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Position Paper

Soil-Site Management Protocols & Best Management Practices (BMP's) for Utility Scale Solar Site Development and Management in Virginia

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A list of abbreviations/acronyms appears at the end of this paper

Overview and Background

Development of Utility Scale Solar (USS) facilities (> 5 MW) will potentially impact at least 200,000 acres of existing agricultural and forested landscapes in Virginia over the next decade; Virginia DEQ currently estimates over 500,000 acres could be affected by 2045. While the intensity of impacts varies dramatically based on local site conditions and infrastructure development practices, anywhere from 10% to > 75% of the existing soil landscape will undergo some level of significant disturbance at most sites. Prediction, management and rehabilitation of these soil x landform effects is critical for (a) minimizing sediment losses, (b) managing and reducing stormwater impacts, and (c) return of these lands to productive uses following site decommissioning. Therefore, a range of essential Best Management Practices (BMP's) need to be prescribed and implemented during the full project lifecycle including (1) preliminary planning/design/permitting, (2) active site development and stabilization, (3) long-term site operation, and (4) final site infrastructure removal and decommissioning.

Currently, USS permitting and development in Virginia is regulated by a mix of programs depending on the size of the site's proposal. Larger project proposals (i.e., > 150 MW) are reviewed by the State Corporation Commission (SCC) while smaller projects (5 to 150 MW) are currently reviewed by the Department of Environmental Quality (DEQ) under Permit by Rule (PBR) procedures, which are currently being finalized under mandate from Virginia House Bill 206, ***Small renewable energy projects; impact on natural resources***, https://lis.virginia.gov/cgi-bin/legp604.exe?221+sum+HB206). This regulation requires appropriate assessment and mitigation protocols and standards be developed (by July 2024) for projects ≤ 150 MW that would disturb a total of more than 10 acres of NRCS defined prime farmlands or 50 acres of contiguous forest lands.

All USS projects are subject to DEQ stormwater Erosion & Sediment Control (ESC) and stormwater management (SWM) requirements along with local conditional use zoning and construction permitting requirements, the latter of which vary widely across the Commonwealth. Recent site-specific guidance from DEQ for solar site SWM and ESC protocols can be found at https://www.deq.virginia.gov/home/showpublisheddocument/16685/638186144540630000. More extensive SWM and ESC guidance, including updated revegetation practices, will also be included in revisions to the upcoming DEQ SW+ ESC Online Manual by July 1, 2024. Depending on their location, projects may also be subject to jurisdictional wetland impact (i.e., Section 404) and/or Chesapeake Bay Act setbacks, buffers and restrictions. On the local level, many counties/cities are requesting a more detailed description of longer-term site infrastructure removal and decommissioning practices, particularly with respect to return of USS affected areas to previous land use potentials (e.g. agricultural production). These recent and ongoing regulatory developments, coupled with increasing public interest in USS development impacts, should lead to more uniform implementation of statewide policies on USS site selection, development and closure practices.

The positions and recommendations presented here are based on our collective 50+ years of research and consulting experience on impacts and stabilization of land-disturbing activities including mining, road construction, urbanization, and wetland restoration/creation. The specific practices recommended here are evolving and based on our assessment of civil plans/geotechnical reports and actual site conditions of over 30 proposed or implemented USS sites in Virginia. More detail on related site rehabilitation research programs at Virginia Tech is available at https://landrehab.org.

The opinions and positions expressed here are intended as supplementary to existing and upcoming Virginia DEQ (or other) regulatory requirements. Our recommendations and are also complementary with current SWM+ESC BMP requirements. Furthermore, we are currently collaborating with a range of scientists at Virginia Tech and other institutions in Virginia to develop a much more extensive underlying and fully referenced White Paper on this topic. Thus, these summary recommendations will be reviewed and updated periodically.

Framework for Overall USS Site Development, Management and Closure

All USS development, management and closure practices should protect local soil and water quality and associated ecological functions and values, including return of decommissioned project areas to productive agriculture, forestry or other pre-planned uses. Essential to this commitment is the application of a range of best management practices (BMPs) that are designed to minimize impacts to soil and water resources during and after site development. Following infrastructure removal, the developer should commit to rehabilitation and restoration of any disturbed areas to optimize their productivity for varied post-closure uses. Those future land-uses are difficult to predict, but may include continued renewable energy production, agricultural practices, silviculture, or other more urban uses with concurrence of landowners and other key stakeholders. Key to this effort is the commitment to full transparency throughout the long-term (25+ year) relationship with local and regional stakeholders with respect to planning and permitting procedures, expected short- vs. long-term impacts, and scientifically based projections for medium- and long-term site productivity potentials for various uses.

Pre-Development Assessment and Planning Practices

- Identify all soil types on site using NRCS Web Soil Survey and/or other resources (e.g., FIW NWI, VT VALEN site, VT Acid Sulfate Soils, DCR karst, etc.) to identify prime farmland units (via NRCS criteria), forested areas, wetlands and other sensitive areas and features.
- Verify presumed soil types, forested areas, wetland boundaries and other limiting features via on-site investigations by a qualified professional when needed.
- Collect baseline pre-development data on important soil health indicators, including topsoil depth, organic matter & aggregation, bulk density, and permeability.
- Establish and map appropriate and required buffers around sensitive features, riparian zones, Resource Protection Areas, drainage swales, sinkholes, rock outcrops, wetlands, etc.
- Utilize gathered information to minimize grading (cut/fill) and other site development impacts to existing soil resources while avoiding impacts to particularly sensitive features (e.g. sinkholes and wetlands).
- Utilize conservative runoff estimators (e.g., higher NRCS CN's and/or VRRM RV's) for stormwater and erosion prediction modeling and SWM BMP specifications, particularly during the development/stabilization phase.

- Adjust design BMP SWM volumes to account for (a) site disturbance and (b) panel imperviousness. This should include adjusting the Soil Hydrologic Group (HSG) designation per DEQ GM 22-2012 guidance.
- Develop detailed *a priori* vegetation establishment and management plans to meet initial site stabilization demands coupled with longer term operational vegetation management needs.

Active Site Development Best Practices

- Carefully establish and maintain all required buffers, setbacks, and all temporary and permanent ESC + SWM BMP's.
- Minimize grading and cut/fill for roads and structures and for leveling or reducing slope grade changes for panel arrays, wherever possible.
- Sites on steeper terrains would benefit from dual-axis tracking systems or U-joints in single-axis systems to minimize cut/fill requirements.
- Use rain sensors to trigger panels to move to more vertical positions when triggered by heavy rain events.
- Anticipate development of "drip lines" below downhill panel edges on slopes and develop appropriate strategies to maintain disconnected flow conditions, restore sheet flow, or increase the time of concentration.
- Predict and document/map all areas of significant soil disturbance including roads, structure and substation pads/surrounds, cable/utility trenches, temporary ESC measures, and engineered stormwater conveyances and ponds.
- Minimize topsoil removal wherever possible and maintain temporary topsoil stockpiles in an aerated condition with deep-rooted vegetation away from wet/saturated areas.
- Utilize light agricultural scale machinery with low pressure tires/tracks whenever possible for site development and maintenance activities. Avoid trafficking site soils during wet/saturated soil conditions.
- Assume that site development will compact the soil to some extent. Assess and remediate root-limiting compaction and smearing of disturbed surface soil materials to 4-6 inches with appropriate mechanical tillage methods. Add and incorporate soil amendments (lime/N-P-K/organic matter) to all final revegetation surfaces based on appropriate field sampling and soil testing protocols as described by Virginia Tech or other DCR approved labs https://www.soiltest.vt.edu/sampling-insttructions.html .

- Sample topsoil stockpiles before return to disturbed areas and develop appropriate liming/fertilization/amendment prescriptions for seeding.

- Where topsoil is not salvaged and returned, assume exposed cut subsoils will most likely be compacted, low in pH and plant available nutrients and sample and test all contrasting cut/fill regraded areas separately.

- Utilize compost, biosolids or other appropriate organic soil amendments where possible and feasible. Apply all soil amendments within DCR/DEQ/VDACS land application, NMP or label requirements.

- Return topsoil to disturbed areas from stockpiles as quickly as site closure conditions allow, or utilize "direct haul" strategies to immediately move actively collected topsoil to adjacent soil reconstruction areas. Loosen returned topsoil or exposed subsoil for revegetation steps with equipment consistent with use in the confined panel array environment.

- Minimize final smooth grading (tracking in) on sloping areas and leave surface "roughened up" where possible.

- Establish temporary vegetation ($\geq$ 75% living cover) within 14 days or less of disturbance wherever possible, including immediately following closure of trenches (returning topsoil back over backfill whenever possible) and installation of panel uprights. Temporary seeding (or stabilization with tacked mulch) should include any internal rough-graded areas that will not be returned to final grade or permanent vegetation for more than 30 days.

- Establish permanent vegetation ($\geq$ 75% living cover, with maximum bare areas of less than 250 sf) on all exposed soils within 7 days of final grading with diverse species mixtures for perennial seedings. Ensure legume establishment ($\geq$ 25% cover) unless intensive turf type management with routine fertilization is prescribed post-development management.

- Ensure that revegetation strategies meet both short and long-term ESC needs, including coupling with longer term active soil/vegetation/grazing management goals. For example, limit animal grazing activities until the permanent vegetation is fully established (e.g. $\geq$ 75% living cover) and viable.

- Utilize combined seeding, liming, fertilization and organic amendment strategies to enhance initial vegetation establishment goals along with enhancing longer term soil health and quality.

- Avoid seeding DCR-listed invasive species such as Sericea/Chinese lespedeza into uplands or overall aggressive species such as reed canary grass into wetter pond and drainageway positions.

Post-Development and Operational Site Management Practices

- Maintain diverse mixed grass/legume stands in panel array zones that are consistent with intended maintenance, mowing or grazing regimes.
- Where possible, use pollinator-friendly and native species in seed mixes that are consistent with panel zone management goals.
- Monitor and document vegetation type, persistence and cover in differing management zones including under and between panel arrays, disturbed road shoulders, stormwater conveyances and ponds, and in undisturbed buffers. Utilize these observations to adjust management and reseeding practices as necessary.
- Utilize buffers and other non-paneled areas for establishment and maintenance of native grasses and/or pollinator species where feasible.
- Avoid working on-site when soil is wet and use light, low wheel pressure vehicles for routine maintenance.
- Establish permanent soil quality sampling and monitoring locations for critical parameters such as organic matter, aggregation, permeability, and bulk density. These locations should include both actively managed undisturbed and reconstructed soil areas to allow for valid documentation of actual soil carbon sequestration rates (if desired for markets or offsets) and other parameters.
- Collect routine soil testing samples from vegetation monitoring areas at least every third year and apply lime, N-P-K fertilizers and other amendments as needed to maintain and meet vegetation management goals for differing management zones.
- Integrate animal grazing management practices such as rotational grazing where possible to assist with vegetation maintenance and enhance soil quality.

Final Closure and Decommissioning Practices

- Reestablish all necessary ESC and temporary SWM controls.
- Evaluate existing soil quality parameters, particularly subsoil compaction, for all areas, particularly those that underwent significant disturbance during site development.

- Minimize repeat soil disturbance associated with infrastructure removal following similar or improved practices used during the development phase.
- If indicated as necessary for a given land use (e.g. agriculture or intensive forestry), deep-rip all significantly disturbed areas to ≥ 24 inches, ensuring soils are at appropriate moisture levels to optimize bulk density remediation.
- Soil-test all areas for final revegetation prescriptions and apply appropriate lime, N-P-K fertilizer and organic amendments.
- If necessary, suppress the existing herbaceous stand to allow for establishment of final targeted agricultural, forest or other pre-planned uses such as urban re-development
- Use appropriate tillage practices (e.g., chisel plow, disk, or rototiller) to incorporate final soil amendments and remediate any final surface soil compaction to ≥ 6 inches.
- Monitor rehabilitation efforts for two seasons to ensure appropriate ESC and SWM compliance along with successful establishment of intended vegetation or cropping system.

Abbreviations Used

BMP – Best Management Practice

CN – Curve Number

DCR – Virginia Department of Conservation and Recreation

DEQ – Virginia Department of Environmental Quality

ESC – Erosion & Sediment Control

FIW – U.S. Department of Interior Fish & Wildlife Service

NMP – Nutrient Management Plan

NRCS – Natural Resources Conservation Service

RV – Runoff value

SW – Stormwater

SWM – Stormwater Management

VALEN – Virginia Land & Energy Navigator; https://valen.ext.vt.edu/web_portal/about

VDACS – Virginia Department of Agriculture and Consumer Services

NWI – National Wetland Inventory– https://www.fws.gov/program/national-wetlands-inventory/wetlands-mapper

VRRM – Virginia Runoff Reduction Method

WSS – Web Soil Survey – https://websoilsurvey.nrcs.usda.gov/app/