VISUALLY INTEGRATED: LINKING VISUAL IMPACT ANALYSES, MITIGATION, AND RECLAMATION FOR LARGE-SCALE LINEAR PROJECTS

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Abstract.—With the recent approval of numerous large-scale transmission lines and pipelines that are now moving toward construction, it is critically important to ensure that these projects are implemented based on findings and assumptions of their associated impact analyses. Although this seems obvious, it has not always occurred successfully on past projects and can be challenging depending on how analysis findings and mitigation measures are applied and tracked. Specifically, degrees of impact and application of mitigation measures are often described in text and/or on forms that do not specifically spell out what portions of the project features they relate to. This paper focuses on effective and proven methods for analyzing visual impacts for linear projects including structuring the visual impact analyses in ways that will help successfully carry out mitigation measures during design, planning, construction, and reclamation.

INTRODUCTION

For large-scale construction projects such as pipelines and electricity transmission lines, there is often a disconnect between findings of the visual impact analysis done before the project and the details of the final project as built. This paper describes an approach that has proven effective at addressing this gap by directly linking project features to visual impact analysis recommendations during the design, construction, and reclamation phases of the project.

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The flow of this process is illustrated in Figure 1. It begins with tying expected visual impacts directly to landscape and project features during the impact analysis. Next, it is important to apply mitigation measures to reduce initial impacts to key landscape features and determine residual impact levels. Impact and mitigation data must then be incorporated into the plan of development (POD), which also includes specific measures for reclaiming the areas of project disturbance. As a project moves into construction, the POD provides specific direction on required mitigation measures. The reclamation plan includes monitoring protocols, standards for measuring success, and guidelines for adapting reclamation techniques to

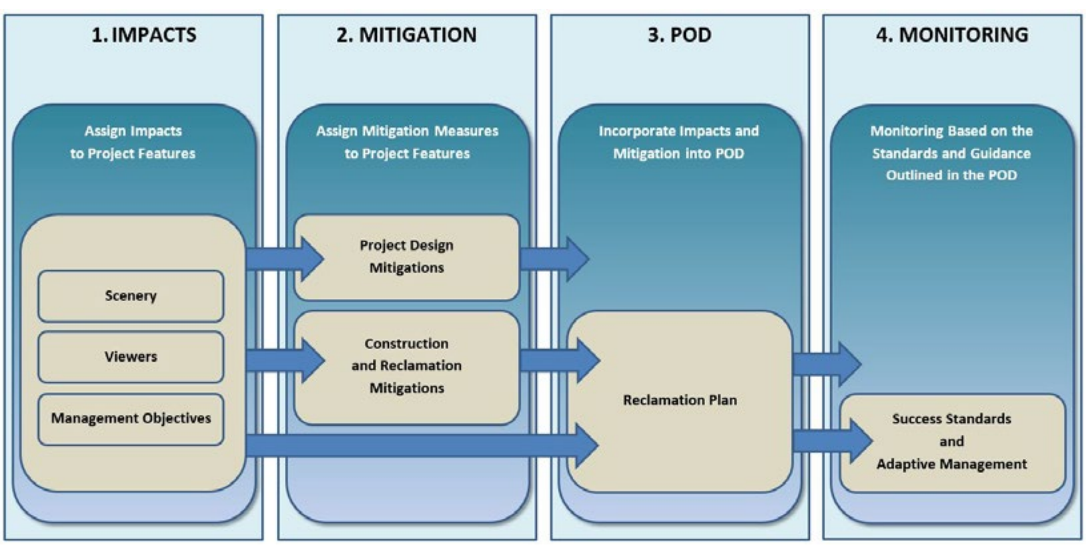

Figure 1.—Visual resource integration flow chart.

ensure that reclamation is successful. Each of these concepts is discussed in this paper with further elaboration on how each step is integrated with the next.

The need for an integrated process grew out of the incredibly complex nature of large-scale projects that cut across huge areas of the landscape, and this process has increased both the speed and precision of visual resource analysis. These types of projects often cross through multiple ecoregions, include hundreds or even thousands of individual viewpoints (residences, recreation sites, and travel routes), and affect multiple Federal and State planning areas. Analyzing each of these components individually can be incredibly time consuming, particularly for multiple design alternatives. However, by automating analysis processes with predictive GIS modeling and conditional impact matrices, potential impacts can be accurately identified and the analyses can be rerun quickly for the new or revised alternatives that tend to arise throughout the EIS process.

Indeed, the ability to establish and track automated analysis techniques is key to efficiently completing detailed analyses for large-scale linear projects. In extreme cases under severe time constraints, successful methodologies involving data simplification have been used successfully on large-scale linear projects to provide rapid, consistent results (Meyer et al. 2015). However, automated analysis techniques eliminate the need for data simplification while allowing an integrated analysis, mitigation, reclamation, and monitoring process.

Although pieces of this integrated process have been evolving since the early 1980s, it was recently used successfully on the large-scale SunZia Southwest, Energy Gateway South, and Harry Allen to Eldorado 500 kv transmission line projects. Each of these projects began with methodologies described in “Visual Resource Impact Assessment and Mitigation Planning: A Defensible Approach for Multistate Extra-High Voltage Transmission Line Projects” (Schwartz et al. 2012). This “comprehensive and hybrid” approach to determining initial and residual visual impacts involves automated processes and GIS modeling that are key to integrating assessment results throughout the reclamation planning and monitoring efforts.

Assigning Impacts Directly to Project Features

The key to successfully integrating these components lies in first tying all impacts directly back to project features. While this is not necessarily a new concept, it is not commonly practiced. Instead, impact results are usually embedded in various forms, tables, and document narratives in the analysis report(s). Moreover, these results are often broadly defined without describing exactly what portions of the project features they apply to. By contrast, assigning impacts directly to project features ensures that project components can be mitigated and reclaimed in proportion to the impacts associated with scenery, viewers, and management objectives.

While there are several methodologies that could be used to accomplish this for both scenery- and viewer-related impacts, automating portions of this process in GIS has proven highly effective. The GIS automation process begins with setting parameters for anticipated impacts to the landscape (landscape contrast) and overall impacts associated with project features (structure contrast). In brief, landscape contrast is based on the characteristics of the existing vegetation types and varying degrees of slope, which are combined to determine expected levels of contrast related to potential ground disturbing activities. Structure contrast, on the other hand, involves comparing proposed above ground project features and existing aboveground-built features to determine expected levels of contrast with existing built features.

After combining these two types of contrast into what is known as overall “project contrast,” this information can be applied in GIS to both scenery and viewer impacts using relational matrices. The advantage of this system and the use of relational tables is that the variables can be easily adjusted after a review of initial results in order to refine results and assure that predicted impacts are accurate. Preliminary results can also be manually overridden by visual resource specialists to account for specific viewing conditions such as skylining or vegetative screening.

This process of attributing impacts directly to project components is completed separately for impacts associated with scenery, viewers, and conformance with management objectives, but the process can

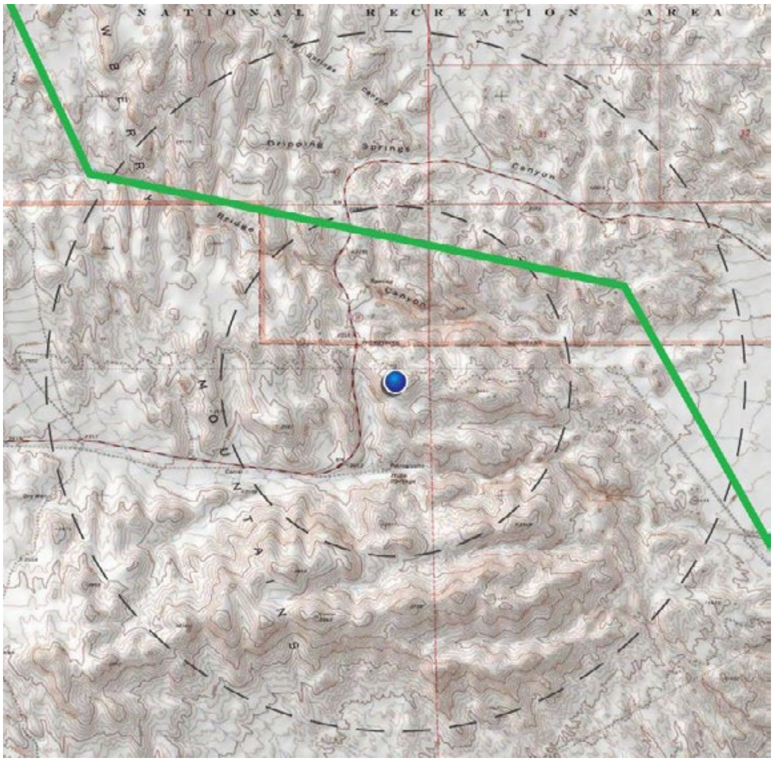

Figure 2.—Viewer (blue), project alignment (green), and influence zones (dashed lines).

also be combined to assess overall impacts for the project and compare alternatives. Impacts to viewers are generally separated into several categories such as residential viewers, recreational viewers, and viewers using travel routes. These categories often involve varying degrees of sensitivity to visual change, which can be discussed by the project team and agencies and then weighted separately within the analyses. The resulting impacts to project components can be tracked in GIS to provide rapid, consistent results. The process also allows the analyst to establish detailed tables and spreadsheets that lay out the impact levels at increments as small as tenths of miles.

As an example, the basic technique is illustrated in Figs. 2 through 4. Figure 2 illustrates linear project alignment (green), a viewer location (blue), and viewer influence zones (dashed black). The influence zones are based on distances at which the project is expected to affect the viewer and can be adjusted for each project based on the physical appearance of the associated landscape and project features. Although this example illustrates only two influence zones, additional zones can also be established at different distances.

As an initial step, Figure 3 illustrates preliminary impacts as high (red), moderate (orange), and low (green) based on conditional statements related to the project's distance from the viewer. By next overlaying a viewshed analysis from the viewing location (in which visible areas are shaded in blue), portions of the project that would not be visible can be eliminated as having no associated impacts (Fig. 4). The remaining high, moderate, and low impacts can then be verified and adjusted by a visual resource specialist based on site observations, desktop analysis, three-dimensional (3D) modeling, and/or visual simulations. This step also allows for adjustments to the conditional statements and influence zone distances if the resource specialist is consistently having to fine tune results to reflect actual conditions.

Assigning Mitigations Directly to Project Features

Once initial levels of impact are connected to the associated project features, selected mitigation measures can be applied to lower the residual impacts of the project. As with impact levels, mitigations should also be tied directly to project features. This approach often involves mitigations that are automated in GIS for application in given situations, as well as mitigations that are applied manually based on specific known conditions.

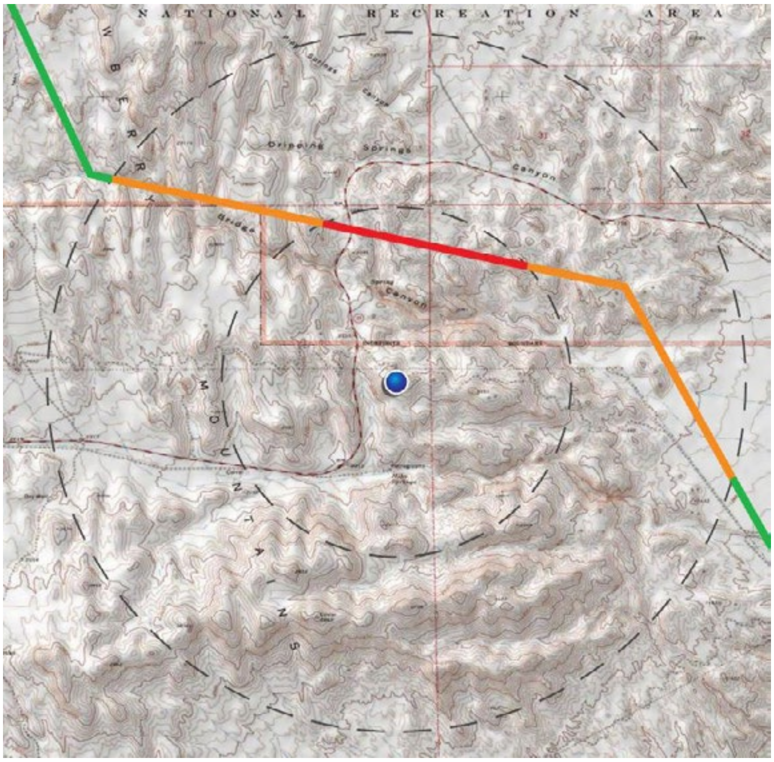

Figure 3.—Preliminary impacts are characterized as high (red), moderate (orange), and low (green).

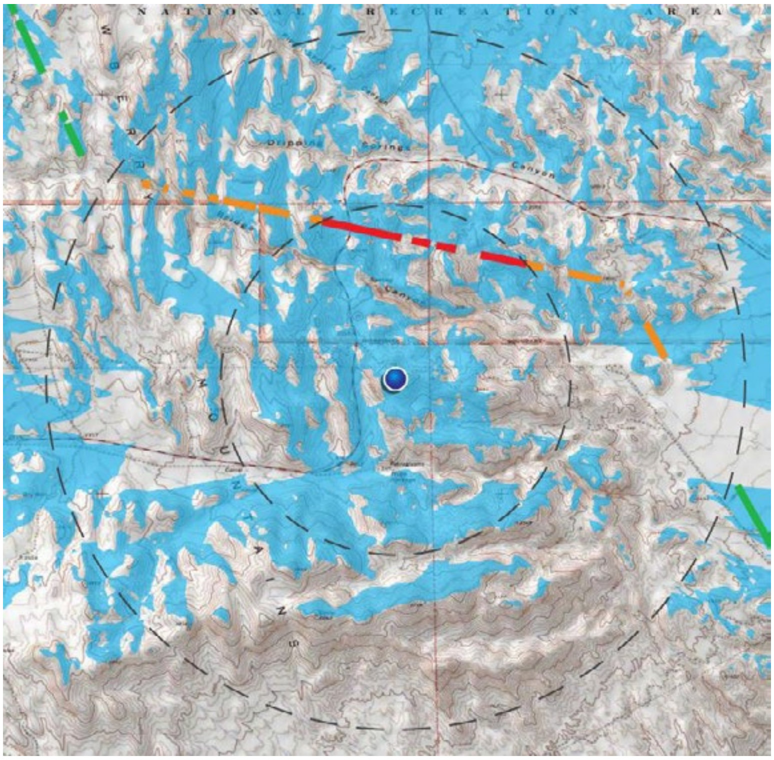

Figure 4.—Visibility and initial impacts. Visible areas are in blue; areas where no impact occurs are shaded beige.

Using a transmission line project as an example, automated mitigations could include matching spans with existing transmission lines, applying overland drive and crush techniques for sensitive areas, or maximizing tower spans in places with sensitive trail, road, or canyon/river crossings. Manually applied mitigations, on the other hand, could include modifying tower types to blend in with on-site conditions or minimizing slope cuts and requiring rock patina/staining in sensitive areas. Applying mitigation measures directly to project features not only allows for reducing residual impacts in the

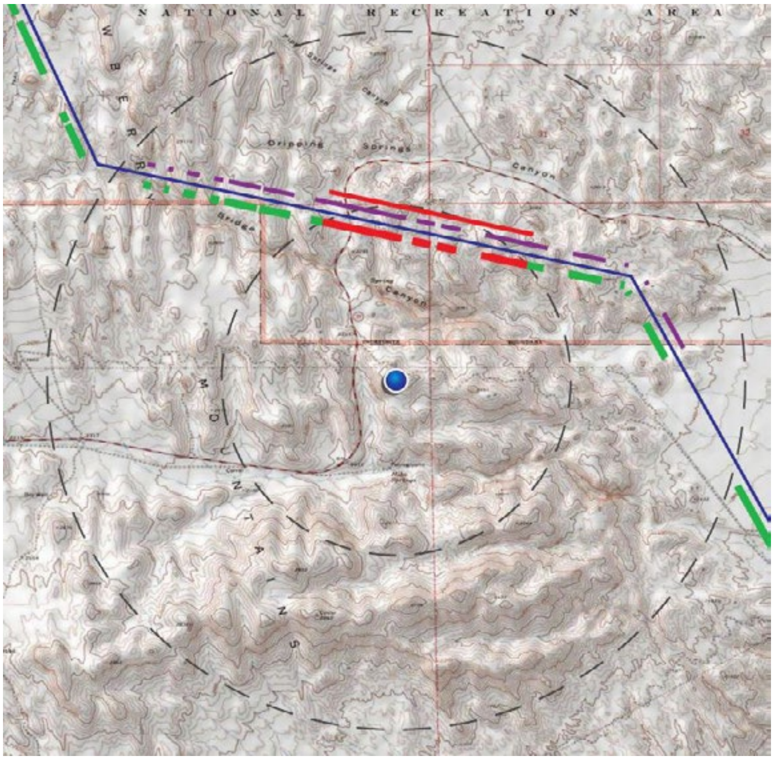

Figure 5.—Mitigation and residual impacts. The mitigation represented by the blue line is intended to be applied to all portions of the project, regardless of impact level or visibility status. The purple mitigation has been applied to all visible portions of the project within the largest influence zone. The mitigation represented by the thin red line has been applied to visible portions of the project within the smaller influence zone.

analysis, but also provides a way to track and organize mitigation data for later inclusion in the design and reclamation planning processes. As with impact results, mitigation results can be tracked and presented in a variety of outputs such as maps, tables, and spreadsheets.

Figure 5 provides an illustration of three theoretical mitigation measures (thin blue, purple, and red lines) being applied to differing portions of the project. As a theoretical example, the mitigation represented by the blue line is intended to be applied to all portions of the project, regardless of impact level or visibility status. The purple mitigation has been applied to all visible portions of the project within the largest influence zone, and the mitigation represented by the thin red line has been applied to visible portions of the project within the smaller influence zone. As a result, note that the mitigation measures in this example are expected to decrease the moderate impact to instead be low but are not expected to have a significant influence on the high impacts within the smaller influence zone. Because mitigation measures have now been applied in Figure 5, the impacts in this figure represent residual impacts.

After final mitigation measures have been determined and applied, those that relate directly to design features are passed on to the project engineers for integration into project design and engineering efforts. This could include changing structure types, spanning sensitive features, matching transmission line spans, or requiring helicopter construction and limiting access road development. The data created by assigning the mitigations to the project features enable project engineers to easily incorporate mitigations into the final project design.

Mitigation measures not related to project design are integrated into the reclamation planning and mapping processes. This integration provides both written and graphic representation of the mitigations, and it joins this information with a system of ascribing reclamation treatments to assure optimal project implementation. Examples of mitigations related to construction and reclamation include requiring overland driving and crushing, limiting slope cuts, rock staining/varnishing, and selective clearing and feathering of vegetation.

Incorporating Impacts and Mitigation Into the Plan of Development

The POD acts as the repository for both the design- and construction/reclamation-related mitigation measures. This document captures revisions to the project design based on the associated mitigation

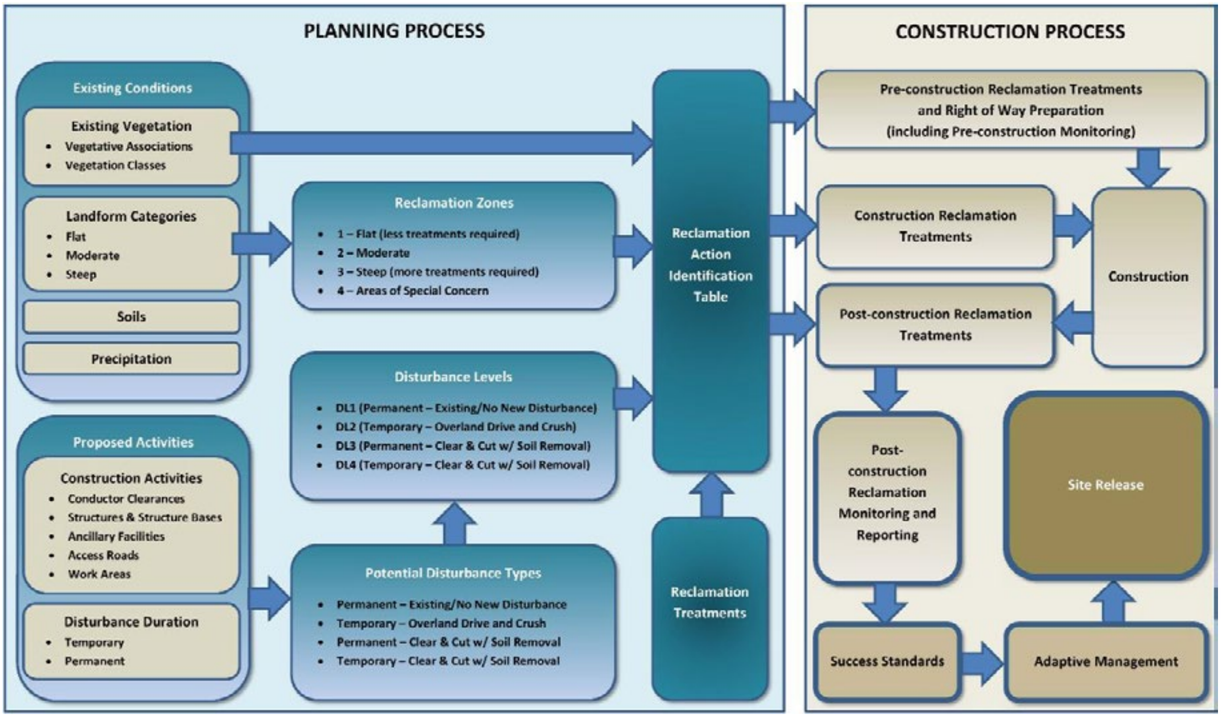

Figure 6.—Reclamation planning and construction flow chart.

measures, and it includes a reclamation plan with both the construction/reclamation mitigation measures and detailed application of reclamation treatments. The reclamation plan should also include a prioritization strategy for addressing areas that will require enhanced reclamation due to heightened visual, biological, cultural, or other sensitivities. In other words, while all areas disturbed by a project will require reclamation efforts, the prioritization strategy increases or focuses reclamation efforts in key areas to assure quicker reclamation. Acting as an additional means of tying reclamation efforts directly back to the impact analysis, the prioritization strategy should focus on areas where impacts and/or sensitivities were heightened, or in areas where the project did not comply with management objectives. With respect to visual resources, locations of amplified impacts or sensitivity may be associated with either scenery or viewers.

An example of a reclamation planning process flow chart is provided in Figure 6 and shows how each piece of a reclamation plan fits into the overall planning and construction process. The left side of this chart represents the reclamation planning steps while the right side of the chart is related to construction steps. This process begins with documenting both the existing conditions (vegetation, landforms/slopes, soils, and precipitation) and the details of the proposed activities. As the primary factor in determining the level of reclamation that will be required in this particular example, the landform categories (steep, moderate, and flat) provide the basis for the reclamation zones. An additional reclamation zone has also been included to address areas of prioritized reclamation efforts.

The details of the proposed activities in this example focus on the different types of activities and disturbances and whether associated disturbances are intended to be temporary or permanent in nature (disturbance durations). The combination of the activities and disturbance durations provide the disturbance types for the project, which are assigned disturbance level categories. The existing vegetation classes, reclamation zones, and disturbance levels are then incorporated into a reclamation identification table, which assigns reclamation treatments based on combinations of these elements. In the construction portion of the reclamation process, the different reclamation actions are incorporated prior to, during, or after construction of the project. Following the post-construction treatments, the reclamation efforts are carefully monitored.

Monitoring, Success Standards, and Adaptive Management

To ensure that the project is ultimately constructed and reclaimed per the expectations and assumptions in the project analysis, the reclamation plan must also include monitoring requirements, success standards, and stipulations regarding adaptive management. Monitoring efforts should begin with preconstruction surveys and data collection for both monitoring and control plots. While monitoring plots are established in areas planned for disturbance, the control plot locations are located in areas that will not be disturbed by the project but otherwise have similar existing conditions. Monitoring plots provide an accurate account of the existing conditions on sites that will eventually be disturbed and later reclaimed. The control plots, on the other hand, provide a continuous set of data that accounts for yearly changes in the area's vegetation, such as increased perennial growth as a result of heavier rainfall totals. Preconstruction data collection for the monitoring and control plots should include both quantitative and qualitative data and should focus on identifying the types and densities of vegetation in addition to other factors such as site stability, slope, soils, aspect, and presence of noxious weeds. Following construction and reclamation efforts, the same quantitative and qualitative data should be collected for the monitoring and control plots on an annual (or more often) basis to monitor reclamation success over time.

Success standards are established to define acceptable levels that constitute successful reclamation. These standards are generally based on achieving minimum percentages of original vegetative variety and density in addition to general site stability. A comparison of pre- and post-construction data provides the basis for evaluating whether standards are being achieved. In the event that monitoring plots are not meeting or exceeding success standards, the reclamation plan must include provisions for adapting reclamation techniques to achieve successful outcomes – also known as adaptive management. The adaptive management approach therefore focuses on increasing reclamation efforts or otherwise adapting the reclamation approach to ensure that deficient areas are improved to meet the success standards.

CONCLUSION

The process and methods described above include planning techniques that have been successful on recent large-scale linear projects and ensure that project implementation and analyses remain directly related. The key to ensuring that this process works includes having the foresight to conduct the initial impact assessments and identifying mitigation measures tied to specific project features for later integration into the POD and construction/ reclamation efforts. This process is presented to share recent methodological successes and to spur further discussion on efforts to ensure that project implementations are consistent with original impact analysis results.

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