Chelsea & Apple Hill
Solar Projects

Memo re: Visual Appearance and Glare Potential

SE GROUP

MEMORANDUM

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TO: Brad Wilson, Ecos

FROM: Mark Kane

CC:

DATE: May 16, 2017

RE: Chelsea and Apple Hill Solar Visual Simulation Analysis

This memorandum serves to summarize SE Group's efforts to visualize the proposed Chelsea and Apple Hill Solar project's in Bennington, Vermont. This effort included building a 3D terrain model (from lidar data and orthophotographs) encompassing the area where the two projects are proposed and extending outward in all directions to encompass the surrounding highway infrastructure, residential areas and Vermont Welcome Center.

This analysis methodology relied on several steps:

1. The 3D model incorporated the CAD design plans provided by Ecos, including the location of proposed panels, their height and form, the location of proposed fence lines, inverter skids, access roads and other supportive elements. These plans were modified to further increase the separation distances between the projects and surrounding properties and public rights-of-way.

2. The topographic basis for the 3D model was derived from high-resolution LIDAR data in the area. This data set extended outwards from the project sites.

3. An aerial photograph acquired by Google (dated September 2014) has been draped onto this topographic elevation model to provide context.

4. To the 3D model was added an assortment of 3D trees and some shrubs (of varying heights and forms) to reflect the existing pattern of vegetation (predominantly deciduous species). The placement of these 3D trees and shrubs was based on the underlying aerial photographs and site photographs taken previously by SE Group. While over 60K trees and shrubs are placed within the 3D model, SE Group believes the real-world density is much higher; likely underestimating the effectiveness of existing (and retained) vegetation in minimizing offsite visibility.

5. SE Group also added 3D elements reflecting the proposed mitigation landscaping within key areas of the projects with the intent to enhance natural screening afforded by existing vegetation. This vegetation was simulated at approximately 5 years of growth.

6. The model also incorporated new, taller fencing (10 feet) outfitted with an 85% opaque mesh (black) screening material along segments of the Apple Hill and Chelsea Solar Arrays. The

purpose of this updated fencing was to create additional screening in close proximity to the arrays and

7. The modeling components were separated into two parts – the Chelsea Solar project alone and the overall Chelsea and Apple Hill Solar projects together. As these are two separate projects, the analysis first considered the visualization of just the Chelsea Solar project. In this set of simulations, the area of the site occupied by the Apple Hill Solar project remains wooded. The second set of simulations reflect both projects in place with the proposed amount of clearing.

8. Five (5) viewpoints were selected from which 3d perspective views of the Project(s) were created. The location of these viewpoints is shown graphically on the each of the Viewpoint Plans provided. The summary below table below provides a description of each viewpoints including the direction of view, the elevation (feet at eye level) of observers, the elevation distance (feet, + or -) relative to the closest panel in each array from this viewpoint and the overall linear distance (feet) between this viewpoint and the closest panel in each (if appropriate) array.

Viewpoint Description	**Direction of View**	**Elevation of Observer**	**Observer Elevation Relative to Closest Panel**	**Distance to Closest Panel**
Vermont Welcome Center	North	663 ft.	Chelsea: - 26 ft. Apple Hill: - 61 ft.	Chelsea: 1620 ft. Apple Hill: 1350 ft.
Route 7 Northbound Lane	Northeast	705 ft.	Chelsea: - 5 ft.	Chelsea: 200 ft.
Residence 1	South	795 ft.	Chelsea: + 45 ft. Apple Hill: + 55 ft.	Chelsea: 595 ft. Apple Hill: 960 ft.
Residence 2	South	762 ft.	Chelsea: + 36 ft.	Chelsea: 350 ft.
Residence 3	Southwest	804 ft.	Apple Hill: + 33 ft.	Apple Hill: 385 ft.

9. The simulated views were developed using a combination of SketchUp, Maxwell Render and Photoshop software. This set of software produced high-resolution model simulations with a focal length of 52mm, equivalent to the human eye. For accurate representation of the project, the 11x17 simulations should be held approximately 17.2 inches away from the viewer's eye. Zooming in or looking at these simulations from distances closer than 17.2 inches is the equivalent of using binoculars or other devices to assist in viewing the projects. The standard practice for visual analysis considers visibility to the unaided eye.

10. Modeling for each Viewpoint assumed an eye level height of 5'5".

11. Modeling for each Viewpoint assumed three conditions; existing, proposed project in summer and proposed project in winter. Existing conditions reflect leaf-on conditions from each Viewpoint. The placement of elements in each view was based on available site photographs and aerial photographs. SE Group staff did not visit any private properties to develop the existing condition view. No clearing for either projects was assumed for these views. For the

proposed condition (summer) the simulation assumed clearing as complete and all components for the appropriate project(s) were installed. It also assumed a date and time of August 18th at 10:30 AM from which the modeling software determined the angle of the sun and cast shadow and light accordingly. All summer trees and shrubs were assumed leaf-on. For the winter condition, again clearing and project components were complete. These winter simulations assumed a date and time of November 8 at 1:30 pm. Again, light and shadow were rendered accordingly. No ground snow was simulated. No atmospheric factors (snow, rain, clouds, fog, haze) were simulated in any of these conditions. The inclusion of such factors would likely degrade potential visibility, particularly from distance.

12. The analysis includes cross-sections through the project site to viewpoints. These cross-sections illustrate the relationship between the viewpoints and each proposed project(s), highlighting the linear distances and vertical relationships. They also indicate where existing vegetation will remain along the site line, where new mitigation plantings are proposed and the location of the fencing.

The above work was combined into a set of plans which are attached. Two sets are provided, one representing just the Chelsea Solar Project and the second with the inclusion of the Apple Hill Solar project. Each set is described below.

CHELSEA SOLAR PROJECT

Viewpoints Plan: This plan map shows the limits of the proposed Chelsea Solar Project) along with the location of the proposed access road, the Visitor (Vermont Welcome Center), the Route 7 corridor and the location of the five viewpoints.

3D Overview Plan: This plan provides a “birdseye” overview of the proposed Chelsea Solar Project in context with the surrounding context. It also illustrates the components simulated in the model (array, access road), the location of the viewpoints and the extent of the modeled 3D trees.

Site Plan: This site-level plan illustrates the location of the Chelsea Solar Project and its constituent components along with proposed landscape mitigation. For this project mitigation measures include plantings along the Apple Hill Road area, plantings north of the array between Residence #2 and the project, plantings along the western boundary between the project and Route 7, the inclusion of a 10-foot-tall fence with 85% screening mesh and the use of darker solar modules with black backing panels. Large (20-24 foot) evergreens are proposed between the Project and Residence #2 to provide immediate and effective screening.

Viewpoint: Vermont Welcome Center

Existing Conditions: Welcome Center (Eye Level): This is the existing view from the parking area of the welcome center looking northward. It shows the existing foreground trees in the parking lot plus the existing vegetation to the north on the project site.

3D Perspective: Welcome Center - Summer (Eye Level): This image is also taken from the Welcome Center looking northward. Looking to center-left of the image in the approximate location where the Chelsea Hill Solar project is proposed, the simulation confirms that the existing area of woods that are preserved continue to fully screen views even from this vantage point.

3D Perspective: Welcome Center – Winter (Eye Level): This image is taken from the same position as above. The trees are shown in winter (leaf-off) condition. The array is over 1,620 feet away to the north. Natural vegetation within the subject property and along the Route 7 corridor screen views from this location. The dark mass of the solar array, coupled with the screening fence help additionally screen views into the site. No unfiltered visibility of the project is possible based on this analysis.

Site Sections: Welcome Center: This cross-section highlights the significant distance and grade relationships between the Chelsea Solar Project and the Welcome Center. The preservation of approximately 300 feet of existing woodland provides considerable buffering from any direct or unfiltered view.

Viewpoint: Route 7 North

Existing Conditions: Route 7 North (Eye Level): This image is taken from a location along Route 7 heading north and slightly south of the proposed Chelsea Solar project. At this point the array is 200 feet away from the observer.

3D Perspective: Route 7 North - Summer (Eye Level): This image is taken from the same location along Route 7 heading north and slightly south of the proposed Chelsea Solar project. A very narrow opening in the existing woods along the corridor allows for a short duration view of a small portion of the project. Landscape mitigation shown in the site plan effectively screens the project. Additional understory plantings that are not captured by the 3D modeling process will likely even further limit and reduce any views from this highly transient viewpoint.

3D Perspective: Route 7 North - Winter (Eye Level): Similar to above, the winter view shows a brief glimpse of the solar project beyond. This glimpse is highly mitigated by the inclusion of the screening fencing, landscape mitigation and the use of the darker photovoltaic modules. These mitigation measure accentuate the general screening that the understory provides. Again, the effectiveness of the retained understory is likely greater than depicted given its density. Additionally, the growth of proposed mitigation plantings will, in time even further degrade potential views.

Site Sections: Route 7 North: This cross-section highlights the distance and grade relationships between the Chelsea Solar Project and the Route 7 North Viewpoint. The preservation of approximately 150 feet of existing woodland provides buffering from any direct or unfiltered view. The inclusion of mitigation plantings along the western edge of the array and the 10-foot screening fence also bolster the efficacy of this retained vegetation.

Viewpoint: Residence 1

Existing Conditions: Residence 1 (Eye Level): This image is taken from a location adjacent to Ms. Harris's home, north of the project and looking south. In the foreground is the existing open lawn. In the midground is a stone wall and apple trees that separates the Harris property from properties owned

by Ecos. The Chelsea Solar project is minimally 595 feet away from this location and 45 feet lower in elevation. It is positioned to the viewers right. No direct or unfiltered visibility of the project is possible based on this analysis.

3D Perspective: Residence 1 – Summer (Eye Level): This image is taken from a location adjacent to Ms. Harris's home, north of the project and looking south. In the foreground is the existing open lawn. In the midground is a stone wall and apple trees that separates the Harris property from properties owned by Ecos. The landscaping elements in the far-midground are proposed mixed deciduous and coniferous plantings to limit views towards the project. The Chelsea Solar project is minimally 595 feet away from this location and 45 feet lower in elevation. No direct or unfiltered visibility of the project is possible based on this analysis.

3D Perspective: Residence 1 – Winter (Eye Level): Like the image above, but rendered in winter (leaf-off) conditions, the visibility of the Chelsea Solar project remains precluded by the continued effectiveness of retained vegetation and the use of the taller screening fence which masks and diminishes the view of the panels. Also, the use of dark backing on the panels is particularly helpful in this location as the photovoltaic surface is facing away from the observer. No direct or unfiltered visibility of the project is possible based on this analysis.

Site Sections: Residence 1: This cross-section highlights the distance and grade relationships between the Chelsea Solar Project and the Residence 1 Viewpoint. The preservation of existing trees (apples) in the midground, coupled with the significant grade change, provides buffering from any direct or unfiltered view. The inclusion of mitigation plantings along the property line and the 10-foot screening fence also bolster the efficacy of these other mitigation features.

Viewpoint Residence 2:

Existing Conditions: Residence 2 (Eye Level): This image is taken from a location at Residence 2, north of the project and looking south. The foreground is dominated by existing woods. The Chelsea Solar project is minimally 350 feet away from this location and 36 feet lower in elevation. The Project is positioned in the center of the view. No direct or unfiltered visibility of the project is possible based on this analysis.

3D Perspective: Residence 2- Summer (Eye Level): This image is taken from Residence 2, north of the project. As illustrated in the Site Section (below), with the development of the Chelsea Solar Project there would be approximately 150 feet of woodlands preserved between the residence and the project fence. As the 3D perspective illustrates, this existing and retained woodland forms a visual barrier to views further south. The inclusion of proposed large evergreen trees near the project (20-24 feet in height) and the use of the 10-foot-tall screening fence preclude direct or unfiltered visibility of the project, based on this analysis.

3D Perspective: Residence 2 - Winter (Eye Level): This image, rendered from the same place as above, illustrates the condition in leaf-off. The dark color of the screening fence and the black backing of the panels (they are oriented away from the observer), considerably lessen visibility. The large evergreen trees near the project (20-24 feet in height) addresses a specific area where, because of the

shape of the terrain, glimpses of the array might have been possible. The inclusion of these mitigation measures preclude direct or unfiltered visibility of the project, based on this analysis.

Site Sections: Residence 2: This cross-section highlights the distance and grade relationships between the Chelsea Solar Project and the Residence 2 Viewpoint. It highlights the approximately 150 feet of existing woods that separates the views. It also shows the location of the large evergreens and screening fence and how the array is placed within the landscape.

Viewpoint Residence 3

Existing Conditions: Residence 3 (Eye Level): This image is taken from a location at Residence 3, east of the project and looking west. A present, this view looks west across foreground trees and the remnant apple orchard. The terrain falls away which greatly lessens view potential. The nearest panel for the Chelsea Solar project is more than 600 feet away making direct or unfiltered visibility of the project impossible based on this analysis.

3D Perspective: Residence 3- Summer (Eye Level): This image is taken from Residence 3, east of the project. The foreground is dominated by existing trees and the remnant apple orchard. The Chelsea Solar Project array falls away from the observer in this view and, when coupled with natural vegetation and the screening fence, is effectively screened.

3D Perspective: Residence 3 - Winter (Eye Level): This image, rendered from the same place as above, illustrates the condition in leaf-off. The dark color of the screening fence and the black backing of the panels (they are oriented away from the observer), considerably lessen visibility. The inclusion of these mitigation measures precludes direct or unfiltered visibility of the project, based on this analysis.

Site Sections: Residence 3: This cross-section highlights the distance and grade relationships between the Chelsea Solar Project and the Residence 2 Viewpoint. It highlights the approximately 150 feet of existing woods that separates the views. It also shows the location of the existing apple trees, the screening fence and how the array falls away from the observer.

APPLE HILL SOLAR PROJECT

Viewpoints Plan: This plan map shows the limits of the proposed Apple Hill Solar array in context with the previously discussed Chelsea Solar Array, the location of the proposed access roads, the Vermont Welcome Center, the Route 7 corridor and three additional residential viewpoints.

3D Overview Plan: This plan provides a “birdseye” overview of the proposed Chelsea and Apple Hill Solar Projects in context with the surroundings. It also illustrates the project components simulated in the model (array, access road, inverter stations, distribution poles), the location of the viewpoints and the extent of the modeled 3D trees.

Site Plan: This site-level plan illustrates the Apple Hill Solar Project and its constituent components along with proposed landscape mitigation measures (14, 8-10-foot-tall white pine trees). The Chelsea Solar Project is shown for context and was included in all simulations developed in this set. For the

Apple Hill Solar Project, the mitigation measures include plantings south of the proposed access drive, the inclusion of a 10-foot-tall fence with 85% screening mesh and the use of darker solar modules.

Site Sections: The first cross-section is placed through the proposed Apple Hills solar array from the VT Welcome Center viewpoint and looking northward. This section highlights the grade relationship between the visitor center and the array, the distances and where natural vegetation exists south of the project which limits direct views northward. An element to note on the section is how far back the project is set from the exposed rock along the north side of the Route 7 access lane (600+ feet). This rock face is readily observed in images from the Welcome Center. This image also shows an area of mitigation planting along the southern edge of the access road.

Viewpoint: Vermont Welcome Center

Existing Conditions: Welcome Center (Eye Level): This is the existing view from the parking area of the welcome center looking northward. It shows the existing foreground trees (made transparent to aid in longer-range views) in the parking lot plus the existing vegetation to the north on the project site.

3D Perspective: Welcome Center - Summer (Eye Level): This image is also taken from the Welcome Center looking northward. Looking to center of the image in the approximate location where the Apple Hill Solar project is proposed, the simulation confirms that the existing area of woods that are preserved continue to fully screen views even from this vantage point.

3D Perspective: Welcome Center – Winter (Eye Level): This image is taken from the same position as above. The trees are shown in winter (leaf-off) condition. The array is over 1,350 feet away to the north. Natural vegetation within the subject property and along the southern edge of the property screen views from this location. The dark mass of the solar array, coupled with the screening fence help additionally screen views into the site. The proposed landscape mitigation measures “close up” potential views north along the access road in all seasons. No unfiltered visibility of the project is possible based on this analysis.

Site Sections: Welcome Center: This cross-section highlights the significant distance and grade relationships between the Apple Hill Solar Project and the Welcome Center. The substantial distance (1,350 feet), the preservation of at least 200 feet of existing woodland along the southern edge of the project, the strategic use of landscape mitigation and the inclusion of screening fencing all work to preclude direct or unfiltered views.

Viewpoint: Route 7 North

Existing Conditions: Route 7 North (Eye Level): This image is taken from a location along Route 7 heading north and slightly south of the proposed Chelsea Solar project. At this point the array is 200 feet away from the observer.

3D Perspective: Route 7 North - Summer (Eye Level): This image is taken from the same location along Route 7 heading north and slightly south of the proposed Chelsea Solar project. Because the Apple Hill Project is completely screened, this view is the same as simulated for the Chelsea Solar Project (above).

3D Perspective: Route 7 North - Winter (Eye Level): See note above, same view as for the Chelsea Solar Project. No direct visibility of the Apple Hill Solar Project.

Site Sections: Route 7 North: See note above, same as for the Chelsea Solar Project.

Viewpoint: Residence 1

Existing Conditions: Residence 1 (Eye Level): This image is taken from a location adjacent to Ms. Harris's home, north of the project and looking south. In the foreground is the existing open lawn. In the midground is a stone wall and apple trees that separates the Harris property from properties owned by Ecos. The Apple Hill project is minimally 960 feet away from this location and 55 feet lower in elevation. It is positioned to the viewers right. No direct or unfiltered visibility of the project is possible based on this analysis.

3D Perspective: Residence 1 – Summer (Eye Level): This image is taken from a location adjacent to Ms. Harris's home, north of the project and looking south. In the foreground is the existing open lawn. In the midground is a stone wall and apple trees that separates the Harris property from properties owned by Ecos. The landscaping elements in the far-midground are proposed mixed deciduous and coniferous plantings to limit views towards the project. The Apple Hill project is minimally 960 feet away from this location and 55 feet lower in elevation. No direct or unfiltered visibility of the project is possible based on this analysis.

3D Perspective: Residence 1 – Winter (Eye Level): Like the image above, but rendered in winter (leaf-off) conditions, the visibility of the Apple Hill project remains precluded by change in elevation, the continued effectiveness of retained vegetation and the use of the taller screening fence which masks and diminishes the view of the panels. No direct or unfiltered visibility of the project is possible based on this analysis.

Site Sections: Residence 1: This cross-section highlights the distance and grade relationships between the Chelsea Solar Project and the Residence 1 Viewpoint. The preservation of existing trees (apples) in the midground, coupled with the significant grade change, provides buffering from any direct or unfiltered view. The inclusion of mitigation plantings along the property line and the 10-foot screening fence also bolster the efficacy of these other mitigation features.

Viewpoint Residence 2:

Existing Conditions: Residence 2 (Eye Level): This image is taken from a location at Residence 2, north of the project and looking south. The foreground is dominated by existing woods. The Chelsea Solar project is minimally 350 feet away from this location and 36 feet lower in elevation. The Apple Hill project is beyond (to the south) of the Chelsea Solar project.

3D Perspective: Residence 2- Summer (Eye Level): This is the same resultant image as depicted for Residence 2 for the Chelsea Solar Project set. The Apple Hill Solar project is not visible from this location.

3D Perspective: Residence 2 - Winter (Eye Level): This is the same resultant image as depicted for Residence 2 for the Chelsea Solar Project set. The Apple Hill Solar project is not visible from this location.

Site Sections: Residence 2: This is the same resultant image as depicted for Residence 2 for the Chelsea Solar Project set. The Apple Hill Solar project is not visible from this location.

Viewpoint Residence 3

Existing Conditions: Residence 3 (Eye Level): This image is taken from a location at Residence 3, east of the project and looking south and west. A present, this view looks west across the remnant apple orchard with a band (about 50 feet in width) of mature woods beyond. The terrain falls away which greatly lessens view potential. These existing features, coupled with the considerable distance (385 feet) between the property and the nearest panel make direct or unfiltered visibility of the project is impossible based on this analysis.

3D Perspective: Residence 3- Summer (Eye Level): This image is taken from Residence 3, east of the project. The foreground is dominated by existing trees and the remnant apple orchard. The Apple Hill array is much lower in elevation relative to the observer in this view and, when coupled with natural vegetation and the screening fence, is effectively screened.

3D Perspective: Residence 3 - Winter (Eye Level): This image, rendered from the same place as above, illustrates the condition in leaf-off. The foreground apple trees continue to punctuate the view but it's the dark color of the screening fence and the black backing of the panels (they are oriented away from the observer) that greatly lessen visibility. With the array dropping away from the fence line, the ability for direct or unfiltered visibility of the project is impossible, based on this analysis.

Site Sections: Residence 3: This cross-section highlights the distance and grade relationships between the Chelsea Solar Project and the Residence 3 Viewpoint. It highlights the approximately 300 feet of existing trees and retained woods that separates the views. It also shows the location of the existing apple trees, the screening fence and how the array falls away from the observer.

GLARE

In earlier considerations for these projects, SE Group evaluated the potential for glare using the Glare Hazard Assessment Tool (GHAT) which was developed by the Sandia National Labs. While that screening level tool does not account for vegetation, the original analysis did not suggest any high probability for glare on surrounding areas. It is important to consider that what glare might occur would have to be focused to the south, away from the photovoltaic surfaces of the arrays. As described above, the two locations considered which were south of the either array were the Welcome Center and the Route 7 North viewpoint.

For Route 7 North, the Chelsea Solar Project has proposed extensive mitigation along the western property line plus the use of a 10-foot-tall screening fence. Both measures, coupled with the distances

(more than 200 feet) and the decision by Ecos to use a darker solar module (which has low albedo and an even lower reflectivity coefficient), would indicate very low potential for glare to be seen.

For the Welcome Center, the computer simulations indicate no direct or unfiltered visibility of either project. Given this, and the considerable distances involved (beyond 1,350 feet), the likelihood of any meaningful impact from glare would be low.

As noted above, in the unlikely event that any glare is generated it would be directed to the south. As such, no possibility of glare-related impacts is possible to the three residential properties considered in this analysis.