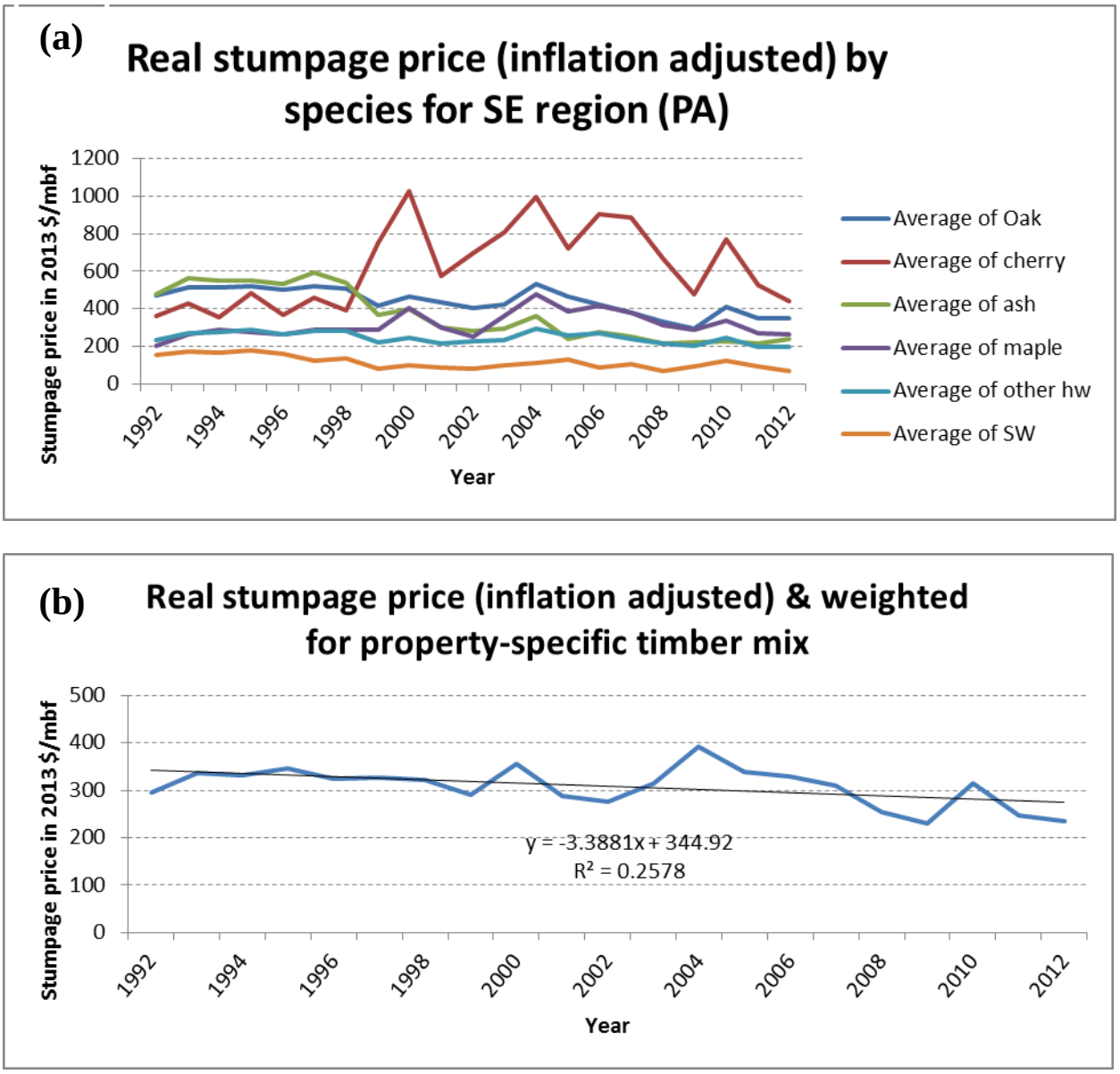

Figure 1: Inflation adjusted stumpage prices by species for Southeastern Pennsylvania (a) and weighted by the property specific timber mix (b). Source: Penn State Extension.

Except for hardwoods harvested 40 years into the future, hard-and softwood sawtimber as well as hardwood pulp volumes for the project scenario were persistently below harvest rates for the baseline scenario (Figure 3). Softwood pulp volumes were negligible in both scenarios.

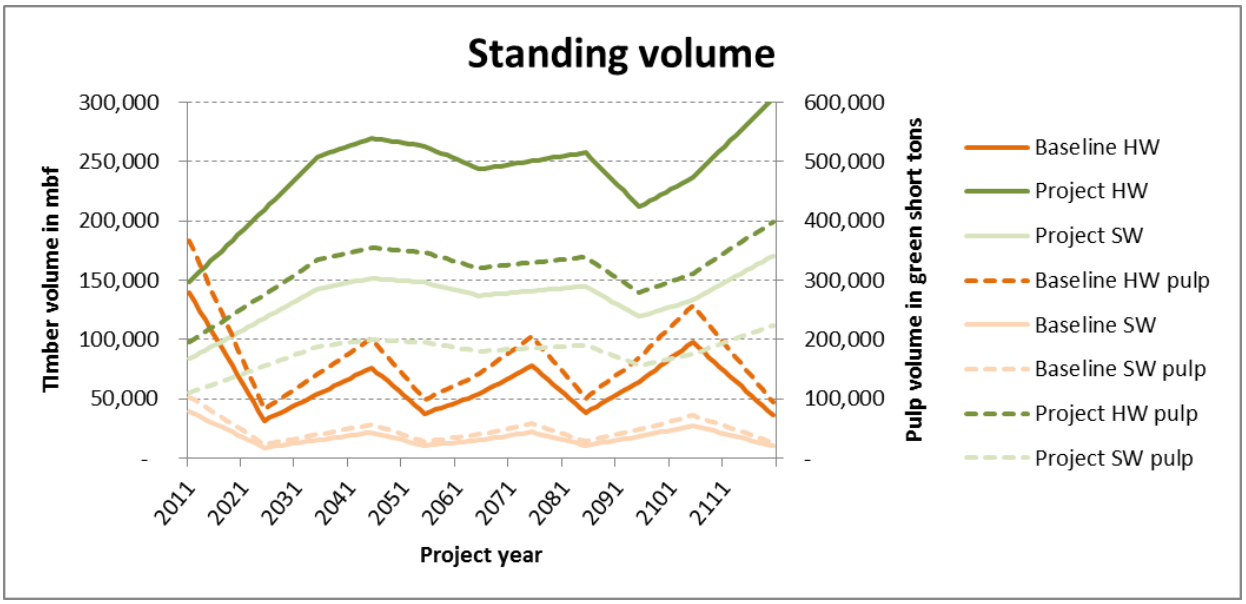

Figure 2: Standing timber and pulp volume over time for the baseline and project scenario.

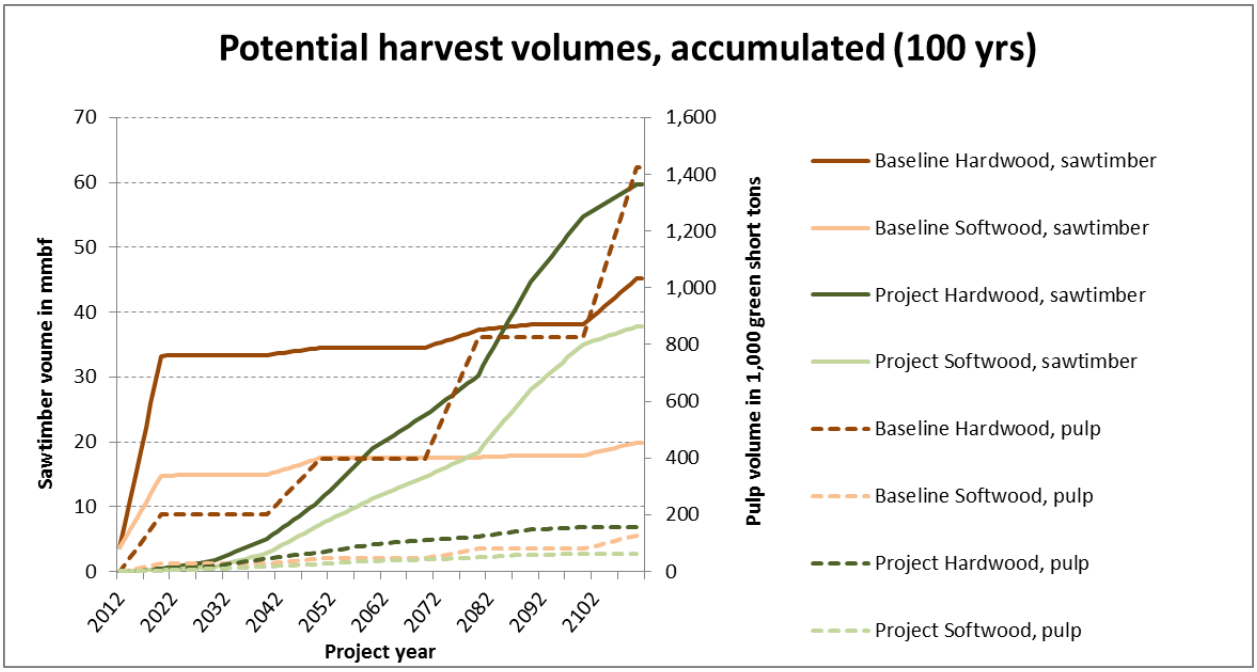

Figure 3: Accumulated harvest volumes for the baseline and project scenario.

For the NPV analysis two time frames were examined:

1. A 60-year reversion timeframe was applied to reflect the easement period associated with logging restrictions under the project scenario.
2. A 100-year reversion timeframe was applied to reflect the entire project crediting period.

At a real discount rate of 5%, the NPV for the project scenario (under the "assumed" case in Table 1) over the 60-year assessment period was $2,138,549, 57% lower than that of the baseline scenario at $4,937,266. Over a 100-year time horizon, the financial gap between the

baseline and project scenario further widened, mostly due to an extended discounting of the reversion value over an additional 40 years resulting in a NPV of $701,388 for the project scenario, equalling less than 15% of the baseline NPV of $4,561,329. It should be noted that such long-term projections, especially in terms of stumpage price (harvest and asset valuation) and cost trends, remain inherently uncertain.

A sensitivity analysis was performed modifying key cost variables to reflect a range from pessimistic to optimistic scenarios (Table 1). Even under the optimistic 60-year case, the project scenario, with an NPV of $5,724,892, does not financially outperform the optimistic baseline with an NPV of $6,410,670. From a harvest level perspective, the project scenario considers a total harvest volume of timber and pulpwood reduced by 40% and 20%, respectively, compared to the baseline scenario over the first 60 years. This significant reduction in harvest levels makes the project scenario highly unlikely compared to the baseline scenario. Considering stumpage price trend assumptions, the project would become economically more attractive if an annual real stumpage price increase of 0.8% above inflation would occur, over the 60-year period, rather than a decrease of 1.1% as suggested by the stumpage price trends observed over the last 20 years in the area. Assuming a gradual reversal of the current downward stumpage price trend, only a very aggressive real timber price appreciation of around 4% per year (above inflation) in the final decades of the 60-year timeframe, coupled with a decline in baseline harvest levels, would make this scenario realistic. As pricing swings of this kind are uncommon and high harvest levels are one of the defining features of the Legal/Common Practice baseline, this scenario is highly improbable.

In summary, the project poses a considerable financial disadvantage to the land owner, thus making an improved forest management project with the harvest volume and stumpage income described above impractical in the absence of carbon finance.

Table 1: Cost and Revenue Assumptions (all monetary values adjusted to 2013 $).

	Unit	Pessimistic	Assumed	Optimistic
Volume output	change in %	-10%	0%	10%
Management costs	$/mbf	70	50	40
Mgmnt cost inflation rate (annual)	annual change in %	2.0%	0.0%	-2.0%
Stumpage price				
Timber HW				
High-quality HW	$/mbf		329	
Pallet/Tie logs HW	$/mbf		69	
Percentage of pallet/tie logs	%		54%	
Timber HW total	$/mbf		189	
Timber SW	$/mbf		72	
Pulp (HW&SW)	$/green ton		2	
Stumpage price inflation (real)	annual change in %	-2.0%	-1.1%	0.5%
Discount rate (real)			5.0%	

Table 2: Net present values (NPV) at a 5% real discount rate for the baseline and project scenarios. Projected NPVs post-60 years (grey font) are associated with an increased uncertainty.

	NPV in 2013 $	
Scenario	60 years	100 years

Baseline	Assumed	$4,937,266	$4,561,329
	Pessimistic	$3,740,359	$3,518,721
	Optimistic	$6,410,670	$5,523,238
Project	Assumed	$2,138,549	$701,388
	Pessimistic	$1,006,377	$201,759
	Optimistic	$5,724,892	$2,311,650

[The Excel workbook with the underlying calculations for this financial analysis* provided separately for validation and verification purposes*]

Step 3: Barrier analysis

Under the CDM Tool, completion of the *Investment Comparison Analysis* negates the need for *Barrier Analysis*.

Step 4: Common practice analysis

Sub-step 4a&b. Analyze other activities similar to the proposed project activity and Discuss any similar Options that are occurring

Based on the expert opinion of regional forest professionals consulted, there are no comparable forest operators - municipal or private, with over 15,000 acres of forested land, in the surrounding counties - pursuing similar timber management practices as those represented in the project scenario.

As forest management activities similar to those projected for the project scenario are not present in the region, the proposed project activity is additional.

2.6 Methodology Deviations

No methodology deviations were utilized in the execution of the Bethlehem project.

3 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

3.1 Baseline Emissions

Per VM0003 equations 6:

The GHG emissions in the baseline within the project area can be estimated as:

$$GHG_{BSL,E} = \sum_{t=1}^{t^*} \left(E_{BSL,BiomassBurn,t} \right) \quad (6)$$

where:

$GHG_{BSL,E}$	Greenhouse gas emissions as a result of forest management activities within the project area in the baseline; t CO_2-e
$E_{BSL,\ BiomassBurn,t}$	Non-CO_2 emissions due to biomass burning as part of forest management during the year *t* in the baseline; t CO_2-e
t	*1, 2, 3 …t** years elapsed since the start of the IFM project activity

As biomass burning is the only emissions source required to be calculated under the protocol, and no biomass burning is carried out in Baseline scenario, baseline CO2e (and non-CO2e) emissions as result of forest management activities are calculated as zero.

3.2 Project Emissions

Per VM0003 equations 36:

The change in GHG emissions as a result of the implementation of the proposed IFM project activity within the project area can be estimated as:

$$GHG_{PS,E} = \sum_{t=1}^{t^*} \left(E_{PS,BiomassBurn,t} \right) \quad (36)$$

where:

$GHG_{PS,E}$	Greenhouse gas emissions as a result of forest management activities within the project area in the project scenario; t CO_2-e
$E_{PS,\ BiomassBurn,t}$	Non-CO_2 emissions due to biomass burning as part of forest management during the year *t* in the project scenario; t CO_2-e
t	*1, 2, 3 …t** years elapsed since the start of the IFM project activity

As was the case with Baseline Scenario, only emissions from biomass burning are required to be calculated under the IFM ERA protocol. Though limited controlled burns will be utilized in the project scenario, no burns will occur on stands following timber removal activities.

As VM0003 only requires that secondary effects be accounted for from burned *logging slash*, and defines *logging slash* as “Branches, other dead wood residues, and foliage left on the forest floor after timber removal,” project scenario CO2e (and non-CO2e) emissions as result of project implementation are calculated as zero.

In accordance with section 3.1.9 in the VCS AFOLU Requirements document, the project baseline will be reassessed by TNC or the Bethlehem Authority every 10 years, for so long as the project continues generating credits or recovering credits from the buffer pool. Each decadal

reassessment will be examined and approved by a qualified and independent professional forester.

3.3 Leakage

Under the applicability conditions of VM0003 and the VCS standard, the only type of leakage emissions calculated for the project are GHG emissions due to *market effects* resulting from a shift in harvests through time.

Per VM0003 *market effects leakage* is defined as: Total GHG emissions due to impacts of project on timber supply and demand.

The impact of the project on timber supply was calculated using equation 41.

$$LK_{MarketEffects} = LF_{ME} * (\Delta C_{ACTUAL} - \Delta C_{BSL}) \quad (41)$$

Where:

$LK_{MarketEffects}$	Total GHG emissions due to market- effects leakage through decreased timber harvest; t CO_2-e
LF_{ME}	Leakage factor for market-effects calculations; dimensionless
ΔC_{ACTUAL}	Actual net greenhouse gas removals by sinks; t CO_2-e
ΔC_{BSL}	Baseline net greenhouse gas removals by sinks; t CO_2-e

As rotations within the project were extended by more than 10 years in comparison to the baseline scenario, the methodology requires that the LF_{ME} be determined by calculating the proportion of total biomass in commercial species that is merchantable (PMP_i) within each project stratum and comparing that figure to the mean proportion of total biomass that is merchantable for each associated Forest Service FIA forest type group (PML_{FT}).

PMP_i was established based on FVS total and merchantable biomass calculations.

PML_{FT} is a percent figure based on default *forest type group* values provided by VCS in the following table:

Forest Type Group	Merchantable Biomass as Proportion of Total Biomass
White Red Jack Pine	77%
Spruce Fir	58%
Longleaf Slash Pine	73%
Loblolly Shortleaf Pine	73%
Ponderosa Pine	64%
Oak Pine	71%
Oak Hickory	73%
Oak Gum Cypress	72%
Elm Ash Cottonwood	73%
Maple Beech Birch	76%
Aspen Birch	61%
Douglas Fir	70%
Western White Pine	62%
Fir-Spruce/Mountain Hemlock	62%
Lodgepole Pine	64%
Hemlock/Sitka Spruce	67%
Western Larch	66%
Redwood	43%
Western Oak	69%

A representative *forest type group* was selected for each of the five currently forested project strata (Mixed Oak High, Mixed Oak Low, Natural Conifer High, Hardwoods High, Plantation, and Scrub) based on the predominant tree species present in each stratum.

The following table depicts the percentage of merchantable biomass in each stratum and the percentage of merchantable biomass in each stratum's associated *forest group type*. The cumulative weighted average percentages were calculated based on the proportion of the total project acres represented in each stratum.

Strata name	Merchantable biomass in each stratum (*PMP_i*)	Associated forest type group	Merchantable biomass in associated forest type group (*PML_FT*)	Acres
Mixed Oak (high stock)	56%	Oak Hickory	73%	11,508
Mixed Oak (low stock)	51%	Oak Hickory	73%	944
Natural Conifer (high stock)	60%	Hemlock/Sitka Spruce	67%	1,908
Hardwoods (high stock)	59%	Maple Beech Birch	76%	1,637
Plantation	60%	White Red Jack Pine	77%	1,008
Scrub	52%	Oak Hickory	73%	586
Weighted average	**56%**	**Weighted average**	**73%**	

The table illustrates that PML_{FT} (56%) is 33% less than PMP_1 (73%). This means a higher proportion of total commercial species biomass is merchantable in the displacement forest (i.e. the area that will be harvested to satisfy market demand for wood products that would have been harvested on the project area in the baseline scenario) than in the project area forest. Therefore a smaller area will have to be harvested in the displacement forest to provide the same quantity of wood that would have been produced on the project area in the baseline scenario.

Per VM0003:

$$PML_{FT} \text{ is} > 15\% \text{ greater than } PMP_i \qquad LF_{ME} = 0.2$$

Therefor the project's leakage factor for market effects (LF_{ME}) is **0.2**.

3.4 Summary of GHG Emission Reductions and Removals

[*For detailed calculation methods please reference the Carbon Calculations folder provided separately for validation and verification purposes*]

Years	Estimated baseline emissions or removals (tCO2e)	Estimated project emissions or removals (tCO2e)	Estimated leakage emissions (tCO2e)	Estimated net GHG emission reductions or removals (tCO2e) before risk deduction	Estimated net GHG emission reductions or removals (tCO2e) after10% risk deduction
2012	-5,112	25,480	6,119	24,474	22,027
2013	-15,897	32,553	9,690	38,760	34,884
2014	-12,301	32,553	8,971	35,883	32,295
2015	-12,301	32,553	8,971	35,883	32,295
2016	-12,301	32,553	8,971	35,883	32,295
2017	-12,301	32,553	8,971	35,883	32,295
2018	-12,301	32,553	8,971	35,883	32,295
2019	-12,301	32,553	8,971	35,883	32,295
2020	-12,301	32,553	8,971	35,883	32,295
2021	-12,301	32,553	8,971	35,883	32,295
2022	-12,916	25,378	7,659	30,635	27,571
2023	-12,446	25,378	7,565	30,259	27,233
2024	-12,418	25,378	7,559	30,237	27,213
2025	-12,418	25,378	7,559	30,237	27,213
2026	-12,418	25,378	7,559	30,237	27,213
2027	-12,418	25,378	7,559	30,237	27,213
2028	-12,418	25,378	7,559	30,237	27,213
2029	-12,418	25,378	7,559	30,237	27,213

2030	-12,418	25,378	7,559	30,237	27,213
2031	-12,418	25,378	7,559	30,237	27,213
2032	-12,420	15,009	5,486	21,943	19,749
2033	-8,766	15,009	4,755	19,020	17,118
2034	-12,087	15,009	5,419	21,677	19,509
2035	-12,086	15,009	5,419	21,676	19,509
2036	-12,086	15,009	5,419	21,676	19,509
2037	-12,086	15,009	5,419	21,676	19,509
2038	-12,086	15,009	5,419	21,676	19,509
2039	-12,086	15,009	5,419	21,676	19,509
2040	-12,086	15,009	5,419	21,676	19,509
2041	-12,086	15,009	5,419	21,676	19,509
2042	44,239	506	-	-43,733	-
2043	-68,105	506	13,722	54,889	10,041
2044	-12,181	506	2,537	10,150	9,135
2045	-12,181	506	2,537	10,150	9,135
2046	-12,181	506	2,537	10,150	9,135
2047	-12,181	506	2,537	10,150	9,135
2048	-12,181	506	2,537	10,150	9,135
2049	-12,181	506	2,537	10,150	9,135
2050	-12,181	506	2,537	3,855.17	3,470
Total	-471,136	726,878	248,349	943,370	849,033

4 MONITORING

4.1 Data and Parameters Available at Validation

Data Unit / Parameter:	*ABSL,1*
Data unit:	Acre
Description:	Area of baseline stratum, 1
Source of data:	GPS coordinates
Value applied:	11,508.2
Justification of choice of data or description of measurement methods and procedures applied:	Recommended in VM0003
Any comment:	

Data Unit / Parameter:	*ABSL,2*

Data unit:	Acre
Description:	Area of baseline stratum, 2
Source of data:	GPS coordinates
Value applied:	944.3
Justification of choice of data or description of measurement methods and procedures applied:	Recommended in VM0003
Any comment:	

Data Unit / Parameter:	*ABSL,3*
Data unit:	Acre
Description:	Area of baseline stratum, 3
Source of data:	GPS coordinates
Value applied:	1,907.7
Justification of choice of data or description of measurement methods and procedures applied:	Recommended in VM0003
Any comment:	

Data Unit / Parameter:	*ABSL,4*
Data unit:	Acre
Description:	Area of baseline stratum, 24
Source of data:	GPS coordinates
Value applied:	0
Justification of choice of data or description of measurement methods and procedures applied:	Recommended in VM0003
Any comment:	No acres currently represent this stratum (Natural Conifers – Low Stock) but in the future, management will cause acres to be shifted into this forest type.

Data Unit / Parameter:	*ABSL,5*
Data unit:	Acre
Description:	Area of baseline stratum, 5
Source of data:	GPS coordinates

Value applied:	1,636.5
Justification of choice of data or description of measurement methods and procedures applied:	Recommended in VM0003
Any comment:	

Data Unit / Parameter:	*ABSL,6*
Data unit:	Acre
Description:	Area of baseline stratum, 6
Source of data:	GPS coordinates
Value applied:	0
Justification of choice of data or description of measurement methods and procedures applied:	Recommended in VM0003
Any comment:	No acres currently represent this stratum (Hardwoods – Low Stock) but in the future, management will cause acres to be shifted into this forest type.

Data Unit / Parameter:	*ABSL,7*
Data unit:	Acre
Description:	Area of baseline stratum, 7
Source of data:	GPS coordinates
Value applied:	1007.6
Justification of choice of data or description of measurement methods and procedures applied:	Recommended in VM0003
Any comment:	

Data Unit / Parameter:	*ABSL,8*
Data unit:	Acre
Description:	Area of baseline stratum, 8
Source of data:	GPS coordinates
Value applied:	586.4
Justification of choice of data or description of measurement methods and procedures	Recommended in VM0003

applied:	
Any comment:	

Data Unit / Parameter:	*BEF*
Data unit:	Dimensionless
Description:	Biomass expansion factor for conversion of annual net increment (including bark) in stem biomass to total above-ground tree biomass increment for species *j*
Source of data:	Jenkins et al. (2003) allometric equations within the FVS' Fire and Fuels Extension Carbon Submodel
Value applied:	Provided in carbon inventory model
Justification of choice of data or description of measurement methods and procedures applied:	Respected BEF equations for the region utilized by the USFS
Any comment:	

Data Unit / Parameter:	*CF*
Data unit:	t C t^{-1} d.m.
Description:	Carbon fraction of dry matter
Source of data:	VM0003
Value applied:	Default value 0.5 t C t^{-1} d.m.
Justification of choice of data or description of measurement methods and procedures applied:	Recommended in VM0003
Any comment:	

Data Unit / Parameter:	*D*
Data unit:	t d.m. m^{-3}
Description:	Basic wood density
Source of data:	National and species-specific data from US Forest Service Forest Vegetation Simulator (FVS)
Value applied:	Provided in carbon inventory model
Justification of choice of data or description of measurement methods and procedures applied:	Recommended in VM0003

Any comment:	

Data Unit / Parameter:	D_{DW}
Data unit:	t d.m. m^{-3}
Description:	Basic wood density of dead wood in the density class – sound (1), intermediate (2) and rotten (3)
Source of data:	FVS
Value applied:	Provided in carbon inventory model
Justification of choice of data or description of measurement methods and procedures applied:	Recommended in VM0003
Any comment:	

Data Unit / Parameter:	*fj(DBH,H)*
Data unit:	t d.m. $tree^{-3}$
Description:	Allometric equation for species j linking diameter at breast height (DBH) and possibly height (H) to above-ground biomass of living trees
Source of data:	Jenkins et al. (2003) allometric equations within the FVS' Fire and Fuels Extension Carbon Submodel
Value applied:	Provided in carbon inventory model
Justification of choice of data or description of measurement methods and procedures applied:	Recommended in VM0003
Any comment:	

Data Unit / Parameter:	*WW*
Data unit:	kg kg^{-1}.
Description:	WW = Fraction of extracted biomass effectively emitted to the atmosphere during production
Source of data:	The source of data is the published paper of Winjum et al. 1998
Value applied:	Provided in carbon inventory model
Justification of choice of data or description of measurement methods and procedures applied:	Prescribed in VM0003
Any comment:	

Data Unit / Parameter:	PML_{FT}
Data unit:	%
Description:	Mean merchantable biomass as a proportion of total aboveground tree biomass for each forest type
Source of data:	Official Government data and statistics within FVS
Value applied:	Provided in carbon inventory model
Justification of choice of data or description of measurement methods and procedures applied:	Recommended in VM0003
Any comment:	

Data Unit / Parameter:	*R*
Data unit:	kg kg^{-1}.
Description:	Root-shoot ratio appropriate for biomass increment of forest type / biome
Source of data:	Jenkins et al. (2003) allometric equations within the FVS' Fire and Fuels Extension Carbon Submodel
Value applied:	Provided in carbon inventory model
Justification of choice of data or description of measurement methods and procedures applied:	Recommended in VM0003
Any comment:	

Data Unit / Parameter:	*SLF*
Data unit:	unitless
Description:	Short lived fraction - proportion of wood products that oxidize immediately in the first three years after harvesting
Source of data:	The Forestry Appendix of US Department of Energy's Technical Guidelines for The Voluntary Reporting of Greenhouse Gas Program (Section 1605b) http://www.eia.doe.gov/oiaf/1605/Forestryappendix[1].pdf Also available as a US Forest Service General Technical Report at: http://www.fs.fed.us/ne/durham/4104/papers/ne_gtr343.pdf Winjum et al., 1998

Value applied:	Provided in carbon inventory model
Justification of choice of data or description of measurement methods and procedures applied:	Recommended in VM0003
Any comment:	

Data Unit / Parameter:	*MLF*
Data unit:	unitless
Description:	Medium lived fraction - Proportion of wood products that decay over a 20 year period after harvest
Source of data:	The Forestry Appendix of US Department of Energy's Technical Guidelines for The Voluntary Reporting of Greenhouse Gas Program (Section 1605b) http://www.eia.doe.gov/oiaf/1605/Forestryappendix[1].pdf Also available as a US Forest Service General Technical Report at: http://www.fs.fed.us/ne/durham/4104/papers/ne_gtr343.pdf Winjum et al., 1998
Value applied:	Provided in carbon inventory model
Justification of choice of data or description of measurement methods and procedures applied:	Recommended in VM0003
Any comment:	

Data Unit / Parameter:	*LLF*
Data unit:	unitless
Description:	Long lived fraction - proportion of wood products that remain stored for 100 years after harvest
Source of data:	The Forestry Appendix of US Department of Energy's Technical Guidelines for The Voluntary Reporting of Greenhouse Gas Program (Section 1605b) http://www.eia.doe.gov/oiaf/1605/Forestryappendix[1].pdf Also available as a US Forest Service General Technical Report at: http://www.fs.fed.us/ne/durham/4104/papers/ne_gtr343.pdf Winjum et al., 1998
Value applied:	Provided in carbon inventory model
Justification of choice of data or description of measurement	Recommended in VM0003

methods and procedures applied:	
Any comment:	

4.2 Data and Parameters Monitored

Data Unit / Parameter:	A_1
Data unit:	Acres
Description:	Area of stratum 1
Source of data:	GIS shape file derived from GPS coordinates
Description of measurement methods and procedures to be applied:	Strata area figures adjusted based on stocking levels and species distribution projected in modeling and verified through inventory updates
Frequency of monitoring/recording:	Decadal, following with inventory update
Value applied:	1,1508.2
Monitoring equipment:	Hand held GPS unit, GIS software
QA/QC procedures to be applied:	Meta data is kept current and uncorrupted
Calculation method:	
Any comment:	

Data Unit / Parameter:	A_2
Data unit:	Acres
Description:	Area of stratum *2*
Source of data:	GIS shape file derived from GPS coordinates
Description of measurement methods and procedures to be applied:	Strata area figures adjusted based on stocking levels and species distribution projected in modeling and verified through inventory updates
Frequency of monitoring/recording:	Decadal, following with inventory update
Value applied:	944.3
Monitoring equipment:	Hand held GPS unit, GIS software
QA/QC procedures to be applied:	Meta data is kept current and uncorrupted
Calculation method:	
Any comment:	

Data Unit / Parameter:	A_3
Data unit:	Acres
Description:	Area of stratum *3*

Source of data:	GIS shape file derived from GPS coordinates
Description of measurement methods and procedures to be applied:	Strata area figures adjusted based on stocking levels and species distribution projected in modeling and verified through inventory updates
Frequency of monitoring/recording:	Decadal, following with inventory update
Value applied:	1,907.7
Monitoring equipment:	Hand held GPS unit, GIS software
QA/QC procedures to be applied:	Meta data is kept current and uncorrupted
Calculation method:	
Any comment:	

Data Unit / Parameter:	A_4
Data unit:	Acres
Description:	Area of stratum *4*
Source of data:	GIS shape file derived from GPS coordinates
Description of measurement methods and procedures to be applied:	Strata area figures adjusted based on stocking levels and species distribution projected in modeling and verified through inventory updates
Frequency of monitoring/recording:	Decadal, following with inventory update
Value applied:	0
Monitoring equipment:	Hand held GPS unit, GIS software
QA/QC procedures to be applied:	Meta data is kept current and uncorrupted
Calculation method:	
Any comment:	

Data Unit / Parameter:	A_5
Data unit:	Acres
Description:	Area of stratum *5*
Source of data:	GIS shape file derived from GPS coordinates
Description of measurement methods and procedures to be applied:	Strata area figures adjusted based on stocking levels and species distribution projected in modeling and verified through inventory updates
Frequency of monitoring/recording:	Decadal, following with inventory update
Value applied:	1,636.5
Monitoring equipment:	Hand held GPS unit, GIS software
QA/QC procedures to be applied:	Meta data is kept current and uncorrupted

Calculation method:	
Any comment:	

Data Unit / Parameter:	A_6
Data unit:	Acres
Description:	Area of stratum *6*
Source of data:	GIS shape file derived from GPS coordinates
Description of measurement methods and procedures to be applied:	Strata area figures adjusted based on stocking levels and species distribution projected in modeling and verified through inventory updates
Frequency of monitoring/recording:	Decadal, following with inventory update
Value applied:	0
Monitoring equipment:	Hand held GPS unit, GIS software
QA/QC procedures to be applied:	Meta data is kept current and uncorrupted
Calculation method:	
Any comment:	

Data Unit / Parameter:	A_7
Data unit:	Acres
Description:	Area of stratum *7*
Source of data:	GIS shape file derived from GPS coordinates
Description of measurement methods and procedures to be applied:	Strata area figures adjusted based on stocking levels and species distribution projected in modeling and verified through inventory updates
Frequency of monitoring/recording:	Decadal, following with inventory update
Value applied:	1007.6
Monitoring equipment:	Hand held GPS unit, GIS software
QA/QC procedures to be applied:	Meta data is kept current and uncorrupted
Calculation method:	
Any comment:	

Data Unit / Parameter:	A_8
Data unit:	Acres
Description:	Area of stratum *8*
Source of data:	GIS shape file derived from GPS coordinates

Description of measurement methods and procedures to be applied:	Strata area figures adjusted based on stocking levels and species distribution projected in modeling and verified through inventory updates
Frequency of monitoring/recording:	Decadal, following with inventory update
Value applied:	586.4
Monitoring equipment:	Hand held GPS unit, GIS software
QA/QC procedures to be applied:	Meta data is kept current and uncorrupted
Calculation method:	
Any comment:	

Data Unit / Parameter:	***Ap***
Data unit:	Acres
Description:	Area of sample plot
Source of data:	
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording:	
Value applied:	N/A
Monitoring equipment:	
QA/QC procedures to be applied:	
Calculation method:	
Any comment:	Variable radius plot design using BAF 10 prism

Data Unit / Parameter:	*DBH*
Data unit:	in
Description:	Diameter at breast height of tree
Source of data:	Field measurement
Description of measurement methods and procedures to be applied:	Tree diameter measured 4.5ft. above the ground
Frequency of monitoring/recording:	Updated during annual inventory process
Value applied:	
Monitoring equipment:	Measured with Logger Tape or calipers
QA/QC procedures to be applied:	Equipment will be maintained in excellent condition. Breast height marked with permanent paint on all recorded trees >5in in diameter
Calculation method:	

Any comment:	

Data Unit / Parameter:	*Index*
Data unit:	Dimensionless
Description:	Site Index
Source of data:	Field measurement
Description of measurement methods and procedures to be applied:	Tree cores taken 4.5ft. above the ground (breast height)
Frequency of monitoring/recording:	Updated during annual inventory process
Value applied:	
Monitoring equipment:	Increment borer
QA/QC procedures to be applied:	Equipment will be maintained in excellent condition. If early rings are narrow in comparison to latter rings (signifying suppression) another core is taken from an alternate site tree
Calculation method:	
Any comment:	

Data Unit / Parameter:	***H***
Data unit:	ft
Description:	Height of tree
Source of data:	Field measurement
Description of measurement methods and procedures to be applied:	Executed in accordance with standard forest mensuration practices
Frequency of monitoring/recording:	Updated during annual inventory process
Value applied:	
Monitoring equipment:	Suunto Clinometer with percent and topographic scales
QA/QC procedures to be applied:	Equipment will be maintained in excellent condition and all height entries will be double checked for reasonableness prior to submission for verification
Calculation method:	
Any comment:	

Data Unit / Parameter:	PMP_i
Data unit:	%
Description:	Merchantable biomass as a proportion of total aboveground tree biomass for stratum *i* within the project boundaries
Source of data:	
Description of measurement methods and procedures to be applied:	Executed in accordance with standard forest mensuration practices
Frequency of monitoring/recording:	Yearly
Value applied:	
Monitoring equipment:	
QA/QC procedures to be applied:	All calculations double checked for accuracy prior to submission for verification
Calculation method:	Divide the FVS merchantable biomass output for a given stratum by the total above ground live tree biomass in said stratum
Any comment:	

Data Unit / Parameter:	***T***
Data unit:	yr
Description:	Number of years between monitoring time *t* and *t1* (*T = t2 – t1*)
Source of data:	Monitoring reports
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording:	Yearly
Value applied:	
Monitoring equipment:	Calendar
QA/QC procedures to be applied:	All calculations double checked for accuracy prior to submission for verification
Calculation method:	Subtraction
Any comment:	

4.3 Description of the Monitoring Plan

The following material outlines the monitoring plan to be followed during the first 10 years following project verification.

Monitoring Method

In the year of validation/verification (2013), a representative sample of 240 variable radius permanent inventory plots will be established across the project area. 43 of these plots will be

integrated from a network of pre-existing continuous forest inventory (CFI) plots on the property dating back to 1991. GIS software will be utilized to randomly distribute plot locations across the various project stratum, in proportion to stratum acreage, while incorporating the 43 existing CFI plots. All 240 permanent plots will be re-inventoried at least once over the following decade to calibrate forest growth models and improve carbon sequestration projections.

Permanent inventory plot centers will be logged using a professional grade GPS unit and monumented by a rebar pole buried in the ground and topped with a florescent plastic cap. Live trees qualifying as "in" using a BAF 10 prism will be recorded for species, total height (in feet), merchantable height to a 4" top, sawtimber height to a 10" top, % missing/rotten[6], and DBH (in 1/10th inches). Site index measurements will be recorded from a dominant tree on every fourth plot sampled. These site index figures will be used to improve growth and yield model results. Standing dead trees qualifying as "in" using a BAF 10 prism will be recorded for height as tree originally stood (based on height of neighboring trees, in feet), height in current condition (in feet), DBH (in inches), % missing/rotten, and decay class[7] (1, 2, or 3). All height measurements will be based on clinometer or laser range finder readings. All DBH measurements will be taken using a logger's tape. All inventoried trees of 5" DBH or greater will be marked with a permanent paint dot at breast height and numbered according to the order within the plot in which they were measured. At each plot a metal tag labeled with the inventory plot number and distance to plot center will be driven at ground level into the inward facing base of a dominant/codominant tree to allow for location of plot center if permanent paint markings fade. This plot design will give forest managers the opportunity to consistently track the growth and development of specific trees over an extended timeline and will allow for improved ease of plot location during field work and site verifications. It should be noted that harvest activities will not be affected by permanent plot locations. This will ensure that permanent plots accurately reflect the silvicultural treatments on the stands in which they reside.

In addition to inventory sampling, management staff will consistently monitor the general health and condition of the forest throughout the course of normal forest management activities (e.g. road maintenance, timber harvesting, boundary marking, etc.), reducing the risk of reversal by disease, pest invasion, and unauthorized timber removal. Any scheduled forest treatments will be documented through pre and post treatment monitoring and all forest removals will be tracked by product class. During pre treatment monitoring, forest staff verify stand stocking and condition before marking stands to designate trees for removal, perimeter of sale, and protected areas. During the harvest forest staff periodically inspect the site to review forest treatment activities and ensure compliance with management standards. Inspection reports are generated documenting inspection findings. Post harvest, a final inspection is carried out to assess conditions of the residual stand, quality of cleanup, and the retirement/stabilization of the landing and skid trails. Following natural disturbance events, affected project stands will be assessed for damage by Bethlehem forestry staff. If damage is significant, the effected areas will be re-inventoried and project scenario models will be adjusted to reflect onsite carbon stocks. Any changes in strata boundaries necessitated by harvesting or natural disturbances (i.e. stands moving from high stocking to low stocking through mortality or harvest) will be mapped and documented.

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[6] If there are portions of the tree that are missing/rotten, percent defect should be estimated with by visually dividing the tree into thirds, estimating the percentage that is missing or rotten in each third, and then using these estimates to determine the total defect by assuming that 70% of biomass is in the bottom third, 25% is in the middle third, and 5% is in the top third.

[7] **Decay Class 1**: Leaves still attached and having intact bark, fine twigs, and branches. **Decay Class 2:** Logs are starting to decompose, leaves largely are absent, and many of the fine twigs have fallen off the larger branches. Bark is typically loose, but only starting to fall off the log. **Decay Class 3:** Only a few large branches remaining, often in the form of stubs, the bark is falling off in large patches, and evidence of sloughing of sapwood is also evident. The outer wood is easily crushed by hand, although the inner portions can appear completely sound.

In years in which forest plots are not re-inventoried carbon stocks will be monitored through forest growth and yield modeling using the US Forest Service's FVS software.

Leakage will be consistently monitored throughout the project crediting period. As the Bethlehem Project Area is the only working forestland owned/managed by BA, the project is automatically in compliance with VM0003's prohibition of *activity shifting leakage*. The project's *Market effects leakage* will be re-assed, prior to each project verification, based on a comparison of the percentage of merchantable timber per acre on the project site compared to other forests within the region (See section 3.3 for a detailed description of all leakage calculations).

In accordance with the VCS AFOLU Requirement document (v3.3), the project baseline will be updated every 10 years. All decadal inventories following the 2013 inventory update, will be carried out in concurrence with the baseline update and the project scenario model and long term average will be calibrated/updated to reflect the most current state of the Bethlehem forest.

Organizational Structure, Responsibilities and Competencies

Blue Source LLC (Blue Source) will oversee the execution and reporting of all project reporting, modeling, and monitoring activities on behalf of the landowners, the Bethlehem Authority. The Nature Conservancy-Pennsylvania (TNC) and Woodlands Management Services LLC (WMS) will be responsible for "on the ground" forest management activities on the project area, and will conduct inventory measurements and data collection. After forest inventory data collection, both WMS and TNC will report results to Blue Source for processing and updating of modeling projections. After processing is complete Blue Source will house all data and submit the necessary documentation for compliance with VCS standards. Blue Source, TNC, or BA will store data in an online cloud storage account for at least two years after the conclusion of the project.

Blue Source is the leading climate change offset portfolio in the nation with more publicly registered third-party verified GHG offsets than any other company in North America. They have deep expertise in carbon project development and substantial experience working with forest carbon.

TNC is an internationally respected NGO that has been active in environmental management for over 60 year. TNC has a long history working with forest based carbon projects dating back to the groundbreaking1996 Noel Kempff climate action project. TNC's Pennsylvania chapter has a staff of qualified natural resource managers and is responsible for Pennsylvania's Working Woodlands forest conservation program designed to protect the states forests while improving private forest management, providing revenue for forest landowners, and fighting climate change.

WMS is a consulting firm specializing in forest management, timberland investment, and land conservation services. WMS staff holds professional degrees in Forestry, Environmental Management, Biology, and Environmental Studies, and collectively bring 45 years of forest management experience to the organization. Founded in 1994, WMS currently manages over 50,000 acres of forestland.

Methods for Generating, Recording, Storing, Aggregating, Collating and Reporting Data

All data will be collected on hand held Pocket PC data recorders incorporated with Pocket Dog data collection software, then downloaded and compiled on Office Dog. All equipment utilized throughout the course of the project will be regularly calibrated to the equipment's specifications and/or the relevant national standards.

Field personnel will use the following equipment for obtaining forest carbon data:

- 75' Logger Tape designed to measure in 10ths of inches

- Clinometer with percent and topographic scales
- 10 Basal Area Factor Prism
- Compass
- Increment borer
- Pocket PC equipped with PocketDog software
- Professional grade GPS handheld unit with point locations

All sample points will be located using professional grade handheld GPS units. At each point the cruiser will carryout the measurement and monumentaion practices described in the *Monitoring Method* section above.

All field data collectors will receive field training and complete several plots with an experienced collector before heading off on their own. Data collectors will be provided with data entry procedure documents that define species codes, product codes and overstory/regeneration tally methods. Tables of 10 BAF critical distances will be provided to each forester to verify border trees.

At each sample plot live trees qualifying as “in” using a BAF 10 prism will be recorded for all of the metrics described in the *Monitoring Method* section above. Where necessary, monumentation will be modified to incorporate new “in” trees and replace degraded monumentation materials. Pocketdog inventory data collection software will be used to record inventory plot data on HP ipaq handheld computers. Custom Pocketdog method sets will be patterned and designed per documented inventory procedures and provided by Fountains Forestry. These custom method sets will help to maintain the integrity of the data by prompting input, listing codes, and constraining entries with custom validation rules.

All inventory data will be uploaded, processed and compiled by TNC and WMS using TwoDog’s OfficeDog software. This will allow for the data to be easily converted to other formats for additional analysis pertaining to carbon offset generation. Multiple backups (to multiple hard drives) of raw data will be performed each time cruise data is uploaded. After upload, TNC or WMS will back up all inventory data and send a copy to Blue Source for statistical analysis and model updating. Blue Source will then compile all monitoring data and analysis and submit the required documentation for verification. BA will store all data in an online DropBox account for at least two years after the conclusion of the project.

Procedures for Auditing and Non-conformities

Non-conformities will be minimized by utilizing Twodog inventory software to analyze inventory plot data. Pocketdog inventory plots will be uploaded directly from the ipaq handhelds into the Twodog inventory software to avoid transcription errors. Once uploaded, inventory plots will be sorted into corresponding forest stands. As plots are sorted into appropriate stand types, data from each plot will be automatically validated by the Twodog software. Twodog will automatically return validation errors for any anomalous entry and trigger the data analyst to make appropriate corrections.

Sufficient field data will be collected to ensure that the uncertainty thresholds within the protocol are upheld. Uncertainty (i.e. the 90% confidence interval as a percentage of the mean) for all measurement pools will be maintained below 10% and a conservative approach will be taken in the selection of parameter values.

Ultimately stand data summary reports will be reviewed for reasonableness by WMS foresters, printed and entered into GIS stand layer attributes tables for archiving and use in day-to-day forest management activities. Additional review of the Twodog stand data reports and GIS attributes tables will be performed as the stand data is analyzed.

5 ENVIRONMENTAL IMPACT

In conformance with Principle 6 of the FSC Forest Management Standard 1.0, FSC certified forests must undergo an environmental impact review, to ensure that "forest management shall conserve biological diversity and its associated values, water resources, soils, and unique and fragile ecosystems and landscapes, and, by so doing, maintain the ecological functions and the integrity of the forest." Specifically, the environmental impact review process included an assessment of the following:

1) Forest community types and development, size class and/or successional stages, and associated natural disturbance regimes;

2) Rare, Threatened and Endangered (RTE) species and rare ecological communities (including plant communities);

3) Other habitats and species of management concern;

4) Water resources and associated riparian habitats and hydrologic functions;

5) Soil resources; and

6) Historic conditions of Forest Management Units related to forest community types and development, size class and/or successional stages, and a broad comparison of historic and current conditions.

Through this assessment it was established that forest management practices on the project area would maintain, enhance, or restore ecological functions in support of healthy forest regeneration/succession and encourage genetic, species, and ecosystem diversity.

In executing the environmental impact review, forest managers queried multiple governmental databases (Rare Threatened, or Endangered Species (RTEs), Historical & Cultural Sites) to determine if relevant items (rare plants, known historical sites, etc.) were know to exist on or near the property, and if hits were received, an approach was designed to afford such items protection. In the case of rare, threatened, or endangered species a strategy was developed to maintain/enhance them. Pages 40-47, 51-52, and 152-158 of the Bethlehem Forest Management Plan provide examples of these maintenance/enhancement activities.

[*The Forest Management Plan is provided separately for validation and verification purposes*]

6 STAKEHOLDER COMMENTS

To engage with the community and to monitor stakeholder issues and concerns, BA conducts monthly meetings that are open to the public. These board meetings are used as a platform to proactively communicate with constituents and obtain feedback, enabling the Authority to stay aware of community concerns and issues. Meeting minutes are posted on the Authority's website, providing an efficient and effective method to inform the public of new or ongoing activities, including forest management operations. The integrated use of monthly public meetings, the

Authority's website, local newspapers, and relationships maintained by City and Authority employees promote a consistent, interactive dialogue with a broad set of stakeholders.

Stakeholder comments can be viewed at: http://www.bethlehem-pa.gov/dept/authority/index.htm

[*Select stakeholder comments related to the IFM project from 10-5-2010, 5-5-2011, and 6-14-2012, provided separately for validation and verification purposes*]