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# Rooting Success: Enhancing Vegetation Establishment Focusing on Baseline Soil Conditions and Best Management Practices

## BACKGROUND

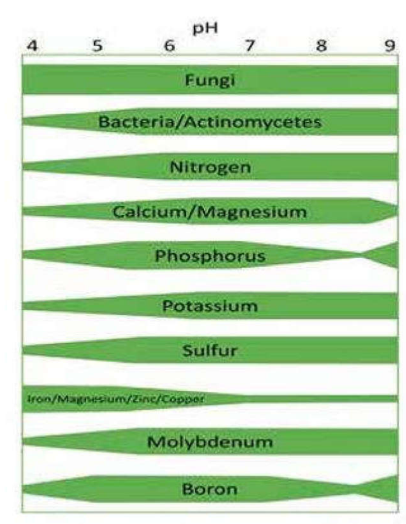
- Successful utility-scale projects require incorporating site-specific vegetation and soil management
- Poor planning at early stages affects vegetation establishment and results in long-term effects of erosion and runoff issues and higher operation and maintenance costs
- Proper planning requires careful consideration of the existing soil conditions, construction preparation and staging, implementation, and consistent communication between stakeholders
- There is a need in the renewable industry to provide solutions that understand how the biological, chemical, and physical properties of existing soil conditions affect the project and can achieve a robust vegetation establishment

## OBJECTIVE

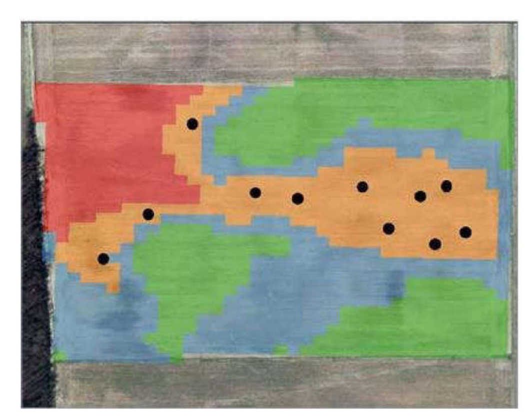
To prepare a site-specific Vegetation and Soil Management Plan that details existing conditions on-site (i.e. soils, noxious/invasive weeds present, etc.), site-specific seed mixes that are regionally tailored, and the implementation of erosion control measures are proposed as effective strategies for successful vegetation growth.

## METHODS FOR SUCCESSFUL VEGETATION ESTABLISHMENT AND SOIL MANAGEMENT

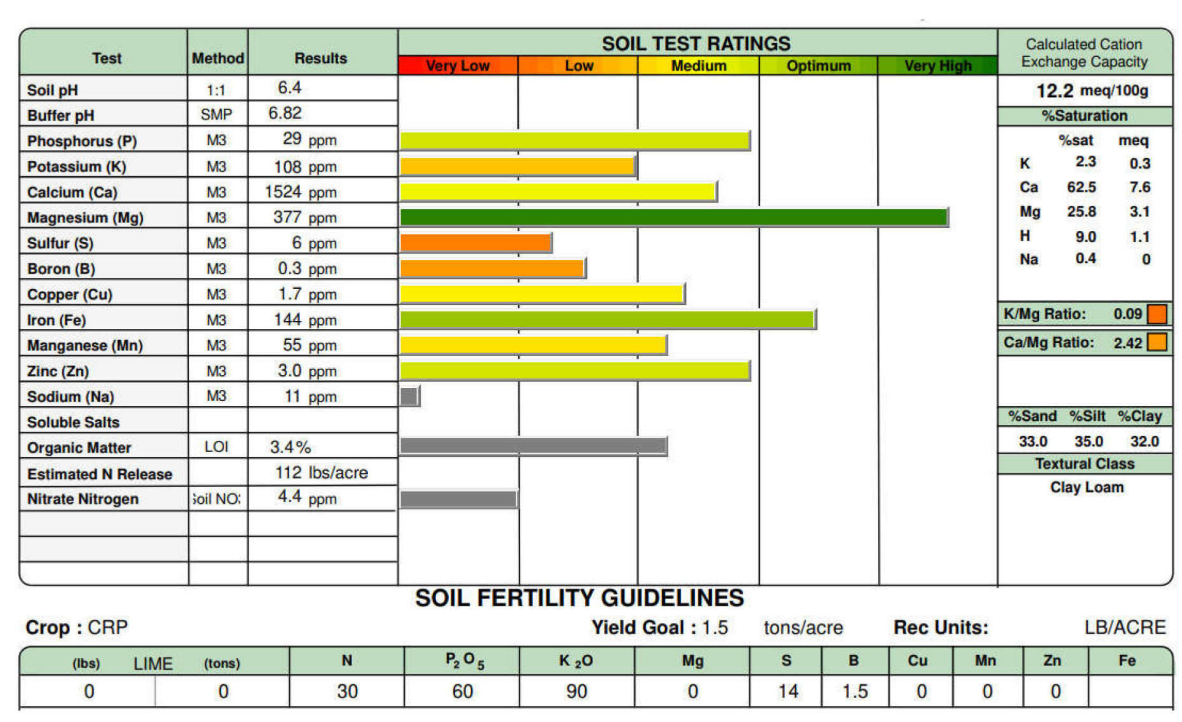
1. Assess site-specific Natural Resource Conservation Service (NRCS) soil map units for potential issues (drainage classifications, fragipans, etc.)
2. Review state-specific noxious weed and invasive species list
3. Develop a soil sampling and analysis plan
4. Conduct site reconnaissance to observe existing conditions
   - Noxious weeds and invasive species survey
   - Ponding, erosional features, or other potential issues that would affect vegetation establishment
5. Interview current landowners to understand historical land management practices
   - Herbicide usage
   - Agricultural management practices
   - Crop harvesting timeframes
6. Conduct an unbiased soil sampling regime and submit soil samples to an accredited laboratory for analysis
   - At a minimum: organic matter, available phosphorus, exchangeable potassium, magnesium, calcium, sodium, soil pH, calculated cation exchange capacity, percent base saturation, nitrate-nitrogen, total carbon, and soil texture
7. While on-site obtain an understanding of topsoil depth for future topsoil segregation
8. Make nutrient amendment recommendations based on the results
   - Lime rate to maximize nutrient availability
   - Nitrogen, Phosphorous, and Potassium rates if applicable
   - Balance nutrient amendments with the proposed seed mix
     - Excess nutrients could lead to an increase in noxious weeds/invasive species
     - Develop regionally specific seed mix
   - Cover crops/Temporary seed mix
   - Seed supply and material availability
   - Perennial seed mixes
   - Review regulatory requirements for pollinators and habitat criteria
9. Incorporate the details listed above into a Vegetation and Soil Management Plan
   - Additional warranted details below:
     - Site preparation methods
     - Erosion control methods/best management practices
     - Topsoil management methods
     - Soil reclamation activities (if warranted)
     - Vegetation installation methods
     - Seeding timeframes
     - Maintenance mowing guidelines
     - Pre-construction and construction phase practices
     - Vegetation monitoring and adaptive management
     - Invasive species management plan
10. Preconstruction conference: includes a presentation of the measures to be taken by the Applicant and contractors to ensure compliance with all conditions of the Vegetation and Soil Management Plan
11. Periodic ecological monitoring throughout the lifecycle of the Project to ensure vegetation establishment and proliferation




*Relationship between soil pH and plant nutrient availability in soil solution. (Modified from Brady and Weil (1999)).*



*The diagram above depicts zone sampling methodology that can be utilized on a soil map unit basis. Other sampling methodologies can be implemented such as "random" and "grid" sampling (Purdue, 2018).*



| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 6.4 |
| Buffer pH | SMP | 6.82 |
| Phosphorus (P) | M3 | 29 ppm |
| Potassium (K) | M3 | 108 ppm |
| Calcium (Ca) | M3 | 1524 ppm |
| Magnesium (Mg) | M3 | 377 ppm |
| Sulfur (S) | M3 | 6 ppm |
| Boron (B) | M3 | 0.3 ppm |
| Copper (Cu) | M3 | 1.7 ppm |
| Iron (Fe) | M3 | 144 ppm |
| Manganese (Mn) | M3 | 55 ppm |
| Zinc (Zn) | M3 | 3.0 ppm |
| Sodium (Na) | M3 | 11 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 3.4% |
| Estimated N Release | | 112 lbs/acre |
| Nitrate Nitrogen | Soil NO: | 4.4 ppm |

SOIL TEST RATINGS: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: 12.2 meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 2.3 | 0.3 |
| Ca | 62.5 | 7.6 |
| Mg | 25.8 | 3.1 |
| H | 9.0 | 1.1 |
| Na | 0.4 | 0 |

K/Mg Ratio: 0.09
Ca/Mg Ratio: 2.42

| %Sand | %Silt | %Clay |
|---|---|---|
| 33.0 | 35.0 | 32.0 |

Textural Class: Clay Loam

SOIL FERTILITY GUIDELINES

Crop : CRP    Yield Goal : 1.5 tons/acre    Rec Units: LB/ACRE

| LIME (lbs) | LIME (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 30 | 60 | 90 | 0 | 14 | 1.5 | 0 | 0 | 0 | |

*The information above depicts a typical laboratory analytical report as a result of soil sampling submission to an accredited laboratory. The data will be used to produce nutrient amendment recommendations.*

## CONCLUSIONS

Our experience indicates that several issues with site revegetation are common in the solar industry where strategic planning is necessary to ensure that proper site preparation, plan implementation, maintenance, and monitoring will be conducted. The main goal is to determine a pathway between the Development, Environmental, Engineering, Construction, and Operations Divisions where budgetary, oversight, and regulatory considerations are identified, responsibilities are clearly defined, and goals are understood and executed. Solar fields require vegetation maintenance solutions that address their unique needs and circumstances and are also efficient and cost-effective.

A baseline understanding of the existing conditions on site is paramount to a successful revegetation establishment. Proper upfront planning and analyses, monitoring during construction, and maintenance during establishment are all equally important strategies for a site-specific successful revegetation project. By aligning stakeholder expectations through strategic solutions and optimizing existing soil conditions, utility-scale solar projects can achieve a harmonious coexistence between solar infrastructure and the surrounding environment.

Finally, long-term ecological monitoring on site is necessary to combat negative public perceptions of solar projects. Other soil parameters can be run to better understand how solar projects affect the ecosystem. Research associated with Environmental, social, and corporate governance (ESG) can lead to standard operating procedures for vegetation and soil management across the solar market.

## REFERENCES

Ackerson, Jason. "Ay-368-w — Soil Sampling Guidelines." Soil Sampling Guidelines, Purdue Extension, Nov. 2018, www.extension.purdue.edu/extmedia/AY/AY-368-w.pdf

Brady, N.C., and R.R. Weil. 1999. The Nature and Properties of Soil. 12th ed. Upper Saddle River, New Jersey: Prentice Hall. Print.

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