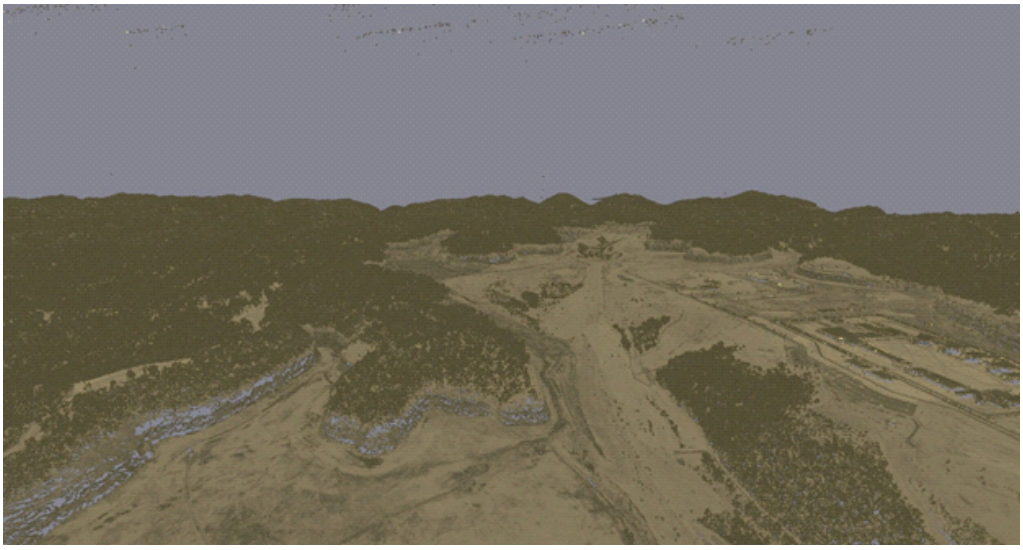
Appendix N – Comprehensive Land Use Master Plan

Comprehensive Land Use Master Plan for the Indian Ridge Site, McDowell County, WV December 30, 2012



Comprehensive Land Use Master Plan

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Executive Summary

The 6,000 acre McDowell County site exhibits scars from former mining operations with exposed highwalls, valley fills and rocky compacted soils. The site's soils, vegetation and hydrology were assessed to understand the ecological composition. Steep slopes, low soil fertility, highly engineered hydrology, and sparse pioneer and hydric vegetation were observed. While most areas were dominated by highly compacted soils and invasive species; historic native vegetation and functioning hydrologic systems were present.

The site was further analyzed in order to identify opportunities and constraints associated with landscape restoration and development. In addition to field observation and measurements, GIS data was collected and analyzed. Data included topography, land cover, soils, road alignment, and hydrology. Aerial LiDAR imagery and three-dimensional spatial modeling was used to communicate, analyze, design and plan for the sustainable energy park.

Participatory planning engaged community groups, local officials and experts in sustainable energy. These groups provided important contributions to the planning process. Researchers learned local concerns, needs and opportunities for connection to the greater community. Economic, educational and recreational opportunities were identified and incorporated into a comprehensive Master Plan for the site. The plan included the spatial layout, hierarchy, and connectivity between residential, commercial, recreational, industrial and sustainable energy land use areas.

Further analysis of green infrastructure opportunities and case study research was performed. This provided a deeper understanding of design processes and successful implementation of restoration and development methods on sites with a similar land use history. A design concept and comprehensive green infrastructure network were used to further the design development. Proposed restoration blended ecological succession with new ecologies that simulate natural systems while incorporating sustainable energy and building. Illustrative renderings and a three-dimensional model were constructed to communicate the site layout and design.

Plans for the site will provide a green energy industry alternative following coal-mining. Sustainable development initiatives seek to restore, to the extent possible, ecosystem services adversely impacted during mining operations. Through community engagement and environmental assessment, a framework for a sustainable energy park integrated low impact development and green infrastructure initiatives that re-build ecological values and functions into the landscape. Recreation, housing, commerce and transportation, will blend practices such as biomass, solar, and wind energy production. The site will not only generate local economic growth through the development of renewable technologies, but will restore ecosystem services which foster ecological and social benefits within the community.

Goal

The goal of this project is to create a framework for developing Sustainable Energy Park (SEP) opportunities on mined lands in Appalachia that can be transferred to other communities facing similar challenges posed by mine-scarred land redevelopment. Consideration has been given to the potential of alternative energy generation such as wind, solar, geothermal and biomass production. We have identified mine-scarred lands in Appalachia suitable for redevelopment into alternative energy production sites that would generate local economic growth, decrease or offset greenhouse gases through carbon sequestration, and promote the development of renewable energy technologies.

Introduction

The Southern Coalfields of West Virginia is a region undergoing extraordinary levels of change through the practice of mountaintop removal mining (Todd 2008). At the core of the disturbance is northern McDowell County in deep southern West Virginia, an economically and ecologically compromised area long dependent on extractive industries and a venue of ongoing degradation. Mountaintop removal involves the excavation of a coal seam from the top down, rather than traditional tunnel mining. The overburden is then disposed of as valley fills, filling stream corridors and disrupting hydrologic functions as well as decimating other natural systems. As 'developable' flat land, the remnant landscape is perceived to provide economic development opportunities for local communities (Associated Press 2010). Expressway alignments, which will skip from mine site to mine site along ridge tops, are constructed as a part of the reclamation process, as are acreages for future development of mixed uses and interchange services. The site of this project is a reclaimed surface mine north of the town of Welch WV and on the border between Wyoming and McDowell Counties including the Indian Ridge Industrial Park (600 acres). The property is owned by the McDowell County Economic Development Authority (MCEDA). This project proposes the positive reuse of the landscape through the installation of alternative energy infrastructure: biomass, wind, and solar; and a phased plan for integration of mixed-use development.

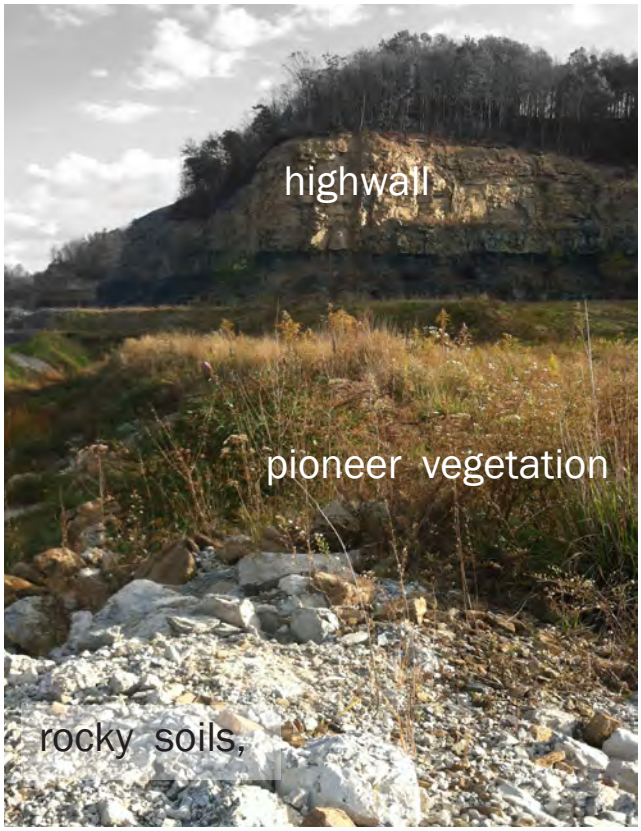
In visualizing change within the six thousand acre project area, researchers created a three-dimensional model of the site using ground-based static and aerial LiDAR (Light Detection and Ranging). Pointools® and Rhinoceros® software were used to construct the model and create a design environment (Berger 2008). The model provides a very recent (2012) portrait of the landscape and its components: bare-earth topography; drainage systems installed as a part of the reclamation mitigation; groundcover, shrub layer, sub-canopy and canopy vegetation; infrastructure, roads, and buildings. The lone resident buildings on the site are components of a Federal Correctional Institution (FCI) McDowell. Designing within the model allowed researchers to test a variety of planning scenarios and create visualizations (Sheppard and Lewis 2006) that captured the phasing of the project, and expressed the aspirations of the community. Visualization phases included: 1. Biomass, Solar, Wind and Recreation; 2. Expressway Development and Interchange Zone; 3. Residential; 4. Commercial and Industrial; and 5. Stormwater Infrastructure, Green Infrastructure and Bioremediation. Local participation ensured that the project addressed local needs in becoming a model project for the region promoting sustainable development approaches to heavily impacted landscapes.

Key planning concepts, beyond the previously mentioned mixed-use development, will represent a new paradigm in sustainable development within an industrial mine-scarred brownfield context. Innovations include applying: Leadership in Energy and Environmental Design for Neighborhood Design (USGBC 2009); green energy economy and job training (USGBC 2009); ecological design and low impact development solutions (US EPA 2013); and the brownfield redevelopment topics: brownfield reclamation; phytoremediation; and soil, water, vegetation reconstruction (Berger 2008, Schneider 2008, Del Tredici 2008).

Environmental Assessment

General Overview

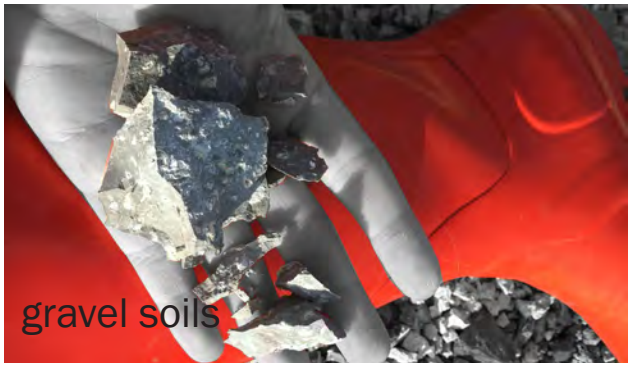
The McDowell County, West Virginia site can be described as a site exhibiting scars from former surface mining operations. Highwalls remain in place and surround the site, exposing layers of geological development. The forest perched on the highwalls is a mixture of mature hardwood species with a thin soil profile. The mine scarred land contained within the highwalls is generally comprised of highly compacted soil, with several rocky, gravely berms and minimal topographic change beyond the valley fill areas. A utility corridor along the future highway right-of-way bisects the site, creating a ridge separating site hydrology. The vegetation can generally be described as successional,comprised mainly of grasses and forbs with pioneer tree species that are both native and invasive. Pioneer species are the first species to colonize a disturbed site. They are fast growing and shade intolerent. Grasses along with forbs, which are broad-leaved herbaceous plants, are examples of non-woody pioneer species. Grading directs stormwater through a series of swales along the highwall edges and surrounding valley fill areas. Several small isolated wetland pockets have formed in flatter areas throughout the site. There are several valley fill areas as evidenced by patches of mature forest and grassy terraces with stone stormwater channels directing water to the remaining valley reaches. The valley fill slopes are extremely steep making them difficult to access and susceptible to erosion. A series of ponds line the bottom of the valley fill. These areas have limited water movement, acting similar to a detention system. The hydrology here is linked and discharges into the adjacent residential valley. Due to the limited soil profile development, excessive soil compaction, and sparse native vegetation, the site is void of significant ecological value and feeds the adjacent valley with an excess of sediment.



Soils

The majority of soils on the site can be characterized as compact rocky, gravely oxidized grey to black silt loam mix. Based on the soil and vegetation quality, there is no evidence that topsoil was salvaged and spread following mining operations. This, in conjunction with excessive soil compaction, has significantly inhibited healthy soil development. Typically, it can be expected that a gravel/silt loam

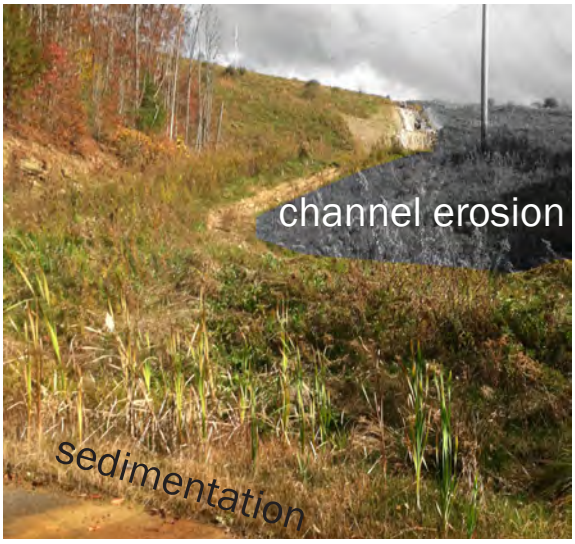
soil mix would allow for some infiltration. However, due to excessive soil compaction, it is anticipated that there will be little permeability in many areas of the site. Soil pH measurements ranged from 4.0 - 7.2. With all but one measurement being below 7.0, the soils may be characterized as acidic. The dominance of broomsedge bluestem (*Andropogon virginicus*) is further evidence that the soils are acidic with low fertility.



Flat topography in areas surrounding valley fills result in the formation of several wetland pockets. Runoff that is not managed through the swale system settles in these depressions where a hydric soil profile, high in organic content, has developed. Even during the dry season these soils remain saturated, with high clay content and show very little evidence of oxidation. There are some wetland areas receiving higher afternoon sun that are drier in comparison with shadier areas. Here, gleyed soil with oxidized root channels indicate that these areas are dry during some periods of the year but have periods of heavy precipitation. The swale systems exhibited similar soil profiles to the wetland pockets. While many of the swales were dry, wetland plants were present in soils with organic content, indicating hydric conditions during part of the season.

Valley fill areas have retained some soil nutrients to maintain original forest cover in areas that were undisturbed. However, due to the steep topography and an oak-dominated vegetation profile, it is likely that the soil profile is shallow and less developed. Steep slopes typically cause soil to erode more easily, which is evidenced from the formation of gullies and sedimentation in the pond areas below. The terraced areas containing rock weirs are similar to the gravely silt loam soils in the fill areas. However, compaction is significantly less, which have caused some areas to be less stable. Sinkholes and settlement have occurred on several terraces that contain less gravel content. Erosion is evident along the edges of the stone weir channels. The most heavily eroded channels are in the southerly valley fill, adjacent to the residential neighborhood. Significant sedimentation in this area is evident. Valley fills are often susceptible to erosion as fill material is less compacted and stone weirs create point controlled hydrology. These valley fills are further stressed, due to their downstream location along the hydrologic chain on the mine scarred land.

Failure of the rock highwalls is a concern. These walls are formed from siltstone, shale, fine grained sandstone, and coal. During restoration, typically the site is graded to form gentle slopes that would not leave an exposed rock face. Since these rock highwalls are susceptible to erosion and sheer failure, an appropriate angle of repose should be considered during development. To ensure people's safety, it is recommended that no buildings are constructed within a distance of twice the height of the rock highwall.



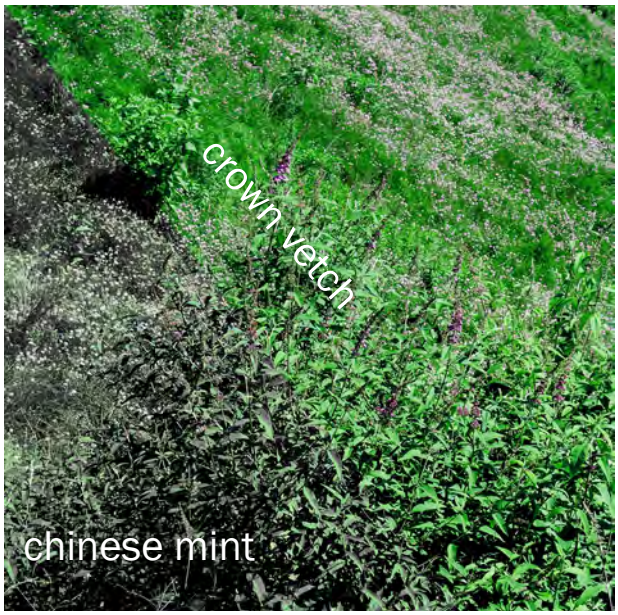
Vegetation

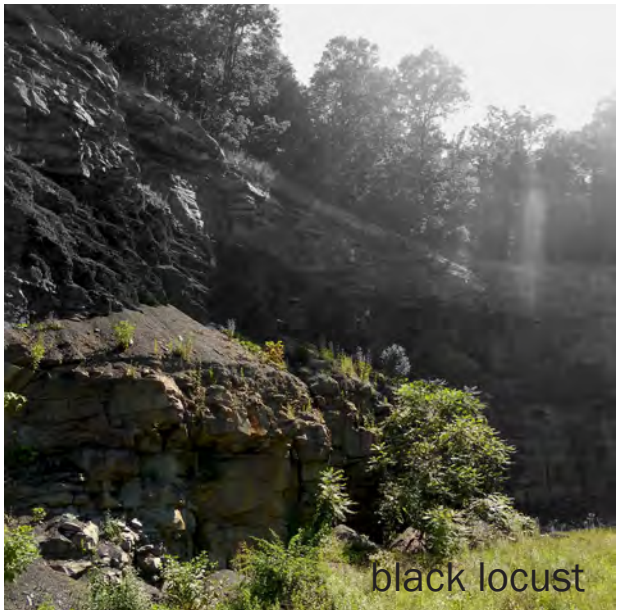
Upland forested areas surrounding the site are comprised of a mixture of hardwood species dominated by Alleghenny-Cumberland dry oak forest and hardwood species such as red, black and scarlet oaks *(Quercus rubra, Quercus velutina, and Quercus coccinea)*. Also present are some Appalachian cove forest species such as red maple *(Acer rubrum)* and yellow poplar *(Liriodendron tulipifera)*. The face of the highwalls are generally void of soil and vegetative cover, except in areas where water is penetrating the rock face. Willows *(Salix spp)*, an indicator of hydrology, are growing along these water patterns.

Vegetation above the valley fill areas, contained within the highwalls, can be described as successional pioneer species comprised of mainly grasses and forbs with some sparse native and invasive tree and shrub species. Dominant non-woody and highly aggressive vegetation such as birdfoot trefoil *(Lotus corniculatus)*, broomsedge bluestem *(A. virginicus)* and crown vetch *(Securigera varia)* are an indication of acidic, low fertile soils. These plants grow in dry, shallow soil profiles and along rocky berms. Crown vetch *(S. varia)* extends throughout valley fill areas where trees are not present. While the invasive nature of crown vetch *(S. varia)* leaves little space for other aggressive and non-native plants such as broomsedge bluestem *(A. virginicus)*, chinese mint *(Elsholtzia stauntonii)*, and autumn-olive *(Elaeagnus umbellata).* These plants have sparsely grown along valley fill terraces. Chinese mint *(E. stauntonii)* has aggressively spread beyond the valley fill areas.

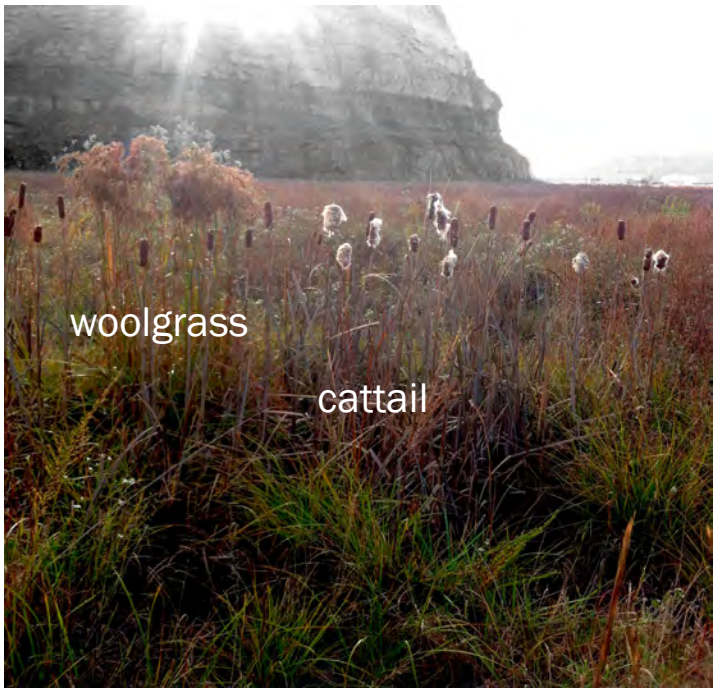
Native species such as staghorn sumac *(Rhus typhina)* and highbush blackberry *(Rubus allegheniensis)* are growing along berms where a shallow soil profile is present. These species further indicate the presence of acidic soil conditions. While they suggest low soil fertility, they provide food and nesting cover for a variety of species. These shrubs exhibit an aggressive growth pattern, creating an extensive root network providing soil erosion control and bank stabilization.

Pioneer tree species such as black locust *(Robinia pseudoacacia)* and empress tree *(Paulownia tomentosa)* are present along berms. While black locust *(R. pseudoacacia)* species are found throughout the site, the empress tree *(P. tomentosa)* is mainly localized to the northerly valley fill region and areas that were disturbed during utility construction. Although there are many efforts in the region to eradicate the empress tree *(P. tomentosa)* because it is considered an invasive species, this tree, along with the black locust *(R. pseudoacacia),* provide nitrogen benefits essential for soil development and plant nutrition. The leaves of the empress tree *(P. tomentosa)* provide nitrogen during decomposition, and black locust trees *(R. pseudoacacia)* have the ability to fix nitrogen from the atmosphere in a form that is accessible for plant uptake. Black locusts (*R. pseudoacacia*) provide additional benefits through their symbiotic relationship with mycorrhiza fungi. This fungus is an important component of soil life and chemistry as it facilitates nitrogen and phosphorous aiding in plant uptake of soil minerals and nutrients. The black locust *(R. pseudoacacia)* and introduction of other legume species will be important for rehabilitating soils throughout the mine scarred lands.





There are several areas throughout the site where wetland vegetation is present. Drainage swales surround the site highwall edge and interior valley fill regions. Sedge species *(Carex spp.)* and woolgrass *(Scirpus cyperinus)* populate narrower swales, where gentle slopes facilitate water movement. Drainage movement through the swale system is interrupted by flat areas where hydrology disperses and infiltrates slowly. These areas, along with several small isolated wetland pockets are dominated by narrow-leaved cattail *(Typha latifolia)* and hybrid cattail species *(Typha x glauca)*. Although these cattail species are highly aggressive and considered invasive, they can perform an important function on mine reclamation sites. sites. They are often planted for their ability to survive acid mine drainage (AMD) conditions, remove heavy metals from solution and provide biomass and organic carbon that generate microbial alkalinity. It will be important to manage cattail aggression by considering native wetland plants that can thrive in acidic soil conditions and can compete and coexist with cattails (*Typha spp)*. Since sedges *(Carex spp.)* and woolgrass *(S. cyperinus)* are successfully established within site hydrologic areas, these species, along with several willow species *(Salix spp.),* should be considered when further developing site hydrology.



A similar species composition of red, black, and scarlet oaks (*Q. rubra, Q. velutina, and Q. coccinea), red maples (A. rubrum)*, and yellow poplars *(L. tulipifera*) in the upland forest is established along undisturbed valley fill slopes. This indicates that mine scarred areas, though fragmented, are a continuation of the surrounding forest. These isolated patches should be linked to create wildlife corridors for species movement. As previously mentioned, crown vetch *(S. varia)* is the dominant plant along disturbed terraced valley fill regions, with broomsedge *(A.virginicus)* and autumn-olive *(E. umbellata)* beginning to colonize as well. The trifecta of these species make the establishment of native species difficult. However, as the area succeeds to forested land cover, the adjacency of many native hardwoods may yield a healthier ecosystem.

Hydrology

Site hydrology is heavily engineered, consisting of valley fills with channelized stone stormwater channels, swales formed by berm shaping and concrete pipe networks that manage drainage associated with the Federal Correction Institute- McDowell development. Hard engineering solutions using pipes and detention overflow structures are limited to the FCI-McDowell area. Hydrology can be best described in two sections, the FCI-McDowell/southerly valley fill area and the northerly valley fill area. Construction of an access road north of FCI-McDowell has created a ridge hydrologically disconnecting these systems. The location of major stormwater features is shown in Figure 1.

FCI-McDowell and South Valley Fill

Stormwater along the site entrance to FCI-McDowell is managed through traditional roadside ditches consisting of turf lawn and check dams that slow water and limit sediment movement. Parking and other hardscape drainage is collected through a series of catch basins and concrete pipes. The swales and pipe systems are directed to three detention basins (Figure 2) located on the northwesterly, southwesterly and southerly sides of the site.

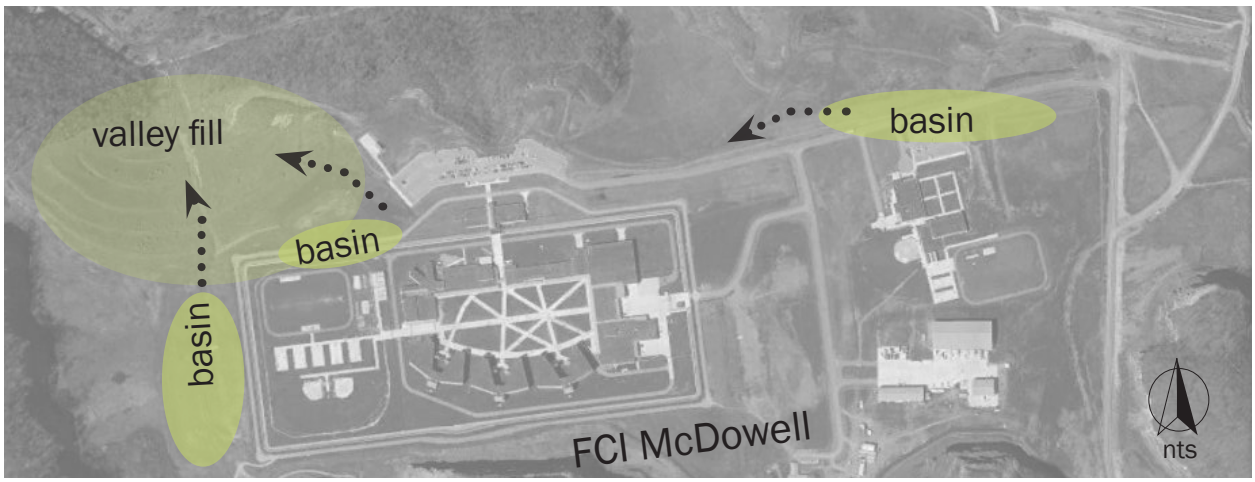


Figure 2: FCI-McDowell Stormwater Basins

While traditional swales and concrete pipes provide little ecological value, the stormwater basins are filled with a variety of native and invasive grasses that provide some water quality and habitat benefits. Unlike turf lawn swales and concrete pipes which move water quickly, the basins slow stormwater movement allowing sediment to fall out of suspension, while vegetation assimilates contaminants from the hardscaped area runoff. In addition to sediment control and nutrient assimilation, water temperature is also an indicator of water quality. Cooler water temperatures contain a greater amount of dissolved oxygen to support fish and aquatic vegetation. Concrete pipes and open water in basins and swales yield higher water temperatures. While grasses and forbs in the stormwater basins help mitigate these higher temperatures, the addition of shrubs and trees would create a canopy to shade and cool water. Shrubs and trees will also help stabilize banks and reduce sediment movement at a greater capacity than the existing forbs and grasses.

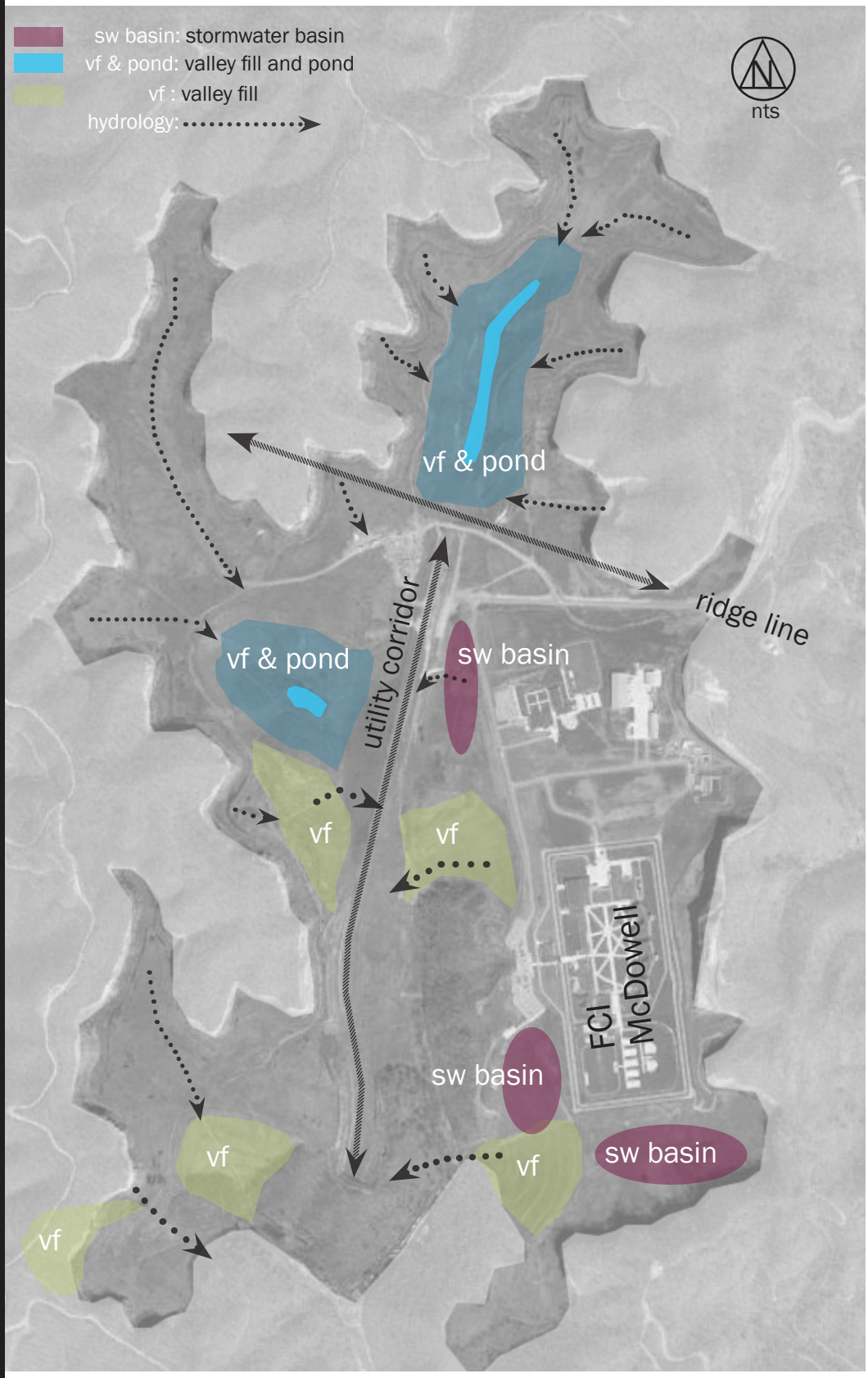
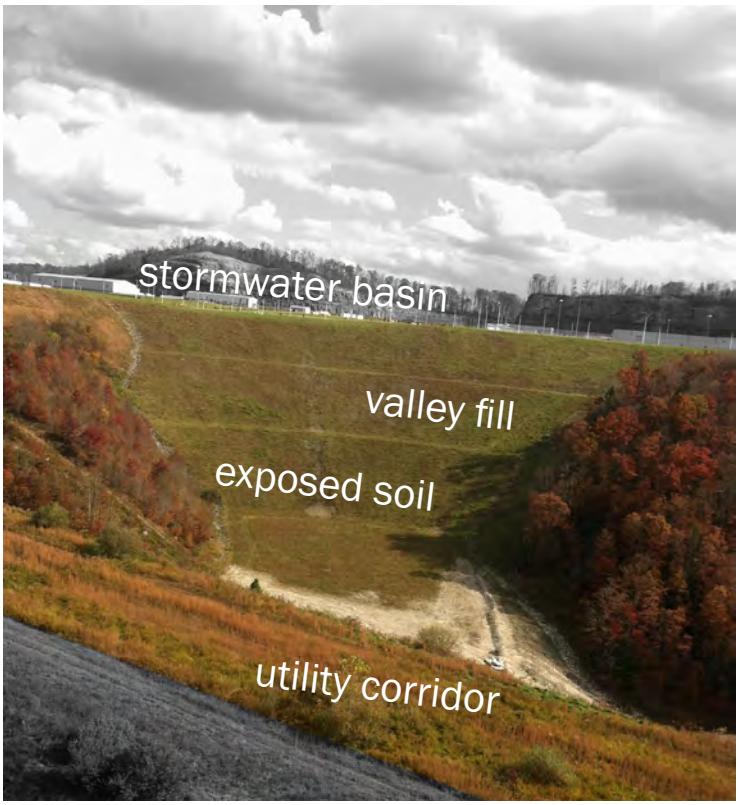


Figure 1 Stormwater Features

The stormwater basins outlet into valley fill areas. The northerly basin discharges into the utility corridor and the southerly basins discharge directly to a constructed valley fill. Both systems' hydrology are connected and flow to the adjacent residential valley. Stormwater from the site has resulted in an excess of sediment in the valley. While the basins collect sediment from FCI-McDowell, they discharge from a single outlet along steep, sparsely vegetated slopes, accumulating sediment along this path. Point source discharge along steep slopes force the water to channelize and move quickly through the valley fill, eroding the sides of the stone weir channels. The northerly basin further contributes to sediment movement as it discharges to bare soil along the unrestored utility corridor. Reducing stormwater contained within these ponds, vegetating the utility corridor, and reconfiguring basin outlets to evenly redistribute water to multiple point sources that use a combination of stone and vegetation stabilization will help reduce sedimentation in the residential valley.



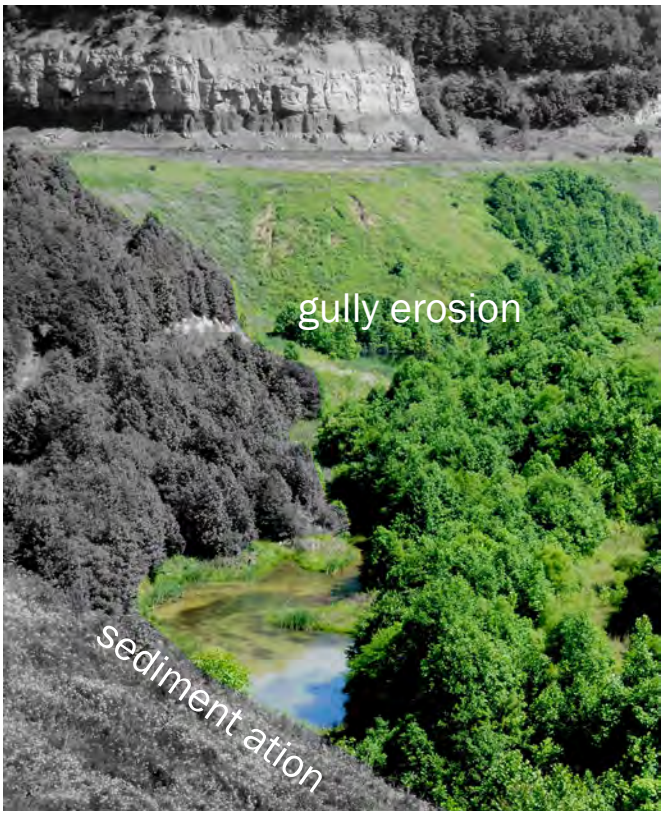
A constructed swale system, formed by berms, manages stormwater in undeveloped areas of the site. Swales run along the highwalls and surround many of the valley fill areas. The highwall swale system is generally narrow and shallow in depth. There are areas where the berm is less pronounced, allowing water to disperse and become less channelized. Here there is evidence of standing water and cattail vegetation. These areas yield some infiltration as water movement is slowed; however, soil compaction has slowed this process. Enhancement of the swale and shallow ponding areas should be considered in restoration. This system of vegetative water movement and settling is common in low impact development practices.

North Valley Fill

Similar swale systems surround the valley fill areas. While the southerly valley fills generally have shallower swales similar to those along the highwalls, the northerly areas have very deep swales with high, steeply sloped berms on each side. These swales are dominated by cattail species *(Typha spp)* indicating hydrologic conditions. However, these swales do not appear to be hydrologically linked to the greater site. The berms create a barrier to stormwater movement. This fragmentation has created deep, linearly isolated wetland infiltration areas. Due to the excessive soil compaction and stormwater runoff isolation, these areas act similar to bog ecosystems, with rainfall being the only connection to hydrology. Sphagnum moss *(Sphagnum spp),* a common bog species, is present in several areas along these swales.

Stone stormwater channels line the slopes of this valley fill. These channels also appear to be disconnected from the swale systems due to berm construction. Rather than directing stormwater runoff to these point systems, stormwater appears to sheet flow along the valley fill slopes. This is evidenced by the formation of gullies that have eroded the non-forested slopes.

There are two ponds in the northerly valley fill area. The ponds are separated by a berm that allows for a hydrologic connection when the water level rises high enough. It is possible that water infiltrates the berm as well, moving from the northerly pond to the southerly pond. The access road to the site that extends west of the prison creates a ridge, disconnecting stormwater movement from this area to valley fills further downstream. Since the water is isolated with no outlet and erosion is present on the nonforested slopes, there is significant sedimentation in this pond system. This is evidenced from the lack of water clarity within the pond.



While many of the swale systems provide an important stormwater service, the swales surrounding this valley fill region provide little functional value. They are unsightly and create a significant safety hazard. Regrading in this area to provide hydrology capacity and ensure safety will be considered during the design. Solutions must consider the sedimentation problems in the valley fill ponds and ensure that no further sediment movement is directed here.

Site Analysis

The site is best described in the Environmental Assessment Section and analyzed graphically in the Site Inventory and Analysis. The following will provide a summary of the site and important elements to consider during design. Key analysis feature areas are shown in Figure 3.

The landscape exposes scars from former mining operations. A constructed swale system lines rock highwalls. Steep valley fill areas with retention ponds are present. The gravely, compacted soil has little nutrient value and is unable to infiltrate stormwater in most areas. A poor soil profile and fragmented native vegetation has led to a strong invasive species plant profile. Steep slopes and limited healthy vegetation have made soil erosion a significant concern. Sediment has compromised water clarity in valley fill areas, and the neighboring residential valley has significant sedimentation from the site.

An ecological approach to design and reclamation will shift traditional focus of form to an emphasis on ecological function. The design shall respond to the existing environmental concerns while incorporating elements to rehabilitate the landscape by recovering ecosystem functions and processes in the degraded habitat. While returning the landscape to predisturbance conditions will not be possible, establishing a geological and hydrological stable landscape can help make the land useful again.

Establishing vegetation to facilitate the development of a healthy soil profile while stabilzing slopes to reduce sediment transport are significant elements in design. Fast colonizing species and cover crops that have the ability to fix nitrogen from the atmosphere are important considerations. Planting many smaller bare-root species that will spread aggressively will be critical for establishing vegetation. Large planting massings that mix trees, shrubs, and herbaceous perennials will allow micro-climate features rather than the landscape designer to determine the placement of plants.

In order to restore hydrologic function to the landscape, low-impact development techniques and green infrastructure elements have been employed. These solutions use natural functions to provide flood control, reduce solar heat gain, improve and stabilize the soil, and create wildlife habitat by improving biodiversity. These systems may also infiltrate, evapotranspirate, or reuse stormwater runoff, while improving water quality.

Because of the current environmental conditions on site, establishing low impact elements and green infrastructure will be challenging. It will be important to respond to current hydrologic patterns and combine them with successes in brownfield remediation where stormwater infiltration is not permitted.

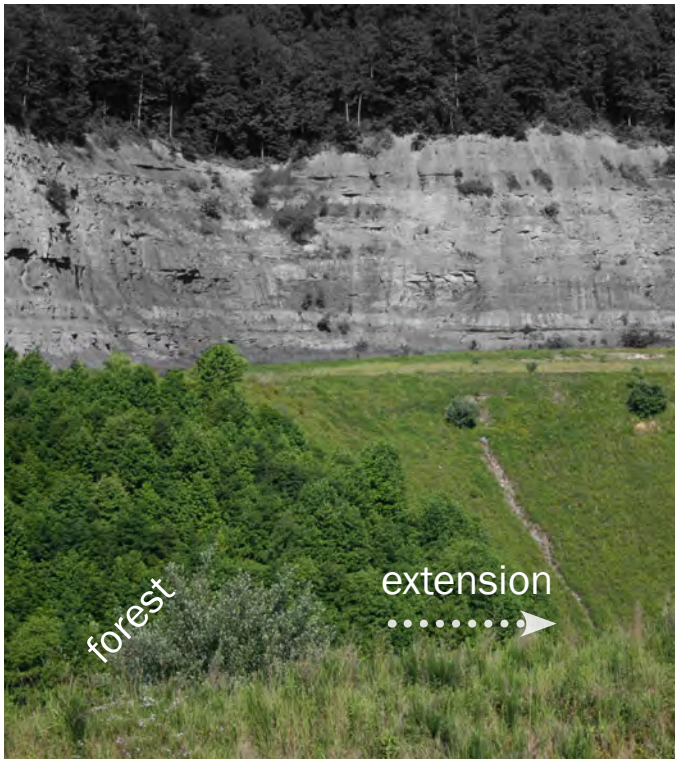
Figure 3 Analysis Features

Previously, the environmental inventory was discussed as individual ecosystem elements: soil, vegetation, and hydrology. The analysis will consider these elements together as a unified system, integrating them with patterns of development (Figure 4). Because of their dynamic interaction, these systems can only be examined as a whole. Therefore, the design must respond to the interactions between nature and society co-existing in a mutually supportive habitat. Within the SEP rock highwalls there are essentially three major systems: the valley and fill area consisting of the original forest cover and erodible valley fill system, the swale/wetland profile, and the rocky/compacted core.

Original Forest Cover and Valley Fill System

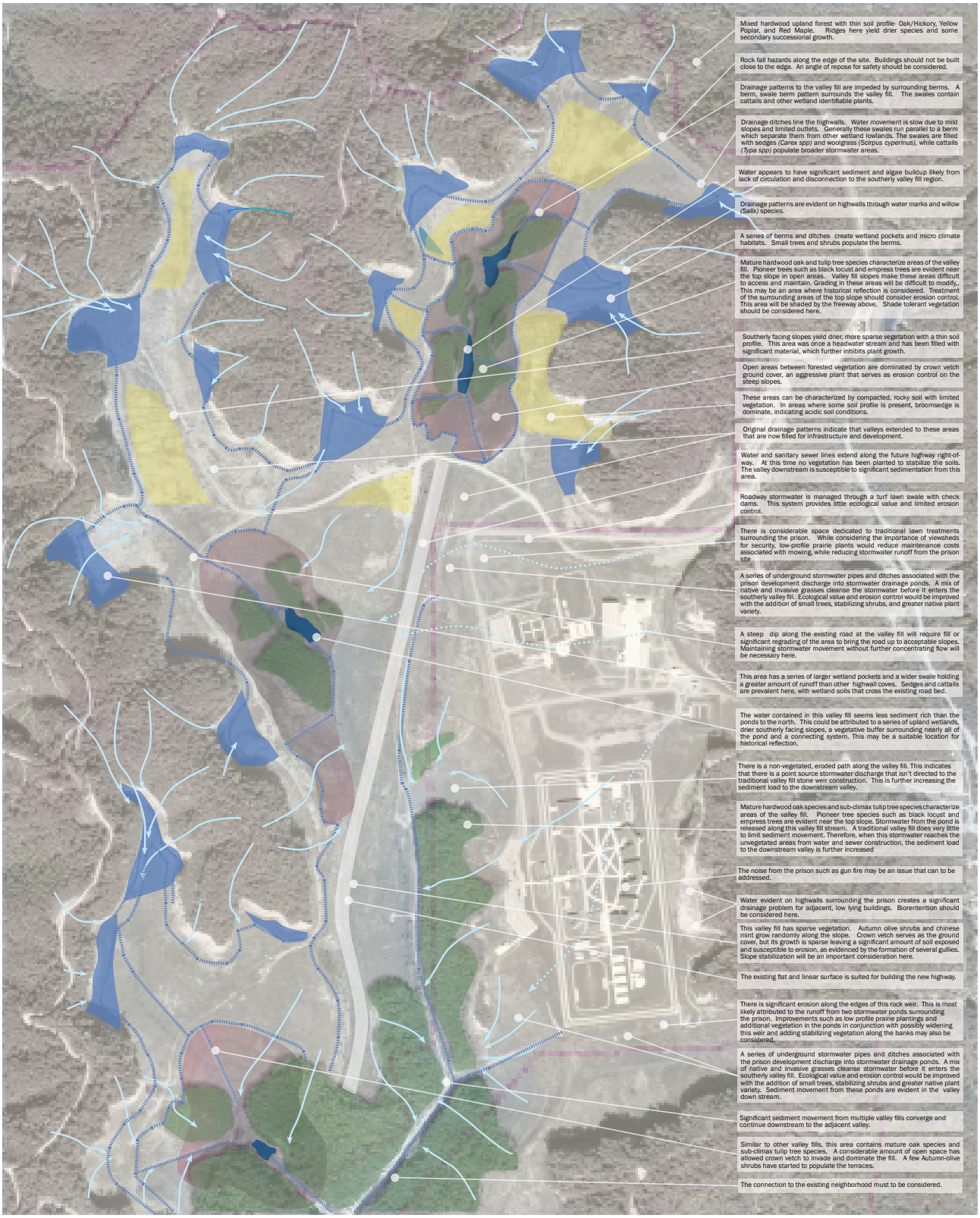
The original oak *(Quercus)*, maple *(Acer)* and hickory *(Carya)* forest is the healthiest and most productive ecosystem on the site. Native vegetation builds healthy soils and stabilizes the steep valley banks, while providing habitat for wildlife. It appears that there was little to no top soil salvaged during restoration. Topsoil not only provides healthier, more productive soils, but it retains the historical vegetation composition in the seed bank (seeds of plant materials that covered the site pre-mining). This ultimately makes it easier to extend the original forest cover throughout the site.

Expanding the forest coverage creates a mosaic pattern of vegetative patch and corridor connections building a network that links wildlife, creates greater vegetative diversity, and provides a more stable forest community. The original forest coverage should be extended in areas where the soil profile allows and the valley fill where there is little woody vegetation and crown vetch *(S. varia)* dominates. While it is anticipated that these species will be able to grow throughout the valley fill, the slope aspect should be considered for appropriate propagation. Oak *(Quercus)* and hickory *(Carya)* species are most appropriate along southerly and southwesterly facing slopes and in areas receiving warmer afternoon sun. Maples *(Acer)* are most appropriate along northerly and northeasterly facing slopes and in areas receiving cooler morning sun. Typically these trees are considered climax species, which are slower growing, not aggressive, and longer lived.



Because climax species take time to establish and erosion and soil health are immediate concerns, pioneer species should also be introduced on the site. Pioneer species can quickly occupy a site and are faster growing and considered the best choice for re-vegetating steep mining sites. Currently, black locusts *(R. pseudoacacia)*, a pioneer species, are establishing throughout the site. As previously mentioned, the black locust *(R. pseudacacia)* is an important species for nitrogen fixation, helping to build healthy soils and provide nutrients for other plants. This species also has the ability to spread easily and cover large areas quickly by producing new shoots from their roots. Other pioneer species that reproduce aggressively through this process are the trembling aspen *(Populus tremuloides)* and the grey dogwood *(Cornus racemosa)*. These species have been proven to successfully establish on steep slopes with minimal soil profiles and compacted soils. Therefore, they will be an important species in re-vegetating the site.

Figure 4: Site Inventory and Analysis



Stormwater Flow
Existing Drainage
Dry Condition
Wet Condition
Steep Topography
Vegetation Patches
Water

0 0.25 0.5 1mi

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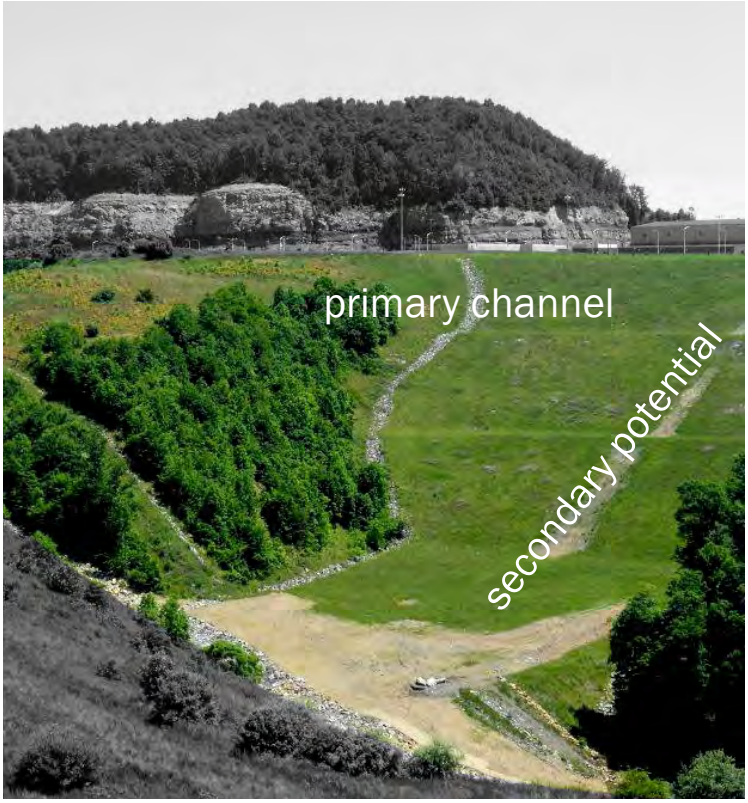
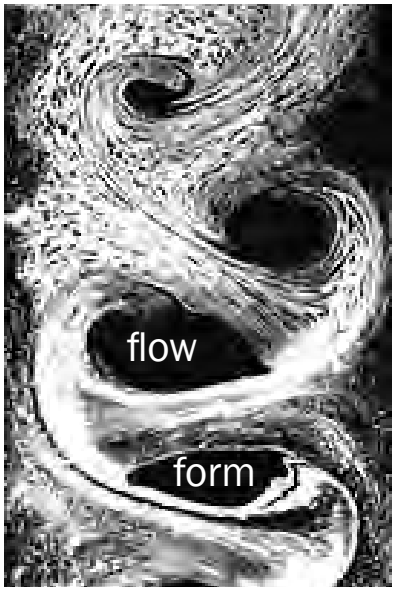
The hydrology along the valley fill slopes is concentrated, with drainage directed through a single stone stormwater channel along terraced hillsides. This is a typical valley fill hydrology construction standard. Concentrating the discharge in a straight segment along a steep slope causes water to move at excessive rates. These channels are overstressed by the rate of stormwater discharge as evidenced by severe soil erosion along the edges. Weaving vegetation through the stones can significantly reduce erosion, providing slope stabilization that bonds with the soil more seamlessly than the stones. Vegetation can also create habitat connections and improve the aesthetics of these engineered systems.

While vegetation can reduce erosion potential, it does not address the problem of steep, concentrated point loaded stormwater systems. A principle of low impact development is to slow water to allow it to be cleansed and infiltrated into the ground, while lessoning the erosion potential. In order to reduce stormwater concentration, additional vegetated stone channels provide multiple outlets rather than a single point for surface runoff and stormwater basin discharge from the FCI-McDowell facility. This reduces the stormwater flow rate passing through the systems, which ultimately reduces erosion potential along valley fill slopes. Additional routes may also moderately reduce the rate at which stormwater reaches the receiving offsite system. By staggering the timing that stormwater discharges from the site, it will reduce stress on the receiving system.





One other consideration that could significantly reduce stormwater movement along the valley fill slopes, while also providing biofiltration, would be to construct a flow-form inspired valley fill stormwater route. Originating in the 1960's from the work of Theodore Schwenk, George Adams and John Wilkes, flow-forms were inspired by the movement of mountain streams. They were designed to simulate this rhythmical cascading movement in order to re-oxygenate and treat water. Flow-forms provide tiers of sinusoidal movement along steep slopes. Stormwater weaves, pauses, and gradually moves down the mountain slopes. The systems combine hard engineering and natural systems. While the form or part of the form is typically constructed with a hardscape material, flow-forms can use an organic soil medium base combined with stone and plants to provide biofiltration, cleansing pollutants. Originally these systems were used in small applications, but have been successfully adapted to accommodate larger flow rates. The construction of these systems can be costly. Therefore, they may be reserved for areas where aesthetics are a priority.

Swale & Wetland

Many of the drainage swales and wetlands appear to be functioning hydrologically, capturing, transporting, and infiltrating stormwater runoff. However, the swales are heavily engineered with deeply cut cross-sections, running for long stretches at a standard offset distance from the rock highwalls. Typically natural hydrology is more organic and less deliberate and controlled. Current hydrology is also managed in either edge swale systems or central valley fill ponds. While pocket wetlands are scattered throughout the site, there does not seem to be a hydrologic link or even distribution of stormwater. Core principles of low impact development promote treating stormwater at the source,while seamlessly integrating it naturally into the landscape. Berms and the central compacted areas prevent continuous stormwater movement.

Since the swales are one of few ecologically functioning hydrologic networks on the site, these systems should remain, but be enhanced to better reflect Low Impact Development (LID) principles. More specifically, stormwater should respond to topography and use natural systems to slow the movement of water, allowing infiltration. One way to achieve this is to level sections of the berm system to create broader, shallower swales. The movement of stormwater through the swales should be interrupted by larger flat areas where water can disperse and infiltrate. While flat topography facilitates this process, compacted soils will slow the infiltration process. Therefore, smaller stormwater volumes should be directed to these areas. In order to facilitate low stormwater volume, these areas should interrupt swale movements often. The stormwater conveyance process is outlined in Figures 5 and 6.

Regrading the swale system that surrounds the northerly valley fill will be especially important. Swales in this region provide litte functional value, are unsightly and create a significant safety hazard. Regrading to provide hydrologic capacity and to ensure the safety of the site occupants will be considered during the design. As previously mentioned, solutions for this region must consider the sedimentation problems in the valley fill ponds to ensure that no further sediment movement is directed here.

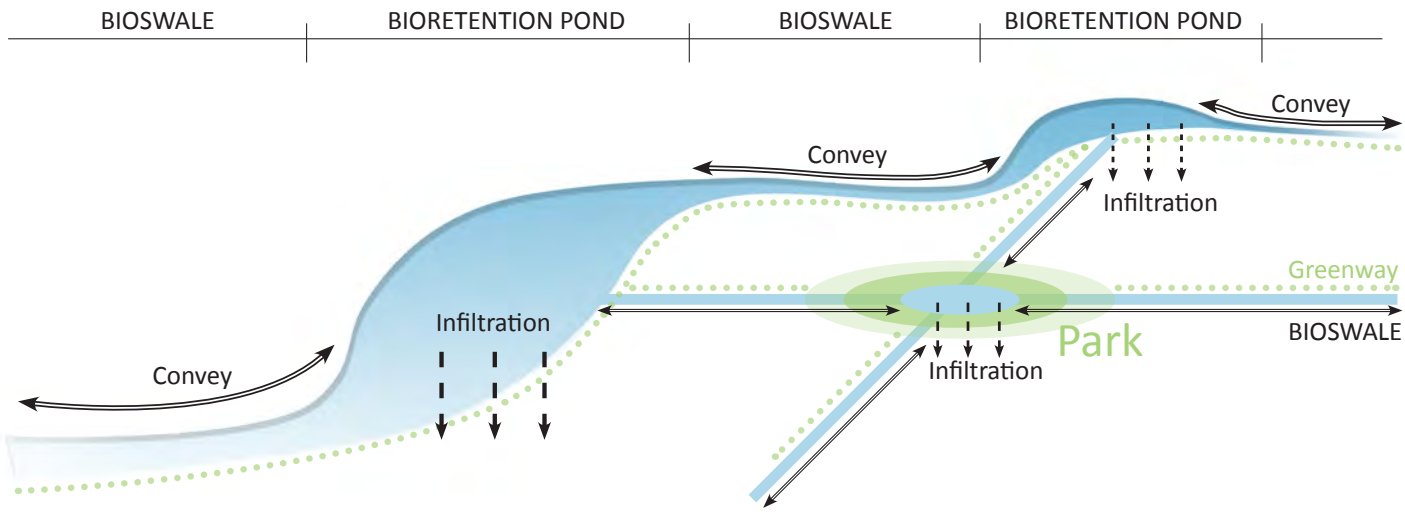


Figure 5: Stormwater Movement Diagram

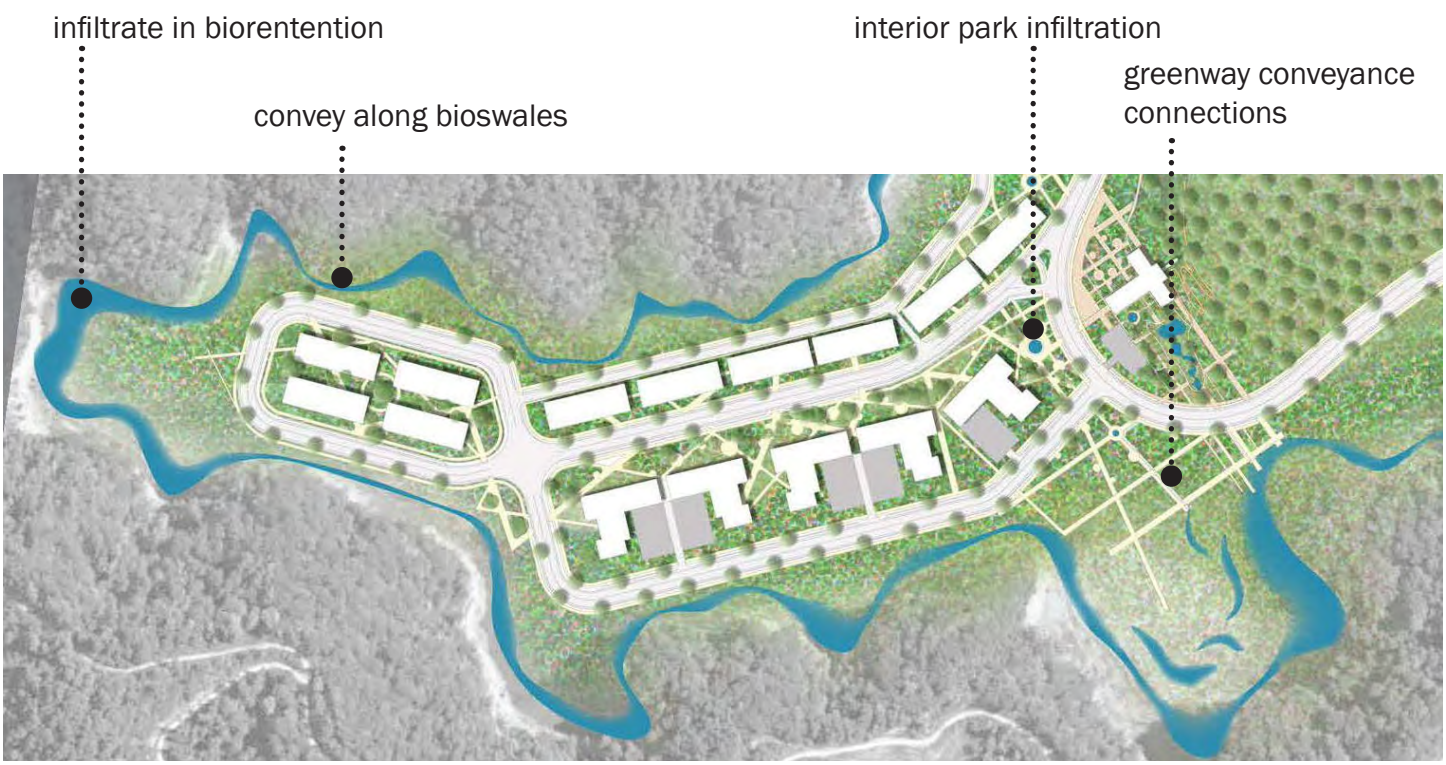


Figure 6: Stormwater Movement Plan

Plant communities in the drainage swales are dominated by cattails *(Typha)*, sedges *(Carex),* and woolgrass *(S.cyperinus)*. While the cattails *(Typha)* are invasive, creating a concern for the establishment of native plants, they perform a valuable function of removing pollutants associated with mining operations. Since their growth remains in control, there appears to be no need to eradicate them at this time. It is recommended that stormwater plants that are aggressive enough to withstand the cattail rhizomial growth should be planted to enhance the stormwater areas. Willow species *(Salix spp)*, would be an excellent addition, as their stoloniferous roots (horizontal root runners) are similar to rhizomial growth, allowing them to outcompete with many species. Research has shown that this species has successfully cohabitated with cattails *(Typha)*. Willows *(Salix)* provide many ecological benefits for the site. They are an excellent food and habitat source for wildlife, effective biofiltrators, are easily cultivated and their soft texture and yellow fall color provide aesthetic value to the site. Since sedges *(Carex)* and woolgrass *(S. cyperinus)* have already proven to successfully grow on the site, these species should also be propagated for stormwater enhancement. The trifecta of species will help build the soil profile to allow for additional colorful forbs that attract pollinators necessary to ecosystem health. Forbs (broad-leaved, herbaceous plants) such as milkweed *(Asclepias syriaca)*, aster species *(Aster spp)*, and goldenrod species *(Solidago spp)*, have established on the site. Their presence should be extended throughout the stormwater system.

http://www.nps.gov

http://fineartamerica.com

http://www.sciway.net

http://en.wikipedia.org

http://libguides.aurora.edu

http://www.usn.org

While these drainage systems provide a valuable hydrologic function for the site, they also create usable outdoor space for people. Throughout the development, design language expressed through stormwater and re-vegetated green spaces should exhibit landscape pattern, process and practice. Green infrastructure and open space areas are linked through pedestrian greenways creating connections that bond people to place. This pattern of movement and connection is evident in Figure 6. Ultimately, the design will create interactions among all species and their abiotic environment. This is vital to maintaining healthy ecological processes and services. Due to the safety concerns associated with the rock highwalls, some of these systems will be purely functional, acting as hydrologic and wildlife mosaics. These areas will provide a buffer that responds to a safe angle of repose between the highwalls and built environment. Stormwater areas further from the rock highwalls will be developed as park spaces for leisure and environmental education. Greenways will link these areas to central park spaces within the site interior. These centralized areas shall serve as important gathering spaces to build community.

Central Core

The central core area is best described as overly compacted with nutrient poor soils and sparse native vegetation. Often this is referred to as the "pavement" of reclamation, because the compaction has created an impermeable surface. Low impact development strategies will be challenging to apply here as green infrastructure and re-vegetation will be difficult.

Since infiltration is limited, green roofs play an important role in managing stormwater. Green roofs have the ability to reduce total runoff by 60% and can detain 85% of the peak flow depending on the depth of the growing medium. In addition to stormwater management, green roofs provide food and habitat for wildlife, improve aesthetics, cool the air through evapotranspiration, prolong the life of a roof's waterproof membrane, and reduce heat loss in the winter and energy demands in the summer.

While these drainage systems provide a valuable hydrologic function for the site, they may also be designed as a usable space for people. There are two types of green roofs: intensive and extensive. Intensive roofs are typically more expensive to construct, hold high plant diversity and have higher maintenance costs. Intensive roofs can be used to create park space and agricultural areas. Centrally-located public or commercial buildings can provide opportunities for community gardens, helping supply food while building community unity. Extensive roofs are typically inaccessible and are less expensive to construct and maintain. Therefore, they will be a likely choice for most of the building development on the Sustainable Energy Park (SEP) site. With only six inches of soil, lower plant diversity consisting of only stonecrop (*sedum*), ornamental onion (*allium*), and iceplant (*delosperma*) are used. These low growing species can be easily installed using modular pre-vegetated mats or trays. A green roof cross-section is shown in Figure 7.

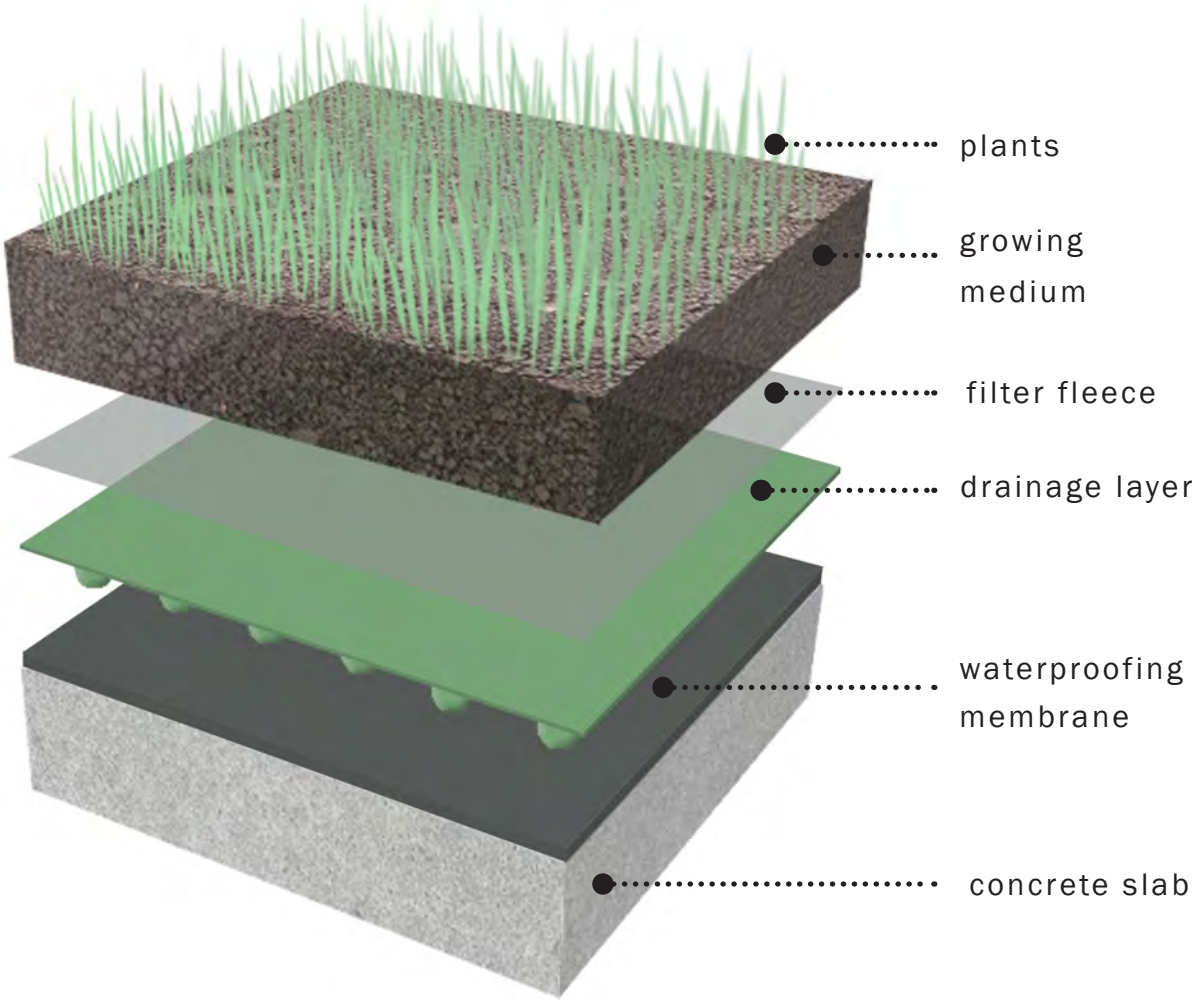


Figure 7: Greenroof Cross-Section

Since energy production is at the core of the SEP development, solar panels will be considered as a part of the design. In order to capture the greatest amount of solar energy, panels need to be southerly facing. Research has shown that northerly facing green roofs are far more productive than southerly facing roofs. Therefore a hybrid system, combining solar panels on southerly roof pitches and green roofs on northerly roof pitches are envisioned to maximize the energy and stormwater benefits. The layout of the street grid and housing placement for the SEP respond to this alignment.

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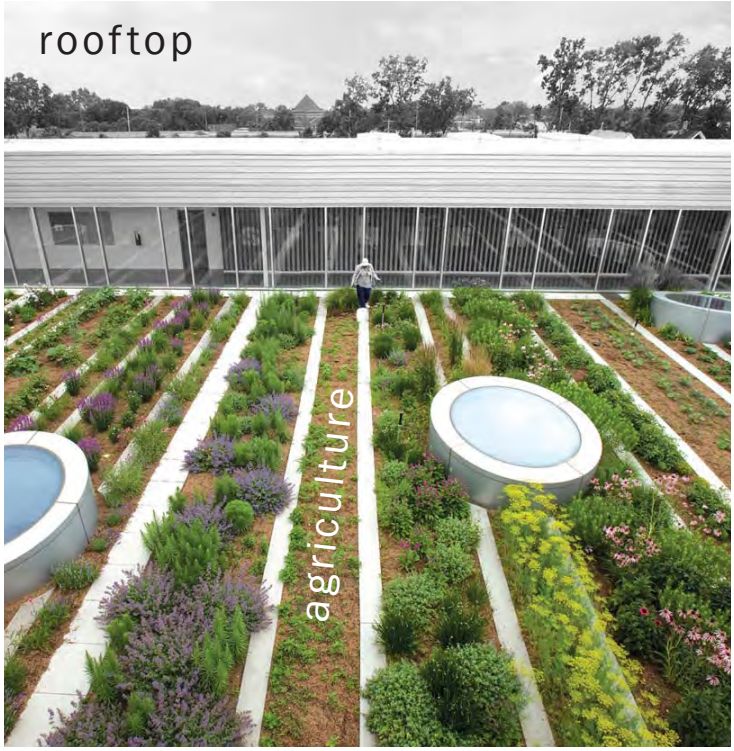
http://absorbant.rssing.com

http://www.motherplants.net



http://inhabitat.com

http://www.flickr.com

http://www.greenroofs.com

While green roof application manages the majority of stormwater within the compacted core area, a considerable amount of stormwater runoff will be generaged from the remaining impervious surfaces. Another important principle in low impact development is using hydrology as an integrating framework throughout the site. While greenroofs loosely achieve this, the spirit of the statement implies movement. Compacted areas limit movement and infiltration of stormwater through natural systems.

It is anticipated that large grade changes to this area will be difficult and costly. Under this assumption much of the soil is impenetrable. This is often the case in brownfield redevelopment, so many of the stormwater principles of brownfields may be applied in design. In many cases of brownfield redevelopment, a cap (typically 12 inches or greater) is placed over contaminated areas to provide a barrier between the contaminated soil and newly developed infrastructure. Just as in brownfield treatment, a cap can be used to add grade to areas, leaving narrow spaces with less fill to serve as stormwater swales. Therefore, rather than trenching swale systems through these areas, the ground is built up around the base of the swales to create their form. While the placement of fill is expensive, it provides many benefits for the site. It creates a healthy soil medium for vegetation development, can infiltrate stormwater providing storage capacity, provides a suitable base for building infrastructure, and can buffer the development from elements that may remain from former mining operations. This building process is illustrated in Figure 8.

Due to the cost of fill placement, this treatment should be strategically applied in areas where soil is most difficult to penetrate and where it can best integrate a framework of natural hydrologic movement through the site. Therefore this treatment should be considered along greenways, near central interior park spaces, and in several low points in areas outside of the greenways and main hydrologic thoroughfares. Vegetation within the proposed swale system should be similar to what is proposed in the swale and wetland areas. This will create strongly recognized and productive wildlife corridors, helping to connect the fragmented landscape.

Vegetation in the central core area will be difficult to establish. Planting many smaller bare-root species that will spread aggressively will be the most successful approach to establishing vegetation here. A similar composition focusing on pioneer species proposed to re-vegetate valley fill areas should be applied to these areas. Black locusts *(R. pseudocacia)*, trembling aspens *(Populus tremuloides),* and grey dogwoods *(Cornus racemosa)* can reproduce aggressively on ecologically stressed sites. These species will help to build the soil profile for some time before climax species can establish.

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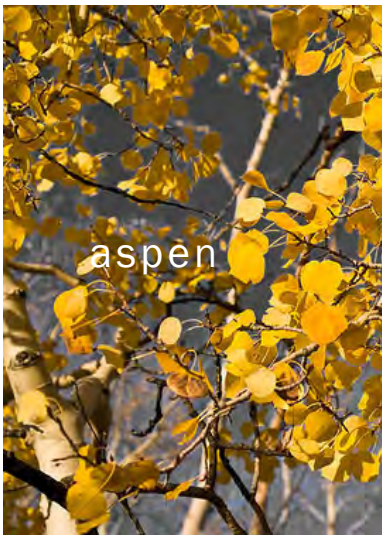

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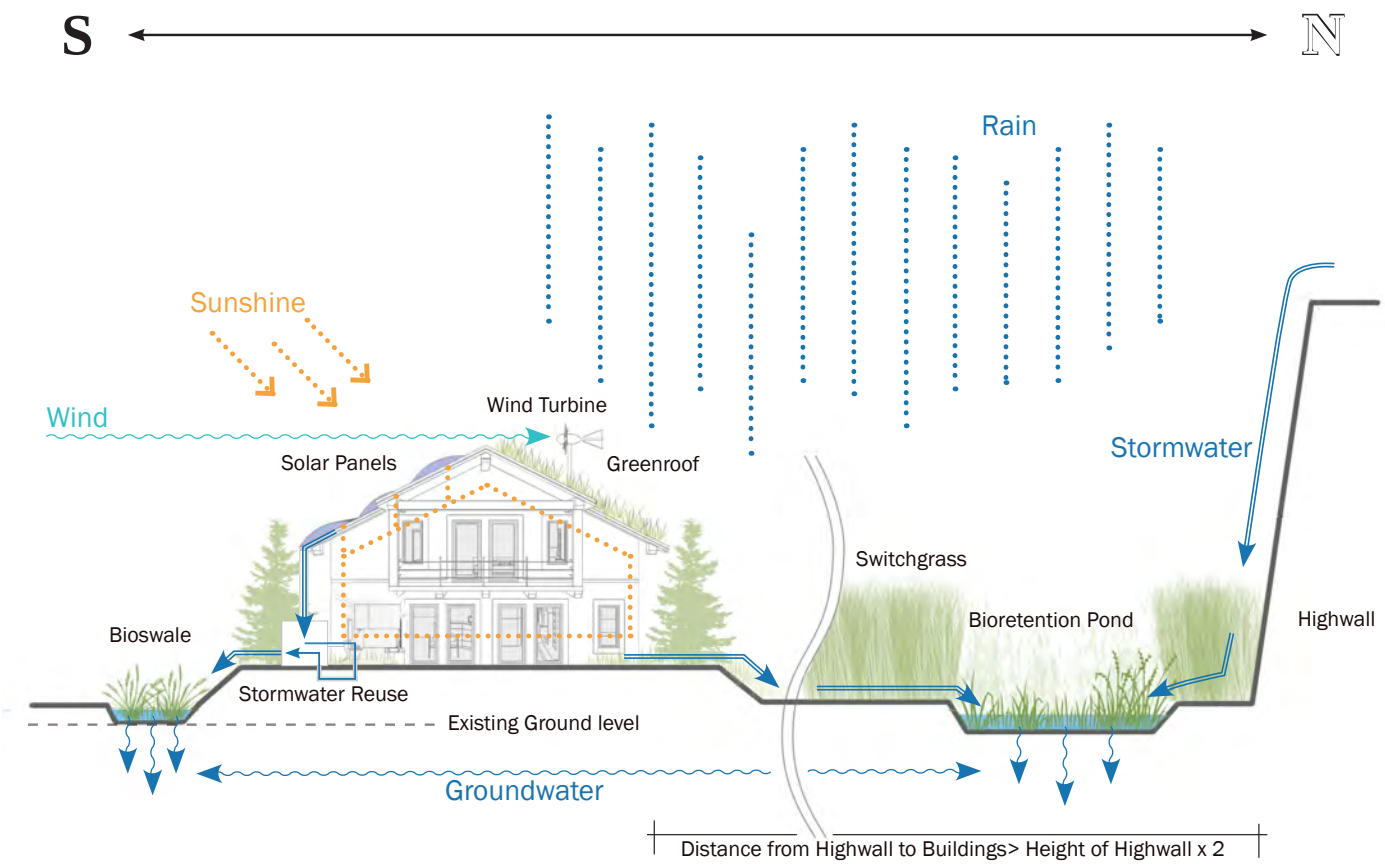

Figure 8: Stormwater Treatment Train

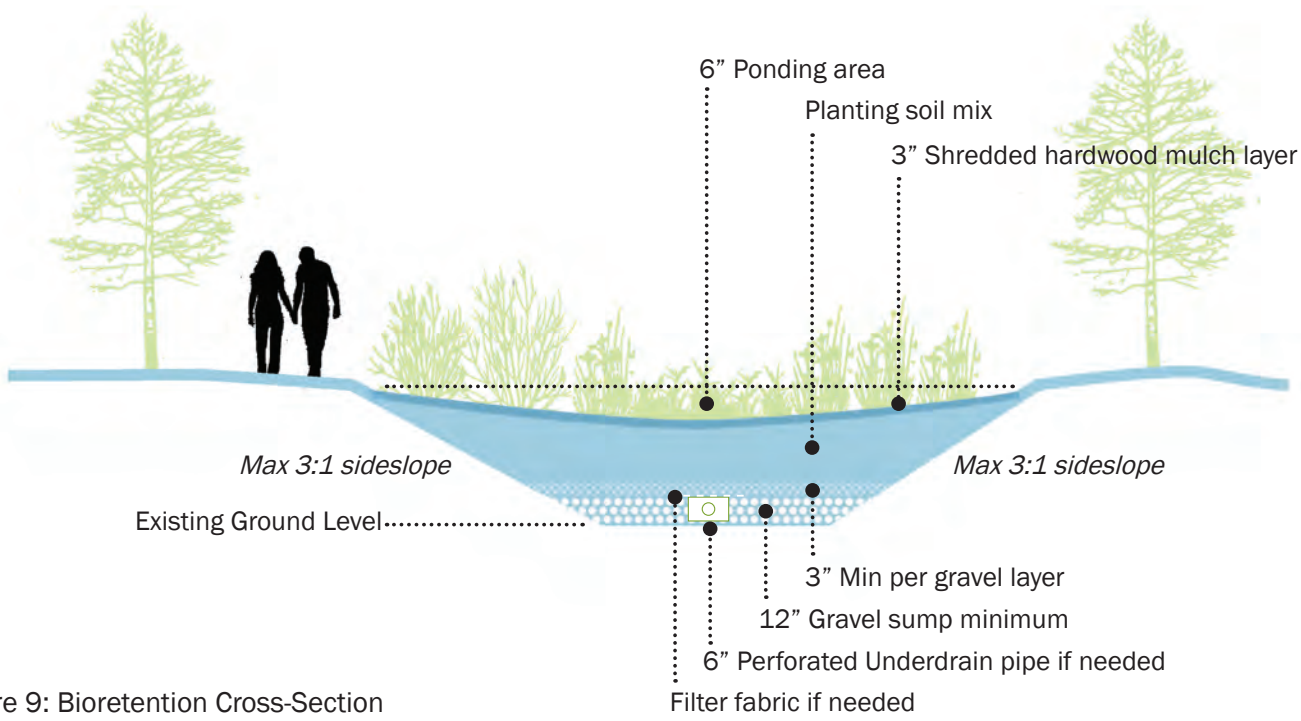

Figure 9: Bioretention Cross-Section

*bioswales have the same cross-sectional elements, but are often narrower and deeper

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GIS Analysis of Site Conditions

The maps below describe overall site conditions in terms of elevation (Figure 10), land cover (Figure 11), slope (Figure 12), circulation/utilities (Figure 13), regional circulation (Figure 14), local circulation (Figure 15), soils (Figure 16), slope aspect (Figure 17) and site hydrology (Figure 18). A brief analysis detailing how the information was used in making planning decisions is provided for each map. All maps in this section were developed by the Natural Resource Analysis Center at West Virginia University.

Elevation mapping allows researchers to understand the opportunities and constraints of the overall site for different types of development. Figure 10 demonstrates that much of the site contains areas of high elevation gradients that would create issues for different types of alternative energy facility implementation and mixed use development.

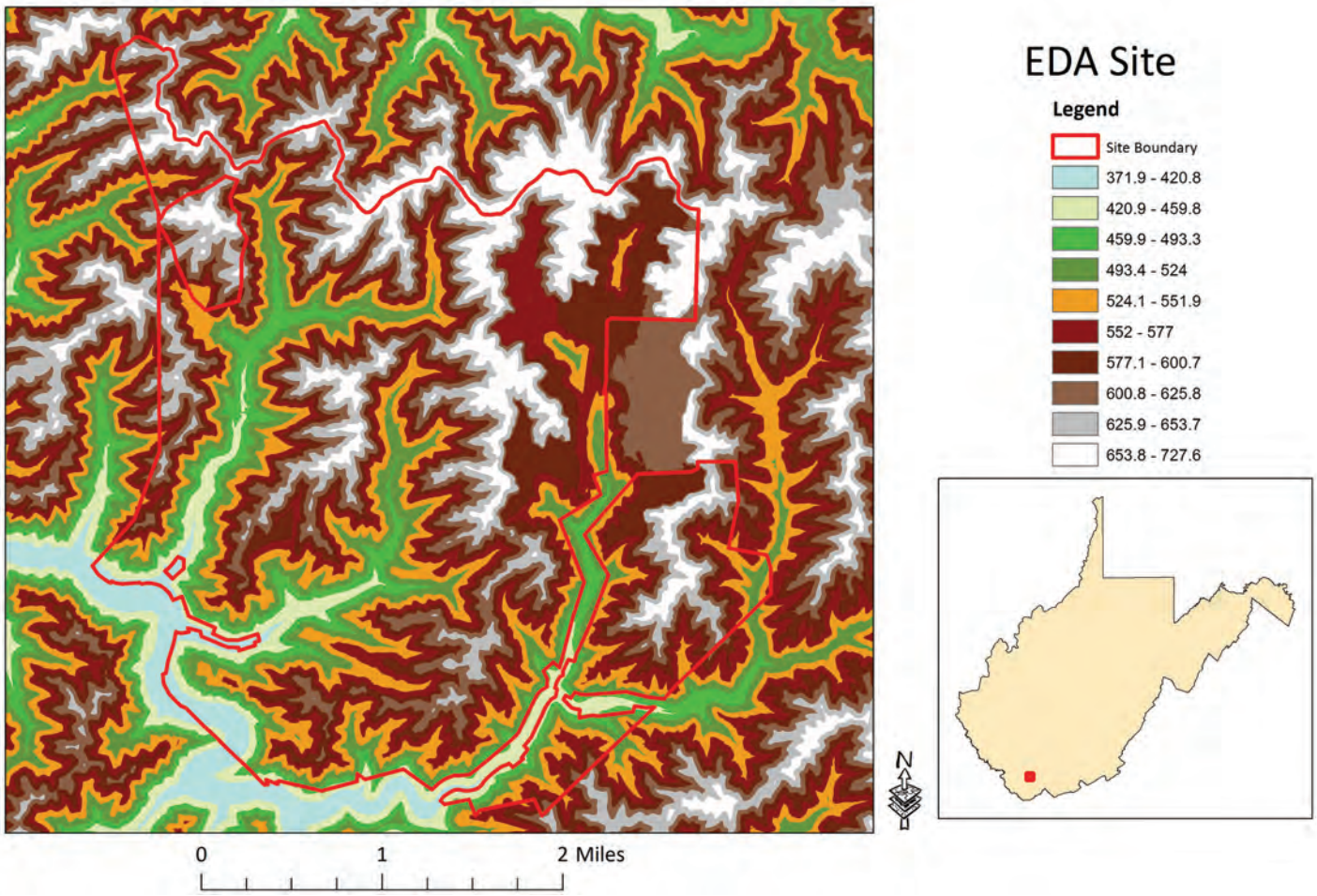


Figure 10. Overall elevation conditions at the Indian Ridge site in McDowell County, WV.

The land cover map (Figure 11) illustrates that the overall site is primarily forested with some areas of previously disturbed areas due to a history of surface mining. Land cover data allows researchers to make informed decisions regarding future site programming and activities. In areas of existing forest a recreation program may be suitable. In areas of disturbance more industrial types of development would be more appropriate. The 'Forest in Permit' areas are currently being surface mined or may be mined in the near future. With foresight these areas may be reclaimed in such a way as to prepare them for future alternative energy facilities. The 'Mine Grass' area to the east of the site is the Indian Ridge Industrial Park site which includes FCI-McDowell (shown in black). Because of the existence of mine grass, planted during reclamation and confirmed through site visits, this area is appropriate for biomass cultivation with soil amendments.

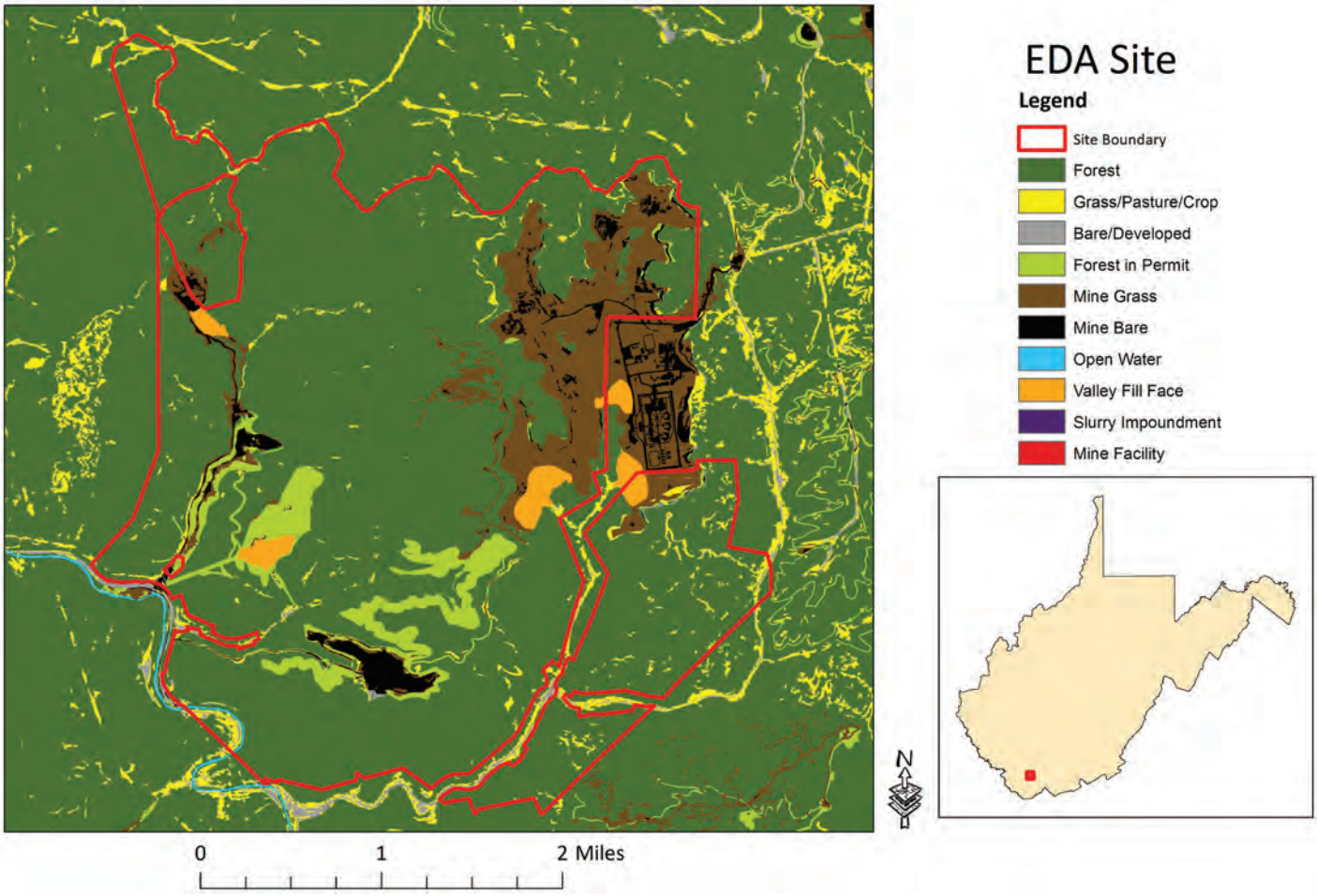


Figure 11. Land cover map of the Indian Ridge site in McDowell County, WV.

The map below, Figure 12, depicts slope in degrees, which provides very strong guidance in siting development within the project boundary. Desirable slopes for constructing buildings generally fall between 0-10 degrees. All of the green areas would be very difficult to build upon with the costs potentially outweighing the benefits. The blue area, the Indian Ridge Industrial Park, is the most suitable area for mixed use development and alternative energy facilities siting.

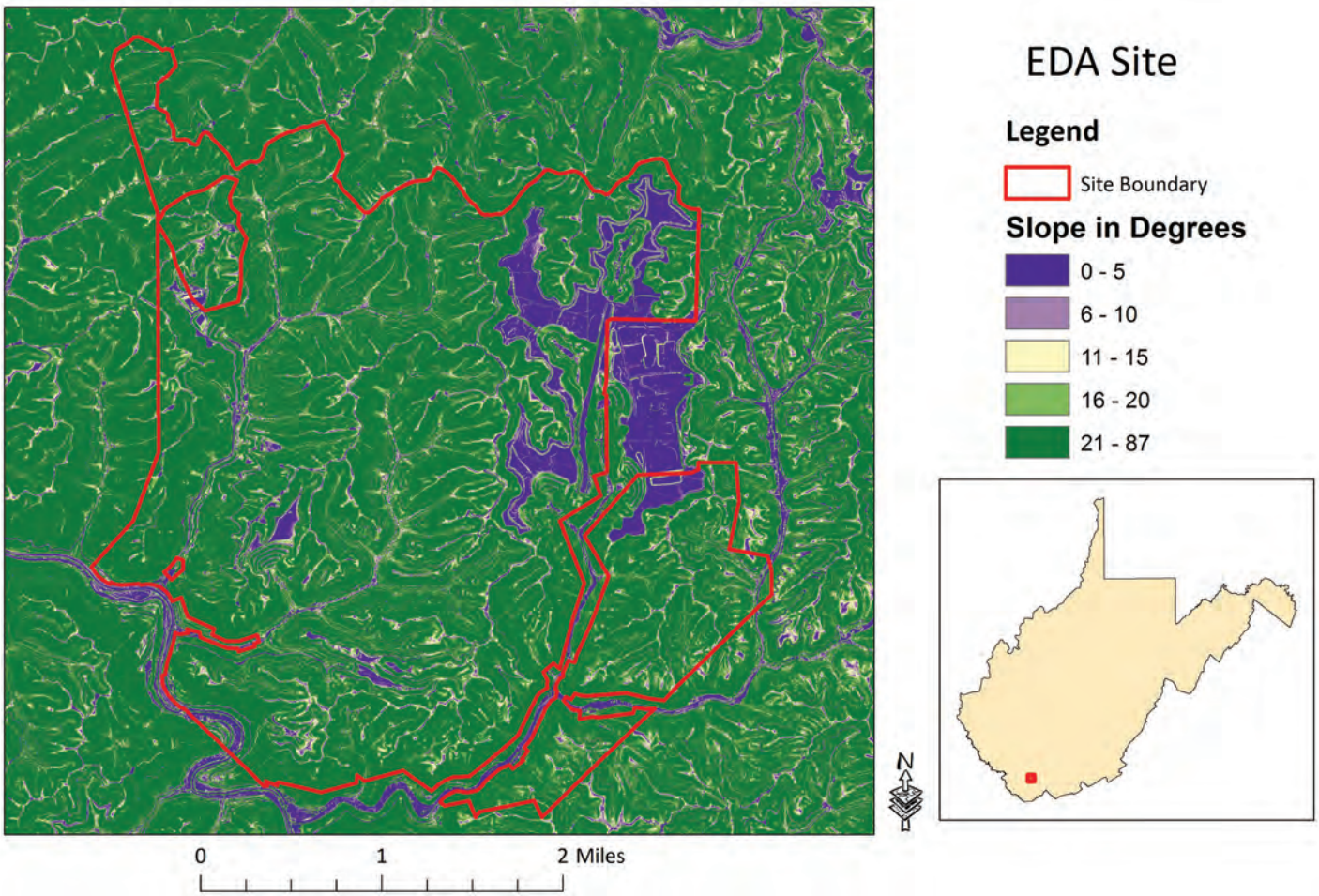


Figure 12. Slope in degrees at the Indian Ridge site in McDowell County, WV.

The map below, Figure 13, shows transmission lines and their proximity to the site boundary and existing facilities. This information will be applied to the alternative energy infrastructure planning in finding the most appropriate location for linking the existing grid to site developments. Also shown are the rights-of-way for the proposed expressways. Plans for the expressways must be acknowledged in envisioning development of the site. This is especially important in siting costly alternative energy generation facilities. The highway buffers (yellow and light blue) limit the location of certain types of facilities but may be appropriate areas for planting biomass crops as a temporary placeholder for future road construction. Existing roads within the site boundary are also an important component in site analysis. The roads access ridge tops and may facilitate delivery and set up of wind or solar energy installations. The roads may also function within a recreational program for the property in envisioning both passive and active recreation opportunities throughout the site. The 'Roads' layer also identifies important access points to and from the Indian Ridge Industrial Park. When envisioning mixed use development in the former surface mined areas, locating access from the developed areas to the wooded areas provides a strong sense of connectivity between the two areas.

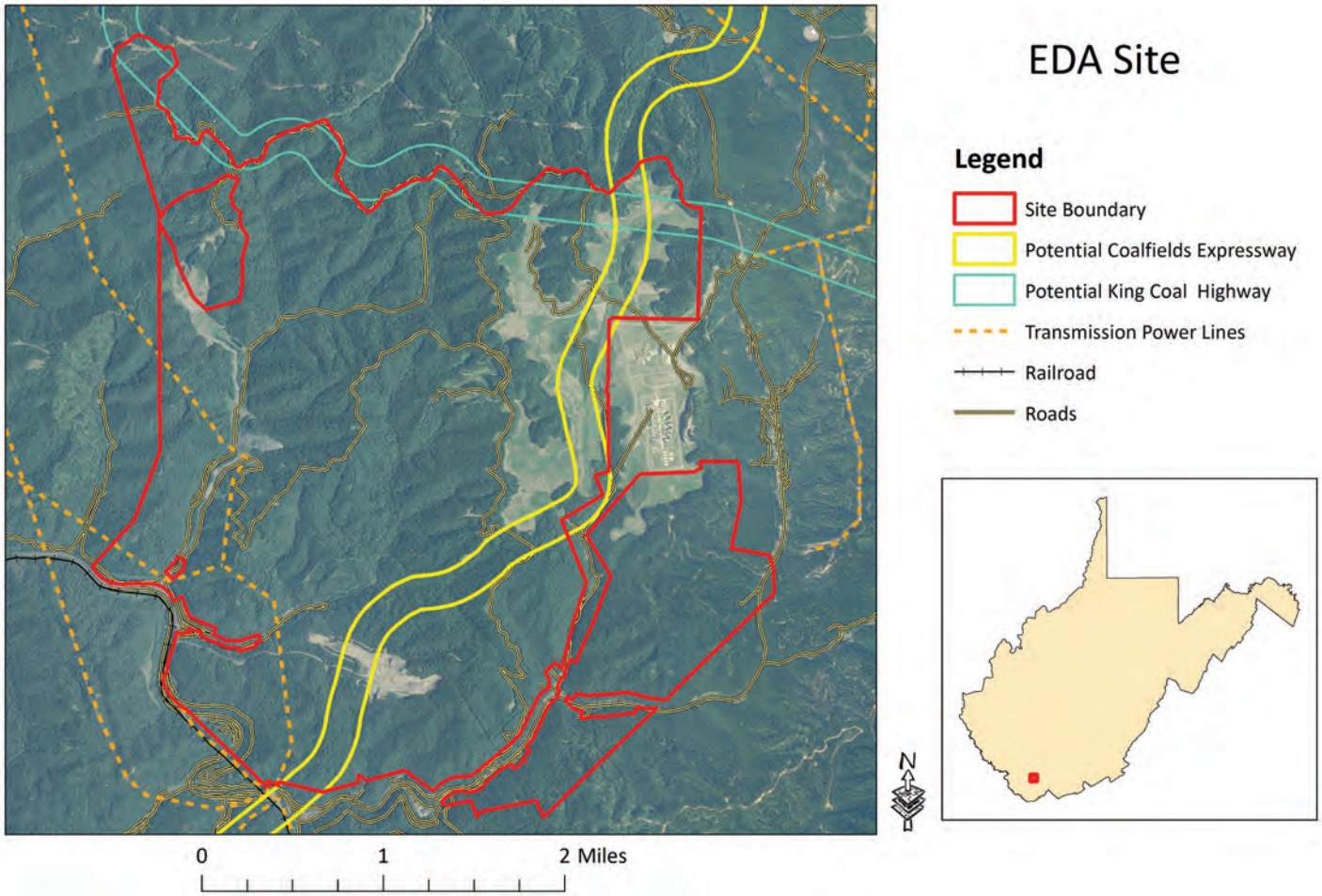


Figure 13. Transmission lines and their proximity to the site boundary and existing facilities at the Indian Ridge site in McDowell County, WV.

Regional circulation allows researchers to look at patterns that could potentially link to the site in the future. This is especially true of trails. Within the overall region of southern West Virginia trail development and definition have become an important economic development opportunity for many towns. The Hatfield-McCoy trail system is fast becoming a regional, national, and international

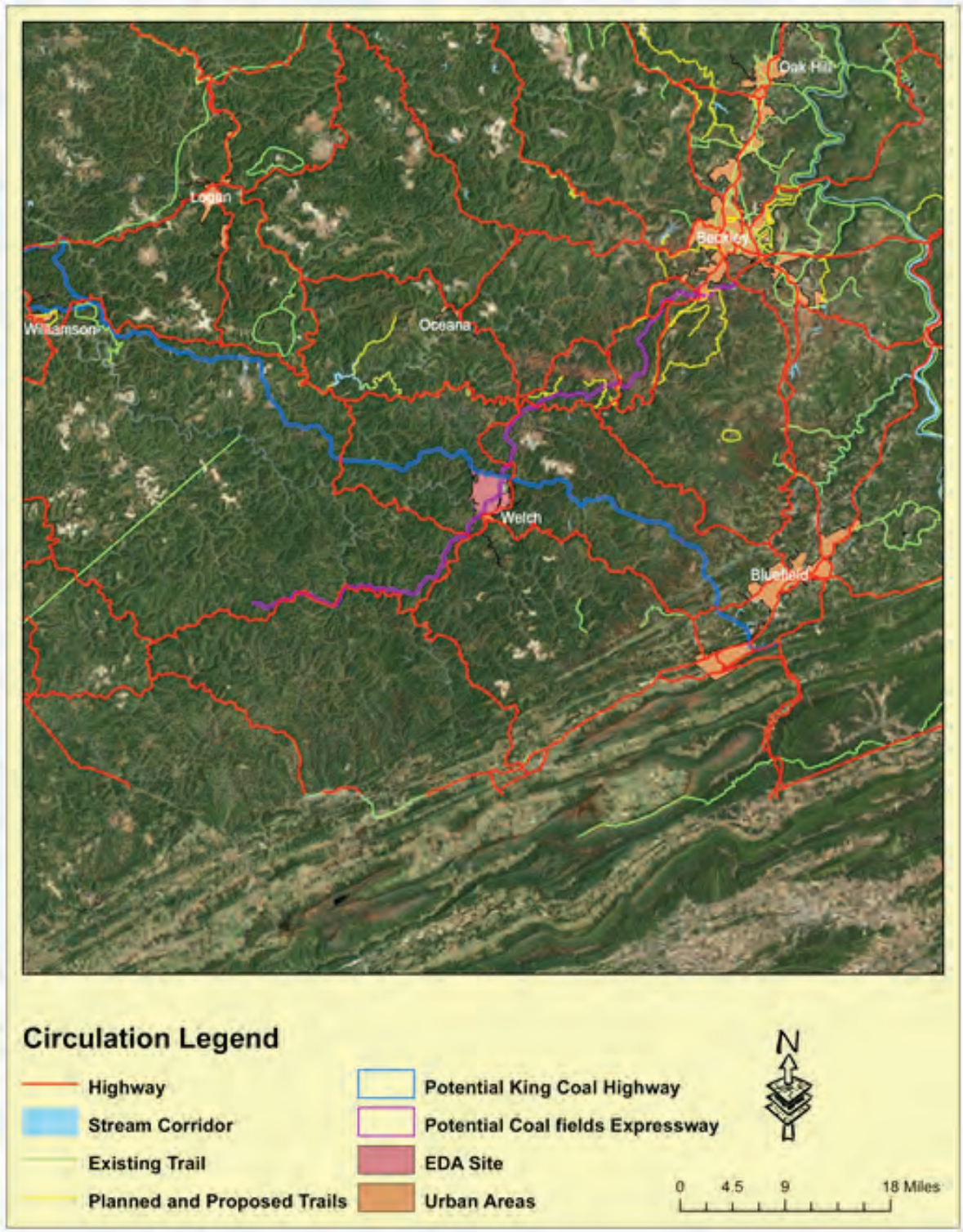


Figure 14. Existing and potential transportation pathways near Welch, WV.

destination for all terrain vehicle (ATV) enthusiasts. Also underway is the delineation of the Great Eastern Trail (GET) which, when completed, would be comparable in length to the Appalachian Trail. While these trail connections do not currently intersect with the Indian Ridge site, future alignments could access the area (Figure 14 and Figure 15).

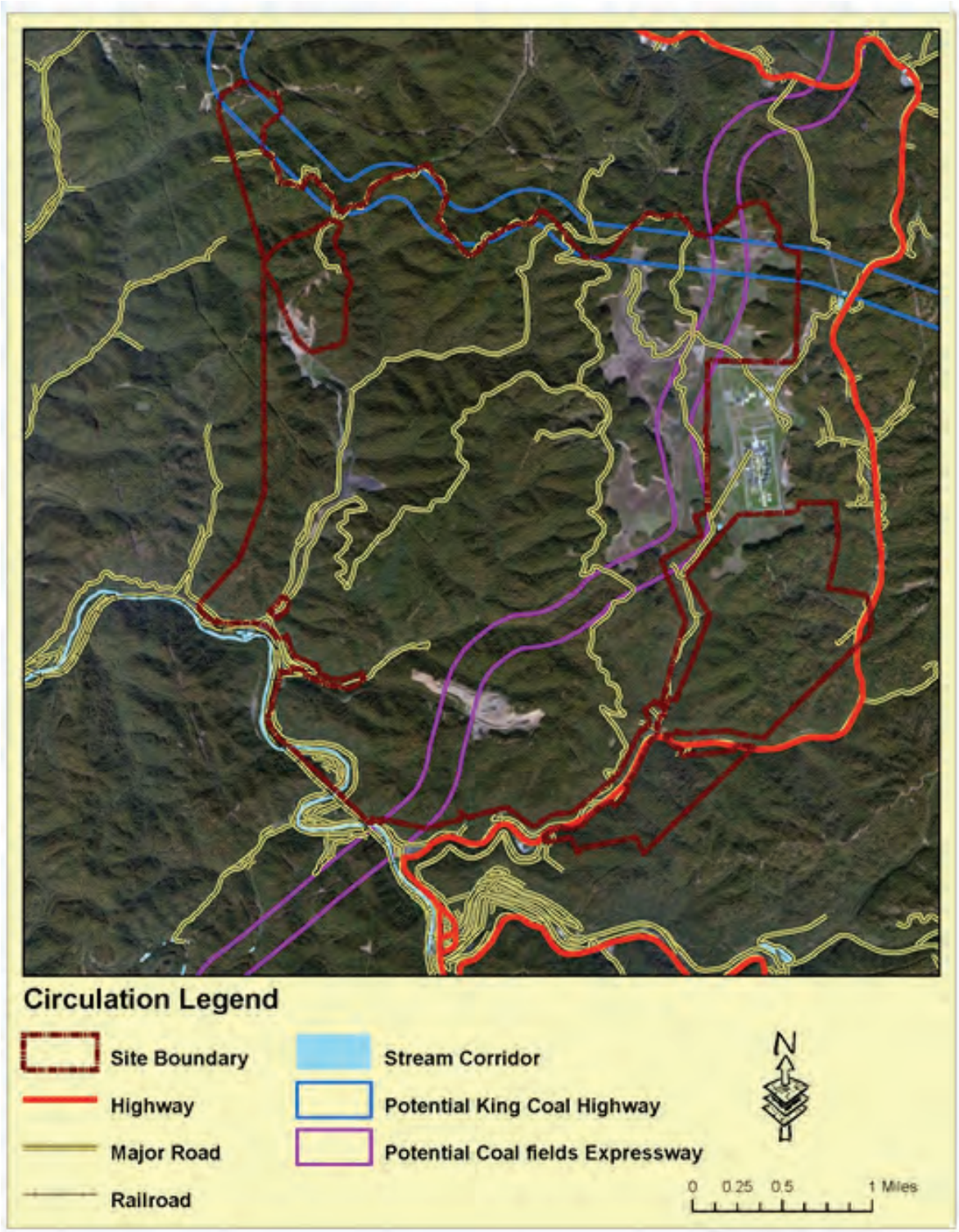


Figure 15 . A closer view of existing and potential transportation pathways near the Indian Ridge site in McDowell County, WV.

Soils data provides planners with very important information to guide their planning and design process. Soils provide opportunities and limitations for site development. Specific soils support unique plant communities. Soil stability is also an important consideration when siting structures, trails, and other potential design elements. Soil drainage is very important when considering site hydrology and stormwater management. Within the project boundary, primary identified soils include Pineville and Berks soils (USDA 1988). Pineville soils are found on the middle and lower mountain flanks and bases on back-slopes and foot-slopes and in coves. Berks soils are found on summits and shoulders of mountaintops with a slope range of 35 to 80% and are formed in material weathered from inter-bedded siltstone, shale and fine-grained sandstone, mixed colluvial material from sandstone, siltstone, and shale. Berks and Pineville soils show a strong association with particular vegetation. Common trees found in these soils are scarlet oak, red oak, black oak, chestnut oak, white oak, yellow poplar, hickory, beech, basswood, and red maple. The vegetation provides habitat typically for grouse, turkey, squirrel, and whitetail deer. Important understory vegetation primarily growing on slopes with cool, north-facing aspect includes cohosh, snakeroot, ginseng, trillium, mayapple, spring beauty, wild leek, and ferns. The available water capacity of the Pineville soil is moderate or high. Natural fertility is medium. Permeability is moderate. Runoff is very rapid. Most areas of this map unit are in woodland. A few small areas of the Pineville soil on side slopes and foot slopes are used as pasture. Because of the slope, surface stones, and a very severe hazard of erosion, the Berks and Pineville soils are unsuitable for cultivated crops and hay and are difficult to manage for pasture. The slope and stones on the surface severely limit this map unit for recreational development. Because of the very steep slopes and surface stones, this map unit is generally unsuitable for community development. The hazard of erosion is very severe in areas cleared for construction. The adjacent map, Figure 16, depicts soil types within the Indian Ridge site in McDowell County, WV pre-mining.

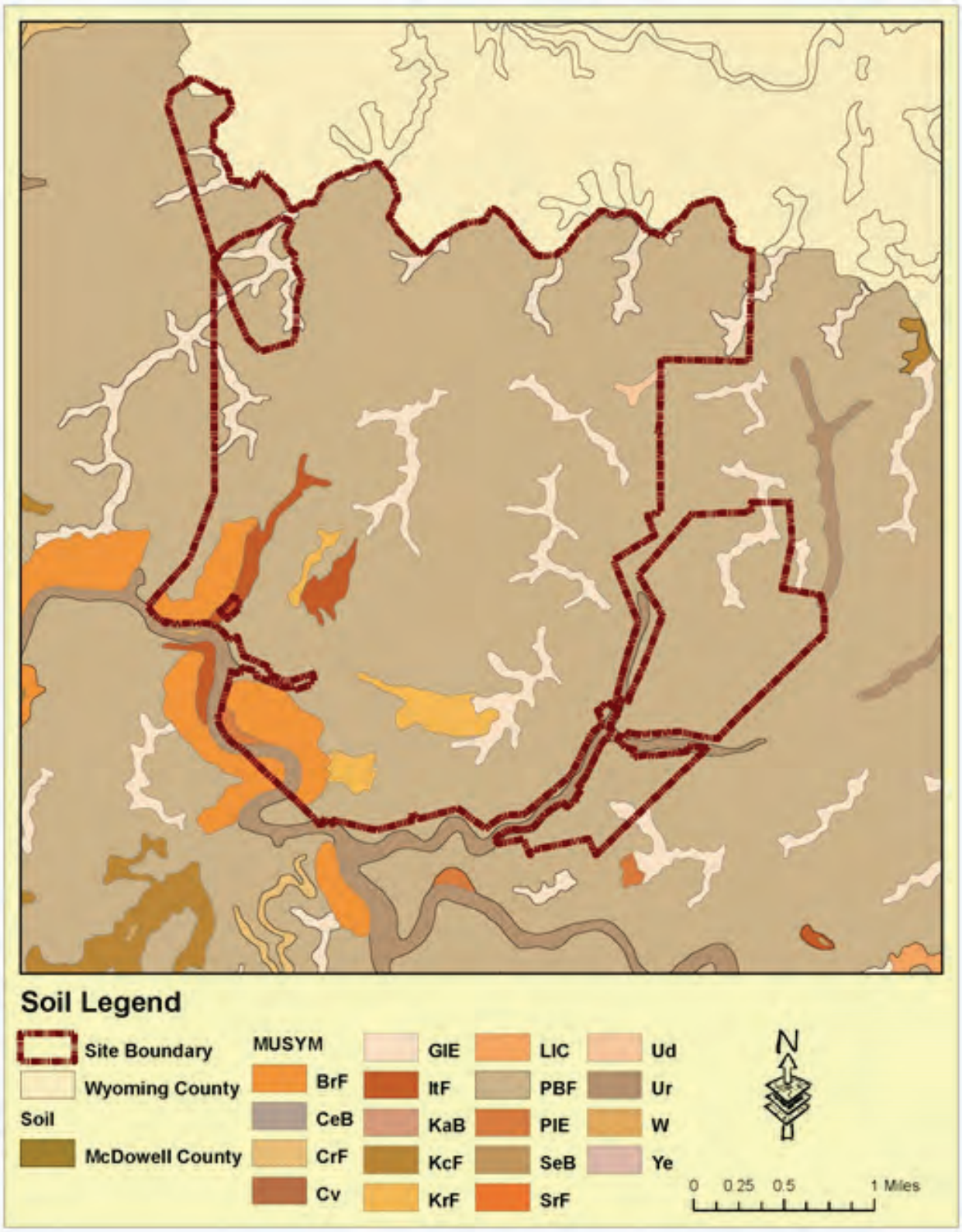


Figure 16. Soil types at the Indian Ridge site in McDowell County, WV site pre-mining.

Slope aspect tells researchers the direction (north, south, east, west) that the particular land surfaces are facing. Especially important for this project is the relation of the land surfaces to the cycles of the sun. The map below, Figure 17, identifies areas that would be most suitable for siting of solar panels within the design site. Other factors that would affect siting of solar infrastructure include slope gradient and soils. Slope gradient may limit solar infrastructure because of the potential restrictions of steep slopes making installation of panels difficult. Soil characteristics may limit installation because of the need for a stable subgrade. Level areas within the Indian Ridge Industrial Park are also suitable without regard for slope aspect as these open areas would allow for full exposure to the sun.

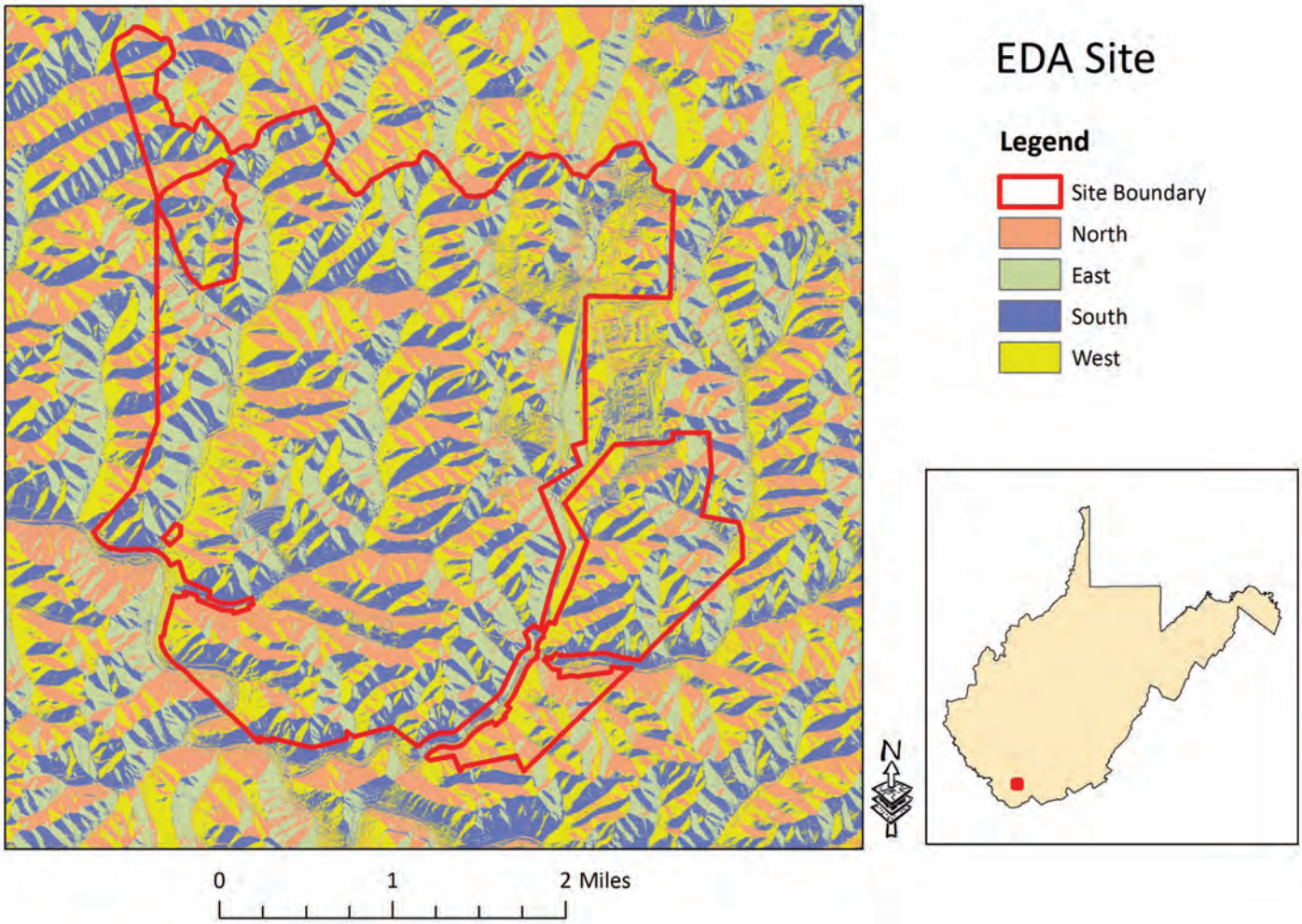


Figure 17. Slope aspect at the Indian Ridge site in McDowell County, WV.

Site hydrology shows water movement over the site pre-mining. Of particular interest to researchers is the site hydrology within the Indian Ridge Industrial Park area. When planning for new buildings, roads, and other infrastructure, researchers will acknowledge existing hydrology in order to weave designs within previously designed swales and pre-existing streams. Because stormwater management is a key component of the planning and design process, blending with existing patterns to avoid negative impacts is an important goal for the project. The map below, Figure 18, shows a detailed current site hydrology hillshade model (a variation in tone from light to dark to delineate the form of the land) with pre-mining streams (blue lines). A more detailed view of current site hydrology is found in Figure 28.

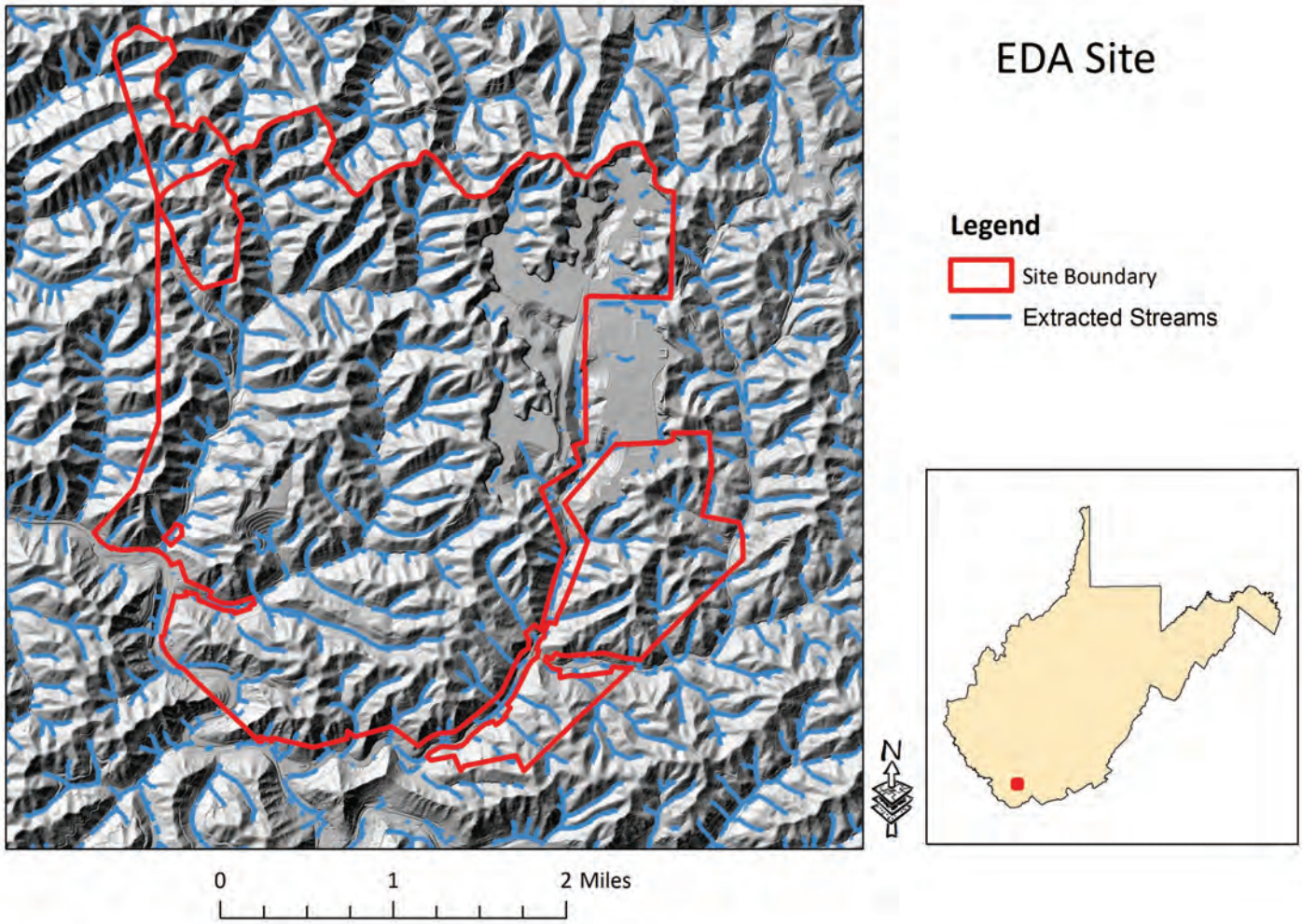


Figure 18. Historic and present hydrology at Indian Ridge site in McDowell County, WV.

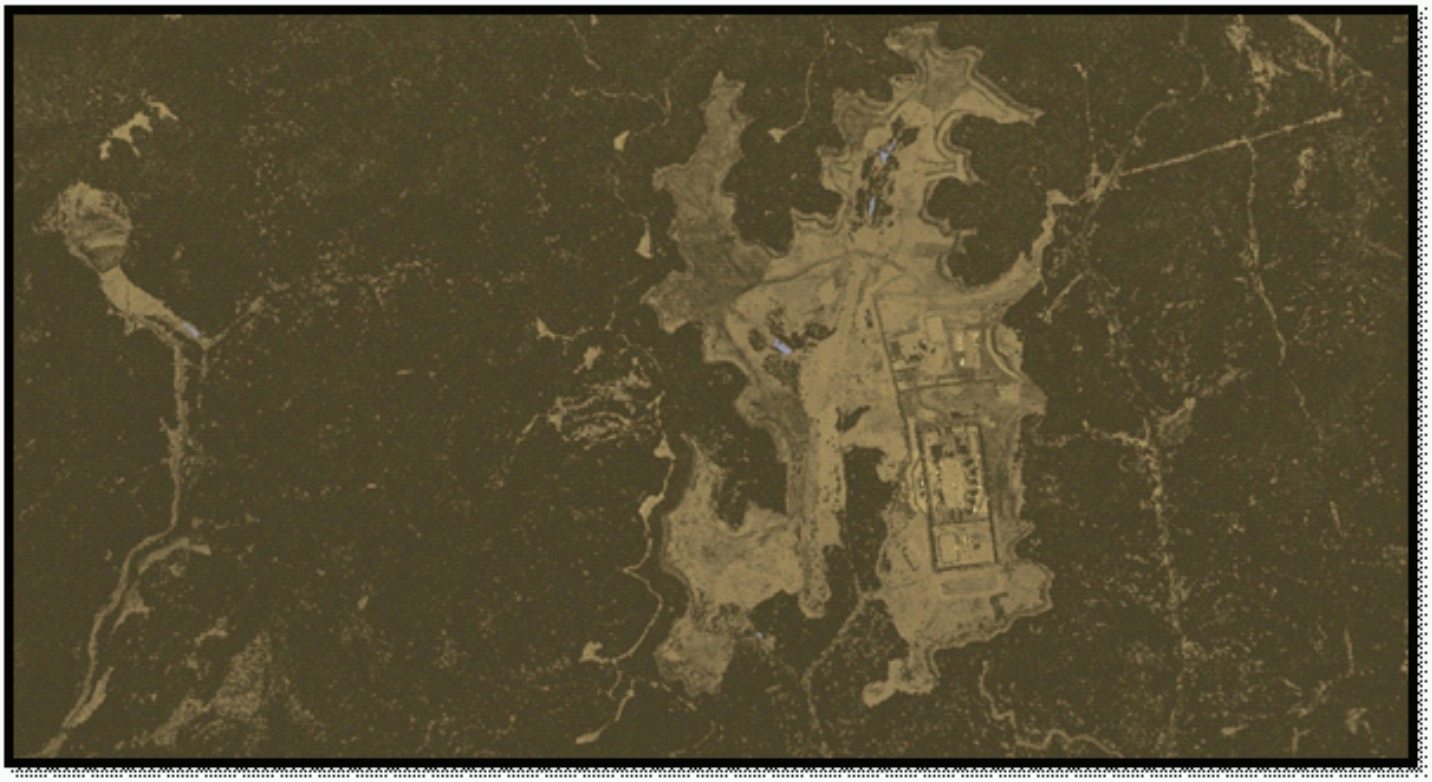


Figure 19. Aerial LiDAR imagery of the Indian Ridge site in McDowell County, WV.

Researchers documented site characteristics using ground-based LiDAR (Riegl® and Faro® brand scanners) for integration with aerial LiDAR (Figure 19) and performed cursory site analysis while laser-scanning. Researchers also obtained and reviewed Environmental Data Resources Report (EDR Report) for Environmental Site Assessment to meet ASTM E1527-05 Standard.

Spatial Analysis and Modeling

Spatial Requirements of Alternative Energy Facilities

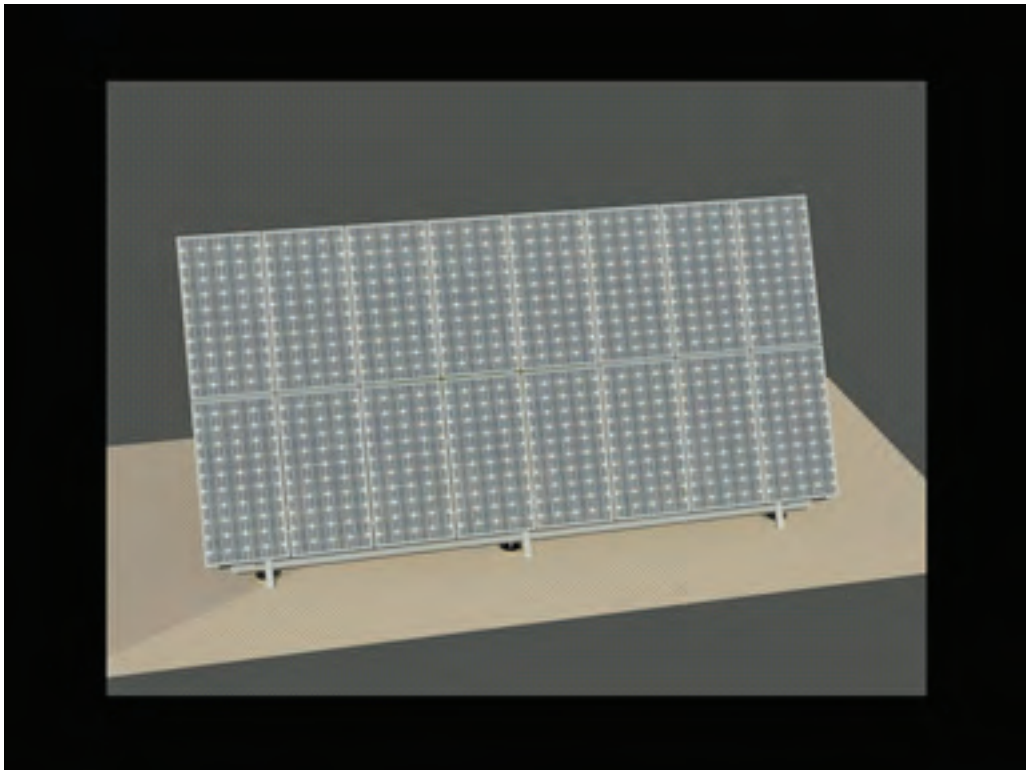
In order to better communicate and perform the inventory/analysis, design, planning, and potential of a Sustainable Energy Park in McDowell County, researchers constructed a three-dimensional model of the approximately 6000 acre site. The research team performed a review of the spatial requirements (physical, structural, infrastructural needs, etc.) in state-of-the-art and practice alternative energy facilities. Investigations included the collection of case studies of completed projects throughout the United States. These projects provided detailed information in the physical needs for site suitability and feasibility of alternative energy facility installation. Structural elements included the dimensions of specific facilities and forms. Infrastructural needs included roadways, energy, and other needs.

Modeling of Alternative Energy Elements for Visualization

Facilities and structures were modeled three-dimensionally at scale so that they could be placed within a spatial three-dimensional digital model for visualization. Wind turbines were created at three different scales: utility, community, and residential scales in order to visualize generation within a variety of contexts (Figure 20). Solar panels were also modeled (Figure 21).

Figure 20. Utility scale wind turbine modeled for insertion into site model.

Figure 21. Solar panel modeled using state-of-the-art design for insertion into site model.



Aerial LiDAR Background: Specifications and Methods

LiDAR has become an established method for collecting very dense and accurate elevation values and subsequent modeling of large-scale environments. This active remote sensing technique is analogous to RADAR but uses light pulses instead of radio waves to measure travel times (Figure 22). The location and elevation of the reflecting surface are derived from: 1) the time difference between the laser pulse being emitted and returned, 2) the angle that the pulse was 'fired' at, and 3) the location and height of the aircraft (i.e. sensor location). Unlike RADAR, LiDAR cannot penetrate clouds, rain, or dense haze and must be flown during fair weather.

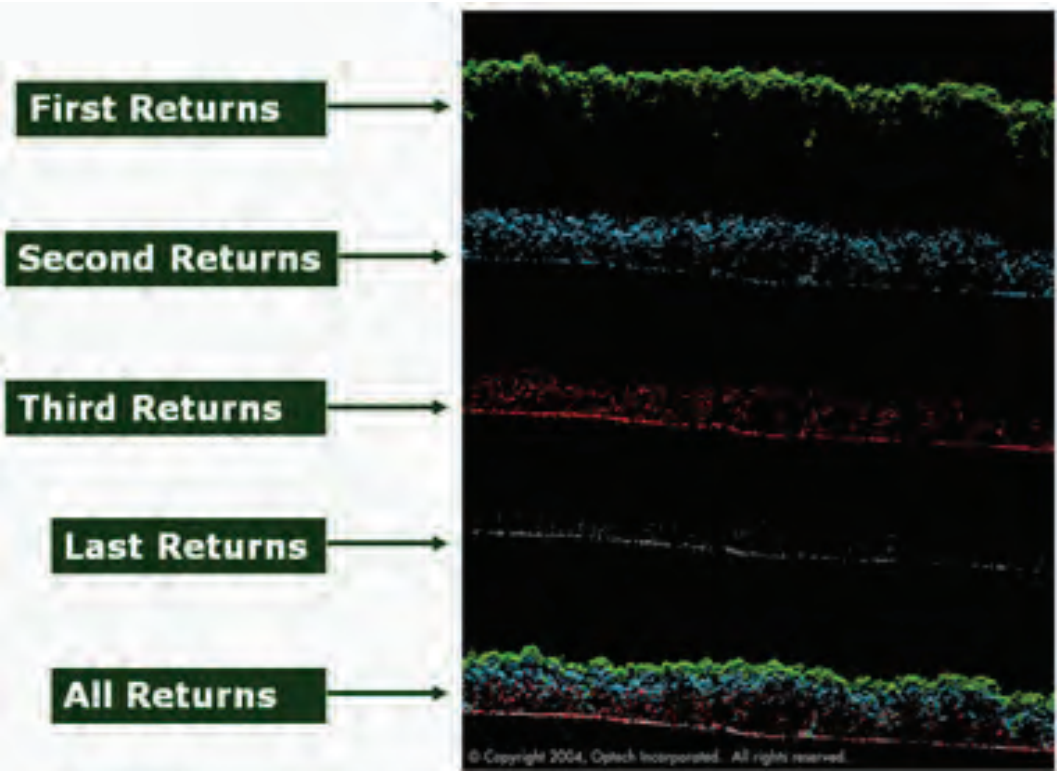


Figure 22. Multiple returns from the Optech® ALTM-3100 LiDAR unit.

An Optech® ALTM-3100, which is capable of emitting 100,000 pulses per second at flying altitudes less than 1,100 meters (3,609 feet), was used to generate the LiDAR data. The system is mounted in a Piper Navajo, a twin engine fixed-wing aircraft.

The Optech® ALTM-3100 is a four-return system, so for each pulse emitted from the sensor (70,000 per second in this case), up to 280,000 can be viable returns if flown over dense canopy with no surface water or atmospheric interference. LiDAR pulses are absorbed in water and cannot penetrate clouds or haze.

When combined, the layers create an accurate depiction of overall landscape characteristics, topography, elevation, vegetation, and site hydrology. The model (Figure 23 and Figure 24) then serves as a base for the rendering of design alternatives and for tracking change over time, and as an immersive environment for design visualization. The resulting pointcloud model was exported to Pointools®, software that allows planners and designers to work with very large data sets through linkages with design software (Google SketchUp®, AutoCAD®, three-dimensional Studio Max®, Rhinoceros®, etc.).

Figure 23. Overall model of study area created using LiDAR data processed in Pointools® software.

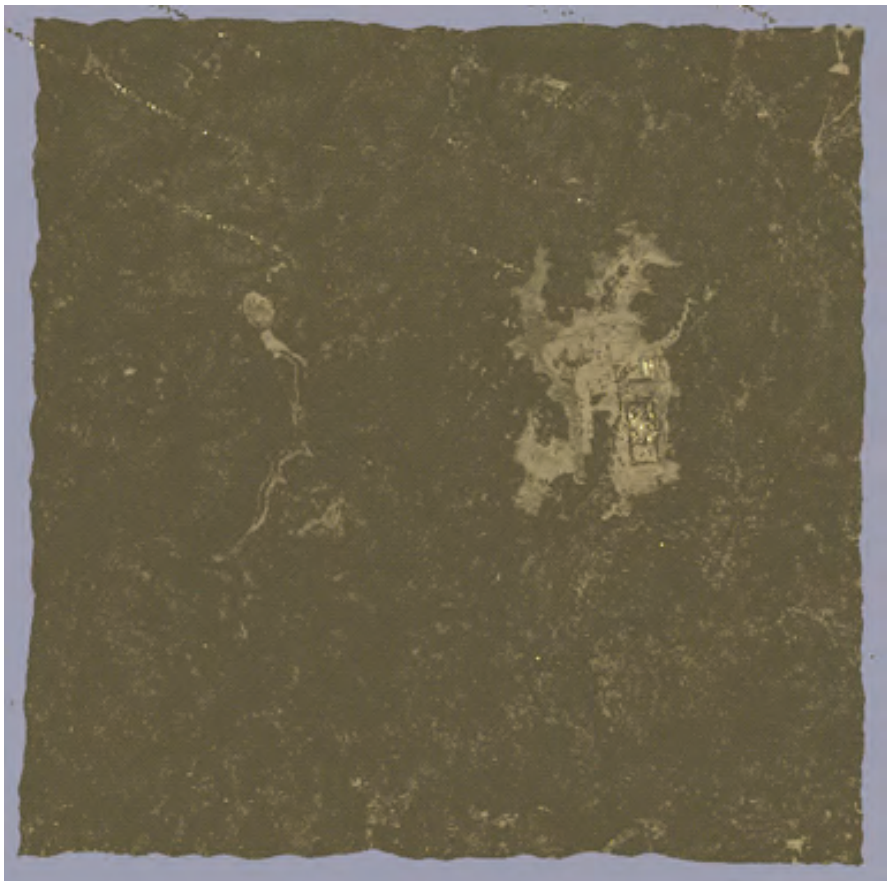
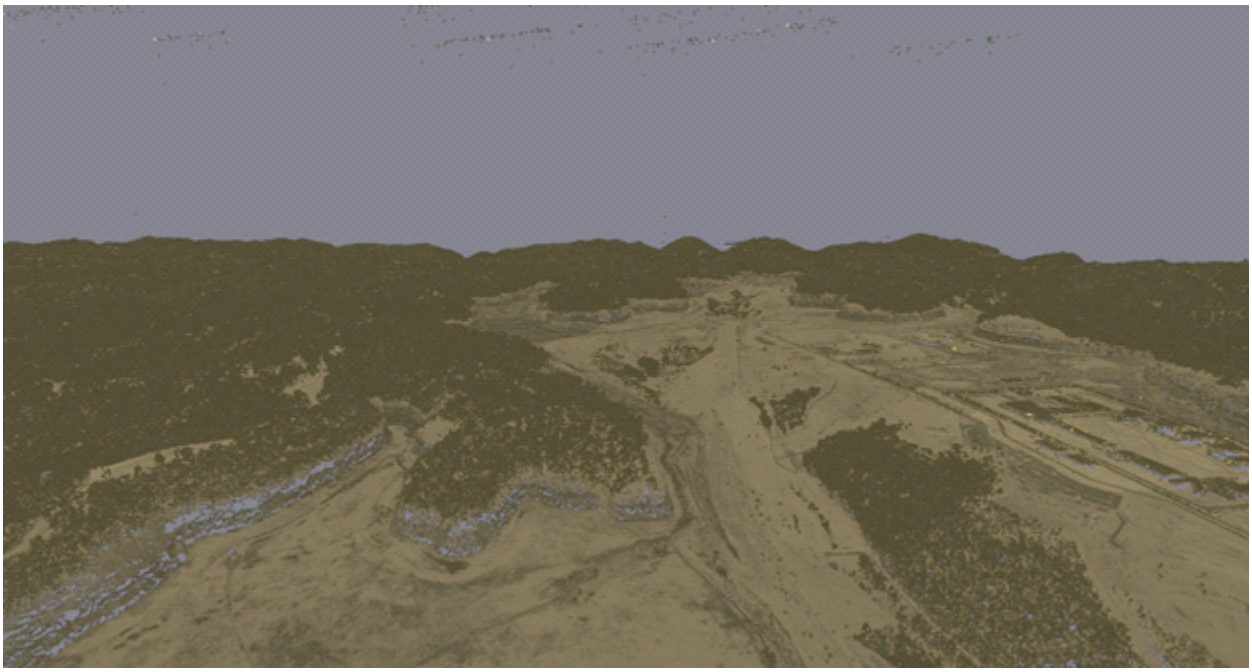


Figure 24. A bird's eye view of the LiDAR model in Pointools® software.



The primary design software used to create visualizations was Rhinoceros®. With the existing pointcloud, researchers were able to model the future expressways (Figure 25) planned for the area. The Geographic Information Systems (GIS) data provided alignments for the Coalfields Expressway (north/south) and the King Coal Expressway (east/west), which are planned to intersect on the northern border of the project boundary. Researchers also modeled the existing FCI-McDowell complex in the three-dimensional digital model (Figure 26).

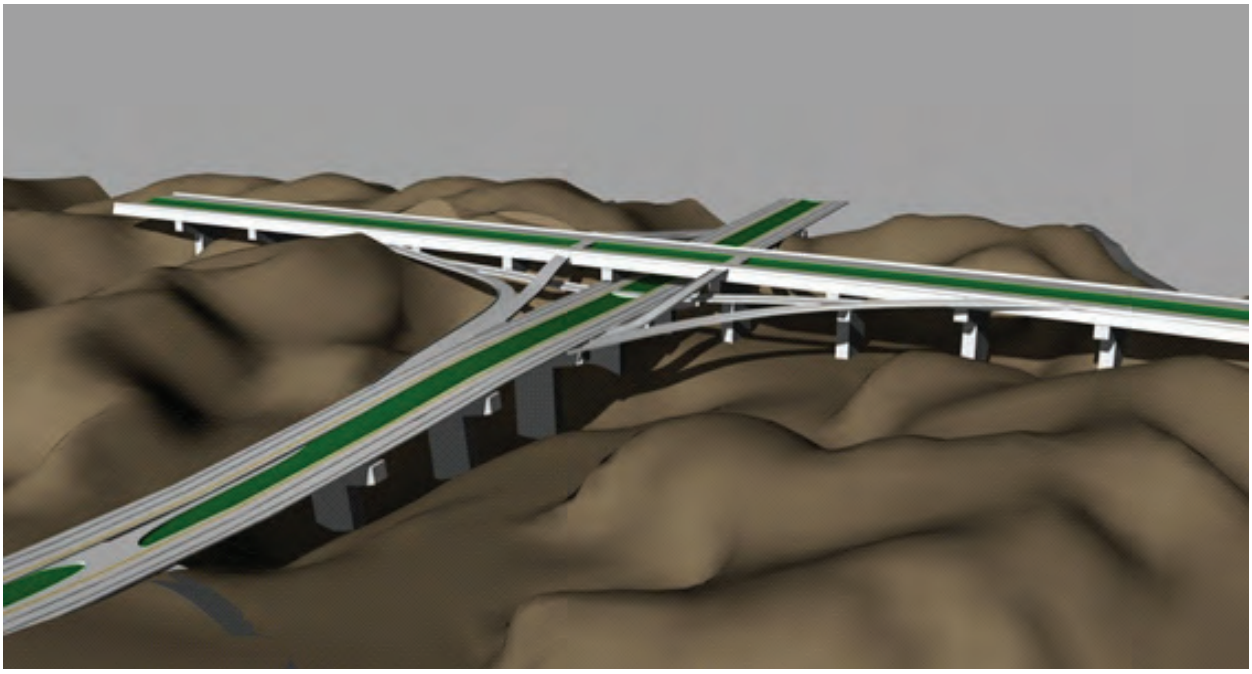


Figure 25. Digital three-dimensional model showing future King Coal and Coalfields Expressways built using Rhinoceros® software.

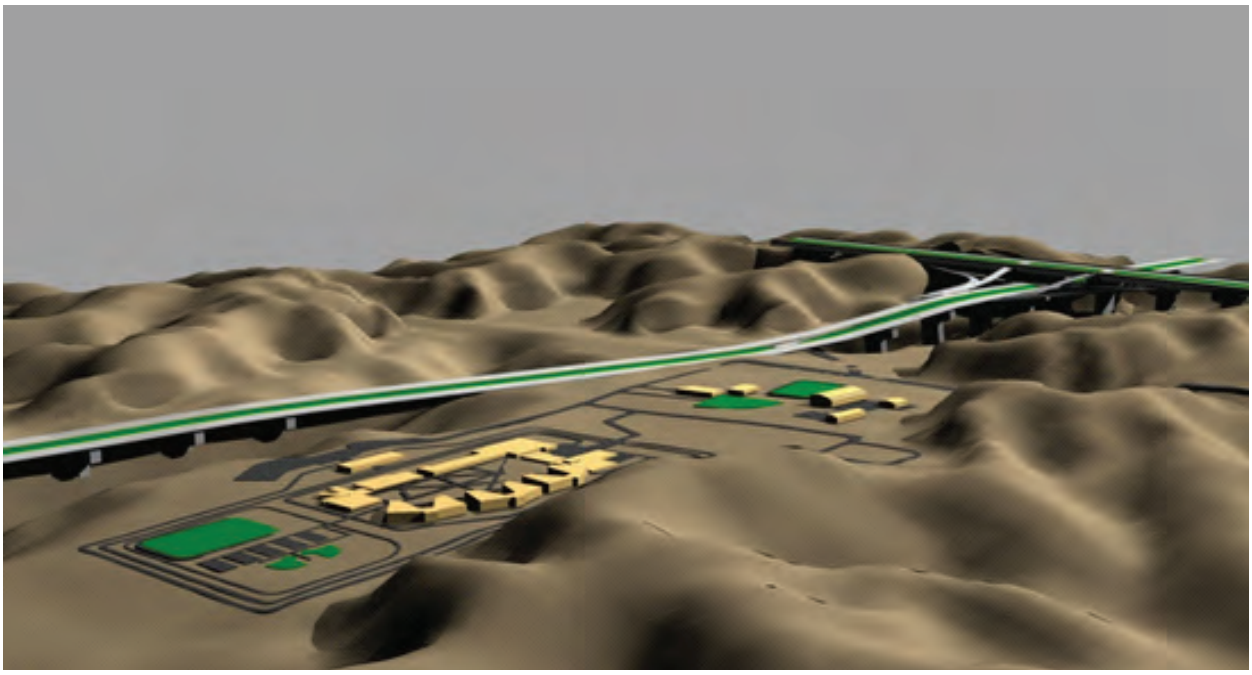


Figure 26. Digital three-dimensional model showing FCI-McDowell within the context of the site and the future expressways.

Detailed inventory and analyses were performed using the LiDAR model. The very detailed topographic data allowed researchers to create a detailed map of site hydrology. Site hydrology information will be applied to the development of green infrastructure design focused on stormwater management. Vegetation for the approximately 6,000 acres was also modeled showing areas of canopy, sub-canopy, shrub layer, grasses and bare earth. When combined, the layers create an accurate depiction of overall landscape characteristics, topography, vegetation, and site hydrology. The model then serves as a base for the rendering of design alternatives and for tracking change over time, and as an immersive environment for design visualization.

The result is a three-dimensional (Pointools®) model of Indian Ridge site's approximately 6,000 acres. Next steps included modeling of existing structures on site including FCI-McDowell, and the proposed highway alignments (Coalfields Expressway North/South and King Coal Highway East/West). Figures 27 to 30 depict LiDAR produced imagery. With the use of LiDAR and the creation of a hillshade image for site topography, a highly detailed inventory of drainage patterns is possible. The drainage plan post-surface mine reclamation includes swales that follow along the edges of highwalls. The swales bring stormwater runoff to two very large detention ponds. Also visible in Figure 28 is the planned and graded alignment for expressway development.

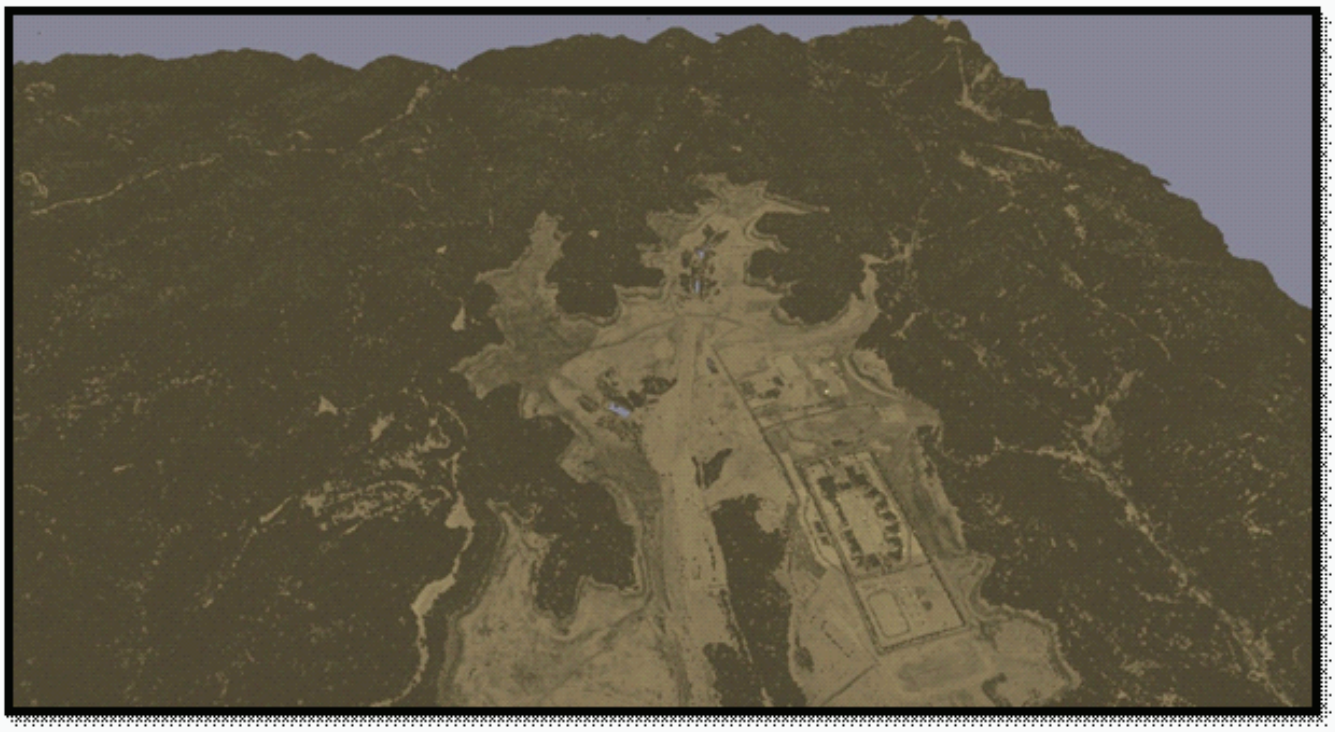


Figure 27. LiDAR axonometric view of proposed SEP site in McDowell County, WV.

Indian Ridge Site: Detailed Drainage

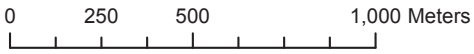


Figure 28. Detailed drainage and topography of the Indian Ridge site in McDowell County, WV.

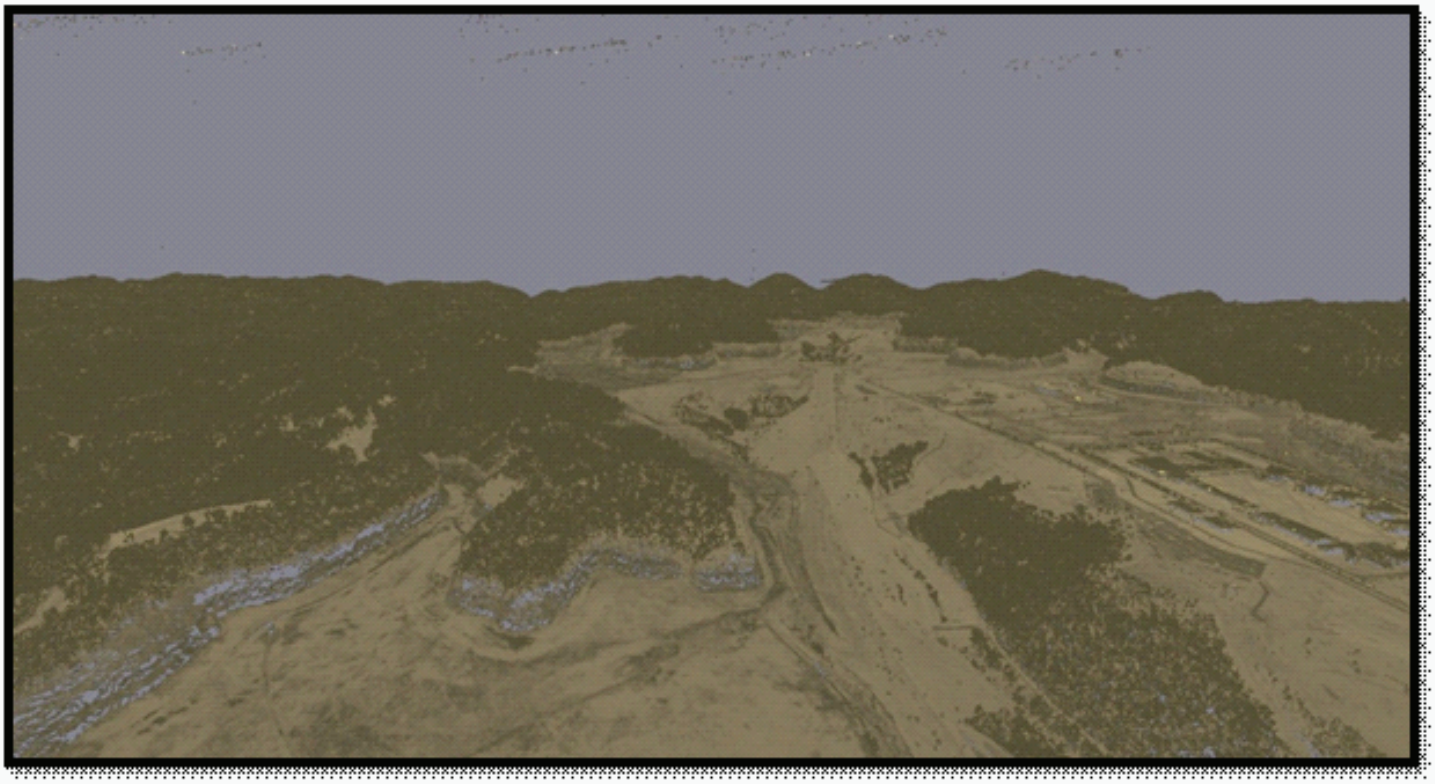


Figure 29. LiDAR produced imagery of proposed SEP Site in McDowell County, WV.

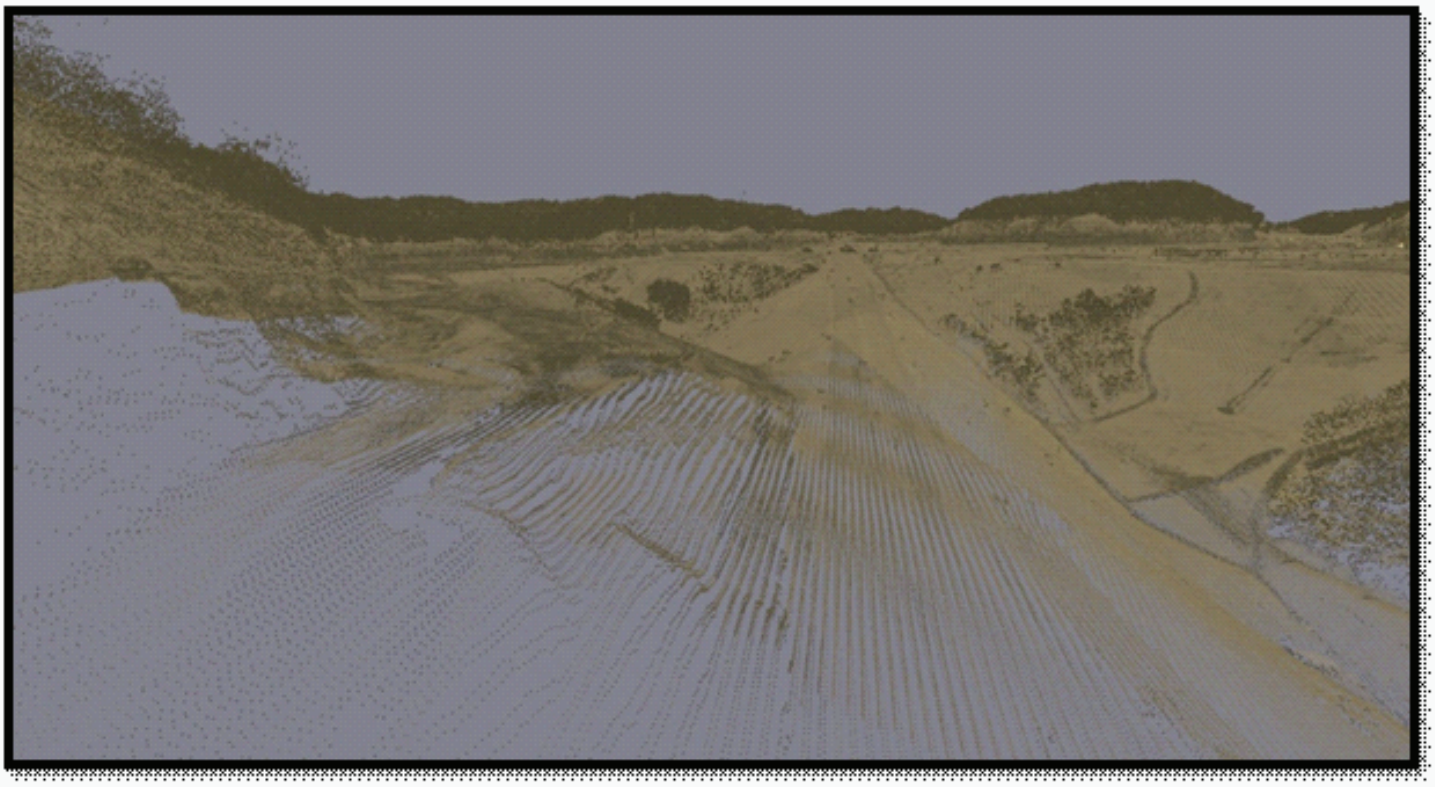


Figure 30. LiDAR produced imagery of the proposed SEP Site, depicting a "fly through" view.

Participatory Planning

Participatory Planning Process with Officials and Experts

The participatory planning process with local officials began with the meeting in Welch just south of the McDowell County Indian Ridge site. Alternative energy experts were engaged to provide a practical critique of project design when conceptual designs were completed. Researchers met with West Virginia regional solar energy experts (MTV Solar) to discuss collaboration/review of solar infrastructure design. Researchers met with US Windforce to discuss wind infrastructure design. These two industry representatives, as experts in their respective fields, provided important contributions to the planning process.

Local Official Participation

Researchers administered a meeting to discuss the proposed SEP project in Welch, through the McDowell County Economic Development Authority. The meeting allowed researchers to hear local concerns and opportunities related to the Indian Ridge Industrial Park site and the entire site under consideration. Stakeholders at the meeting identified groups and individuals for engagement in the participatory planning process. There were multiple purposes identified for the meeting; to introduce West Virginia University team members and McDowell County officials and attendees; introduce the SEP Project to local McDowell County officials and other attendees; discuss potential stakeholder groups for participation in the planning process; discuss a potential public-wide engagement strategy during project planning; discuss other opportunities that may be addressed during the planning process, i.e. industrial park location and design; to discuss opportunities created by expressway alignments, public recreation needs, gateway opportunities, National Coal Heritage Trail connections, etc.; clarify the project site boundary and access to the site; and to coordinate a visit to the project site for surveying purposes (LiDAR and environmental assessment). The meeting occurred on Wednesday, March 28, 2012, and site visits followed that afternoon and the next day.

The meeting brought local insights and sensitivities to the attention of the research team. One of the key outcomes of the meeting was to identify other groups for participation. The identified groups and individuals included: the local Chamber of Commerce, local schools, Southern West Virginia Community College (Saulsville), WVU Extension agents, WVU-Extension 4H representatives, Copper Ridge Landfill representatives, and the warden at FCI-McDowell. Individuals involved in alternative energy projects currently active in McDowell County were also identified including high school teachers and local Health Sciences and Technology Academy (HSTA) representatives. Local alternative energy projects include a solar experiment at Mount View High School and potential methane harvesting/ trash to energy facilities at Copper Ridge Landfill.

Local knowledge communicated during the meeting assisted researchers in defining the boundary of the site for planning. Individuals at the meeting had worked closely in bringing FCI-McDowell to the property; the group had gone through several iterations of planning and design in envisioning future use of the industrial park. The site had been identified for mixed-use development through a land use master plan (LUMP) developed for the West Virginia Division of Energy Office of Coalfield Community Development. The mixed-use development for the site is appropriate as it is the location of the future interchange between the King Coal Expressway and the Coalfields Expressway. The participants had identified 'new' energy development opportunities for the site including a possible hydro-pump project and a possible mine-water-heat energy generating facility. The group perceived a relationship with FCI-McDowell to be a strong opportunity for partnership through work camps and green energy job training programs.

In terms of recreation, participants had witnessed the positive economic impacts of the regional all-terrain vehicle trail and envisioned potential connections to the Hatfield-McCoy trail, specifically reaching out to Ashland where trail alignments had been defined. The participants did perceive a potential conflict in developing a 'formal' trail system in McDowell County. Specifically they thought that residents may resist paying the fees and following the rules if trails were proposed for the project site. Participants discussed the potential for specific county resident access without major restrictions.

Another connection that would benefit site development was with the National Coal Heritage Trail US Route 16. As a gateway from the planned expressways (King Coal and Coalfields Expressways) to the historic and cultural resources of the established route, the industrial park site would be a key hub in drawing visitors to the region.

Participants also identified key community needs in real estate and economic development. Through local discussions the group had identified a need for rental properties. Many of the workers at FCI-McDowell commute over an hour to work. Local housing does not satisfy the demand. They also see a need for a hotel/motel at the industrial park site; visitors to FCI-McDowell have difficulty finding overnight lodging.

Assets that participants identified through discussion include existing site infrastructure. Existing infrastructure includes roads, water, electricity, and other utilities. Water retention for runoff was established in the mine reclamation process. Discussants also perceive strong potential in providing utility support for FCI-McDowell.

Expert Participation and Consultation

As a planning component of the project, regional experts in the field of alternative energy generation were consulted multiple times throughout the project development. Solar energy experts (MTV Solar) were recruited to discuss collaboration and in their role as potential reviewers of solar infrastructure design for the McDowell site. Their participation allows for the most context-sensitive design solutions as they work designing, implementing, and managing solar infrastructure projects throughout the northeastern region. As a company, they are committed to building local economies through alternative energy projects, training local contractors, and educating the public. Their participation may have positive impacts on the residents of Welch and the region.

Wind energy expert consultation consisted of meeting with US Windforce, a key player in developing wind energy projects at the Allegheny Front, particularly in Logan County, WV. They portrayed very clearly the financial margins necessary for completing a privately funded project. Their input provided insight into the feasibility of the McDowell County project. When implementation is more fully developed for the site, US Windforce's participation may become a key component to grounding the planning project within the realities of wind energy development on the site.

Focus Group Meetings

Following the meeting with officials at the McDowell County Economic Development Authority (EDA), focus group meetings were organized. To gather a broad base of input, three focus group meetings were scheduled, in addition to meetings with newly identified stakeholders. The meetings were held on June 14, 2012 at the Welch Public Library. After the meeting with McDowell County EDA, leaders of the Copper Ridge Landfill and administrators at FCI-McDowell were contacted for private meetings. Focus groups were organized under the subject areas: education, business/industry, and recreation. With the input of the EDA already establishing a mixed-use program, researchers decided on more specific and detailed topical areas for coverage in focus group meetings. Questions designed to spur

conversation between participants were consistent across the three groups though with different areas of emphasis. Individuals were contacted for participation through email and phone calls. Many were eager to contribute their input to the project. The following discussion lists the questions asked of each focus group, followed by the summary results and analysis of input collected at each focus group meeting. The concluding section translates collected information to planning and visualization of the Master Plan and potential project and program initiatives.

Education Focus Group
Questions and Topics:

- What do you see as opportunities for this project in addressing educational needs in the region?
- What types of skills training could you foresee being a part of this development?
- What programs are currently underway that would relate well to this development?
- What new programs could be developed in relation to this development?
- How would these new programs be administered or facilitated?
- What do you see as other opportunities in relation to this development?
- What do you foresee as potential problems in relation to this development?
- What is the most pressing need in education in this region?

Education Stakeholder Input and Results:
Focus group participants expressed that education and interpretation should not exclude celebrating history of coal mining in the region. Existing programs and degree programs at high schools and the local community college should be integrated and have a strong potential for contributing to the project. Building additional education programs around the new development would also enhance local opportunities for focused degrees, and enhance other campuses' offerings. Opportunities were noted especially in the area of computing and creating a 'certification' center in the new development. Also, the development was seen as a potential training ground for 'green jobs.' Training for 'recreation' and 'tourism' industry jobs was also noted as a potential emphasis in relation to the new development. Establishing recreational facilities, especially high adventure facilities, and training individuals in their operation was seen as an opportunity. Officials from FCI-McDowell already have a solar panel installation training system so the development of solar facilities on the site could provide real life experience and training to work camp inmates. Carpentry, masonry, and building management programs could also create strong connections to future development. The key component of education programming in reference to the community college and FCI-McDowell was job training, preparing students and inmates for professional careers with livable wages that could fit into, and enhance, the local economy.

In terms of high school education, local leaders perceive a strong potential connection to the Health, Science and Technology Academy (HSTA) program. Developing curriculum related to the new development and assisting local educators in implementing the curriculum would be necessary, especially in terms of scheduling and planning as this occurs months prior to the beginning of the school year. Curricular opportunities discussed included focusing on environmental mitigation and using the site as a laboratory for water resource management and biodiversity studies.

Housing is an issue that was identified by the participants. Recruiting teachers and faculty to the area has been difficult due to a lack of housing.

Education focus group participants also commented on appropriate recreational opportunities centered on active living that the new development could address. Walking trails free from All-Terrain Vehicle usage would be desirable. Linking the site development to quality of life resources would benefit local residents.

Business and Industry Focus Group
Questions and Topics:

- What do you see as opportunities for this project in addressing business/industrial needs in the region?
- What types of businesses/industries could you foresee being a part of this development?
- What business/industrial projects are currently underway that would relate well to this development?
- What new business/industrial projects could be developed in relation to this development?
- What would help jump start these new business/industrial projects?
- What do you see as other opportunities in relation to this development?
- What do you foresee as potential problems in relation to this development?
- What is the most pressing need in business/industry in this region?

Business and Industry Stakeholder Input and Results:
Current projects adjacent to or within the study area boundary could create strong connections to the Indian Ridge development site. The local landfill is planning for development of a 'waste to energy' facility so infrastructural improvements would be mutually beneficial. Stakeholders identified the FCI-McDowell as a potential consumer of alternative energy. The participants see a need for a tourism visitor center on the site as a gateway into the region. They also see a need for housing for area employees. Many local employees commute long distances to work places, especially FCI-McDowell.

Focus group participants envisioned different businesses and services that could be a part of the Indian Ridge site development that were lacking in the area. These businesses include retail stores, a Magic Mart, auto parts stores, All-Terrain Vehicle (ATV) service and parts shops, building materials outlets, a livestock market, outdoor-type markets, and laundromats. Participants thought that this development could spur entrepreneurial spirit in the area that is currently lacking. They also voiced a need for a large scale event space for hosting the county fair, ATV racing, theatrical and musical events, rodeos, races, car shows, and carnivals.

New expressway and utility development were seen as necessary elements in the development of the region creating better access into and out of the area. The new expressways would provide connection between existing site developments and the Indian Ridge Industrial Park. Roads and railroads would help to counter loss of population trends and enhance local school investment and quality, a perceived barrier to in-migration. The rarity of flat developable land is also seen as a barrier to new industry development in the region. In concert with developing new lands, engineering creeks and local rivers to be more sustainable was also seen as an opportunity to attract new settlement.

Recreation Focus Group
Questions and Topics:

- What do you see as opportunities for this project in addressing recreational needs in the region?
- What recreational programs are currently underway that would relate well to this development?
- How does this site relate/compare to other recreational resources in the area?
- What new programs could be developed in relation to this development?
- How would these new programs be administered or facilitated?
- What do you see as other opportunities in relation to this development?
- What do you foresee as potential problems in relation to this development?
- What is the most pressing need in nature-based recreation in this region?
- What is the most pressing need in other recreation in this region?

Recreation Stakeholder Input and Results:
Recreation stakeholders voiced opportunities for the site to function both regionally and locally in enhancing facilities and programs. A connection to the Hatfield-McCoy Trail was seen as an opportunity as plans are already underway to connect War, WV to Welch and Davy, WV. Hiking, biking, and dog-walking, as healthy living improvements, were mentioned as potential new facilities for the site development. The group envisioned open space with water, a playground and integrated environmental education within the site. Mountain-biking, ATV trails and BMX biking trails could be implemented. Creating a Hatfield-McCoy type trail system for mountain bikes was seen as an opportunity. A recreational site already under development, Twin Branch, could be connected to the development site enhancing local trail systems. Currently ATV riders use trails on private property or "renegade" trails. Providing management and control to local trails is a concern. Local users have voiced opposition to controls including requiring helmets and boots and limitations on alcohol consumption, though participants see these controls as necessary. Participants would like to see the town of Welch become more 'ATV friendly' as they have seen positive economic impacts of ATV users in other communities. Other activities mentioned for park development include a paintball facility, zip-lining, a snow park, rock-climbing, hunting, fishing and geo-caching. Participants identified conflicts between some of these uses, especially in relation to hunting seasons.

Participants voiced a need for a wellness center and discussed issues and gaps in facilities at local parks. Popular activities that could be facilitated with new development include a golf driving range, a firing range, and radio controlled aircraft piloting. Locally, communities are in need of a Department of Parks and Recreation. Participants discussed creating a non-profit for managing recreation sites or a public/private partnership developed similar to the Hatfield-McCoy organizational structure. They saw the new coal methane tax monies as a potential opportunity for investing in recreation-focused development.

Focus group participants recognize that recreational visitors will require services: gas, food, and lodging. The new development could provide these important visitor services. In terms of other development for the site, participants discussed fast-food franchises, outdoor equipment retailers, and sports shops.

Figure 31: Researchers meeting with students.

Participation with Local Youth
In order to address questions and concerns of local youth, an event was scheduled at the McDowell and Wyoming County 4H camp with a self-selected student group. In this way the group was small enough to engage in a meaningful way. An agenda was set for the meetings with 4H students that sought to educate them on the project and provide a forum for discussion. It was also hoped that the students would contribute meaningfully to the design process. The 4H Camp was held in Glen Fork during the week of June 25-29, 2012. Working with a youth group (Figure 31) was a very important component of the project in that their contributions gave voice to an underserved population group, and it is hoped that as the next generation of adults they may

recognize potential 'new' energy opportunities as defining their region, especially as a viable reuse strategy for surface mined sites.

The image below, Figure 32, depicts a three-dimensional digital site model and the 'kit of parts' that students were able to use in designing the site. The kit of parts includes, from left to right, a wind turbine, perennial grasses, a solar panel, an industrial building, suburban type housing, high density apartment style housing, high income detached housing, and single family detached low density housing. The FCI-McDowell complex is also shown, as are the planned expressways. The images in figures 33 to 35, on the following pages, depict potential designs from the three student groups.

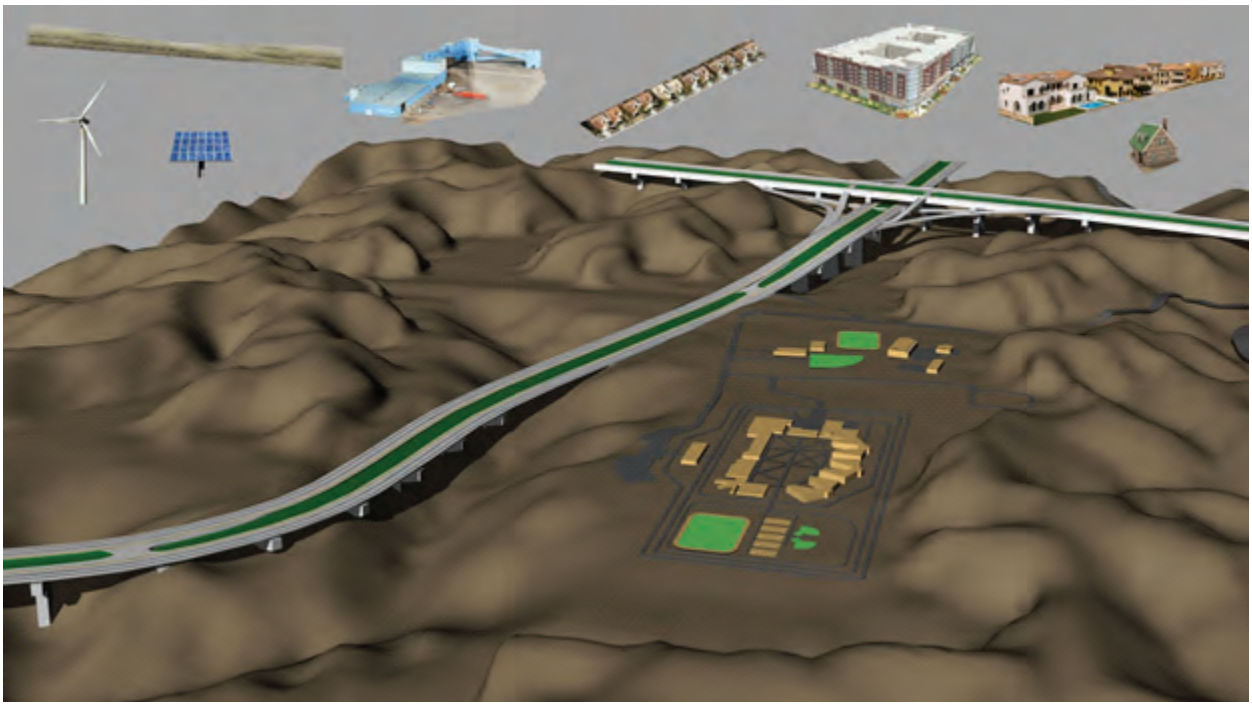


Figure 32. Three-Dimensional Digital Site Model and Kit of Parts.

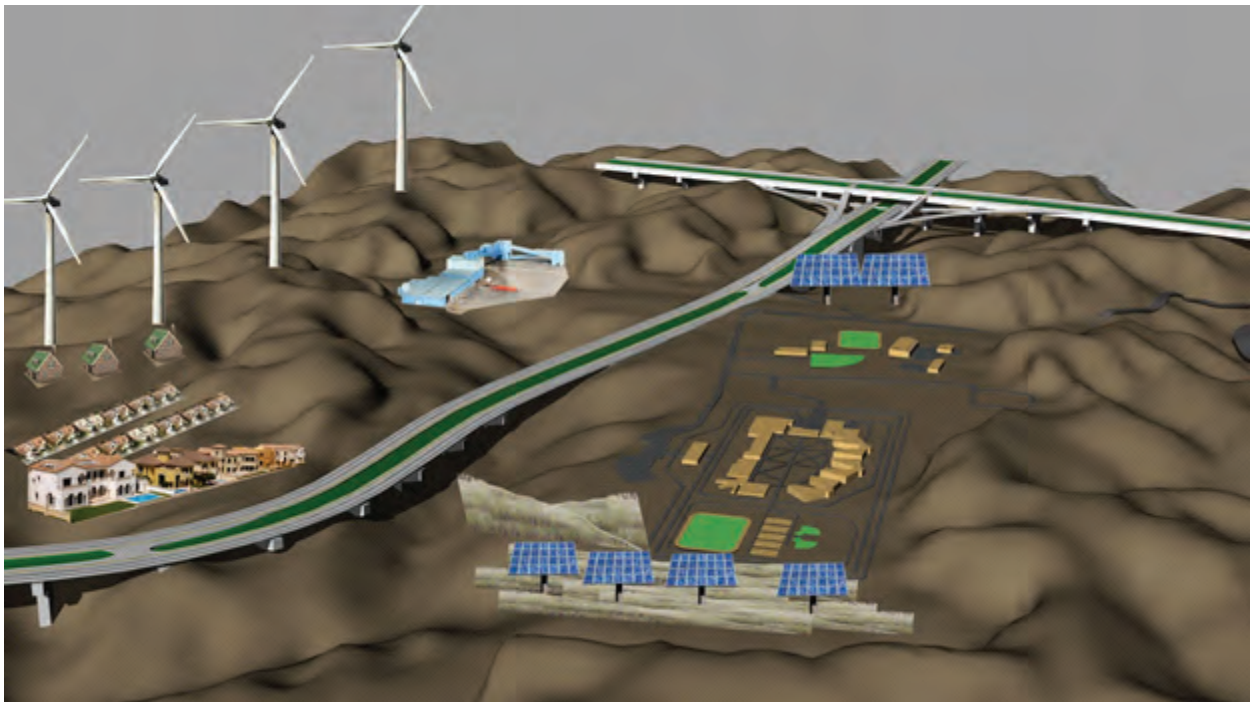


Figure 33. Group 1 Design of the Site Plan.

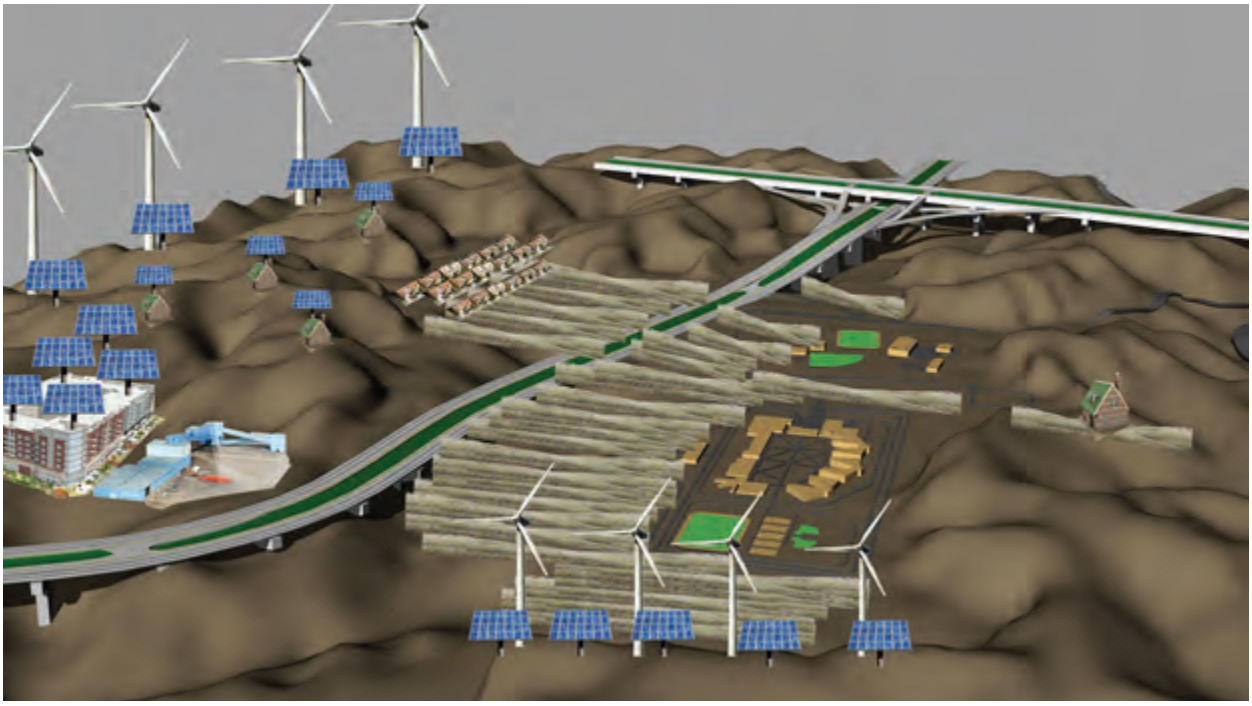


Figure 34. Group 2 Design of the Site Plan.

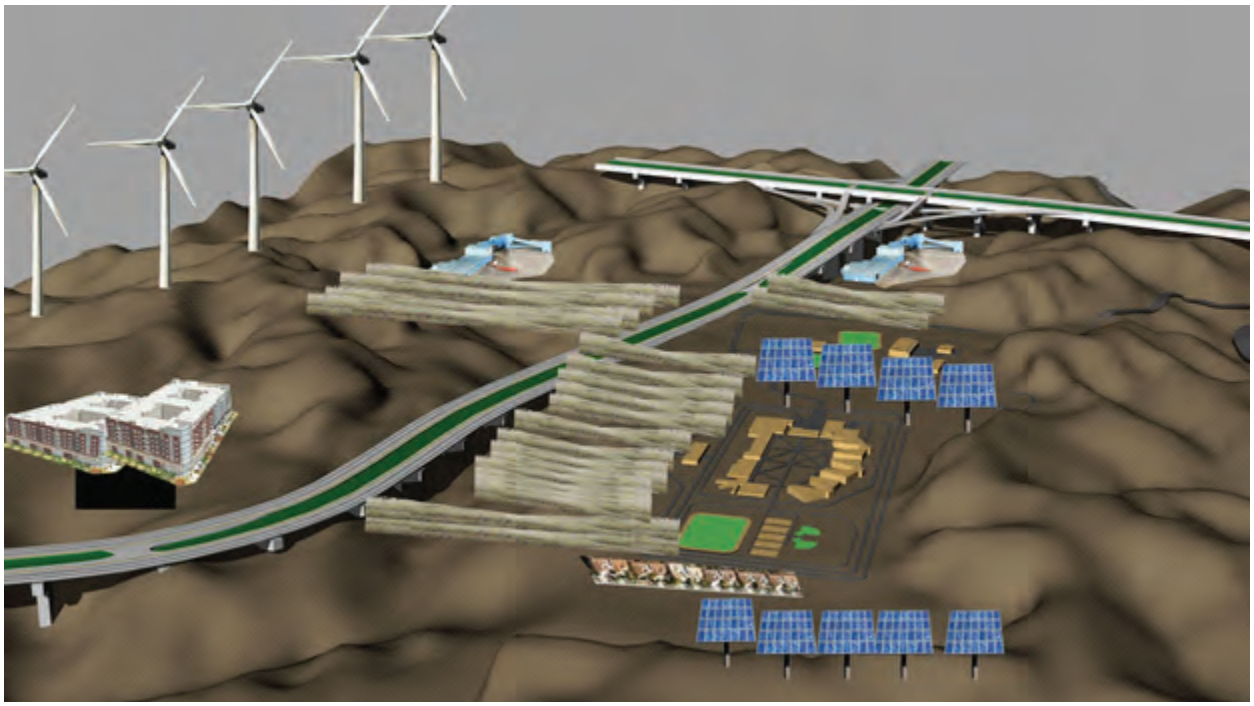


Figure 35. Group 3 Design of the Site Plan

SEP Comprehensive Master Plan

Land Use Master Plan

Integrating all of the previously described information and defining areas for specific land uses within the Indian Ridge Industrial Park was the next step in the planning process. As discussed in the "Local Official Participation" and "Community Participation" sections of this report, guidance in land uses that are needed within the region are industrial, commercial, recreational, and residential. Alternative energy suitability modeling allows researchers to site these facilities in the most appropriate locations.

The Land Use Master Plan for the Indian Ridge Industrial Park attempts to satisfy the community needs for developable land and provide for spaces to integrate alternative energy generating facilities. The topography of the existing stormwater infrastructure creates limitations in siting facilities. Other primary limiting factors are the planned expressway corridors. High volume roads require a buffer. Leaving these areas open for future road construction by planting biomass/switchgrass in the corridor allows for transitioning the area at a later date. Industrial uses are placed adjacent to the main highway interchange, while residential development is proposed in the south and east of the site. Locating residential development here provides for a sense of seclusion from the highway. Solar infrastructure is located close to FCI-McDowell so that the facility may take advantage of nearby energy production. This location, with its full southern exposure, will also be most efficient in solar collection. Commercial development is included in an 'Interchange' zone, providing needed services that were identified as desirable by participants. Areas of switchgrass are planted in areas that are considered marginal, or lacking the spatial requirements of other land uses or in close proximity to areas of sensory disturbance, i.e. highways and industrial development. While the Land Use Master Plan shows segregated land uses, the next level of planning and design proposed integration of land uses. The integration of alternative energy elements (wind, solar, and biomass), on a smaller scale, was interwoven with necessary infrastructure and building prototype design. Green infrastructure design of stormwater systems will also become an interwoven pattern in the Master Plan (Figure 36).

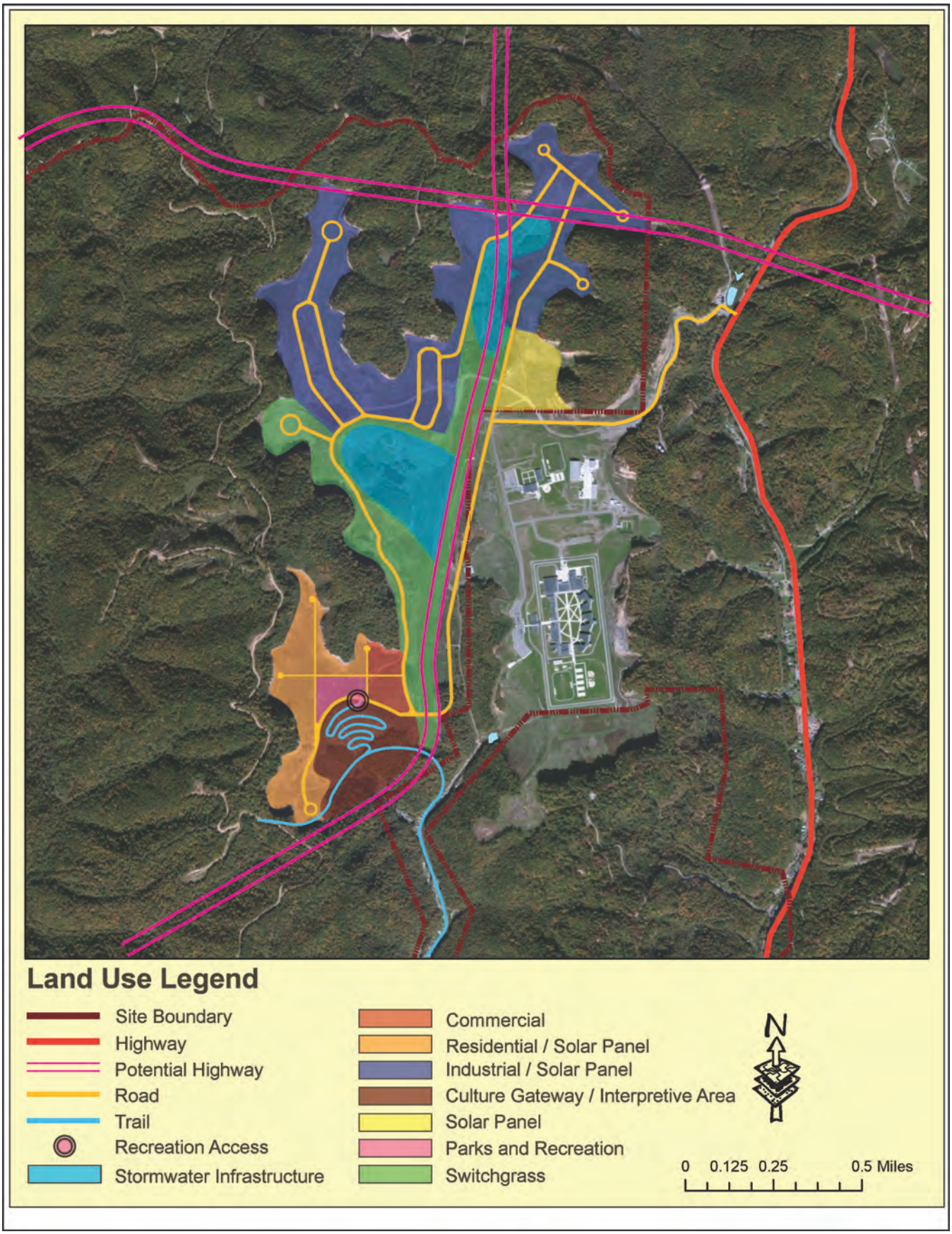


Figure 36. Land Use Master Plan for the Indian Ridge Industrial Park, McDowell County, WV.

Regional Land Use Master Plan

Most significant in Figure 37 are the permit boundaries for future surface mining to the south of the Indian Ridge Industrial Park site along the ridgeline. By envisioning this area as a potential future alternative energy site, specifically with wind integrated with biomass production, a new connectivity is created. The wind turbine polyline shown on the map identifies ridge tops that are connected with existing roadways. These areas are also outside the two kilometer buffer so that noise impacts will be reduced for residents of north Welch, new residential development, and the FCI-McDowell population. The areas of forest within the property boundary that do not have a designated land use are programmed in more detail in the Regional Trail Master Plan (Figure 38). Input from local officials has indicated that recreation land is a potential use of this area and is an identified need in the community. Access to this large recreation area from Welch will take advantage of existing roadways.

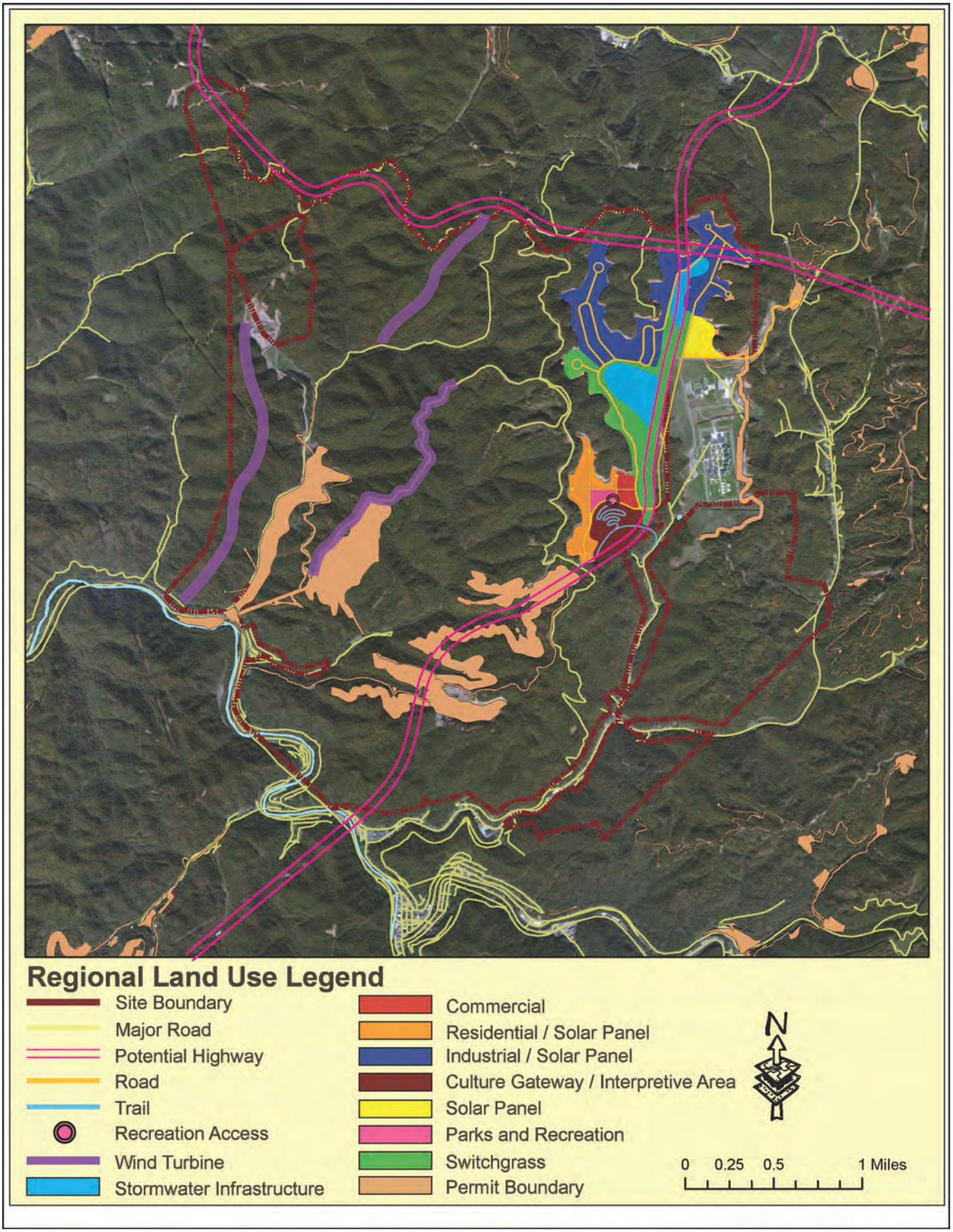


Figure 37. The Regional Land Use Master Plan shows the entire site owned by the McDowell County EDA.

Regional Trails Master Plan

The Regional Trails Master Plan shows the entire site owned by McDowell County EDA and adjacent areas. Input from local officials and citizens indicates that recreation land is a potential use of this area, and is an identified need in the community. Access to this large recreation area from Welch will take advantage of existing roadways. ATV type recreation is creating positive economic development in the region, especially areas connected to the Hatfield-McCoy Trail System. Pedestrian trails are also proposed for more passive hiking and biking through the forested landscape.

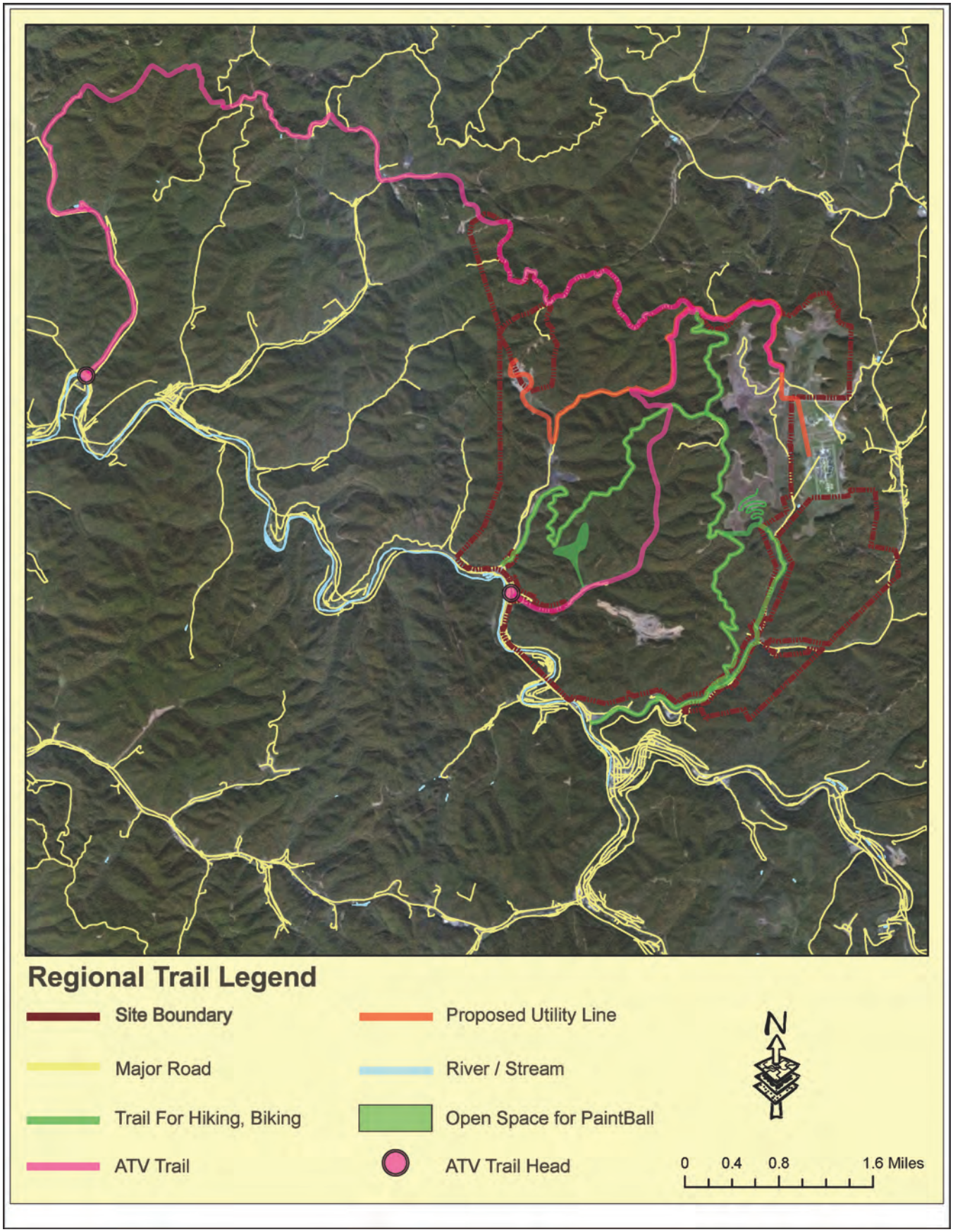


Figure 38. The Regional Trails Master Plan shows proposed new trails and connections to existing trails. Recreation areas as determined by focus group participants are also shown on the plan.

Development Phasing

Phasing development of the Indian Ridge Industrial Site allows for a visionary marketing effort with designated areas of future development. The 'Interchange Zone' would not be a suitable land use until the expressways are constructed; however, using that land temporarily in producing biomass through perennial planting creates a placeholder for change. Additionally, lands designated for residential/commercial development and industrial development can support biomass production through planting or succession while waiting for investment. Solar infrastructure would necessarily be permanent, however, so designating the area adjacent to FCI-McDowell as a future 'new energy' gateway element into the industrial park would create a sense of character for the overall site and define a powerful entry experience.

Phase 1: Visualizing Biomass, Solar, Wind

As the first phase in property development the areas appropriate for significant alternative energy facility installation were identified for infinite long term use. Switchgrass, or other grasses, to be used for biomass production is a very rugged species that is drought-tolerant and fast growing. Soil amendments will be required to support cultivation. The soils on site are currently compacted and require specific additions to be productive. Necessary soil amendments for creating a positive growing medium at one of the sites tested within the industrial park for tall grass hay or pasture (less that 30% legume) establishment include: Aglime applied at three tons per acre ground lime; Nitrogen Fertilizer applied at fifty to two hundred pounds per acre; Phosphorus Pentoxide (P2O5) Fertilizer applied at one hundred twenty pounds per acre; and Potassium Oxide (K2O) Fertilizer applied at one hundred twenty pounds per acre. These recommendations are for a yield goal of three to four tons per acre and assume a soil pH corrected to 6.5. Nitrogen (N) needs depend on desired yield goal. Potassium (K) application should be reduced if magnesium (Mg) is low (less than 100 lbs/acre). Any fertilizer or approved organic material that will supply the plant nutrients recommended may be used. A county extension agent can suggest locally-available fertilizers to suit the recommendation. Fifty pounds per acre Nitrogen can be applied by itself or with a complete fertilizer in late winter and/or September. An additional fifty pounds per acre of Nitrogen can be applied after the first cutting if desired. Soil should be retested each fall for adjustments to the above inputs. Figures 39 through Figure 44 show three-dimensional digital visualizations of the Indian Ridge site development phasing.

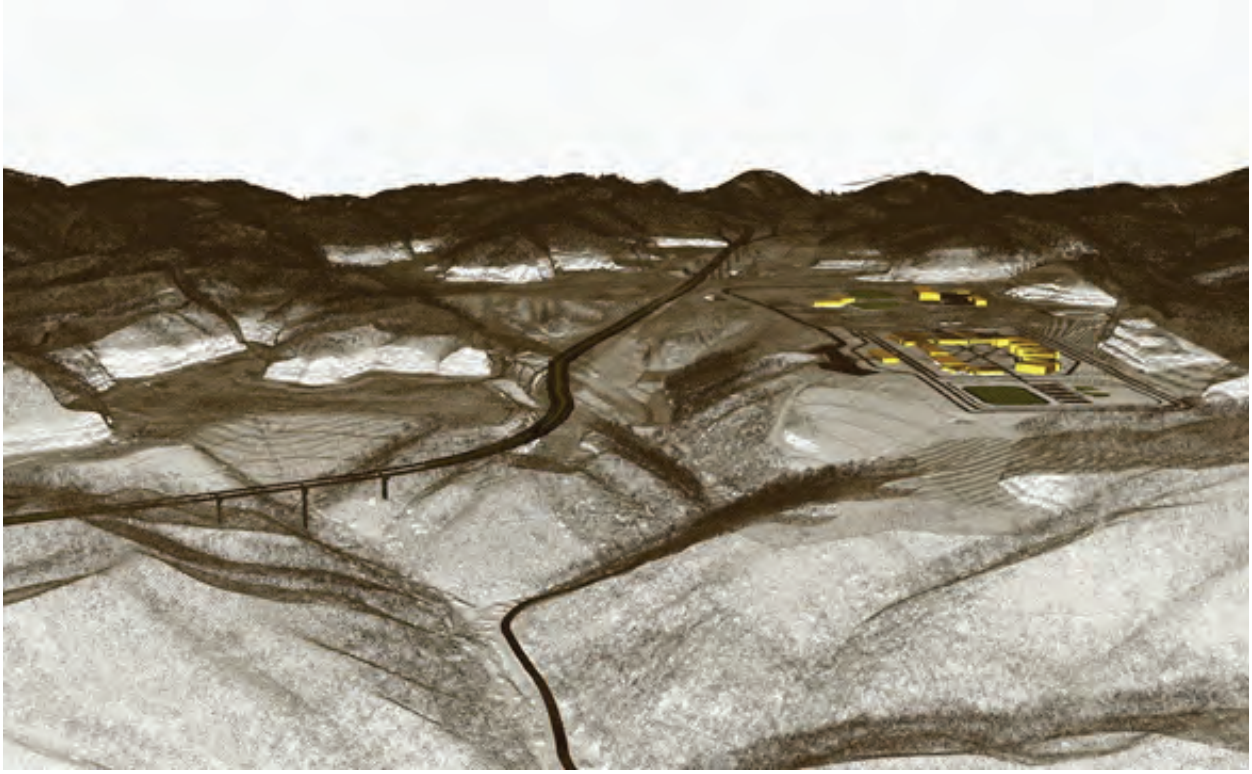


Figure 39. Three-dimensional digital site model with integrated expressways (view from south).

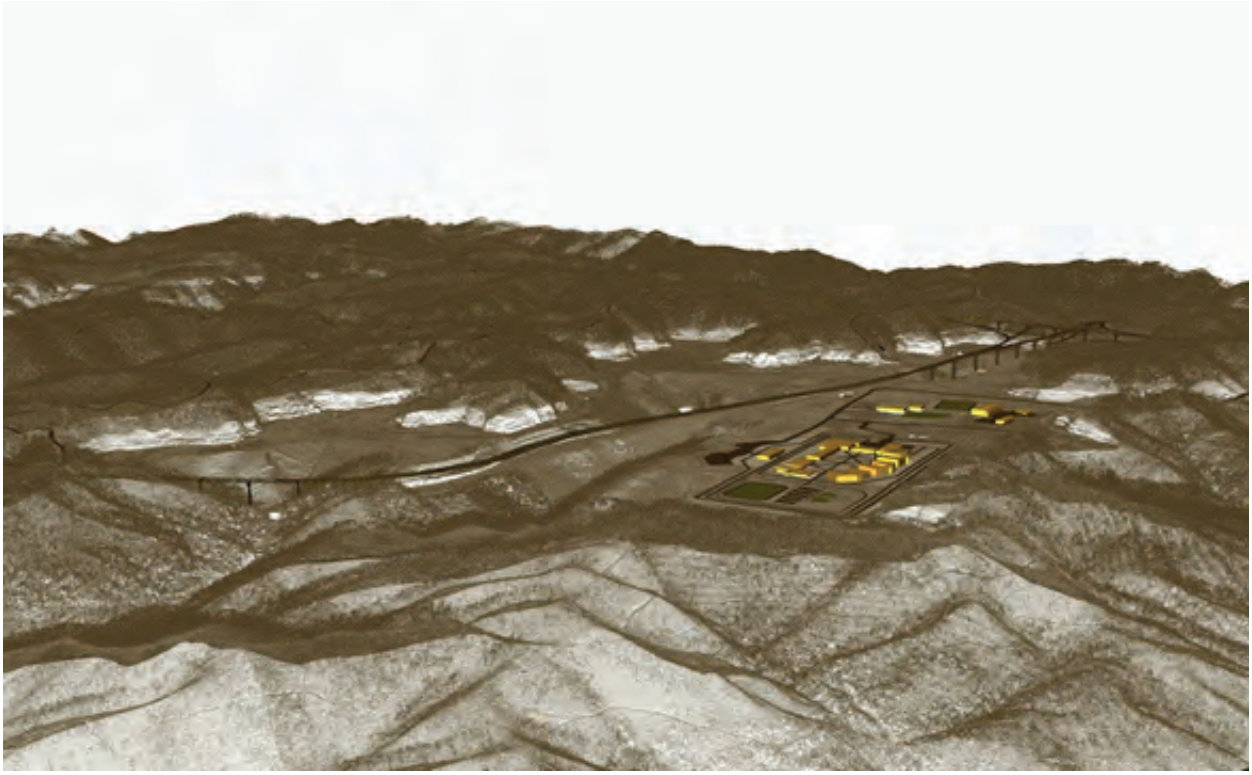


Figure 40. Three-dimensional digital site model with integrated expressways (view from southeast).

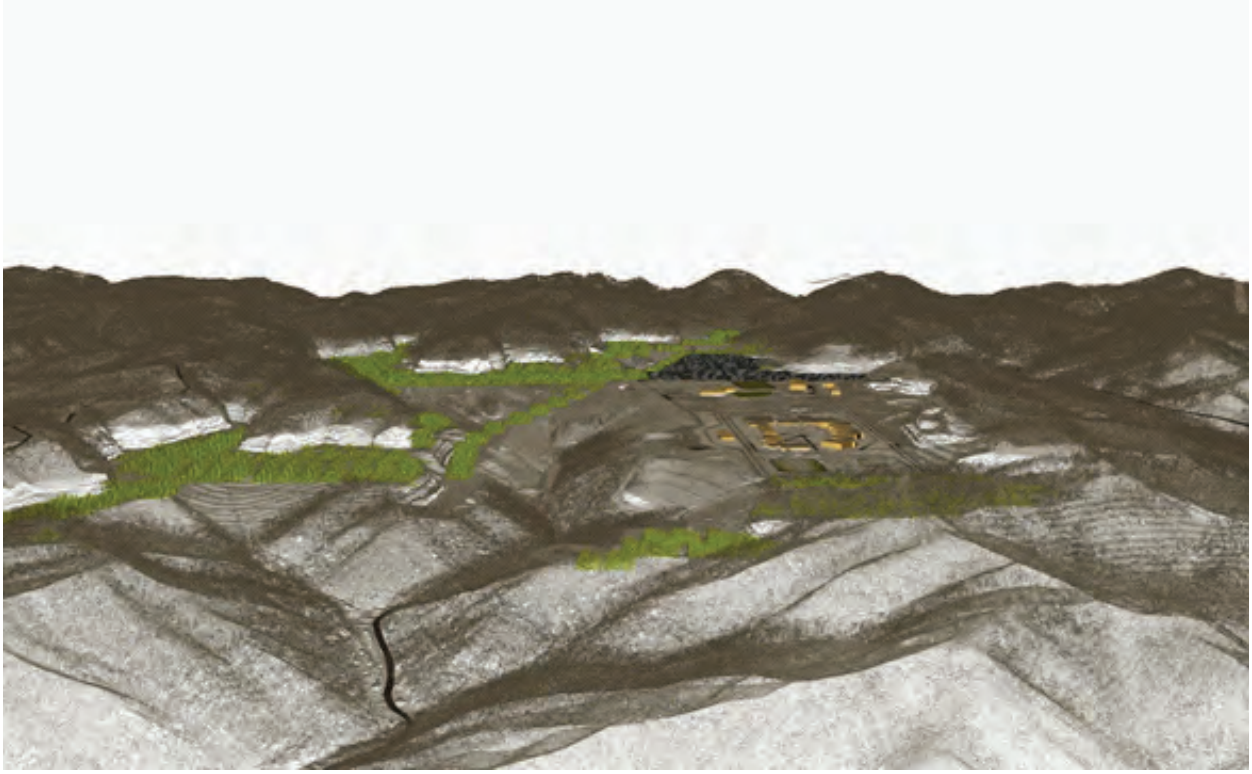


Figure 41. Three-dimensional digital site model with integrated biomass and solar facilities (view from south).

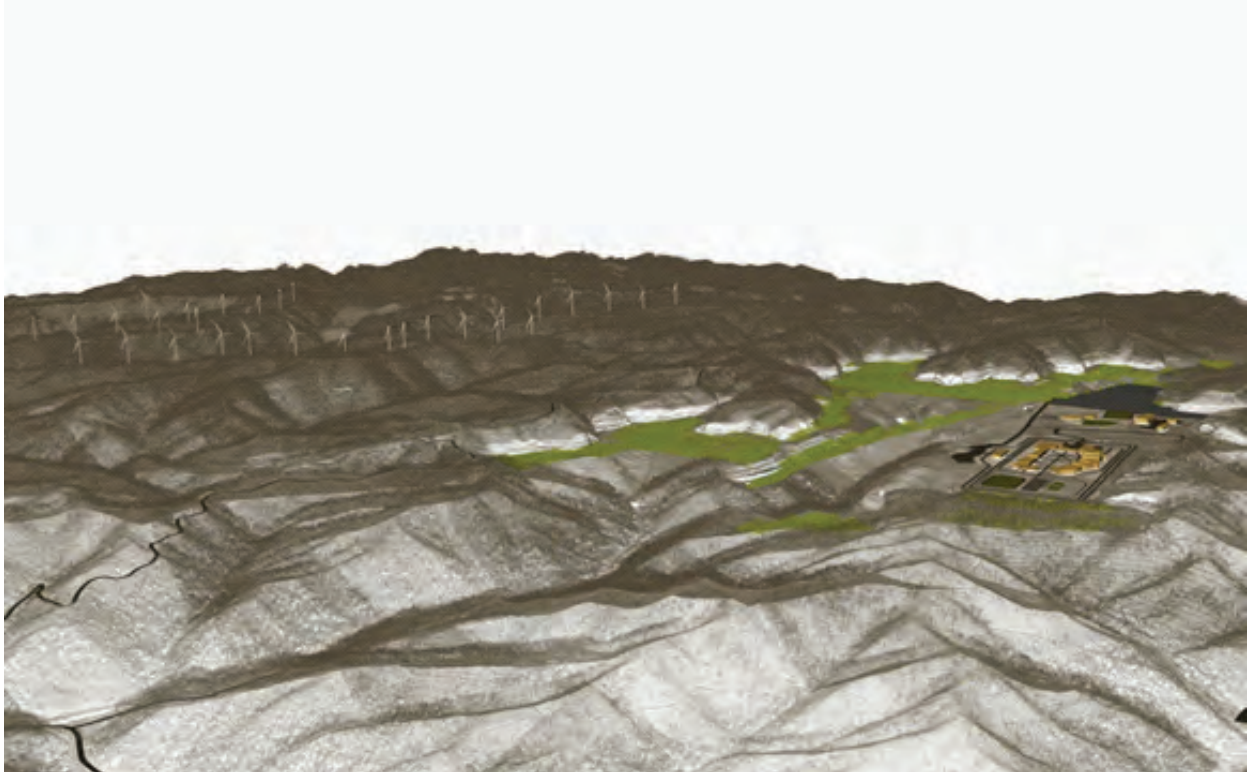


Figure 42. Three-dimensional digital site model with integrated wind, biomass, and solar facilities (view from southeast).

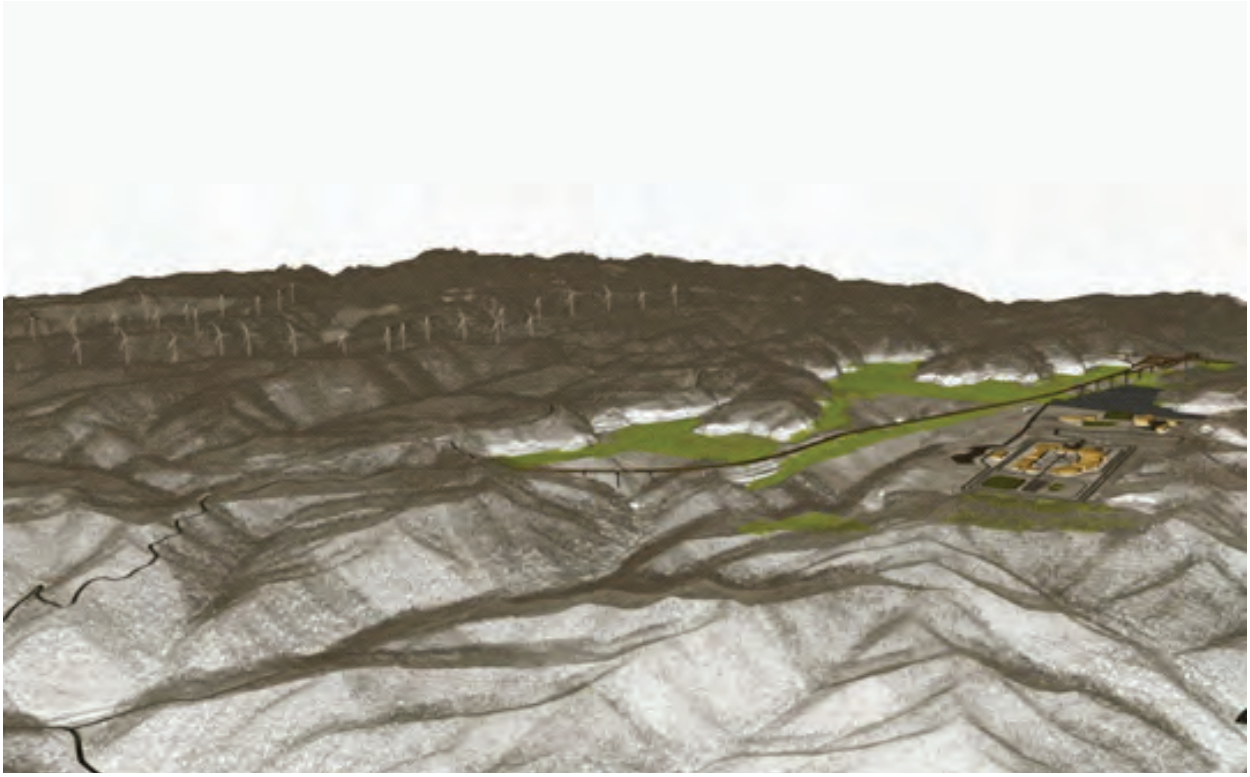


Figure 43. Three-dimensional digital site model with expressways, integrated wind, biomass, and solar facilities (view from southeast).

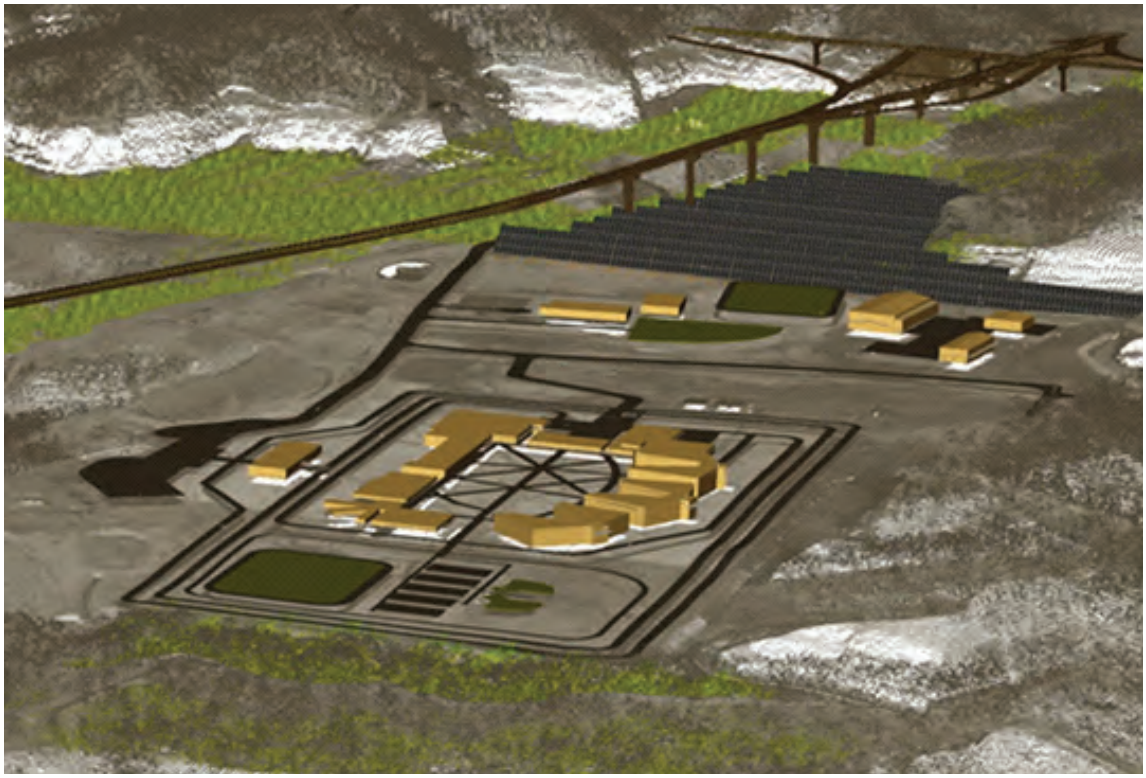


Figure 44. Detail view of three-dimensional digital site model with expressways, integrated biomass and solar facilities (view from southeast with FCI-McDowell in the foreground).

Detailed Land Use Master Plan- Phases 2/3/4: Visualizing Mixed Use Development

Phase 2: Interchange Zone (existing industrial area)

Phase 3: Residential/Commercial at Southern Access

Phase 4: Industrial at Northern Access

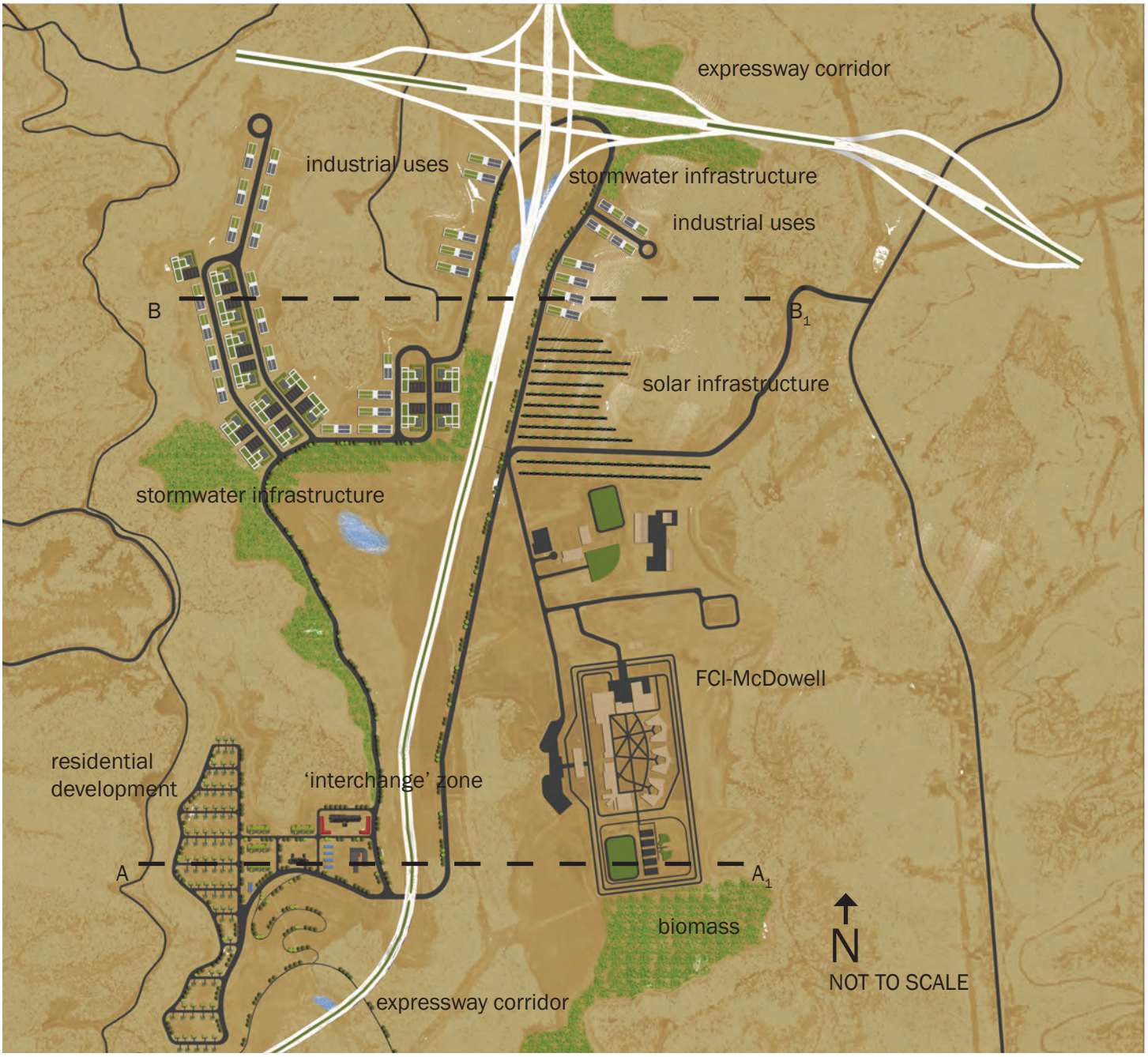


Figure 45: Land Use Master Plan showing circulation patterns and areas of development.

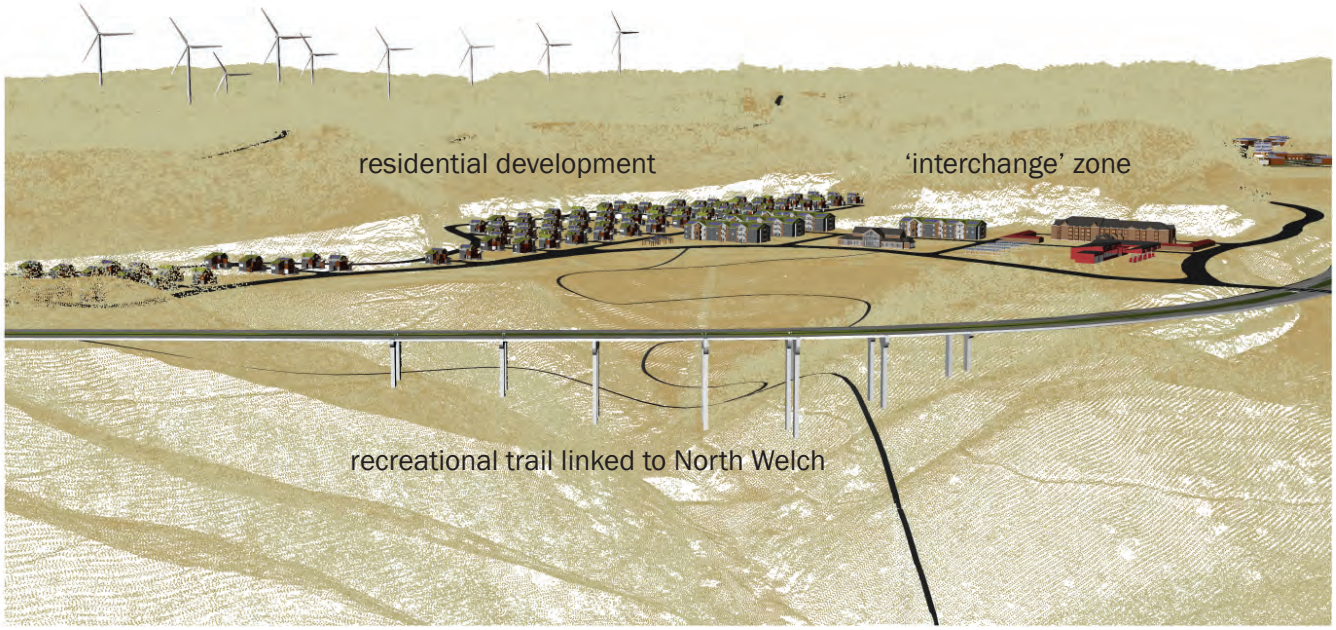


Figure 46: Bird's eye view of Land Use Master Plan from east.

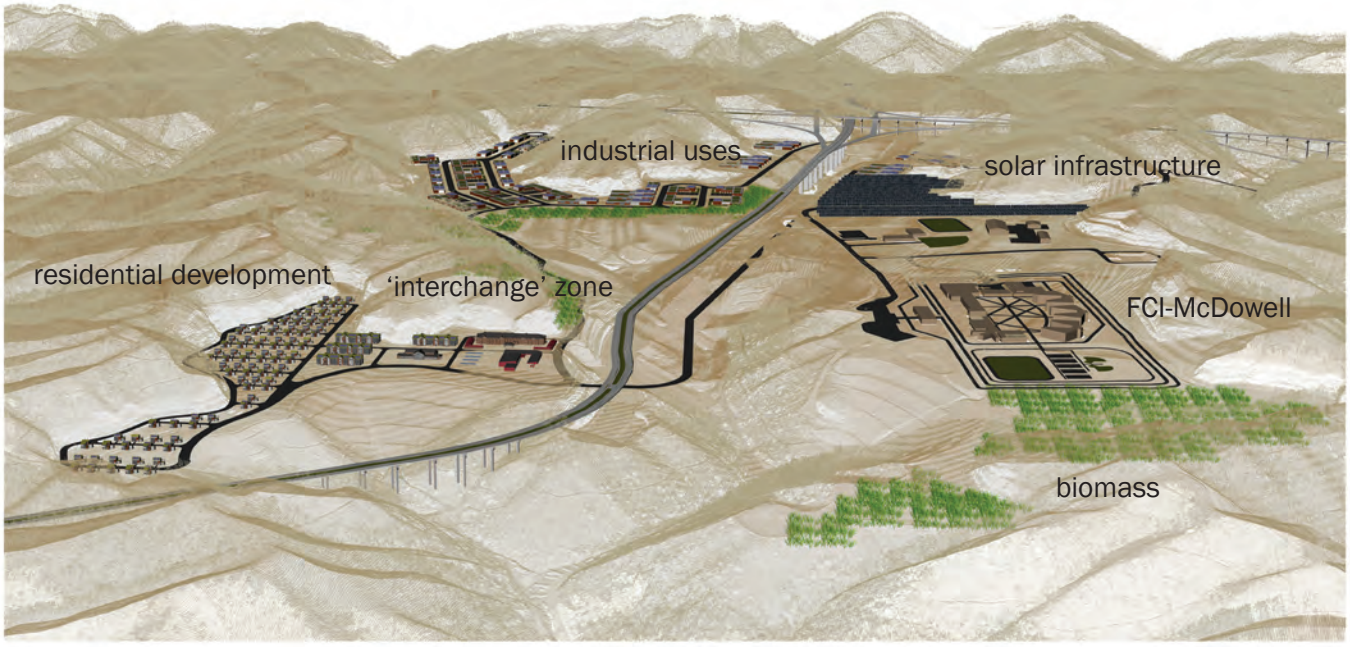
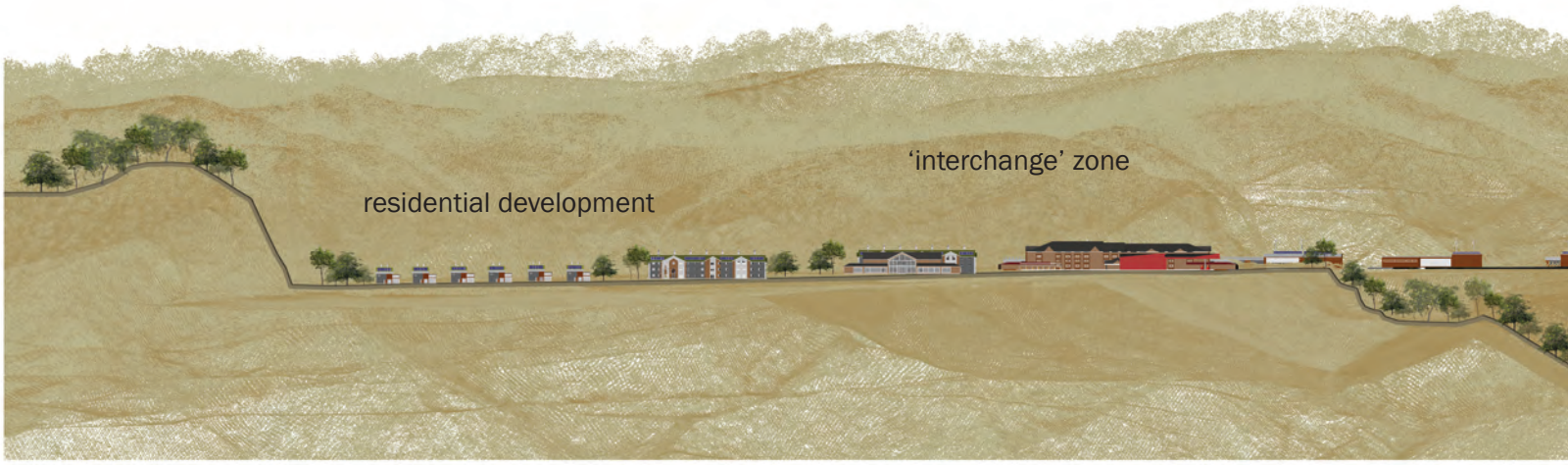
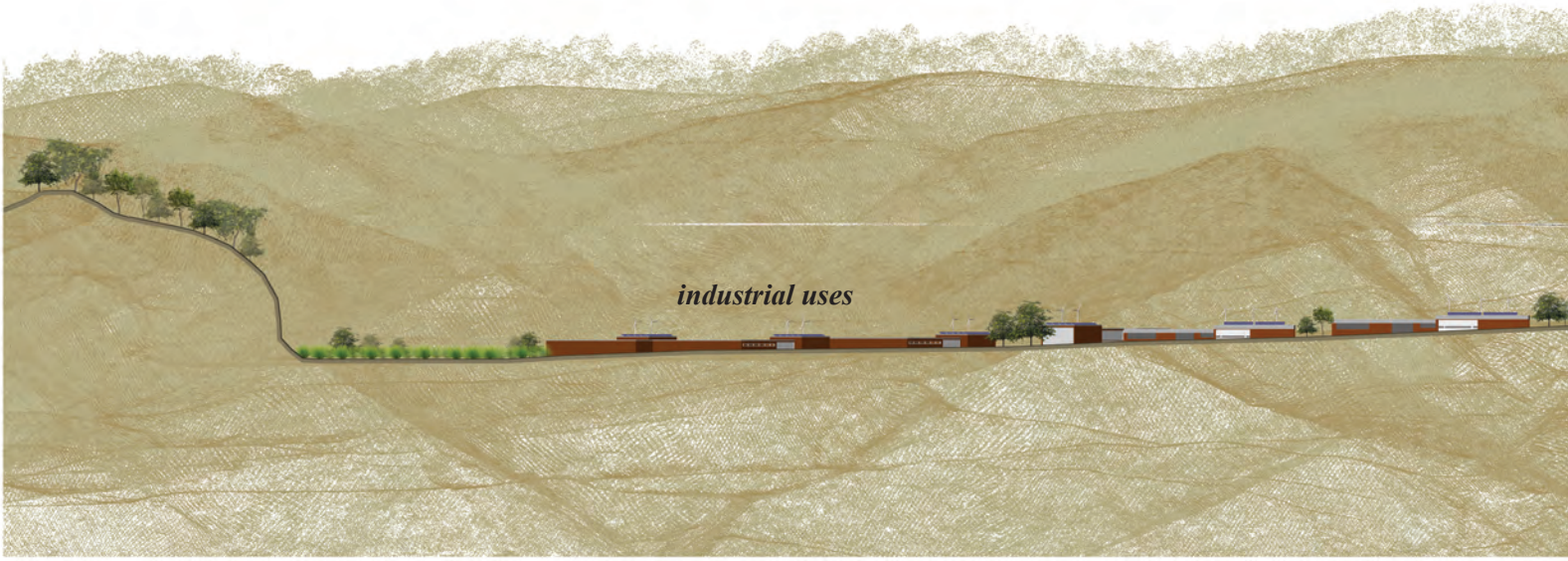


Figure 47: Bird's eye view of Land Use Master Plan from south.



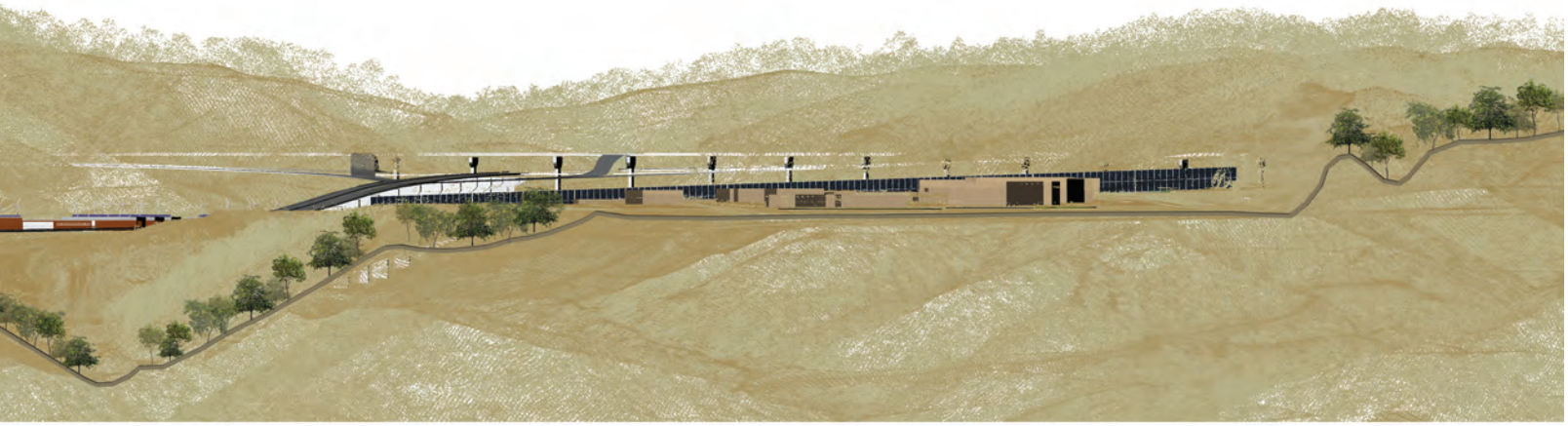
section A-A_1

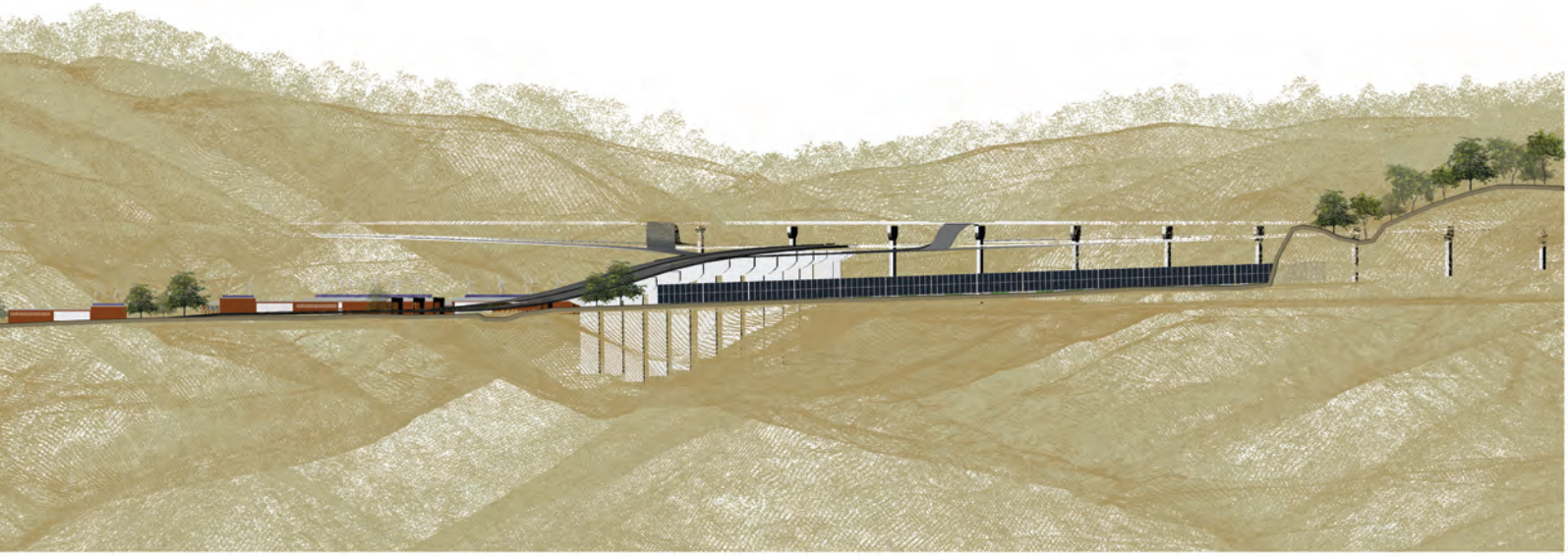
Figure 48: Section cut of Land Use Master Plan showing different areas of development



section B-B_1

Figure 49: Section cut of Land Use Master Plan showing different areas of development





Low Impact Development (LID) and Green Infrastructure

Low impact development (LID) is an approach to land development that protects natural resource systems while reducing infrastructure costs by working with nature to manage stormwater close to its source. LID is used to restore or maintain a watershed's hydrologic and ecological function by managing hydrology in a way that promotes natural stormwater movement while reducing the impacts of hardscape and building elements. Treating stormwater as a valuable resource rather than as a waste product, LID principles include: maintaining natural drainage patterns, preserving vegetation, understanding soil conditions, and disconnecting impervious surfaces in order to slow and cleanse stormwater runoff. The SEP site exhibits many signs of environmental degradation from former surface mining activities. Therefore, it will be important to recognize where key opportunities to build ecosystem function into the landscape exist. By employing LID practices that influence the form of design and respond to these opportunities, the landscape can begin to heal.

http://inhabitat.com/

http://cstreetne.blogspot.com

In addition to LID practices, a network of green infrastructure elements will help to restore and sustain ecological values and functions. Green infrastructure generally refers to methods that mimic natural processes through a collection of open space, parks, wetlands, healthy stream and infiltration-based low impact development practices. These initiatives have the potential to filter air and water pollutants, provide flood control, reduce solar heat gain, enhance and stabilize soil and provide wildlife habitat, building biodiversity while improving human health and strengthening people's connection to nature and sense of place (Benedict 2002).

http://opentecture.blogspot.com

http://.asla.org.

While green infrastructure systems add value by building ecological functions into the landscape, the sustainability and success of green infrastructure cannot rely on science alone, but should focus on the dynamic interactions between nature and society living in a mutually supportive habitat. This expands the discipline of landscape ecology to include human-dominated environmental and place-based problems with solutions that respond to cultural landscape vernacular. This holistic approach responds to a greater spectrum of natural processes and human interaction, inspiring people to experience nature while increasing their ecological literacy.

Links between landscape science and landscape design are integral to the success of achieving many societal needs with regard to landscape ecology success. It is commonly accepted that ecological sustainability is only realized to the extent for which societal disposition is aligned with the perceived value of the ecosystem services (Dickson 2003). It is often through design language that landscape patterns, processes, and practices are understood by society, influencing the human propensity to effect landscape change (Lister, 2009).

Therefore, it is not only important that elements that heal the landscape bring alternative forms of energy and building infrastructure to the site, but that they are arranged to create spaces where people engage in community and nature. Ultimately, this approach allows landscape design to serve as the link between living, science, and art.

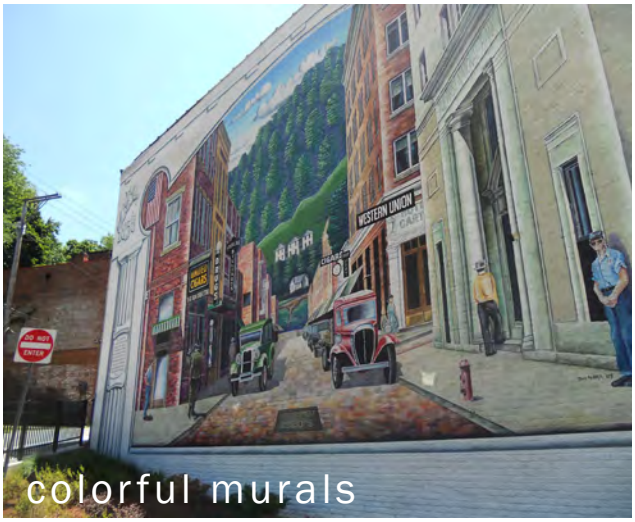
http://www.nps.gov

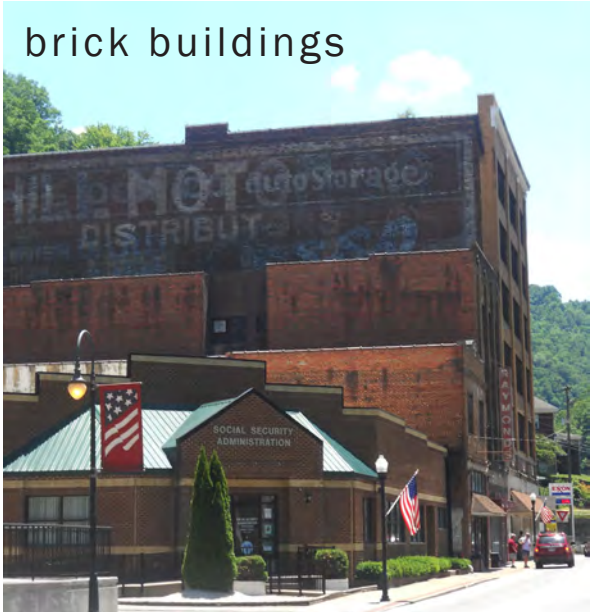
http://www.lakecountyil.gov

http://hpigreen.com

People and Placemaking

While the human effects and integration were incorporated into landscape restoration of the previously described systems, it will be important to weave a placemaking component into the design. Placemaking is a form of design that responds to community assets, culture, potential, and motivation. It can transform a massive undefined area into a memorable center for community gathering and interaction. Using indigenous landscape intervention and cultural vernacular, design can improve both landscape performance and resiliency. The following photos are taken in and around the Town of Welch.





It is not only important to recognize the successional landscape while incorporating people and place, but the design shall also reflect the scars from former surface mining operations. The reclamation process shall strive to avoid an intent to obscure the site's extractive industrial past in order to set precedent on the ecological development of the future. This may be achieved in architectural and public art elements that reflect industry through materiality and form. A space dedicated to reflection and recognition of the former land use is proposed at a central location, the Heritage Park. The park can be experienced from a multitude of levels. It can be seen from the freeway, experienced from its central core hub, or explored from paths that wind through the valley fill.

Case Studies

As a part of the research process, a case study inventory was completed. Sites that inspired or contained similar elements as those proposed for the SEP site were studied in order to understand the design process, implementation and success of restoration and development methods. The following sites served as case studies: The Steel Yard, Qunli Stormwater Park, Marcraes Gold Site, and the AMD and Art Project.

http://.asla.org.

http://.www.epa.gov

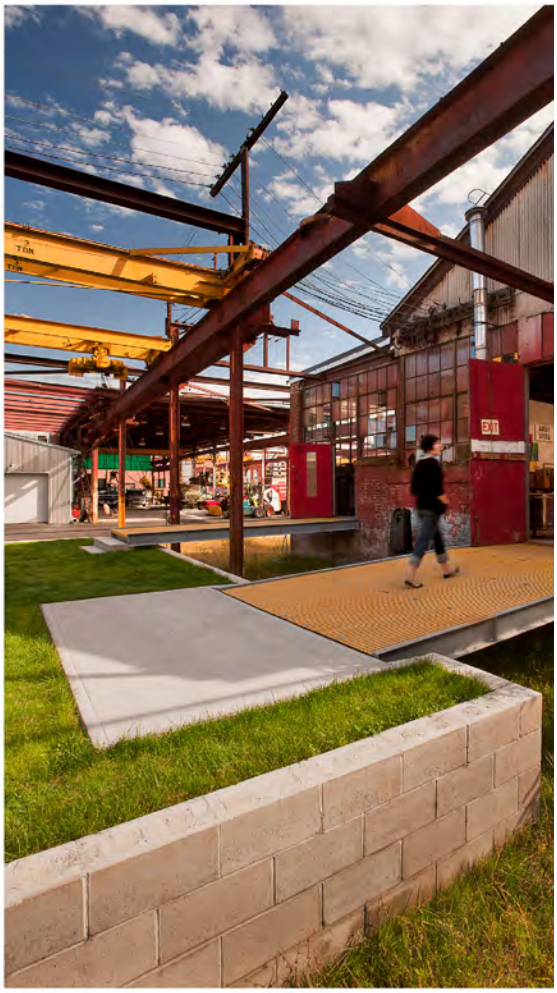
http://www.historic.org.nz

http://.asla.org.

The Steel Yard transformed an abandoned steel fabricating plant into a working art campus and social event space. Providence Steel and Iron was a brownfield site with significant lead contamination. Rather than removing the soil, it was left in place and the site built above. A minimum 12 inches of clean fill or pavement was placed over the entire space. Since this ultimately left the buildings at a lower elevation than the surrounding ground, a series of moats surrounded the building footprints and managed the site's stormwater. The moats were lined with 12 inches of soil and native plantings, providing water storage capacity and pollutant uptake capabilities.

Placemaking was also an important consideration for the design. The former site history of steel fabrication is celebrated through design elements. Recycled materials and steel frames are used to create site features. A central lawn space serves as a gathering space for community building.

The stormwater treatment for the SEP site is similar to the implementation at the Steel Yard. Due to the excessive compaction and possible contamination of the soil, the design treats the existing ground as an impenetrable surface in many areas and site features are built on clean fill. Soil and native plants are added above the existing ground elevation to form bioswales for stormwater retention, filtration, and conveyance.



http://.asla.org.

Qunli Stormwater Park serves as a green sponge, cleansing and storing urban stormwater. The cleansed water is integrated with other ecosystem services providing protection of native habitats, aquifer recharge, recreational use, and aesthetic experience. The design allowed the central part of the wetland to succeed naturally, while the exterior sections were graded and additional site features were added. Aggressive-growing trees were used to reforest areas, while grasses and sedges were used to populate the wetland spaces and provide erosion control. The site can be experienced along multiple levels. A network of paths link ponds and mounds, creating a walkthrough experience. Platforms and seats enable people to have close contact with nature, and skywalks allow the site to be viewed from above.

The stormwater parks proposed for the SEP site not only provide a vital role for stormwater management and habitat development, but also create places for people to engage with their natural surroundings. Many of the spaces, particularly near the valley fills, can be viewed and experienced along multiple levels.

http://.asla.org.

http://.asla.org.

The Marcraes Gold Site is a reclamation project located on the former Oceana Gold Mine. A heritage and art park was the core of the rehabilitation plan for this site. The design provided a recreational resource that combines history, art, designed landscape, the natural environment, ecology, technology and traditional and alternative agriculture into a self-sustaining destination for tourism.

Just as the SEP site, this site considered ecological restoration, infrastructure, historical preservation, and creation of landscape intervention as key elements for site development. Elements such as open pits, waste rocks and other scars remained in place, and the designers responded to these existing conditions. The intent was not to obscure the origins of the site's history, but to allow the site to restore through ecological succession and to provide social and ecological enhancement.

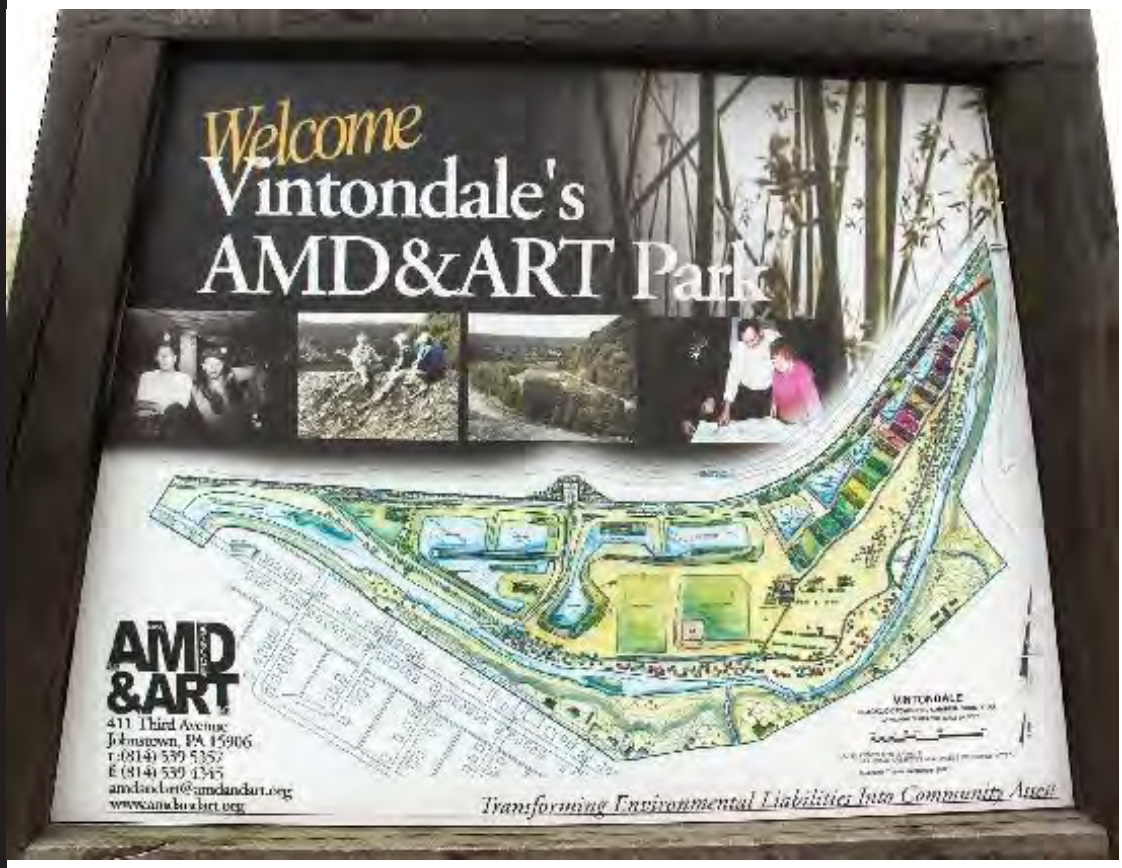
http://www.whitsundaytimes.com.

http://www.oceanagoldopenday.co.nz

http://www.odt.co.nz

The AMD and Art Project merges art with acide mine drainage treatment. The goal of the site design is to not only provide good science, but also engage the environmental degradation and abandonment to bring an understanding of the problem and the solution. Art and community engagement were vehicles used to achieve this success. Similar to southern WV Coalfield sites, this project was located within a community that was still deeply connected to the coal mining industry. One of the early stages of design for the SEP site involved the engagement of focus groups to have a deeper understanding of community needs. The design responds to cultural vernacular and considers other placemaking and artistic elements that celebrate the site's past while healing the scars for future ecological and community successes.

http://www.greenmuseum.org



http://members.virtualtourist.com

Summary

In summary, the restoration for the site blends ecological succession with new ecologies that simulate natural systems responding to current site conditions and constraints. As the landscape heals, sustainable energy and other building infrastructure are interjected into the site dynamic. These elements not only consider ecology of the site, but respond to people and place. Figures 50 and 51 illustrate the time process of ecological succession and compare it on a time scale to the development of the site.

The following steps summarize the reclamation envisioned for the SEP site outlined in this document:

1. Recognize the scars of the extractive operations through design.
2. Allow ecological succession to recover the former landscape, while interjecting new unpredictable ecologies that respond to the scars of the former land-use.
3. Identify complex relationships between organic, mineral, and social phenomena.
4. Use art and landscape architecture to create synergistic development.

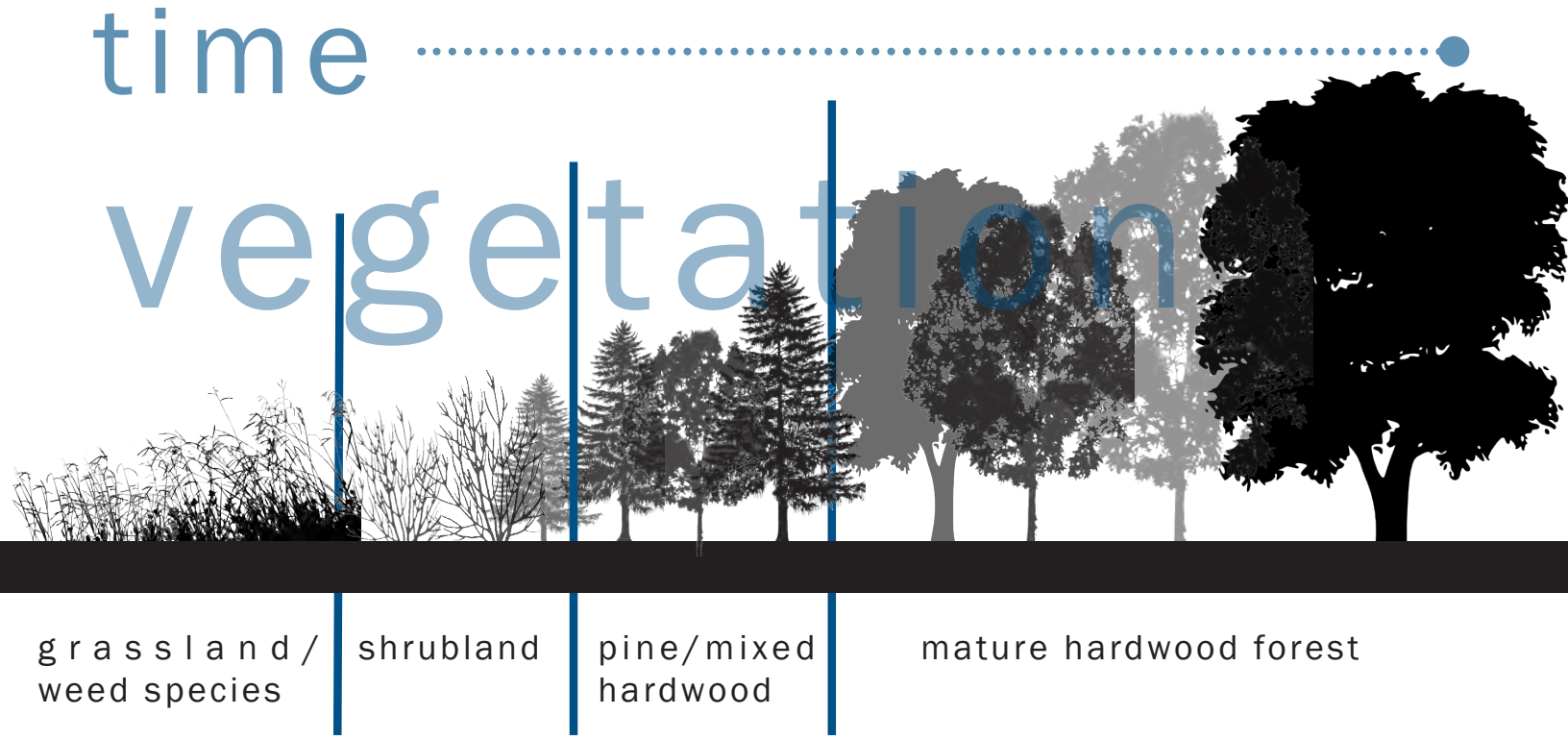


Figure 50: Ecological Succession

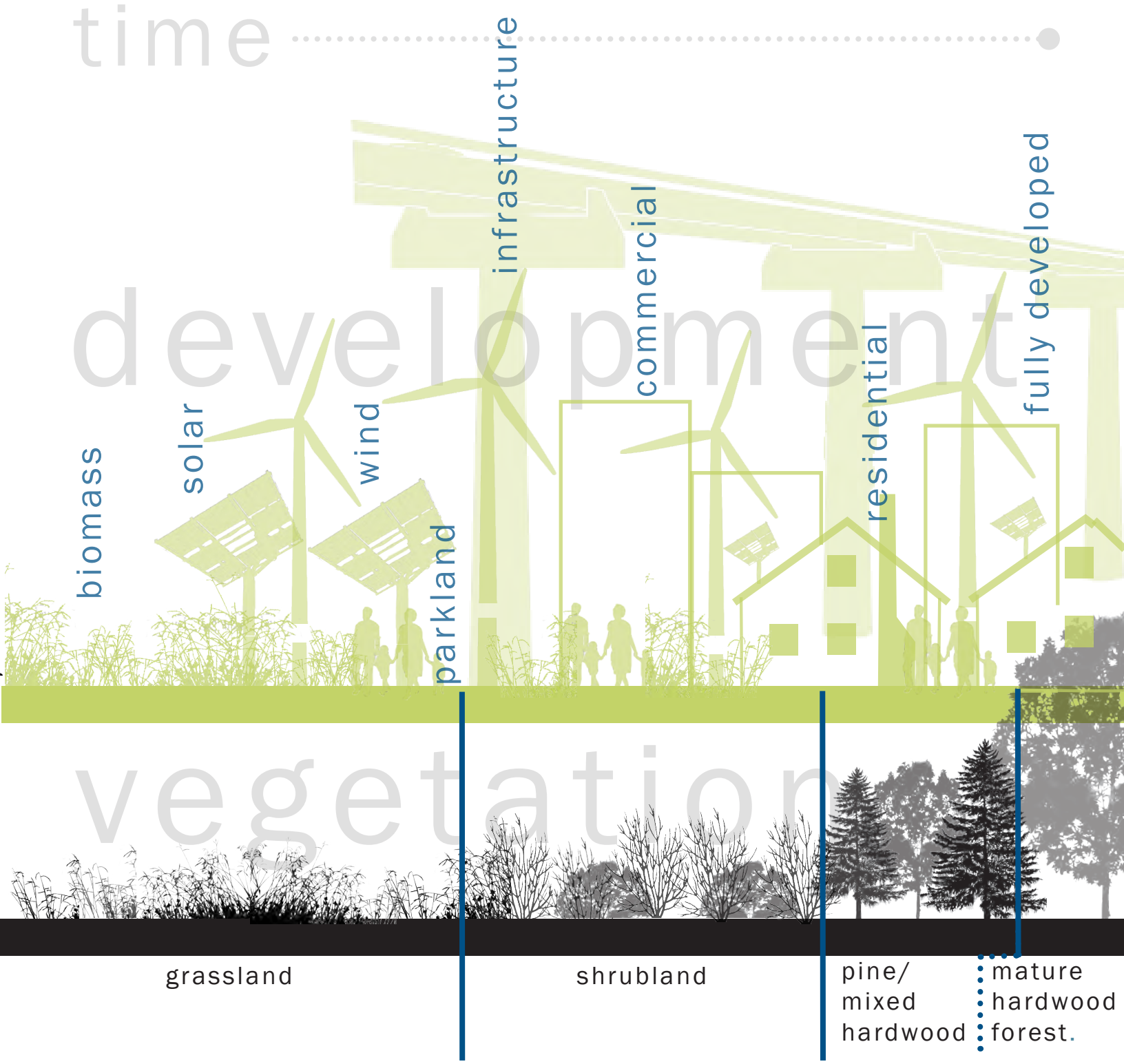


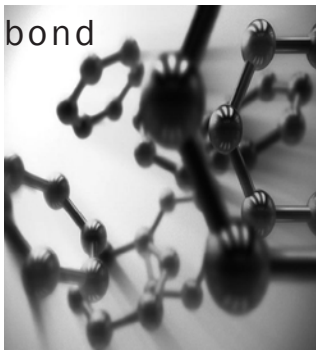
Figure 51: Development versus Ecological Succession

SEP Design Concept

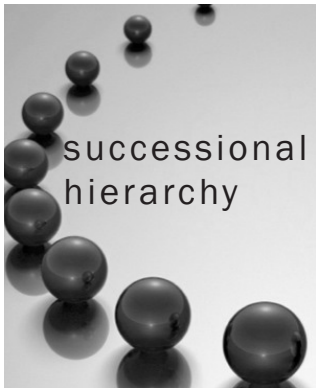
While reflecting on the past scars of the landscape, a successional hierarchy that bonds with community creates the energy to heal the landscape.

SEP Design Concept

To understand the community bond whose energy drives the healing process forward, it is important to recognize the successional landscape and development, while reflecting on the scars from former surface mining operations. The form of the design responds to the orderly frames of development, interrupted by the chaos of biological patterns. This is recognized through natural processes such as stormwater movement and forest development that organically weave through the site. Green infrastructure and open space areas heal the landscape and are linked through pedestrian greenways, creating connections that bond people to place. Core areas connect varying land uses and serve as spaces for reflection of historical landscape patterns. The valley fill ponds reflect both pre-mining vegetative forest cover and new orderly topographic tiers and linear streams from mining operations. These areas are designed to be experienced from multiple levels, further referencing succession. The reflective spaces can be intimately experienced at the base valley fill, explored through the valley fill climb, provide a gateway at the development level or be viewed from the freeway above. Understanding the landscape constraints associated with former landuse is a necessary component towards successional landscape healing. Community and ecology bond to create the energy to drive this process forward.



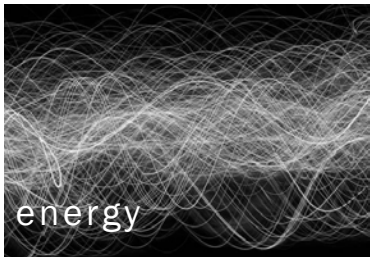
http://www.snc.com



http://www.beholdingeye.com

http://archive.constantcontact.com

http://keithdotson.photoshelter.com



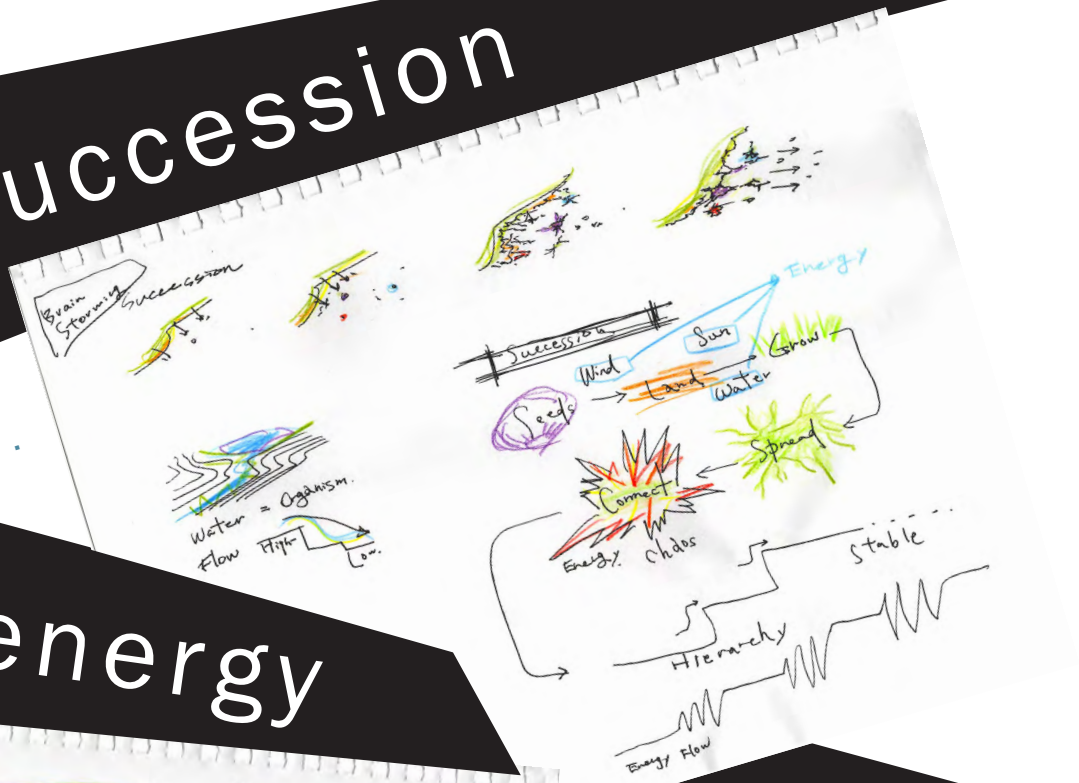
http://energyfanatics.com

http://officialbodyup.blogspot.com

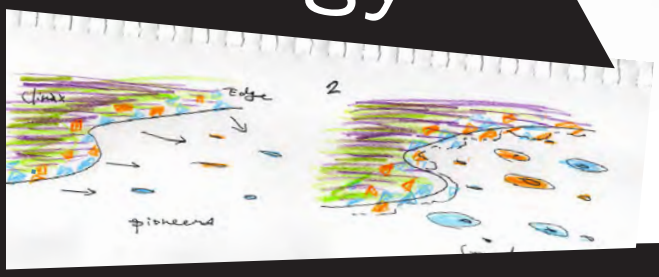
http://www.environmentalgraffiti.com

SEP Design Concept

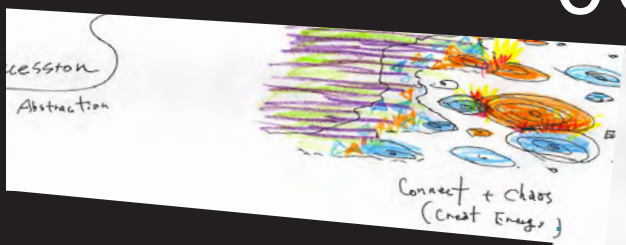
succession



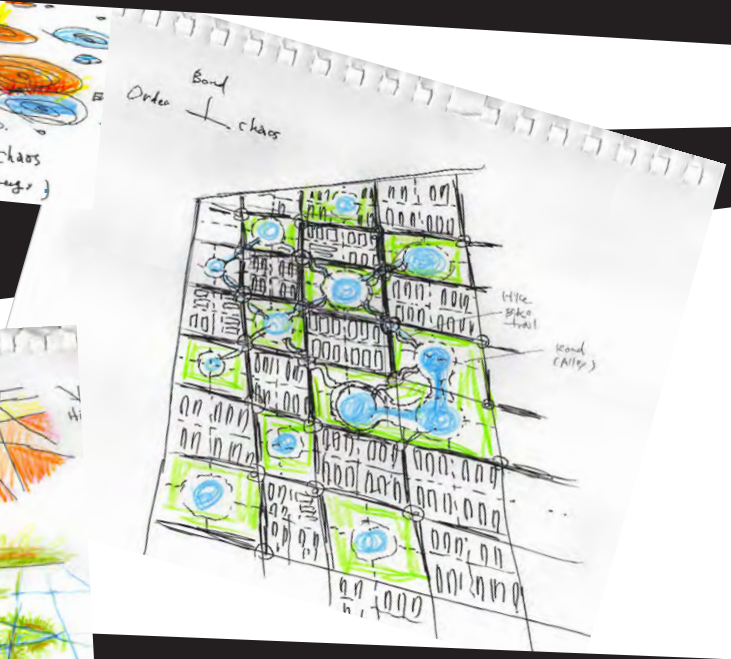
energy

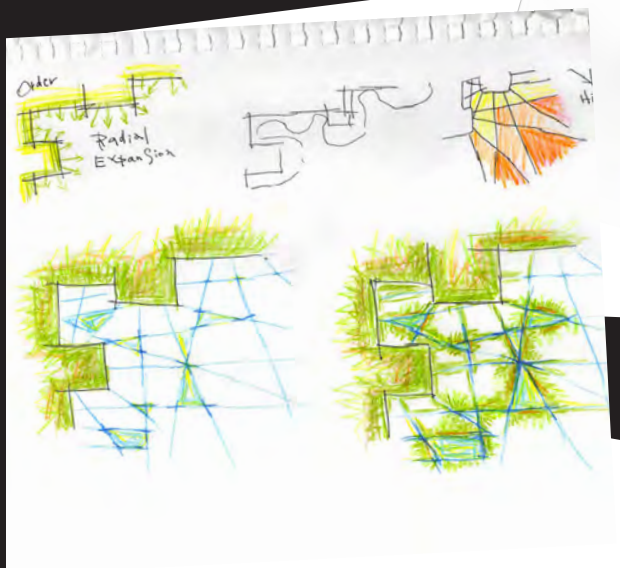


connection



chaos





order

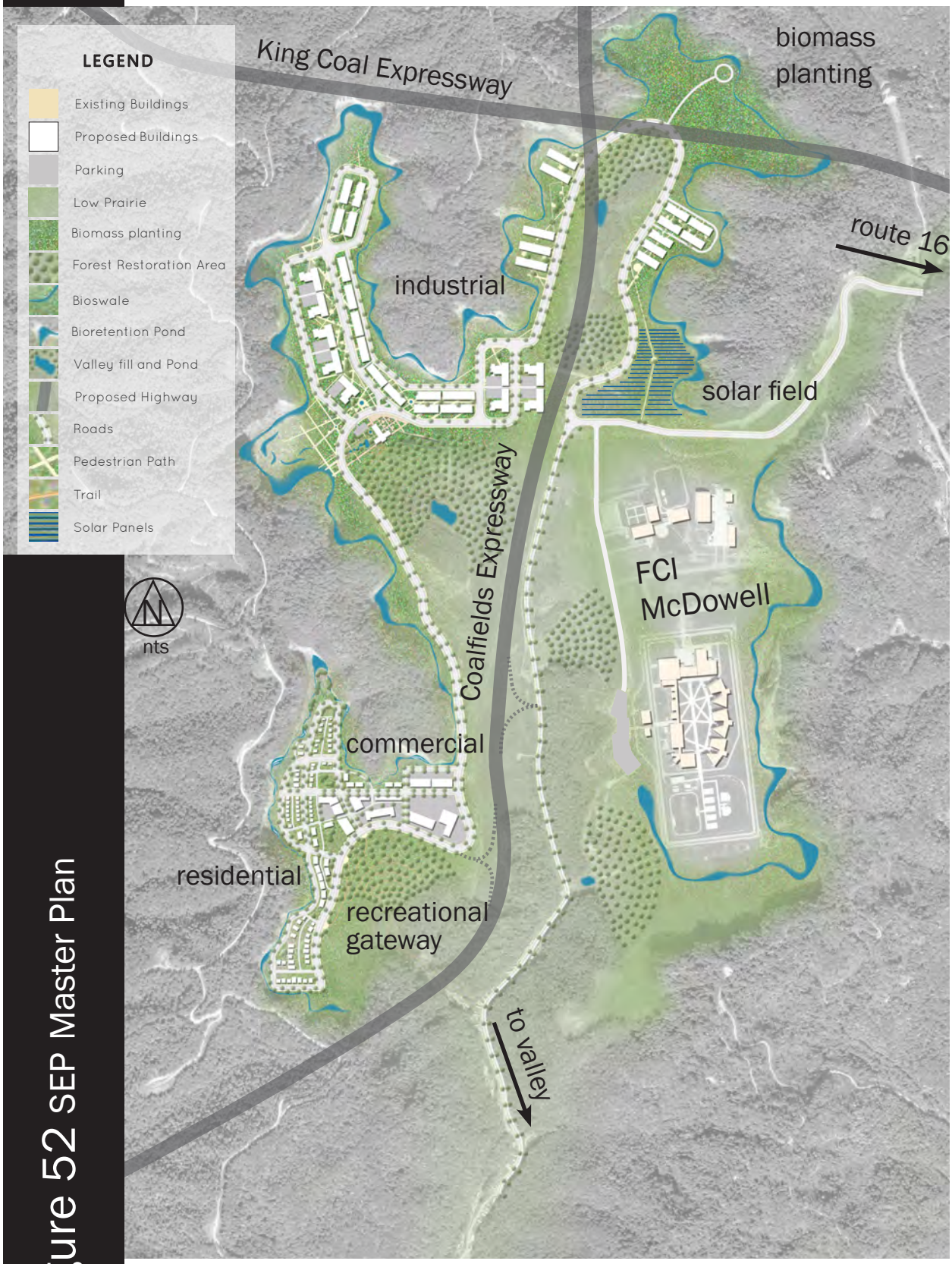
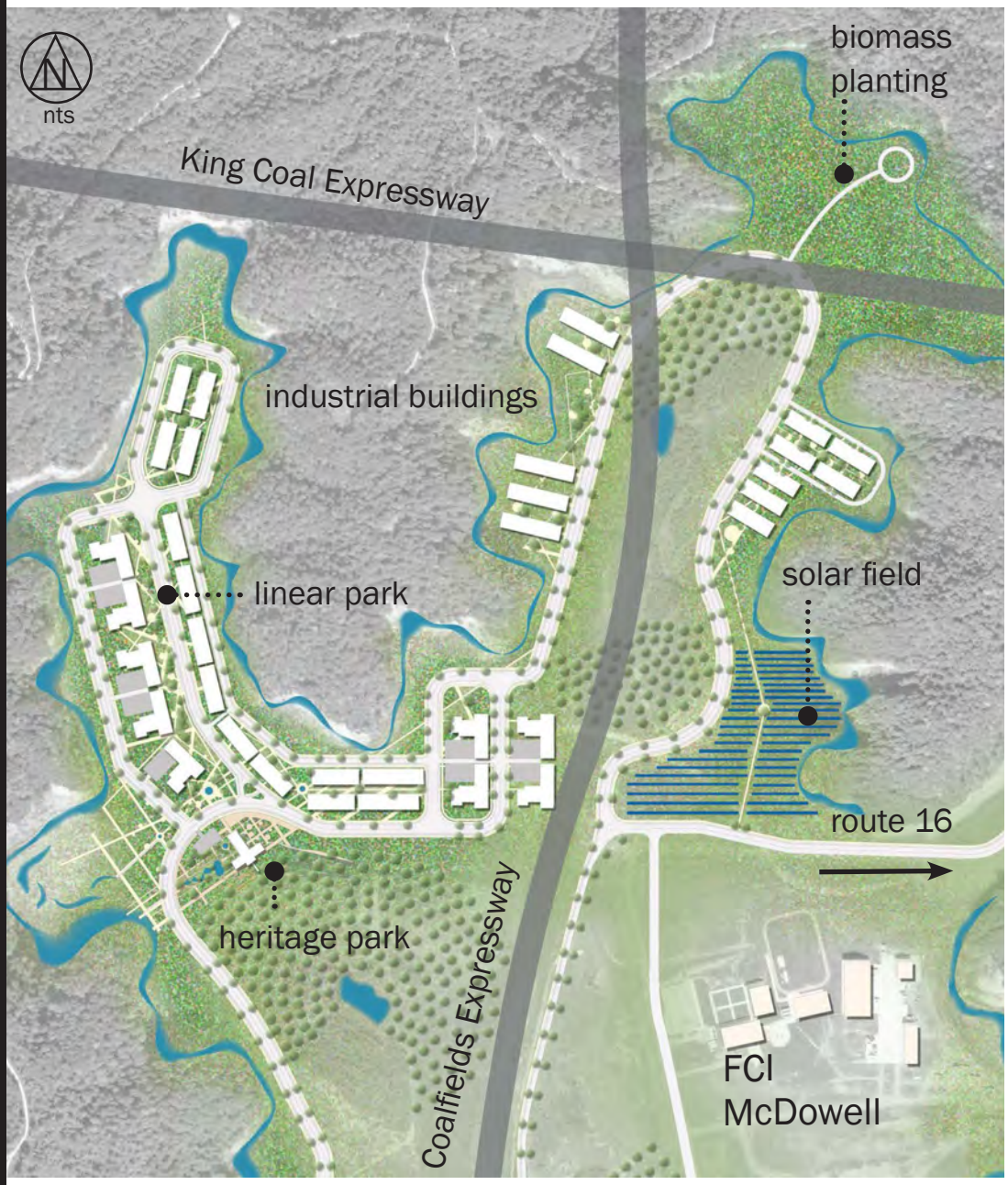


Figure 52 SEP Master Plan

Figure 53 Master Plan Industrial Area



This area of the site is dominated by industrial land use. The entry is lined with solar fields, while biomass plantings fill undevelopable areas between buildings and wind turbines occupy rooftops. A commanding sculptural element signifies the location of the larger biomass planting field and can be seen from multiple locations throughout the site. The heritage park for historical reflection overlooks the valley fill areas. A long linear central green provides social and recreational space.

Figure 54 Master Plan Residential and Commercial Area

This area of the site contains the commercial, residential and recreational areas. The recreational gateway forms a central spine along the commercial and residential transect. The site layout reflects new urbanism principles with homes arranged to respond to the front yard and park space. Stormwater weaves through the site with several stormwater parks scattered throughout.

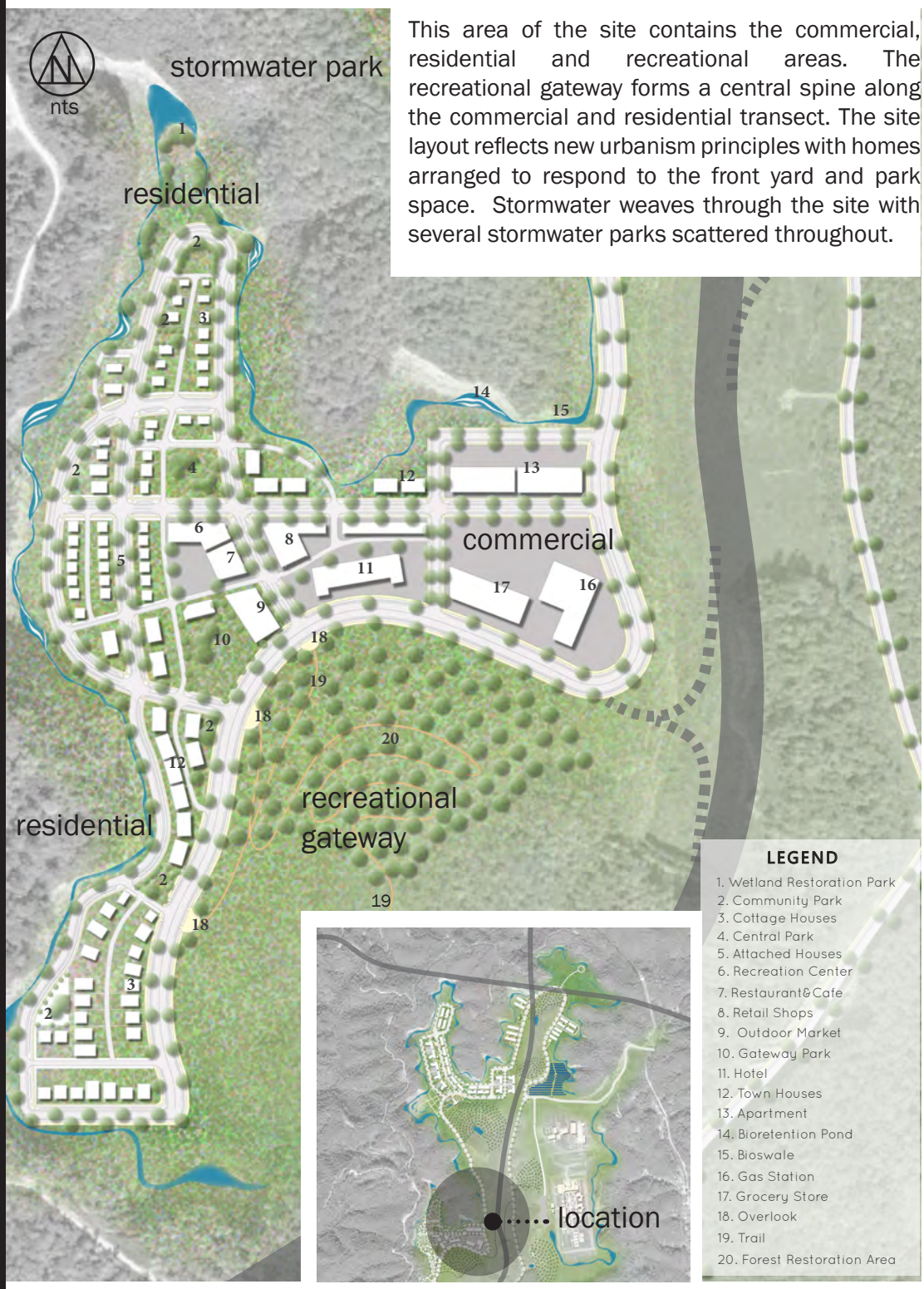


Figure 55 Master Plan Perspective Location Map

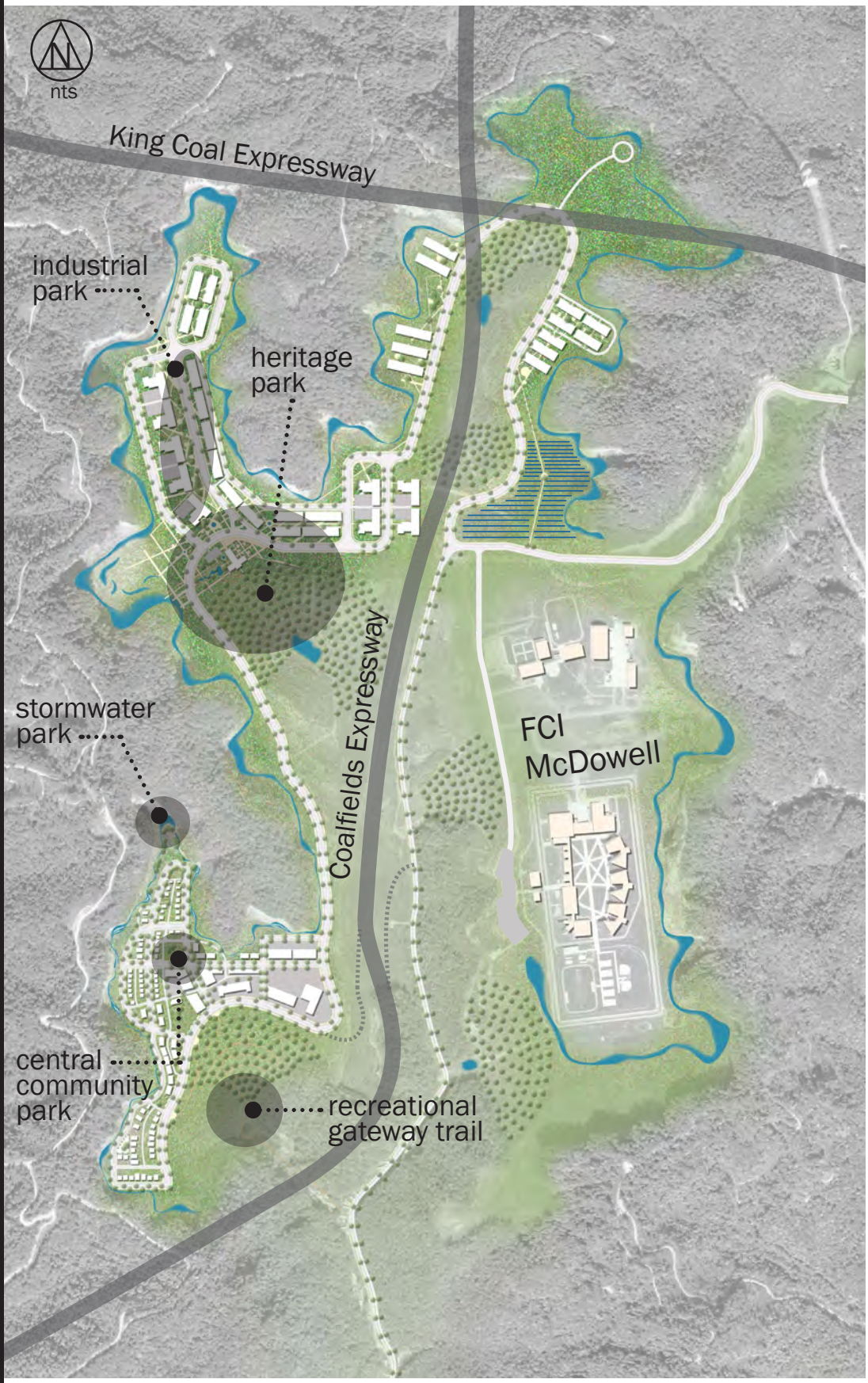


Figure 56: Heritage Park: a historical reflection experience.

It is important that the reclamation process strive not to obscure the extractive industry, but use the past setting as precedent for the ecological development of the future (Barnett 2008). In order to respond to this past, a heritage park is proposed for the site. The park is centrally located and can be seen from the freeway above, experienced from its central core hub or explored from paths that wind through the valley fill. The rigid form and industrial architectural elements respond to the harsh, extraction history of place. The park overlooks the large extraction pits. The water within the pits reflect the surrounding original forest cover and valley fill areas. This area also reflects the shadow of the users exploring the space.

Figure 57: Industrial Park: a linear green for recreation, relaxation and socialization.

A linear park is proposed along the spine of the industrial section of the development. A common central green space is not only important to residential areas, but to industrial and commercial spaces as well. Not only will the greenspace serve as a stormwater movement and filtration area, but will become a greenway for pedestrian movement and gathering. This is an important element in providing healthy spaces for workers to socialize during break periods, while also providing a space to heal the landscape and connect fragmented ecology.

Recycled materials of former mining and other industrial equipment provide a design language that responds to the site's former industrial use. Elements are intended to create an industrial feel, with rigid lines and materials, while weaving an ecological ribbon of native plantings.

Figure 58: Stormwater Park: restoring, educating and connecting people to nature.

Stormwater parks add value by building ecological function into the landscape, while managing the site's stormwater and providing passive recreational and social space for the community. It is important that these spaces provide a mutually supportive habitat; considering people, wildlife and plant communities. This holistic approach to space inspires people to experience nature while improving their ecological literacy. These spaces respond to low impact development practices, using a swale and bioretention system to cleanse and infiltrate stormwater. These parks create spaces to engage people in nature and social interaction with their community. They serve as a link between nature, science and art.

Figure 59: Central Community Parks: a central gathering core.

Central community parks serve as important spaces for neighborhood gathering. Large open greens serve similar functions as the stormwater parks, providing a space for stormwater to slow and be cleansed. These parks are scattered throughout the interior residential and commercial neighborhoods. The front porches of homes overlook the park space, while greenways link pedestrians throughout street grid. Central greens are important for strong neighborhood social building. In addition to stormwater infiltration, these areas may contain common play spaces, community gardens and neighborhood gathering events.

Figure 60: Recreational Trail: a gateway for outdoor exploration.

This area serves as the recreational gateway for the SEP park. Adjacent to the valley neighborhood below, it provides a link to the surrounding community. Steep slopes require switchback trails to access the SEP site above. A variety of trails, marked with rock cairns guide users through many different elements of the landscape. Seating areas for rest and reflection are distributed throughout the trail system.

plant palettes

historic climax species
invasive species
hydric species
successional species
biomass species

Oak Species *(Quercus spp)*

historic climax species

http://www.statesymbolsusa.org

http://ernielb.blogspot.com

http://en.wikipedia.org

large tree

climax species

slow growing

wildlife food source

thick, durable bark

Hickory Species *(Carya spp)*

historic climax species

ttp://www.oplin.org

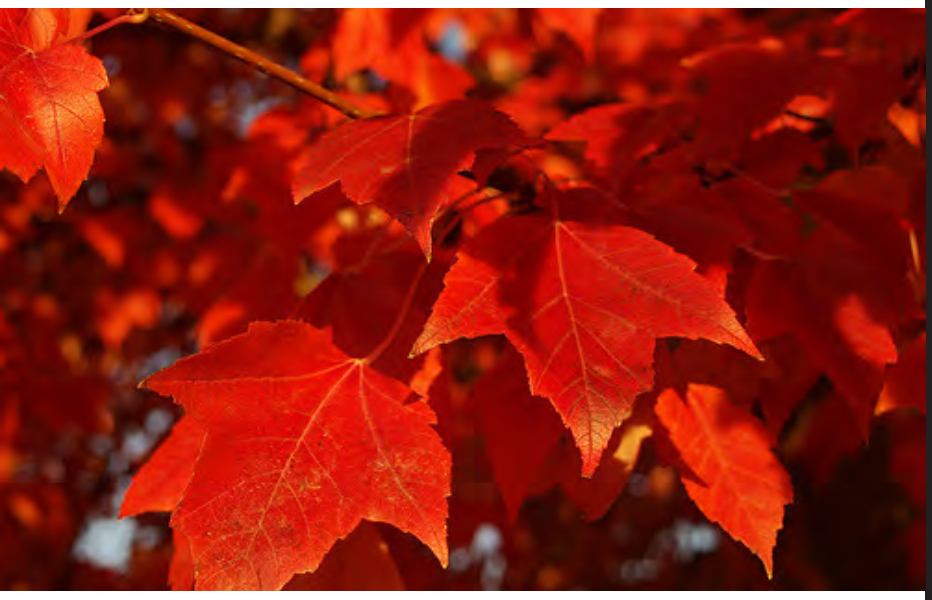
- large tree
- climax species
- slow growing
- wildlife and human food source
- vibrant yellow fall color
- exfoliating bark

http://s960.beta.photobucket.com

http://www.silysavg.com

Red Maple *(Acer rubrum)*

historic climax species



http://www.fcps.edu

http://caquino.photoshelter.com

- large tree
- wetland and river floodplain habitat
- wide speciation range and tolerance
- wildlife food source
- vibrant red fall color

Autumn-olive *(Elaeagnus umbellata)*

invasive species

http://wearemadeofdreamsandbones.blogspot.com

http://livingafield.com

http://people.cst.cmich.edu

deciduous shrub or small tree

height up to 10 feet

thorny

bronze and silvery spots on leaves and twigs

invasive species, indigenous to Asia

fruits heavily

fixes nitrogen, yielding aggressive growth

ability to grow in low pH 4.0

cutting and herbicides to eradicate

Cattails *(Typha spp)*

invasive species

http://althealing101.blogspot.com

http://bioweb.uwlax.edu

a reed plant

height ranges from 3 feet - 10 feet

aggressive growth habit, reproducing through rhizomes

efficient nutrient uptake

hydric indicator

Crown Vetch *(Coronilla varia)*

invasive species

http://odeliaivy.wordpress.com

http://www.scienceu.com

http://colorsofthegarden.blogspot.com

perennial herb

low growing creeper with lengths as long as 6 feet

aggressive growth on disturbed sites

invasive

soil stabilizer

pink/purple flowers throughout summer

Birds-foot Trefoil *(Lotus corniculatus)*

invasive species

http://informedfarmers.com

http://www.minnesotawildflowers.info

http://nixahardware.com

perennial herbaceous plant

low growing, up to 6 inches

small yellow flowers that produce legumes

prefers sandy soil

typically used as a forage plant, grown with grazing plants

some varieties are a good source of nectar for insects

invasive plant

Broomsedge bluestem *(Andropogon virginicus)*

invasive species

http://njaes.rutgers.edu

grass

height ranges from 3 feet - 4 feet

clumping growth

indicator of acidic soil conditions

typically found on disturbed sites

invasive and aggressive

orange-brown fall color

cotton-like fall blooms

http://njaes.rutgers.edu

http://www.hiltonpond.org

Willows *(Salix spp)*

hydric species

http://people.duke.edu

http://www.flickr.com

http://www.creativityforthesoul.com

tree or shrub

height variation from 1 feet - 8 feet

hydric indicator

aggressive rhizomial growth

can be propagated with cuttings

bank stabilizer and erosion control

wildlife and habitat source

Sedges *(Carex spp)*

hydric species

http://www.illinoiswildflowers.info

http://www.sevenoaksnativenursery.com

flowering graminoids

grow in thick tussocks

nearly 100 species

hydric indicator

spikelets of inconspicuous flowers

wildlife food and habitat source

http://libguides.aurora.edu

Woolgrass *(Scirpus cyperinus)*

hydric species

http://www.colby-sawyer.edu

http://www.flickr.com

http://www.flickr.com

sedge species

heights up to 6 feet

aggressive growth

shaggy brownish inflorescence

hydric indicator

wildlife food and habitat source

soil stabilization

Asters *(Aster spp)*

hydric species

http://fineartamerica.com

http://f1f11.blogspot.com

http://littermob.blogspot.com

perennial forb

aggressive growth

height ranges from 8 inches - 8 feet

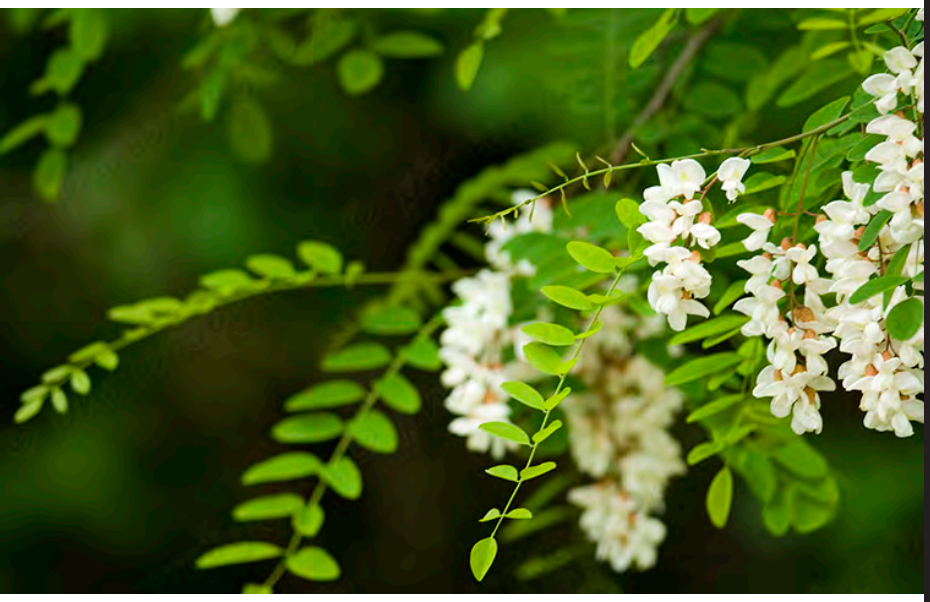
important pollinator species

late summer/early fall long colorful blooms

Black Locust *(Robinia pseudoacacia)*

successional species

http://www.fcps.edu



http://the3foragers.blogspot.com

http://www.fcps.edu

pioneer tree

height up to 100 feet

naturalized and somewhat invasive

ability to fix nitrogen from mycorrhiza fungus root growth

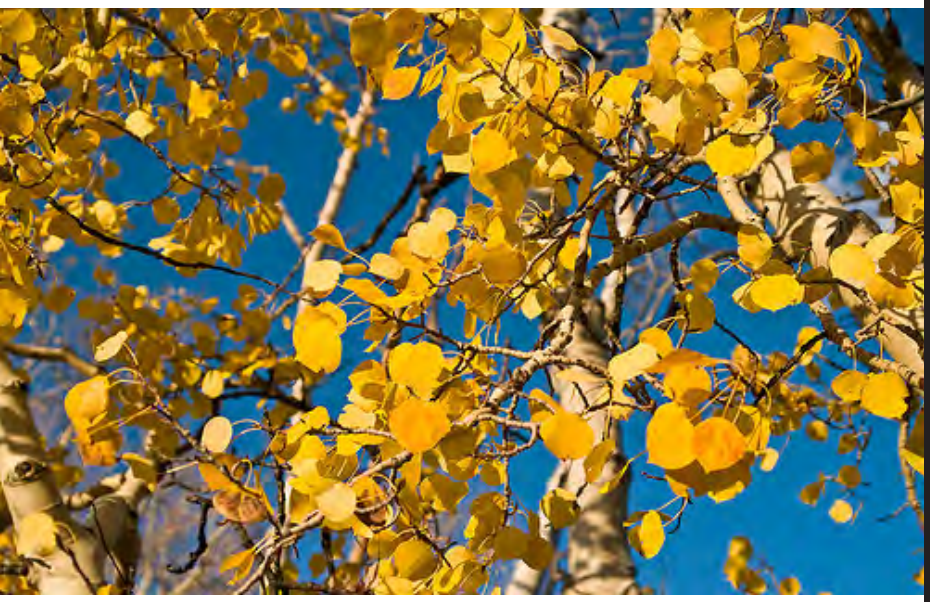
wood used for fence posts

white flowers in late spring attract pollinators

Trembling Aspen *(Populus tremuloides)*

successional species

http://www.art.com



http://www.sevenoaksnativenursery.com

pioneer tree

spreads through rhizomial growth producing numerous ramnets

photosynthetic white bark

columnar form

waving leaves

vibrant fall color

excellent wildlife food source

https://lawyernursery.com

Grey Dogwood *(Cornus racemosa)*

successional species

http://www.whiteoaknursery.biz

http://www.all-creatures.org

http://www.uwgb.edu

pioneer shrub

aggressively grows through root suckering

root system is excellent for erosion control

wildlife food and habitat source

glossy red fall color

large showy white spring blooms

Switch Grass *(Panicum virgatum)*

biomass species

http://stopsuckingatlife.wordpress.com

perennial grass

aggressive rhizomial growth

clump forming

height ranges from 3 feet - 6 feet

finely textured seedheads

four season interest

golden fall color

http://smithsonianscience.org

http://blog.speculist.com

Arundo Grass *(Arundo spp)*

biomass species

http://www.myclimatechangegarden.com

perennial grass

clump forming habit

height up to 12 feet

bronze seed heads

http://www.blackoliveeastnursery.ne

https://dnr.state.il.us

Miscanthus *(Miscanthus spp)*

biomass species

http://davisla.wordpress.com

http://www.diggingdog.com

http://www.agri-media.ca

perennial grass

clump forming habit

wind swept appearance

tolerant of many soil conditions

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