BLM

Technical Note 446

The Use of COLOR for Camouflage Concealment of Facilities

April 2015

NATIONAL SYSTEM OF PUBLIC LANDS
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

A drilling rig sits atop the Roan Plateau in western Colorado. (image courtesy of Richard Compton)

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Abstract

In accordance with the Bureau of Land Management's (BLM's) policies regarding the stewardship of public lands, it is the BLM's responsibility to manage public lands in a manner that will protect the quality of the scenic (visual) values. The rising dependency of public lands to satisfy market demand for natural resource development and rights-of-way grants for facility placement often competes with the other public interest of protecting landscape character and preserving the quality of outdoor experiences. This competition drives the need to implement sound design strategies to preserve the visual character of the landscape. The use of color and camouflage applications on facilities is one such design strategy that may be used to minimize visual impacts from development. This technical note is a result of numerous field studies on the use of camouflage conducted over an 11-year period and is intended to provide guidance on the manipulation of color and camouflage application strategies for the effective visual concealment of built facilities.

In a historically significant area such as Split Rock in Wyoming, the visual character of the landscape greatly contributes to the visitor's experience—allowing visitors the opportunity to look through the eyes of emigrants who once traveled by foot, horse, and wagon along the California, Pony Express, Oregon, and Mormon Trails. Photo credit: Linda Blakeman

Introduction

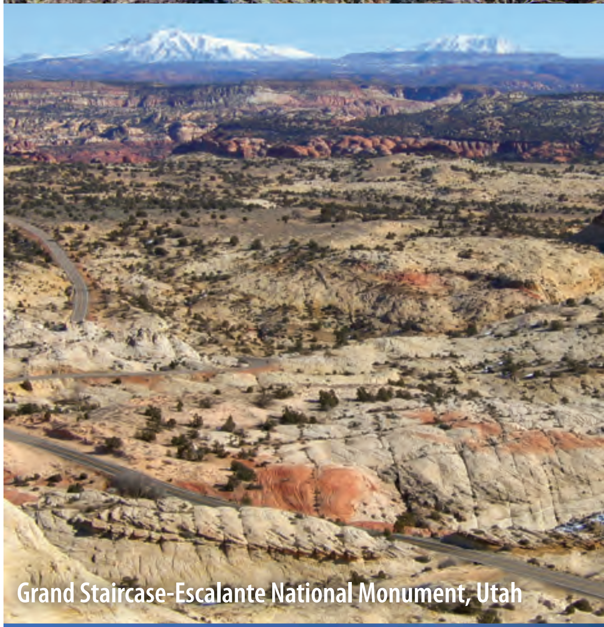
The need to protect and preserve visitors' experiences of natural, cultural, and scenic resources is an escalating imperative for land managers, as the visual setting of the surrounding landscape holds just as much value as the individual resource. The rise in surface-disturbing activities in western landscapes has resulted in encroachment on scenic settings, compromising visitors' experiences. National priorities for energy development, which include conventional and renewable energy resources, have placed uncommon pressure to use landscapes that are ideal for solar, wind, geothermal, and other energy-related development. The demand for new transmission corridors to carry this energy to market also has the potential to alter the visual character of the landscape. The role of public land management involves accommodating the demand for resource development while protecting the scenic values of the landscape and the integrity of its naturalistic character.

In order to balance the need for development and the protection of natural, cultural, and scenic resources, the Bureau of Land Management (BLM) has supported efforts to develop effective strategies for minimizing impacts to visual resources. While significant research on the use of color and camouflage applications for military use has been conducted by the Department of Defense, there has been little study concerning its applicability for minimizing impacts to visual resources on the natural landscape. Necessitated by a lack of field-tested camouflage methods for concealing built facilities within scenic settings, an 11-year study was conducted by the BLM, contractors, and project partners in order to test the effectiveness of patterns, colors, and application methods for minimizing visual impacts associated with public land-use development. This technical note is a culmination of many years of research and is meant to provide practical guidance regarding the use of color and camouflage on development facilities.

Consider using the camouflage technology presented in this tech note when development occurs within the foreground viewshed (1 mile or less) of the following:

- Congressionally designated areas, including national historic sites and landmarks, national scenic and historic trails, wild and scenic rivers, wilderness and wilderness study areas, national conservation areas, etc.
- Highways and roadways, including national scenic byways and BLM backcountry byways
- Interpretive trails and sites
- Native American religious sites
- Special recreation management areas
- Visually sensitive cultural landscapes
- Views extending from national parks, national monuments, wilderness areas, national conservation areas, national scenic trails, etc.
- Other areas with especially unique and/or sensitive aesthetic and scenic characteristics treasured by the public


Morley Nelson Snake River Birds of Prey National Conservation Area, Idaho. Photo credit: Bob Wick


Grand Staircase-Escalante National Monument, Utah


Steens Mountain Cooperative Management and Protection Area, Oregon. Photo credit: Bob Wick

Goal

The goal of this tech note is to provide BLM personnel, industry representatives, permit regulators, and the public with effective guidelines on the use of color and camouflage to conceal development facilities in order to protect the visual integrity of scenic BLM landscapes.

Objectives

- To supplement existing literature concerning best management practices for the protection of visual resources on BLM-administered lands.
- To aid in the responsible management of visual resources in multiple-use landscapes.
- To support continuing research in the development of effective practices for minimizing the visual intrusiveness of facilities in the landscape.

Relevant Mandates/Policy Statements

Federal Land Policy and Management Act of 1976

- Section 102(a)(8) states that "…it is the policy of the United States that public lands be managed in a manner that will protect the quality of…scenic… values."
- Section 103(c) identifies "natural scenic values" as one of the resources for which public lands should be managed to best meet the present and future needs of the American people.
- Section 201(a) states "The Secretary shall prepare and maintain on a continuing basis an inventory of all public lands and their resource and other values (including…scenic values)…"
- Section 505(a) requires that "Each right-of-way shall contain terms and conditions which will…minimize damage to scenic and esthetic values…"

National Environmental Policy Act of 1969

- Section 101(b) requires that measures be taken to "… assure for all Americans… aesthetically… pleasing surroundings."
- Section 102 requires all agencies of the federal government to "utilize a systematic, interdisciplinary approach which will insure the integrated use of…. environmental design arts in planning and in decisionmaking which may have an impact on man's environment."

Surface Mining Control and Reclamation Act of 1977

- 30 U.S.C. 102(d) requires that measures be taken to "assure that surface coal mining operations are so conducted as to protect the environment."

Mission The Bureau of Land Management's mission is to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.

Background

In 2003, BLM-Wyoming received grant funds from the Department of Energy through the BLM's Washington Office Fluid Minerals Program to fund research and prepare written guidance for the use of camouflage on leased oil and gas facilities that encroach upon historic and sensitive cultural landscapes administered by the BLM. Recognizing the applicability to renewable energy development, the BLM's Washington Renewable Energy Policy augmented the project funding in 2009 through the American Recovery and Reinvestment Act in order to afford additional field testing. During the past 12 years, a literature review and multiple rounds of field testing were completed in order to better understand the practical use of camouflage technologies for BLM applications. When the first written draft of this document was completed in 2007, a strategic decision was made to withhold its release until the methods outlined were tested and verified in the field. The results from the field tests are summarized in the following reports, which may be found at www.blm.gov/wo/st/en/info/blm-library/publications/blm_publications/tech_notes.html:

- "The Use of Color to Mitigate Visual Impacts," 2007

- “Environmental Color and Camouflage Mitigation Field Test,” April 2011
- “Camouflage Demonstration and Evaluation,” November 2011

This tech note provides proven methods for incorporating camouflage applications into the existing suite of visual resource best management practices. It is recommended that this tech note be used in conjunction with the following publications on minimizing visual impacts, which can be found at the URL in the previous paragraph:

BLM’s Visual Resource Management System:

- BLM Manual 8400, “Visual Resource Management”
- BLM Handbook H-8410-1, “Visual Resource Inventory”
- BLM Handbook H-8431-1, “Visual Resource Contrast Rating”

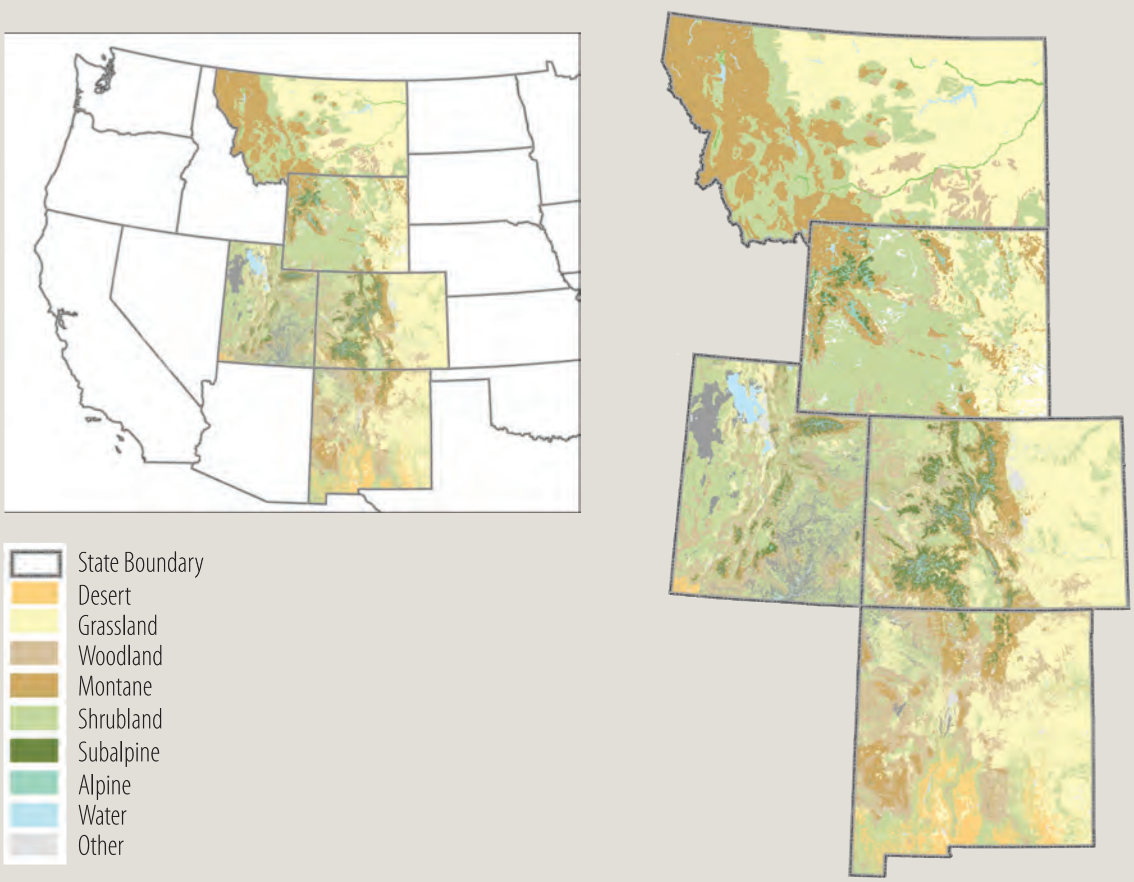
Design guidelines and best management practices:

- “Best Management Practices for Reducing Visual Impacts of Renewable Energy Facilities on BLM-Administered Lands”
- “Guidelines for a Quality Built Environment”

Tests conducted in the field used a variety of techniques to refine the selection process for color, pattern, and texture in multiple BLM landscapes, while exploring multiple methods of applications including adhesives and stencil painting.

Study Area

The primary study area included Colorado, Montana, New Mexico, Utah, and Wyoming. However, the concepts and ideas discussed in this tech note apply throughout the Western United States and Alaska. Within this area, there are seven distinct vegetative zones: desert, grassland, woodland, montane, shrubland, subalpine, and alpine. Each zone is dominated by its own palette of colors.



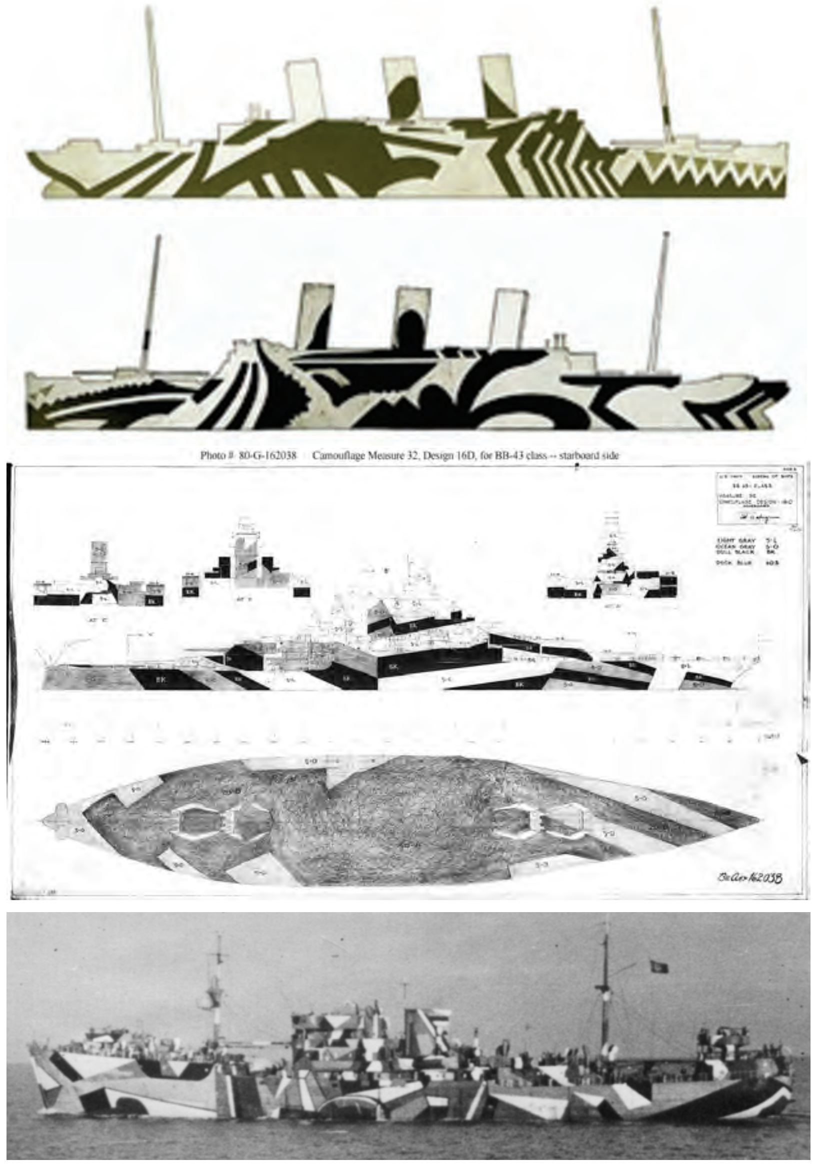
Camouflage

Camouflage Technology

Modern camouflage technology has its roots in the art community. The first form of camouflage technology was artist Abbott A. Thayer's countershading of naval warships for military use in 1898, during the Spanish-American War. Further advances were made to the technology during World War I when it became known as dazzle camouflage or dazzle painting. The objective of dazzle camouflage was not to hide but to disrupt the form of naval warships and confuse the enemy about the ship's critical target points through deception.

During World War II, use of camouflage was expanded by adding concealment as an objective. Additional patterns were developed and applied to not only ships, but also to uniforms, aircraft, and vehicles.

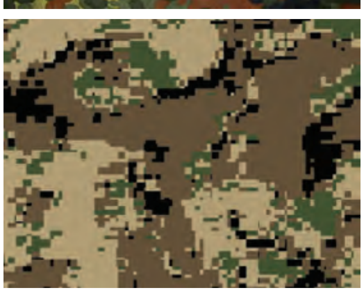
Much like this early application, some current camouflage techniques are used to break up the geometric form of facilities, using highly contrasting colors to mimic the patterns of light and shadow in the landscape. However, modern military camouflage is now rooted in the science community rather than the art community.



Examples of dazzle painting used on warships in World Wars I and II.

World War II-style camouflage pattern.

Flecktarn introduced in 1990.



Fractal pattern introduced in the early 2000s.

Transition from an Art to a Science

Recent camouflage research and advancement in the fields of psychophysical engineering and science have led to the technology of fractal or pixelated camouflage and stems from more than 30 years of military research. More specifically, the technology discussed in this document draws from the science behind the invention of Dual-Texture Gradient Pattern (Dual-Tex) camouflage, which was rigorously tested against other established patterns in the 1970s (O'Neill and Johnsmeyer 1977). A Dual-Tex pattern is composed of two patterns of different scales—the macropattern and the micropattern—in which one pattern fits inside the other pattern. The macropattern attempts to disrupt the visual form of the subject, while the micropattern blends the disrupted form with the background textures and colors. Modern fractal patterns developed on the Dual-Tex premises are created through the use of mathematical algorithms designed to analyze and replicate the spatial frequency of light patterns found in nature that make up the visible setting. Results are therefore measurable and adjustable.

Use for Facilities

Camouflage is effective for visual mitigation when multiple colors are applied in an organic pattern that replicates the natural textures, breaking up the form of an object. The colors of the pattern should repeat the colors seen in the surrounding landscape—including the shadows—to create the illusion that the object is part of its surroundings, both positive and negative space. The simulation to the right provides an example of how camouflage applications can break up the form of an object.

Visual Perception

Vision provides a conduit to the brain, where we collect and store information that communicates place and influences our experience. This visual information of an object or landscape setting can be categorized into five elements: form, line, color, texture, and scale. The incongruity of certain facilities in a landscape can be jarring to the visual senses and may negatively impact our perception of the visual scenery. By modifying the form, line, color, and texture to mimic the visual characteristics of the surrounding natural environment, the visual impacts of intrusive structures can be diminished. Along with proper siting in the landscape, repeating the colors and textures of the surrounding landscape can help minimize the visual contrast of facilities and structures.

By modifying the form, line, color, and texture to mimic the visual characteristics of the surrounding natural environment, the visual impacts of intrusive structures can be diminished.

In terms of BLM visual resource management, sensitivity is a measure of the general public's acceptance of visual change to the landscape. In sensitive landscapes where development may compromise the visual resource, or where distance and siting alone are not sufficient to conceal facilities, it may be necessary to apply a single color or a multicolor camouflage treatment in order to meet the visual resource management objectives. Such situations may include development within the viewsheds of cultural and historic sites, national historic trails, BLM backcountry byways, congressionally designated areas, etc. The application of color and camouflage is not limited only to sensitive landscapes but should also be considered in any situation where development will cause significant alterations to the visual character of the landscape. Such strategies should be used in conjunction with other best management practices and design approaches (see page 26 for a list of publications regarding best management practices) and should not be relied upon as the only method for reducing adverse visual contrast.

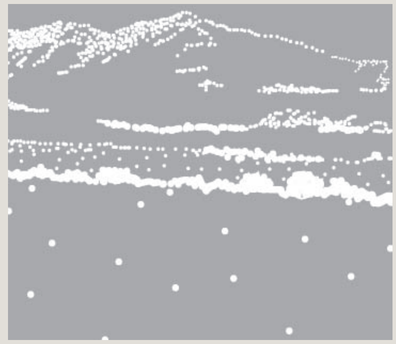
Because of the variability of landscape characteristics found on BLM lands, it is important to carefully evaluate site factors when determining the proper color, texture, pattern, and application method to be used on a given facility. The following section provides guidelines to aid in the selection and application of color and camouflage on facilities, while providing examples of successful uses. It addresses single-color application, a BLM-selected standard camouflage pattern, how to select the most appropriate color composition, and how to develop customized patterns.

Five Elements of Visual Information

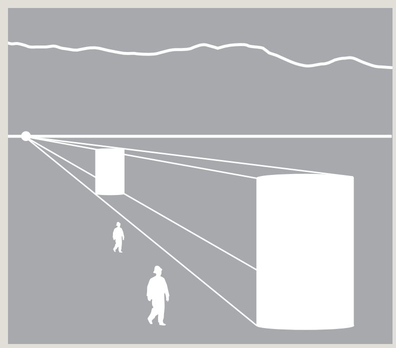
Form is defined as the mass or shape of objects in the landscape.

Line is the real or imagined path the eye follows when viewing the landscape.

Color is the major visual property of reflecting light of a particular intensity and wavelength from surfaces and creates the visual contrast of the landscape.



Texture is the aggregation of small forms or color mixtures into a continuous overall surface pattern of objects, often vegetation, in the landscape.



Scale is the proportionate size relationship between an object and the surroundings in which it is placed.

Use for Facilities

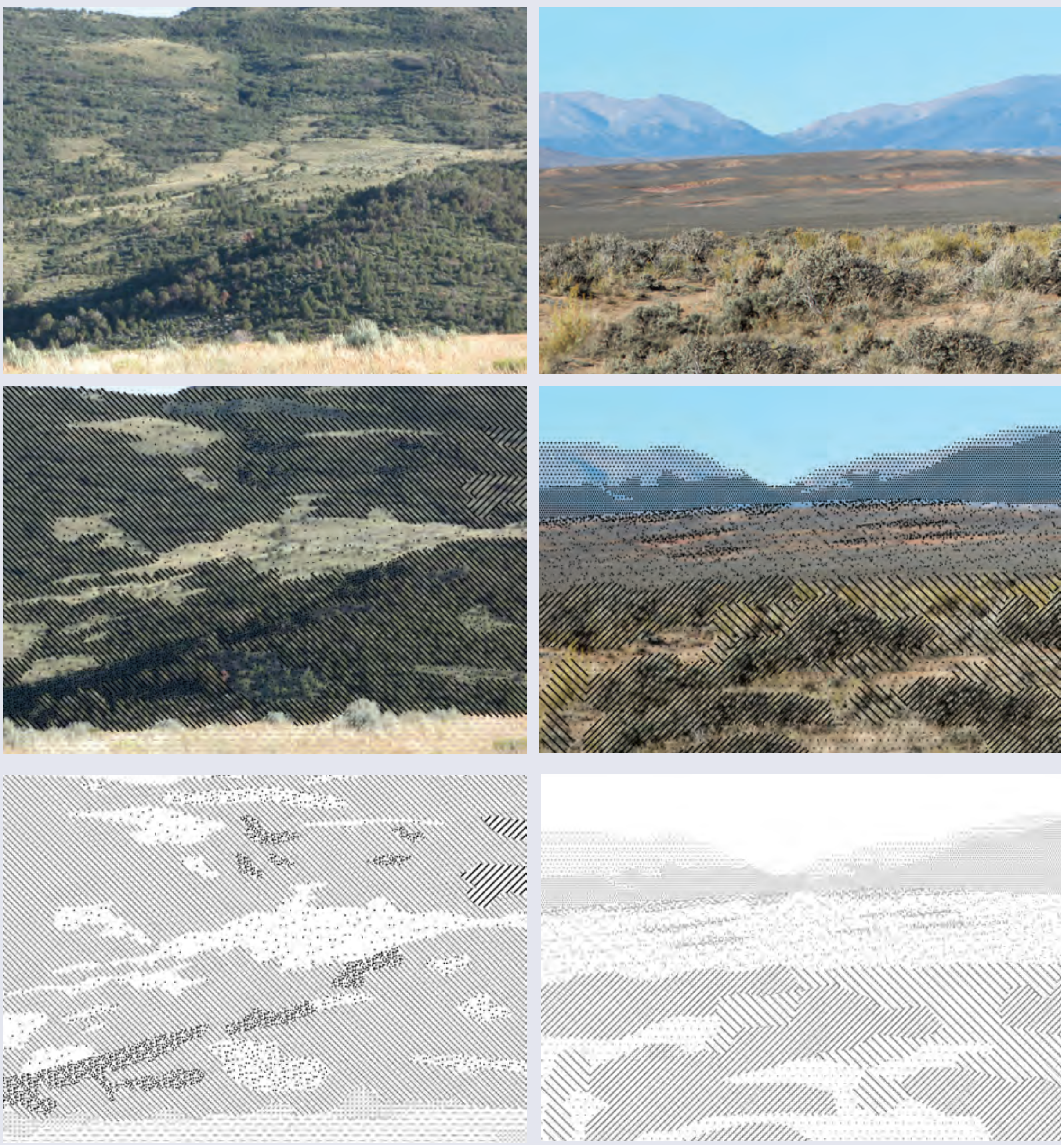
In some cases, a simple single-color application is sufficient to greatly reduce the visual impact of a facility. This is especially true on linear elements, such as transmission facilities, and on facilities in landscapes with very little variation in texture and color.

Decide on Single-Color Treatment or Camouflage Technology

The project team considered predominant soil color, vegetation color, degree of texture and color variation, distance, and primary observation direction in order to make informed decisions regarding color applications. Some conditions or combinations of conditions lend themselves more appropriately to single-color applications, while highly contrasting and textured landscapes may warrant the use of camouflage. The team thoroughly evaluated the visual character of the various sites and settings before making selections. This section walks through the team's selection process and can serve as a guide for field implementation, especially in the rare event that development of a custom pattern is warranted.

Color and Texture

The effectiveness of color and camouflage applications is greatly dependent upon the color and texture of the surrounding landscape. In order to better visually understand the complexity of landscape pattern, it is often helpful to treat the landscape as a collection of light and dark objects. By breaking down the landscape into basic elements of form, line, color, and texture, it is easier to see how ranges of colors and patterns may fit into the landscape.



A site evaluation can help determine whether a single-color treatment is adequate or if a multiple-color treatment would be more effective, which leads to a second determination of whether the BLM-selected standard camouflage pattern is suitable for a specific landscape setting or if a custom pattern should be developed. The following series of steps is recommended to decide which single color or which pattern and color combination provides the best solution.

Site Evaluation

Select key observation points. As explained in BLM Handbook H-8431-1, "Visual Resource Contrast Rating," the key observation points (KOPs) are the most accessible, commonly used viewing locations. Digital images of the landscape and facility should be taken from these locations. KOPs and the project location should be documented using global positioning system (GPS) technology; this information can also be used to calculate the distance between the KOPs and project location.

Determine the primary viewing season. The colors and patterns of the landscape change with the seasons, and no single color palette will work perfectly in every season. When selecting colors, seek the best overall solution for the widest range in seasons or for the most important season.

Site Evaluation and Key Observation Points

It is important to determine KOPs, or key observation points, prior to evaluating for color, pattern, and scale. KOPs are specific points at which the proposed or existing facility will be most frequently viewed—typically roads, trails, pulloffs, or scenic overlooks. Digital photographs, along with GPS coordinates, may be taken from the KOPs and used for photo simulations to aid in the selection process.

Angle and distance of observer position impact the relative spatial dominance of objects in a landscape.

Decision Criteria Between Using Single-Color or Multiple-Color Treatments

The single-color treatment is the most conventional best management practice for reducing adverse visual impacts. In most circumstances, this treatment will likely produce the most affordable and acceptable results in visual impact reduction. However, there are circumstances when this level of treatment does not produce the necessary results for addressing either the levels of sensitivity associated with the area or for achieving the resource management plan's (RMP's) VRM class objective. Often, these two issues may be related, with the sensitivity level being the primary rationale behind the designation of a more restrictive VRM class objective; however, there may be circumstances in which sensitivity levels are not adequately protected by the VRM class objective. Both of these situations may warrant the use of camouflage treatments to properly mitigate the impact, even in circumstances in which the proposed project is in conformance with the RMP's VRM class objective.

Heightened areas of sensitivity may be found in the foreground proximity (1 mile or less) of Native American sacred sites, historic sites and landmarks, national scenic and historic trails, and culturally significant landscapes and within viewsheds of special designations (e.g., national parks, wilderness areas, and others), scenic road corridors (e.g., national scenic byways, state scenic byways, BLM back country byways), scenic vistas from communities and neighborhoods, etc.

Since multiple-color camouflage mimics the landscape's texture on untextured facilities, the effectiveness diminishes over a range of distance. The visual properties of the treated object begin to lose their integrity as compared to those of the naturally textured landscape. The object will begin to mute into a single perceived color when viewed from more distant locations, while color variation in the textured landscape remains visually apparent. Camouflage treatment is more effective when the observer's position to the treated facility is within a range of ¼ mile to 1 mile. This range may expand either way depending on the scale of the facility being proposed, assuming a facility of typical scale as being a 15-foot high by 12-foot diameter cylindrical oil/gas tank. Facilities half this size may have favorable camouflage results in proximities closer than a ¼ mile, while effectiveness may be increased at distances greater than a mile by adjusting the pattern scale upward on larger sized facilities.

Single-color treatments will likely produce the best results in fine-textured landscapes with little color variation, whereas multiple-color camouflage treatments will render enhanced results in landscapes with greater levels of color variation coupled with medium to coarse textures. Camouflage treatments also work well in single-color landscapes with coarser textures, unless the coarseness allows for placing the facility fully within the shadowed areas. In this case, a single-color treatment with a darker shade will produce the best results for the least investment.

Single-Color Selection

Colors should be selected using the BLM Standard Environmental Color Chart as a guide, which may be obtained by contacting the BLM Chief Landscape Architect or the Printed Materials Distribution Services (see appendix 1 for contact information). The color chart provides standard paint color chips that can be taken to any paint provider to ensure true color matching. The chart also includes general guidance on color selection for multiple types of landscapes.

Recommended Method. It is best to select the appropriate color while in the field and in close proximity to the project site. To more accurately evaluate the colors in the landscape setting, at the appropriate distance, use the following steps:

1. Use the BLM Standard Environmental Color Chart to select the paint colors that appear to be most appropriate.

Alternative Method. The above photo shows a convenient way to evaluate colors with other project team members that may not be able to participate in the field evaluation, or for additional study after returning to the office from the site visit. While taking a digital photograph of the site from each KOP, hold a chart of selected color chips so it will appear in the foreground (1 mile or less) of the photo. Select three to four colors that appear to fade into the landscape.

2. Create test color panels by applying the selected paint to individual pieces of plywood or similar material at least 24 by 48 inches in size (sets of prepainted panels may be ordered from the BLM National Sign Center at 307-328-4312).

3. Place the panels in the landscape at the approximate location of the facility. Ensure careful placement of the panels to avoid a shadow effect from back-lighting (e.g., when the sun is positioned behind the panel) or front-lighting conditions.

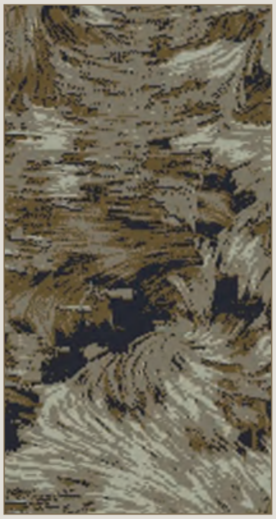
4. Evaluate the panels from a distance in increments of 200 feet and up to 1,000 feet from the project location to the KOP.

5. Eliminate colors that contrast most in the landscape, selecting a maximum of three or perhaps four for further evaluation.

Tip: When using a single-color application, consider that darker colors recede into the landscape while lighter colors tend to stand out. It is important to select colors a shade or two darker than the predominant color in the landscape, which will also help reduce the effects of fading over time.

One of the first examples of a single-color application on a structure on BLM land, which uses a dark shade of green to blend in with the surrounding vegetation.

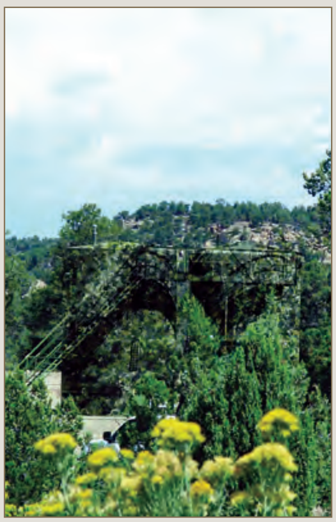
Standardized Pattern Simulations



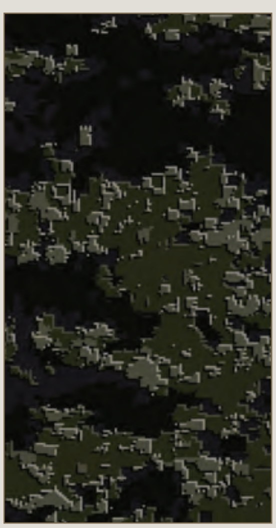
Corona Flow©

Shrublands

Woodland Bush2©



Woodlands



Vapor-softwood©

Montane

Selecting Multiple-Color Camouflage Patterns

A facility is a candidate for camouflage treatment if it is within a mile of the KOP, if the surrounding landscape has special scenic values and/or cultural landscape sensitivities, and if the landscape has a medium to coarse texture. The goal is to effectively minimize color contrast between the existing/proposed facility and the natural landscape character. Exercise care when applying camouflage technology. Avoid using off-the-shelf commercial patterns or hiring a contractor to use creative artistic license to treat a facility. This practice has a high potential of leading to nonadaptive and ineffective treatments that can, in fact, create a greater level of contrast that would draw the observer's attention to the facility.

Keep in mind that some facilities, such as gas production fields, may span more than one landscape setting and, therefore, require more than one color and/or camouflage pattern. However, using multiple patterns and color combinations when landscape settings vary should be weighed against the visual advantages of repeating a common standardized treatment, especially when the character variations are subtle within the different settings.

BLM-Selected Standard Camouflage Pattern

Developing site-adaptive camouflage patterns is a complex process. The project team selected a camouflage pattern to serve as the standard choice for facilities on BLM land through an extensive process of developing potential patterns, color experimentation, and field testing research.

Using HyperStealth Biotechnology Corporation's pattern copyright licenses and stencil template licenses, the project team initially developed 10 camouflage patterns by deconstructing the visual elements within representative images of BLM landscapes, grouping them into objects, and calculating the spatial frequency between the grouped objects. This task was accomplished using low-level image segmentation and two-dimensional shape matching. The data was used to develop computer algorithms in order to generate 10 different customized patterns using Dual-Tex camouflage pattern design principles.

Field testing narrowed the 10 camouflage patterns to 3 stenciled patterns and 4 printed patterns on adhesive applique. These choices were found to have the most universal application among the various BLM landscape types. The three stenciled patterns include Corona, Tumbleweed, and Reztex, while the four adhesive applique patterns include Corona, 4-Est, Vapor, and Nevada. These patterns were further field tested, and the three-color stenciled Corona camouflage pattern was clearly found to

Corona Pattern
The Corona pattern consistently outperformed other patterns in the field and nearly disappears into this grayscale simulation.

This image illustrates the role of texture in pattern selection. The Corona pattern was found to be one of the most successful patterns in multiple BLM landscape typologies.

be the most effective choice in the greatest number of BLM landscapes. Using the standard three-color Corona pattern still requires adjusting colors in the field and scaling the pattern.

Adjusting the Scale of the Standard Camouflage Pattern (Corona)

Camouflage applications are most successful at distances between 650 feet and ¾ mile; at closer distances, camouflage may actually make facilities stand out, while a single-color application may be just as successful for facilities further away than a mile. Based on the distances of the facility from the KOPs, the scale of the standard pattern may need to be adjusted to maximize results. The general rule of thumb is that the further the distance, the greater the scaling, which will increase the pattern's range of effectiveness.

The primary reason camouflage effectiveness drops off beyond 1 mile is largely due to the fact that most facilities being treated have smooth untextured surfaces, whereas the surrounding landscape contains true three-dimensional texture. As a result, the human visual acuity to discern the replicated texture on smooth surfaces rapidly diminishes from ¾ to 1 mile out from the target. Therefore, increasing the pattern scale when facilities are placed at greater distances may help compensate for the lack of true texture and extend the range of effectiveness.

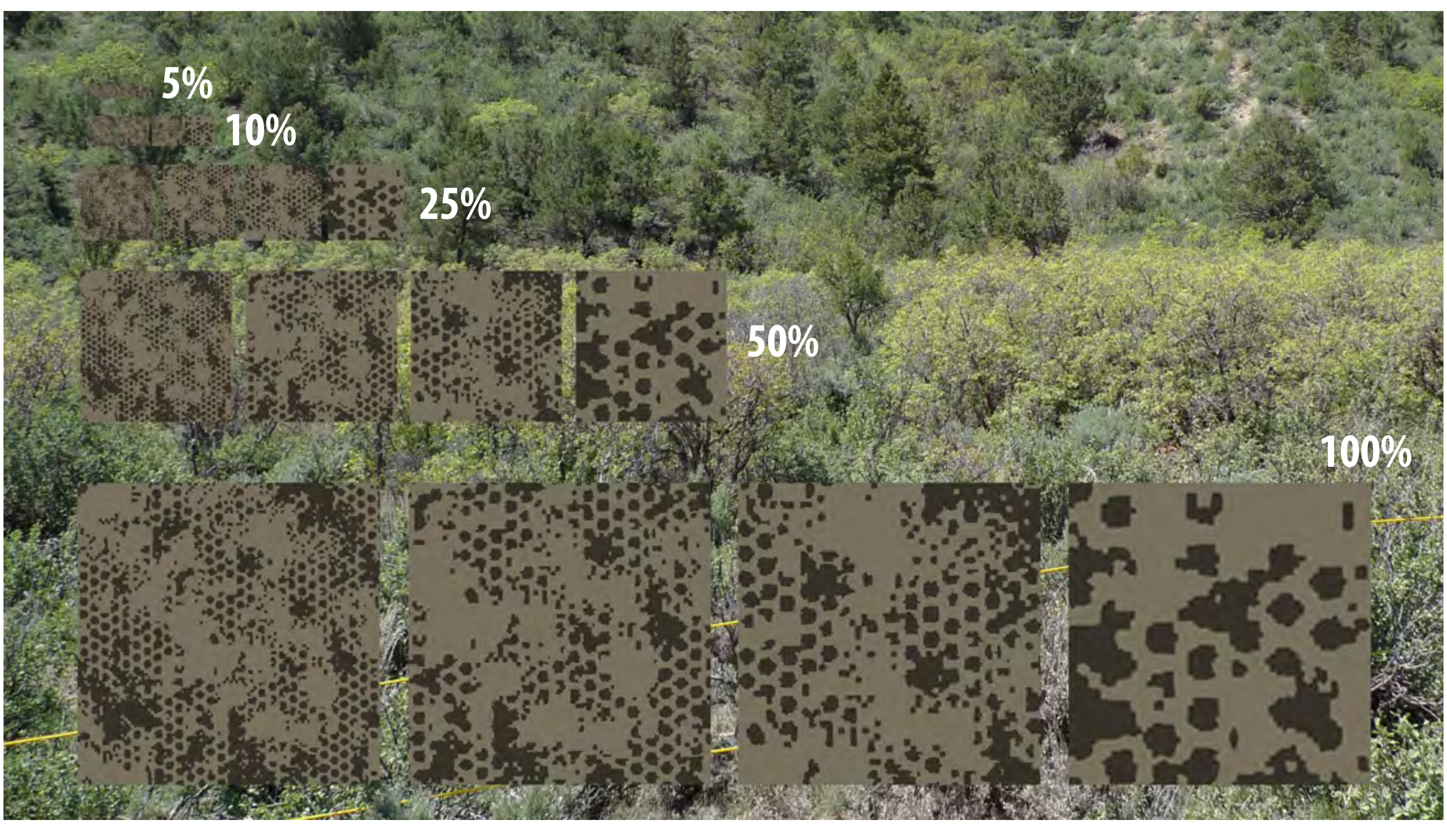


Illustration of patterns shown at different scales.

While not tested as a part of this project, it is reasonable to anticipate that if a facility is texturized at a similar spatial frequency as the landscape, then it is likely that camouflage effectiveness will extend well beyond the 1-mile mark. How far the effectiveness will extend is currently unknown and requires more research and field testing.

The goal of using camouflage applications is to mimic the balance of light and dark, or contrast, in the surrounding environment. Pattern scale should be determined by first establishing the angle and distance at which the facility is most likely to be viewed. Photo simulations of patterns overlaid on the landscape may be helpful in establishing appropriate scale.

If multiple KOPs are within the effective ¼ mile to 1 mile range from the treatment location, one may be faced with the decision of whether to adjust the pattern scale to favor the results from a KOP that is within close proximity or whether to compensate for a more distant KOP. If this is the case, careful field examination of the facility's form, size, and spatial orientation within the landscape scale will help determine the appropriate KOP from which to adjust the pattern's scale. If the facility's form is in context with or smaller in scale to the immediate surroundings and downplays its potential visual dominance, then defaulting to a smaller scale pattern for more close-range effectiveness may be a better option. Often, the treatment will likely be effective at greater distances.

For example, an oil and gas tank is partially buried, 9-feet tall, low profile, and the lower portion is partially concealed by low-growing vegetation (e.g., 3-foot sagebrush). In this circumstance, a careful field evaluation of a finer textured pattern with the appropriate color selection may prove very effective in mitigating the color and texture contrast, while also disrupting the visual form of the facility. This helps the facility to essentially become visually absorbed into the immediate setting at close range.

However, if a larger facility (e.g., 25-foot-tall oil and gas tank)—in which form outcompetes the color and texture contrast—remains visually conspicuous within close range regardless of pattern scale adjustment, then perhaps favoring a larger scale pattern that increases its effectiveness at greater distances would have greater value as viewed from more distant KOPs. It is critical that these decisions are based on field evaluations rather than solely from photo evaluations.

During field testing of the Corona pattern at multiple KOPs, the pattern was increased to 400 percent for the full-scale oil and gas tank, testing for more effective results at a 1-mile distance between the KOP and tank site.

Selecting Colors for the Standard Camouflage Pattern (Corona)

For the standard pattern, select colors from the BLM Standard Environmental Color Chart. When the project team field tested the Corona pattern on an oil and gas tank, the three-color combination of black paired with juniper green and Carlsbad canyon from the BLM Standard Environmental Color Chart proved most effective in this particular setting; however, localized visual conditions may warrant different color variations to maximize camouflage effectiveness.

At this particular test site, Carlsbad canyon replicated the bright color reflection of sun-exposed surfaces

When choosing colors from the BLM Standard Environmental Color Chart for a two-color application, select one light tone and one dark tone. Patterns of three or more colors should also include mid-range tones.

and/or the interstitial transparency of the site's surroundings; black replicated the shade and shadow of the surfaces that were not exposed to sun and the interstitial dark areas of the site's surroundings; while juniper green was the predominant recessive color within this particular landscape. Carlsbad canyon and black are often found to be present in the more colorful and texture-varied landscapes, whereas other color combinations from the BLM Standard Environmental Color Chart may be found more effective in those less visually complex and more sparsely vegetated landscapes. It should be noted, though, that there are no default colors for the Corona pattern, and each site should be analyzed for the best possible color combination.

Before field testing different color combinations in the Corona pattern, first, evaluate different color combinations using photo editing software (see the "Photo Simulations" section on page 16). While some BLM personnel may be proficient with image editing software and fully understand the field testing and selection procedures explained in this tech note, it is suggested that others seek the assistance of qualified contractors.

It is recommended to develop test boards with different color variations at different scales, as explained in the "Camouflage Demonstration and Evaluation" November 2011 report. Creating test boards can be accomplished by acquiring the pattern stencil (see appendix 1 for stencil vendors) and by either painting the panels or providing the stencil to the BLM National Sign Center, which will produce the panels for a nominal fee.

The BLM National Sign Center is available to produce test boards for verifying scale and color selection in the field. The field office needs to provide the stencils to the National Sign Center in order for them to produce the test panels.

Creating Custom Camouflage Patterns

While a concerted effort was made to develop a standard camouflage pattern (Corona), there may be circumstances in which the standard pattern doesn't provide the desired results, and it may be necessary to create a custom pattern. A custom pattern should best repeat the textures in the landscape immediately surrounding the project. A finely textured pattern with many colors may be more effective when viewed at shorter distances (such as ¼ mile away), whereas a finely textured pattern tends to blur into a solid color from distances further away (such as ½ to 1 mile away). This is known as isoluminance. Patterns with coarser textures and two to three highly contrasting colors are better suited to distances beyond 650 feet.

Generating a new and effective camouflage pattern is a complex and sophisticated process that should only be attempted through using qualified camouflage design professionals. As discussed earlier in this tech note, camouflage technology has advanced beyond creative artistic interpretations to a science-based process for generating effective solutions. Thus, effective results require expert professionals knowledgeable in the principles of psychophysical engineering and proficient in advanced computer programming.

If a field office decides to seek assistance from a professional camouflage designer to develop a new pattern, then it is critical to establish minimum contractor qualifications and stipulate generic specifications that require the use of camouflage science and technology. The camouflage science and technology should be equal to or better than those used in the development of the standard camouflage pattern.

The following wording is recommended (1) when soliciting the service of a qualified camouflage design contractor to assist the BLM or (2) to provide to an industry proponent that has been authorized to move forward with a permitted action that contains a requirement to use camouflage technology as a condition of approval:

"BLM custom camouflage patterns shall be both military and science-based and developed by qualified contractors with demonstrated credentials in the application of psychophysical engineering principles in the production of site-specific patterns and color combinations. Fractal-based patterns shall be created through systematic algorithmic calculations using object segmentation of two integrated pattern measures that address two visual processes in parallel:

1. ambient vision – detection of shape and geometric coloration (form, line, scale) labeled as the "macropattern" and interrupts the human "where is it" recognition of introduced visual contrast;
2. focal vision – recognition and analysis of detail (color and texture) labeled as the "micropattern" and interrupts the human "what is it" recognition of introduced visual contrast.

The dual patterns shall be developed independently of camouflage coloration where color attributes are added based on chromaticity and contrast found within the landscape setting of the proposed site development location.

The macropattern shall disrupt the symmetrical axis of the proposed facility, and the micropattern shall embody the spatial frequency spectrum mimicking the textures immediately surrounding the site location.

Pattern development shall be derived from a survey that defines the bands of optical elements of the natural landscape digitized into photometric pixels using fast Fourier transform mathematical algorithms that decompose images of the site and landscape into spatial components.

The final camouflage pattern(s) shall be specific to the tactical microenvironment of the proposed facility's location, in order to effectively "hide" the facility. Samples of customized camouflage shall be field tested by placing properly sized prototypes within the landscape and evaluating them at various distances in increments of 200 feet and up to 1,500 feet and perhaps as far away as 1 mile from the target location. Pattern, pattern scale, and coloration shall be evaluated and calibrated based on distance ranges associated with casual observer key observation points (KOPs), KOP criteria, and contrast rating evaluation described within BLM Handbook H-8431-1, "Visual Resource Contrast Rating."

A refined, calibrated camouflage based on the first field testing evaluation shall be field tested a second time by applying it to a facility at the appropriate distance with the appropriate background, simulating the tactical setting that the camouflage is being produced to mitigate visual impacts.

Field testing shall demonstrate effective measurable results of integration into the spatial (spatial frequency spectrum), color (spectral properties, specularity, and brightness), and contrast (luminance) characteristics of the tactical environment."

The contractor will likely provide more than one draft pattern for consideration and will require field evaluation very similar to how the standard camouflage pattern (Corona) was determined. This process involves analyzing and quantifying the performance of patterns in both color and texture of the landscape. These patterns can be described as fine, medium, or coarse. Determine the horizontal or vertical orientation of the patterns, as well as the consistency of their characteristics. Select the highest performing pattern based on the dominant pattern of the landscape.

Adjusting the Scale of the Custom Camouflage Pattern

When selecting the best pattern from the choices provided by the contractor, the scale of the pattern to be used and the distance of the facility from the KOPs should be considered. The goal of using camouflage applications is to mimic the balance of light and dark, or contrast, in the surrounding environment. Pattern scale should be determined by first establishing the angle and distance at which the facility is most likely to be viewed. Photo simulations of patterns overlaid on the landscape may be helpful in establishing appropriate scale (see the "Photo Simulations" section on page 16). For more information on adjusting the scale of the custom camouflage pattern, see the section of this tech note titled "Adjusting the Scale of the Standard Camouflage Pattern (Corona)" on page 12.

Selecting Colors for the Customized Camouflage Pattern

After first determining the appropriate texture and scale for the camouflage application, colors should be selected using the BLM Standard Environmental Color Chart as a guide. The color selection process should be the same as for a single-color application.

For a two-color application, the color choices should include one dark tone (e.g., Yuma green) and one light tone (e.g., Carlsbad canyon). This creates a transparent effect by contrasting the sun-exposed surfaces (replicated by Carlsbad canyon) and the interstitial shade and shadows (replicated by Yuma green) of the landscape. The two-color


Standard Environmental Colors

Carlsbad Canyon | Covert Green | Shadow Gray
Juniper Green | Shale Green | Sudan Brown
Beetle | Yuma Green | Carob Brown

The **Standard Environmental Colors** chart was developed to assist with color selection to minimize the visual contrast of a facility in the landscape.

In order to ensure color accuracy, use an original color chart to match paint. When matching the color chip, request the paint company to have their computer scan set on "natural light." Compare the new paint sample to the color chip under indirect natural sunlight. Use semi-gloss paint, where appropriate, to enhance durability yet reduce reflectivity. Select colors a shade or two darker than the surrounding landscape to account for natural shadows, normal fading, and weathering.

Order **Standard Environmental Colors** charts by emailing your request to: Printed Material Distribution System (PMDS), **BLM_NOC_PMDS@blm.gov** or fax to 303-236-0845. Provide the quantity requested along with a contact name, physical address (no P.O. Boxes), and telephone number. For more information or questions, please call 202-785-6574.

Standard Environmental Colors Chart CC-001: June 2008 | BLM/WY/ST-08/015+8450 contrasting pattern proved to have enhanced results over a single-color treatment in visually varied (polychromatic) landscapes. Maximizing contrast between the two colors worked best in distances beyond a ½ mile, whereas narrowing the level of contrast proved more favorable when closer than ½ mile. The results were less favorable in monochromatic landscapes; a single-color application of Carlsbad canyon worked well against a bare-ground backdrop (e.g., Bookcliffs area of Colorado and Utah) or carob brown in the red rock canyon environments.

In landscapes with more visual variety, custom camouflage patterns using three colors are more complicated, but also more effective. Again, these patterns may include a lighter color (e.g., Carlsbad canyon), contrasted with black (replacing Yuma green) as the dark shadow color, and one of the mid-range shades, which may include Sudan brown, juniper green, shale green, or shadow gray. Carob brown may be a preferred third color when in red rock canyon environments. When adding a third color, Yuma green no longer produced the contrasting results achieved in the two-color pattern. While Yuma green is the darkest shade on the BLM Standard Environmental Color Chart, its shade is too close to the medium-range options to create enough discernable contrast, whereas using black achieved the desired results. Using a range of dark and light shades is meant to mimic the light and dark colors and shadows in the landscape, creating an illusion of partial object transparency.

The project team found that customized camouflage patterns with more than three colors did not add any discernable value in return for the added expense.

Note: Different conditions call for different patterns and color combinations. Extensive field testing is required in order to successfully develop a customized camouflage pattern and select companion colors. It is strongly encouraged to seriously contemplate using the standard Corona pattern before pursuing customized camouflage patterns.

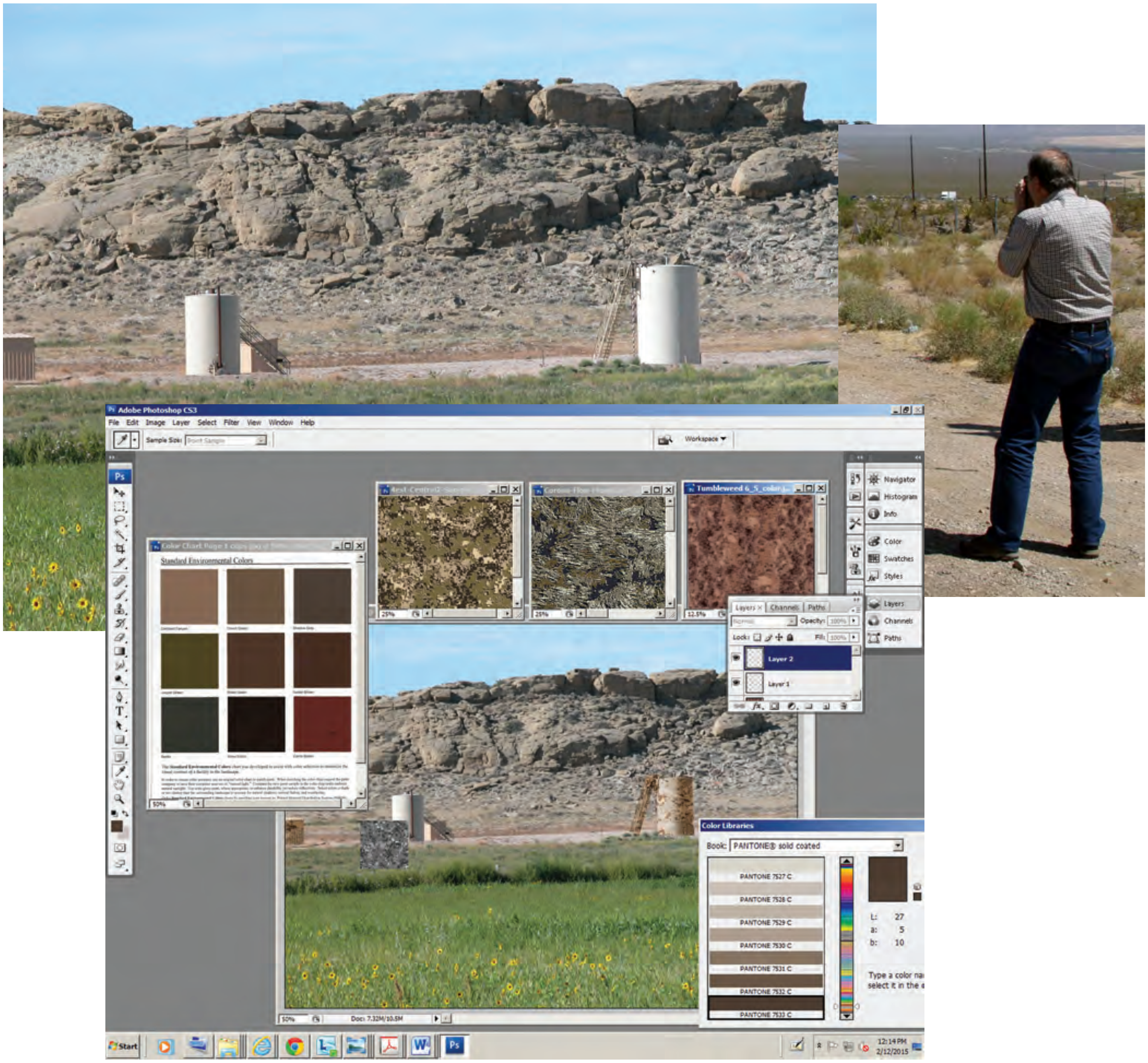
Photo Simulations

A photo simulation using Photoshop or similar software is an effective way to visualize how various color and pattern combinations will look against the backdrop of the existing landscape. High-quality digital images of the facility or location of a planned facility taken without zoom from KOPs and other points of interest may be used by anyone with basic proficiency in image-editing software to test color combinations and patterns. Distortion-corrected panoramic images spanning 124° and 55° represent the human horizontal and vertical field of view, respectively. The process may be used for both existing and planned facilities.

Examples of Photo Simulations

It may be helpful to simulate revegetation in conjunction with color and pattern options.

While the color treatment on the low-profile tanks in the image above is sensitive to the surrounding landscape, a camouflage treatment would further minimize the visibility of the tanks, as demonstrated in the simulation.



Existing facilities:

1. Use a digital camera to photograph the facility from each KOP, preferably during the early morning or late afternoon when the sun angle creates the most contrast in the landscape. Try to avoid midday, when the light tends to be flattest.

2. Select a base color and two to three additional colors.

3. If you are technically proficient with imaging software, apply a camo pattern to the photo of the facility using Adobe PhotoShop, PhotoImpact, Digital Image Suite, or a similar program. Specialized software is also available to create digital camouflage patterns.

Planned facilities:

1. Place a surveyor's pole, stake, or a piece of plywood with a brightly colored flag in the location of the planned facility. The flag should be as close to the estimated height of the facility as possible.

2. Use a digital camera to photograph the marker from each KOP, as described for existing facilities.

3. Import an image of the planned facility type into each photo, using the position and height of the flag to determine the proper location and scale.

4. Select colors as previously described.

5. Apply a digital camouflage pattern as previously described.

Camouflage Application Methods

Once the appropriate pattern, scale, and colors have been selected, the next step is to determine the most effective and cost-efficient application method. Several methods may be appropriate and should be determined on a case-by-case basis by a qualified visual resource management specialist. These methods include, but are not limited to: vinyl adhesive appliques, stencil painting, custom painting, screening, and mesh coverings. The BLM and its contractors extensively tested paint stencils and vinyl adhesive appliques.

Stencil Painting

Painting is the most common color treatment application method in the field and also works well for applying camouflage treatments. Due to cost, ease of installation, and durability, stencil painting is regarded as the most effective method of application. Paint may be applied directly onsite or at the fabrication plant prior to installation. Painting is most effective on structures such as buildings and tanks that have long, continuous, and mostly smooth surfaces. Paint colors may be easily matched to colors from the BLM Standard Environmental Color Chart, have a life expectancy of 10 or more years, and can be installed over the course of a few days.

Masked painting involves creating an adhesive stencil by cutting a pattern into a flexible medium with a computer-guided laser. Because the laser cutting of the stencil is potentially the greatest expense, the stencil should be cut from material that can be used multiple times and easily cleaned for proper storage. In field tests, a Tyvek stencil lasted four to five uses, and a polycoated paper lasted only two to three uses. Polycoated paper had a tendency to tear, and its use is not recommended. While not field tested as a part of this project research, it was suggested that using rubberized magnetic sheet material may be ideal, although a flexible plastic material adhered with strong magnets should work as well. Stencils should be no larger than 24 by 30 inches in size for ease of application and storage; larger stencils may be difficult to affix and may be susceptible to tearing, but this depends on the material used. The most time-consuming part of the process is placing the stencil on the tank, but once placement is finished, painting can be done quickly. Therefore, it is helpful to have multiple full stencil sets on hand to paint a larger area at one time.

See appendix 1 for stencil vendors.

Paint types and life expectancy. Epoxy paints provide the best surface adhesion and long-term wear in western environments, where extremes of heat and cold are the

Steps for masked painting are as follows:

- Thoroughly clean the facility surface.
- Paint the base color over the entire facility.
- After the facility is dry, adhere the adhesive stencil to the facility, and apply the second color.
- Remove the adhesive stencil.
- Repeat based on the number of masked layers required to complete the pattern design.

Apply the base coat.

Affix the stencil, and apply the second color.

Repeat until the pattern design is complete.

This is the finished product.

norm. The life expectancy of these paints is 10-12 years. Low-sheen ceramic paint is used on U.S. military aircraft. It is applied like traditional paint and has a life expectancy of 20 years. A gallon will cover up to 1,000 square feet.

Vinyl Adhesive Appliques

The project team also explored and field tested vinyl adhesive appliques but discovered challenges with color correctness during applique production. Effective quality control would likely overcome this limitation, making vinyl adhesive appliques most suitable for applying highly complex, multicolor camouflage patterns. Vinyl adhesive appliques with complex patterns and more than three colors can be more affordable and more effective in close ranges; however, the project team found that highly complex patterns with more than three colors tended to drop out of consideration when field testing. The project team found that the orientation between key observation points and facilities on BLM lands tended to be out of the range in which more complex patterns would prove advantageous.

Vinyl adhesive appliques are applied using adhesive-backed vinyl sheets, which are typically available in 34- or 52-inch sheets and in continuous lengths. Multiple panels may be applied side by side, much like wallpaper, to cover a facility. Field tests have indicated that this method may be well suited for short-term or temporary facilities or facilities that will be viewed at a close range and require complex patterns.

Because it is digitized, the technology is easily adaptable for use on both new and existing facilities. The vinyl panels can be applied in the field or prior to transporting to the final destination. Custom panels may be developed by submitting the dimensional requirements, preferred pattern, and color selection in the form of digital artwork to the product manufacturer. Production can be completed in a relatively short period of time. A third-party contractor that has been prequalified by the product manufacturer commonly completes the application of the vinyl adhesive to the facility.

Vinyl applications can be either permanent (may last 10 to 15 years) or temporary (less than 5 years), with adhesives designed for the period duration and type of use. Permanent adhesives are warranted for 5 to 7 years depending on the product. Adhesive types also depend on flexibility and articulation requirements. The more acute the angle to be covered, the more plasticity in the material required, which generally translates into a shorter material life cycle. It is recommended that the vinyl be applied over a dark base coat of a color within the pattern to extend its life expectancy. As the vinyl flakes off during the latter years of life expectancy, the dark undercoat will be gradually revealed and prolong the duration of effectiveness.

This method was found to be easily applied to facilities with ladders and other protruding ancillary components by simply cutting the material with a box cutter to work around these elements. Concerns over whether commercial printers can match ink colors to the BLM Standard Environmental Color Chart should be noted, as well as the life cycle of the inks under certain environmental conditions. Another potential drawback of this method is that the adhesive can only be applied one time and cannot be painted over as the applique begins to weather and deteriorate. This may lead to limitations when repurposing facilities such as oil and gas tanks.

Paint Stencils and Vinyl Adhesive Appliques at a Glance

	Vinyl Adhesive Applique	Paint Stencil
Material Cost	$5,000 or approx. $5/ft^2	$1,050 or approx. $1/ft^2*
Paint Cost	N/A	$400 or approx. $.40/ft^2
Labor Cost	$2,000 per 8-hr day for a two-person crew (10 hours of labor total)	$2,000 per 8-hr day for a two-person crew**
Total	$7,250 or approx. $7.25/ft^2	$7,450 or approx. $7.50/ft^2
Application	Moderate	Intensive
Longevity	5-7 years	10-plus years
Facility Type(s)	Smooth, continuous surfaces, some bump outs are okay	Smooth, continuous surfaces
Comments	• Fades more quickly than paints. • More effective for close-range and highly complex patterns. • May be difficult to obtain inks that match colors from the BLM Standard Environmental Color Chart.	• Effective for simple two- to three-color patterns. • Colors from the BLM Standard Environmental Color Chart are easily obtained. • Once purchased, stencils may be reused for multiple facilities (see material specs).

* Prices in 2012 dollars. This is the initial cost for two sets of stencils using a polycoated paper, as opposed to a recommended heavier material, which would raise the cost. However, using a heavier material would lower the expense overall, as one set could be used for multiple tank applications.

** Testing the paint mask requires 48 hours of labor (three 8-hour days for a two-person crew), but using a fast-drying paint would cut this time by at least half. Labor time could be further decreased by having multiple stencil sets on hand and by using contractors who have experience with the method.

Covers/Nets

Covers and nets provide a simple method for quickly adapting existing facilities to the color tones of the surrounding landscape. The camouflage industry has developed multispectral covers and nets that visually conceal facilities. Some covers and nets also have concealment attributes relative to near infrared, thermal infrared, and broadband radar detection. While visual detection is the primary focus of this tech note, there may be situations, such as national security, when these concealment attributes are advantageous. These products are durable (some brands are fireproof), resistant to scratches and snags, simple to use, and light in weight (less than 90 pounds).

Nets and covers are best suited for short-term use in temporary situations and can be reused as necessary. They are useful for covering soil stockpiles, storage yard materials, and drilling ponds. Covers and nets may also be used for some types of long-term installations such as individual tanks, tank batteries, and well heads.

Covers can be a standard size and draped over the facility or fitted to the exact dimensions. Custom fitting is preferred due to the potential effects of wind on a loosely fitted cover. Covers can be manufactured with stock camouflage patterns and colors or with custom patterns and colors for better adaptation to natural surroundings. The cost and production time vary greatly depending on pattern, type, and quantity ordered.

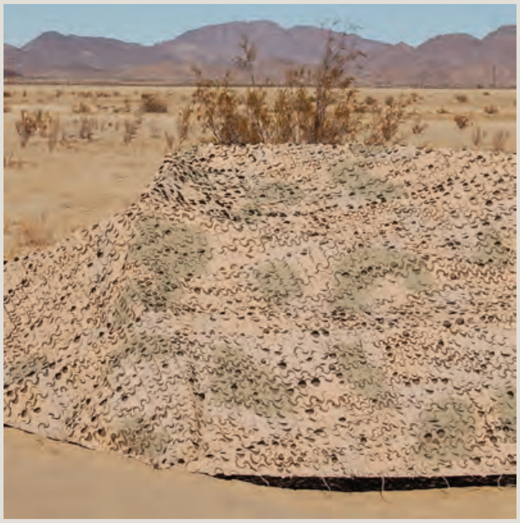
Stand-Alone Screens

Screens may be erected independent of facilities to provide visual barriers. They may be constructed of wood, metal, fiberglass, rigid plastics, or other products and may be painted with a preferred camouflage pattern using colors appropriate to the surrounding landscape.

Fiberglass screens and other moldable products can be manufactured with the pattern and colors embedded into the material. Standard product information indicates that these products:

- Are maintenance free.
- Are flexible but will not deform.
- Have superior structural strength.
- Have a surface coating that provides excellent protection against ultraviolet light, with no noticeable color change after intense long-term use.
- Are nonreflective.
- Have a service life of 15 years.

Stand-alone screens are most effective when used to block the view of a low-profile facility or a disturbed surface such as a well pad. This method works best when the viewing plane is higher than the viewer. Due to its two-dimensional, vertical orientation, the screen support system requires engineering to compensate for wind loading. The material is available in widths from 40 inches to 54 inches and in lengths limited only by the shipping container.



An example of spectral camouflage netting.
Photo credit: www.army-technology.com

A stand-alone fiberglass screen blocks the view of a well pad. The pattern can be customized to better match the landscape.
Photo credit: www.LBIE.com

Examples in the Field

While a slightly darker shade may have been better for this tank, this single-color application successfully minimizes its visual impact.

Vinyl adhesive application from approximately 650 feet away.

Paint stencil application from approximately 330 feet away.

The application of a darker landscape color greatly reduces its prominence in the landscape.

Paint stencil application from nearly 1,000 feet away.

Transmission power line that was factory painted with a single color and installed circa 1976.

Summary

Using Color as a Tool for Visual Mitigation

The diverse western American landscapes—forested mountains and wooded valleys, arid desert, open grasslands and shrublands—draw more and more visitors, residents, and development each year. Preserving the visual quality of these landscapes is an important and increasingly complex part of the natural resource manager's job.

Selecting an effective mix of colors to populate the standard camouflage pattern or in the development of a custom pattern can be complex tasks. Seeking the assistance of qualified contractors is encouraged for both of these endeavors in order to optimize results.

Using color to mitigate the visual effects of development can provide a relatively simple, cost-effective solution. A specific series of steps is recommended to select the most appropriate color(s) and method(s) of application.

1. Evaluate the site.

- Select key observation points (a minimum of ¼ mile from the project area).
- Determine the primary viewing distance. Will the facility be less than 1 mile away from the KOPs or more than 1 mile away?
- Determine the primary viewing season.

2. Determine whether a single-color or multiple-color treatment is necessary.

- Single-color treatments usually work best for facilities less than ¼ mile away or more than 1 mile away and in fine-textured landscapes with little color variation.
- Multiple-color treatments usually work best for facilities between ¼ mile and 1 mile away and in medium- to coarse-textured landscapes.
- Ensure the level of treatment will address the level of sensitivity associated with the area.

If using a single-color treatment:

3. Select color.

- Select three to four colors from the BLM Standard Environmental Color Chart, preferably while in the field.
- Evaluate their performance by placing individual 2-foot by 4-foot color boards in the landscape, and select the most appropriate color.
- See the section of this tech note titled "Single-Color Selection" on page 10.

If using a multiple-color treatment:

3. Decide whether to use the standard camouflage pattern (Corona) or to create a custom camouflage pattern.

- Adjust the scale to maximize results.
- Select colors using the BLM Standard Environmental Color Chart as a guide, choosing a mixture of light and dark tones.

- See the sections of this tech note titled "Selecting Colors for the Standard Camouflage Pattern (Corona)" on page 13 and "Selecting Colors for the Customized Camouflage Pattern" on page 15.
- Use Photoshop or similar software to analyze various pattern and color combinations.
- Color-correct, revise, and retest the colors and patterns.
- Field test.

4. Select camouflage application method(s).

- Evaluate the facility type and period of use, considering extremes of climate and other controlling factors on the site.
- Evaluate the total application cost and the application longevity.

Application Types and Materials

Four basic application methods are described in this tech note, each with distinct advantages and disadvantages.

Paint

- Versatile (adheres to most surfaces and shapes).
- Cost effective for single-color and some multiple-color applications; may become cost prohibitive for masked multiple-color applications on a large number of facilities.
- Can be applied during fabrication, prior to site delivery.
- Requires minimal maintenance for 10-20 years, depending on the type applied.

Vinyl Adhesive

- Unlimited choice of patterns and colors.
- Adheres best to smooth, continuous surfaces and can be cut easily to work around pipes and other elements.
- Mass production and future reproduction possible.
- Installation can be accomplished using unskilled labor.
- Color correctness not yet mastered by manufacturers to produce matches to the BLM Standard Environmental Color Chart.
- Effective for up to 10 years when installed over a dark primer coat.

Covers/Nets

- Designed for temporary or long-term use.
- Available in a variety of patterns and colors.
- Custom fitting recommended to avoid the effects of wind.
- Can prevent near infrared, thermal infrared, and broadband radar detection.
- Cost and manufacturing time vary greatly depending on pattern, type, and quantity.

Stand-Alone Screens

- Can be made of wood, metal, or fiberglass.
- Fiberglass types may have custom patterns and colors embedded. They are maintenance-free and flexible, will not deform or change color, are protected against ultraviolet light, and have a service life of 15 years.
- Recommended for low-profile installation only.
- Require an engineered support structure to withstand wind loads.

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Chad Schopp, Geologist, Custer National Forest, Montana

Corporations

David Achten, 3M Commercial Graphics Division, 3M Company

Rob Cimperman, 3M Commercial Graphics Division, 3M Company

Guy Cramer, President and CEO, HyperStealth Biotechnology Corp.

Chris Drewitt, Aquamar Group

David Hughes, ITT Advanced Engineering and Sciences

Kate Schwarzler, Otak, Inc.

Michael Olofsson, Saab Barracuda LLC

Joseph Resnick, Chief Scientist, NxGenUSA

Simon Tan, 3M Commercial Graphics Division, 3M Company

Michael Wood, Senior Director, Business, and Product Development, Saab Barracuda LLC

Individuals

Ken Henley, U.S. Marines (retired)

Timothy O'Neill, U.S. Army (retired)

David Welch, Preservation Officer, Oregon-California Trails Association

Appendix 1: Vendors

The following vendors are authorized for distribution of copyright camouflage pattern stencils mentioned within this tech note.

HyperStealth Biotechnology Corp.
#3 - 20,000 Stewart Crescent
Maple Ridge, B.C. Canada V2X-9E7
gcramer@hyperstealth.com

Trinity Consulting
P.O. Box 21134 Maple Ridge Sq.
Maple Ridge, B.C. V2X-1P7
info@specintel.com

Protective Force Gear Inc.
939 Laurier St.
Rockland, Ontario K4K1E3
matt@protectiveforcegear.com

HyperStealth Biotechnology Inc.
1560 Broadway
Suite 2090
Denver, Colorado 80202
info@hyperstealth.com

United Dynamics Corp.
1919 14th St.
Suite 330
Boulder, Colorado 80302
info@uniteddynamics.com

132 Group
424 Investors Place
Suite 103
VA Beach, VA 23452
bill@132group.com

For more information regarding vendors, contractors, and specifications, please contact the BLM Chief Landscape Architect.

BLM Chief Landscape Architect
U.S. Department of the Interior
Bureau of Land Management
Division of Recreation and Visitor Services
1849 C Street, NW (MS-MS-2134)
Washington, DC 20240
(202) 912-7284
jhmccart@blm.gov

To obtain a copy of the BLM Standard Environmental Color Chart (brochure number CC-001), please contact: BLM_OC_PMDS@blm.gov or fax requests to (303) 236-0845. Maximum order 25 copies. All orders shipped Federal Express Ground; provide street address and phone number.

It is recommended that this tech note be used in conjunction with the following publications on minimizing visual impacts, which can be found at www.blm.gov/wo/st/en/info/blm-library/publications/blm_publications/tech_notes.html:

BLM's Visual Resource Management System:

- BLM Manual 8400, "Visual Resource Management"
- BLM Handbook H-8410-1, "Visual Resource Inventory"
- BLM Handbook H-8431-1, "Visual Resource Contrast Rating"

Design guidelines and best management practices:

- "Best Management Practices for Reducing Visual Impacts of Renewable Energy Facilities on BLM-Administered Lands"
- "Guidelines for a Quality Built Environment"