Eclectic GIS

Innovative GIS from Computer Terrain Mapping, Inc.

Issue 2, 2000

Castle Rock Enacts Ridgeline Regulations

Turbulence is nothing new for the Town of Castle Rock, Colorado - at least geologically speaking. Like much of Colorado, the Town had spent a great deal of its geologic past beneath ancient seas. Multiple uplifts raised the area, volcanoes buried it beneath lava and ash, rock-slides and mud-slides covered it as well. Out of this mind-numbing chaos came the present landscape - a breath-taking assortment of bluffs and ridges, broad valleys and steep mesas.

At times, it seems like this geologic turmoil has spilled over into local politics. Situated in the center of rapidly-growing Douglas County, Castle Rock has experienced its own set of growing pains - infrastructure problems, traffic congestion and the loss of scenic vistas. These growing pains reached a crescendo in December 1998, when voters narrowly defeated a proposed 180-day moratorium on new building, intended to allow the Town to "catch its breath" and examine its approach to growth.

It was another such moratorium that connected CTM with the Town. A recently approved ridgeline development had an unexpectedly high visual impact. Citizens got mad; council members acted. A 180-day ridgeline building moratorium was put into place and an advisory committee, representing diverse community interests, was formed to analyze the problem. A consultant team made up of ERO Resources of Denver, Clarion Associates of Denver and Computer Terrain Mapping (CTM) of Boulder was hired to work with the advisory group to map the critical ridgeline areas, develop strategies to protect these areas, and implement all this into the Town' Municipal Code.

This 21-member advisory group was a diverse bunch. Landowners, environmentalists, developers and concerned citizens were all represented. With land use regulation involved, many issues were bound to be contentious, and this was certainly the case. However, the group worked together surprisingly well. Divergent interests respected the rights of others to express different opinions. Through it all, the group appreciated how the ridgeline mapping technology supplied an objective measure of the common parameters they had established.

The methodology resulting from this project provides an innovative model for communities interested in protecting significant scenic resources. The ridgeline mapping process resulted in a three-tier protection scheme (figure 1). The first level of protection allowed structures to be built to heights allowed by zoning (35 feet), but specified restrictions on materials, lighting, color and tree plantings. The second protection level required that the mitigation standards of the first be met, along with the building height restriction of 25 feet. Finally, the third protection zone prohibited any building whatsoever, with existing structures and final platted developments exempt.

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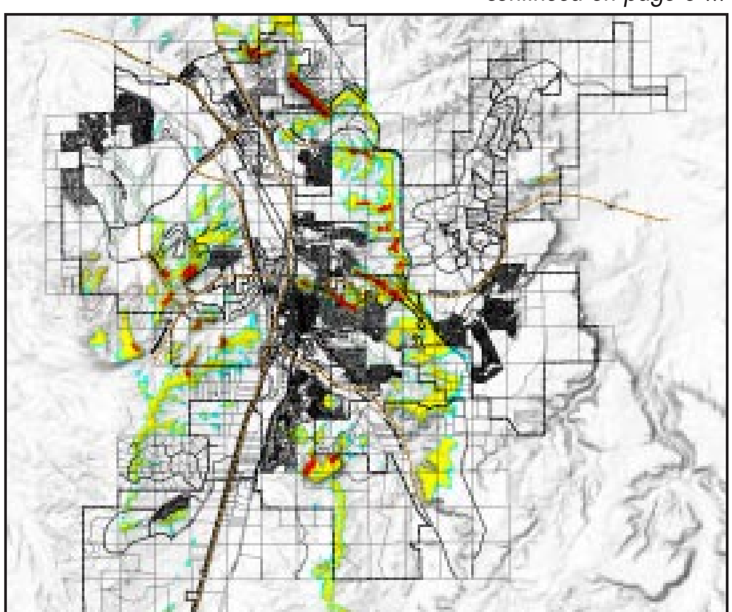

CASTLE ROCK SKYLINE MAP

Visual Concerns Help Sink Quarry Proposal

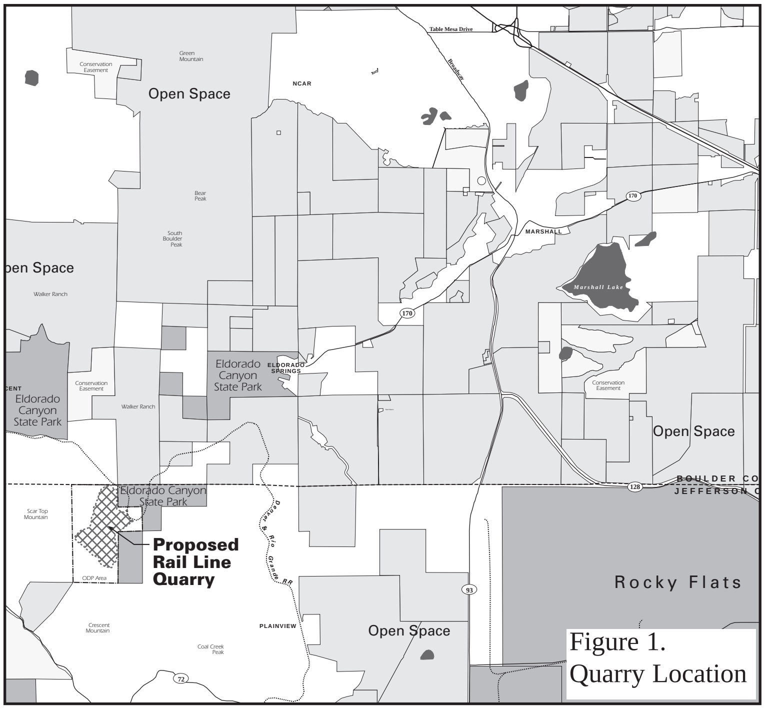

Figure 1. Quarry Location

In October 1999, the Board of County Commissioners for Jefferson County, Colorado, rejected a rezoning application that would have allowed aggregate quarrying adjacent to Eldorado Canyon State Park. Even though the Jefferson County Planning Commission had previously recommended that the application be approved, a variety of health, safety and aesthetic issues along with concerns regarding the compatibility of the proposed quarry with surrounding land uses all contributed to the Board's denial decision. CTM played a significant role in supplying analysis on the visual impacts of quarrying the property.

The 380 acre parcel is located in north-central Jefferson County, adjacent to the Boulder County line (figure 1). One of the more contentious issues regarded the fact that although Jefferson County had the decision-making authority, most of the serious impacts occurred within Boulder County. Indeed, both the City of Boulder and Boulder County opposed the project. This generated considerable intergovernmental tension, exemplified in a letter from Peter Fogg of the Boulder County Land Use Department: "To dismiss such issues as noise, visibility, lighting and surface water quality as ones which have little direct relationship to Jefferson County is based solely on geologic and geopolitical serendipity."

Among the considerable number of negative impacts were significant visual issues. On behalf of a local homeowner's association, CTM performed a variety of visual analyses to quantify the visual impacts, should the quarry be approved.

First, we utilized viewshed mapping technology to determine what areas would have views of the quarry, and how much of the quarry would be visible from any locale. Figure 2 shows the results of the analysis. The colors indicate the number of acres within the quarry that would be visible from a given observation point. Over 10,000 acres were determined to be within the quarry's viewshed. Several of the areas with the highest visual impacts were on public lands - Eldorado Canyon State Park and Boulder County's Walker Ranch Open Space, for example.

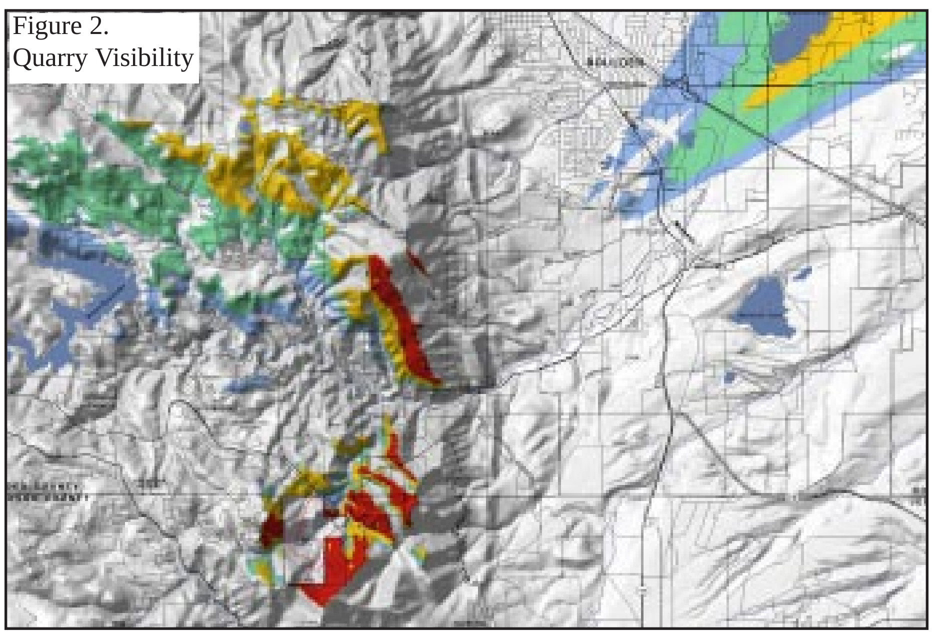

Figure 2. Quarry Visibility

A second type of analysis involved mapping which areas within the proposed quarry would be most visible. This "visibility census" mapping can help planners minimize the visual impact of a

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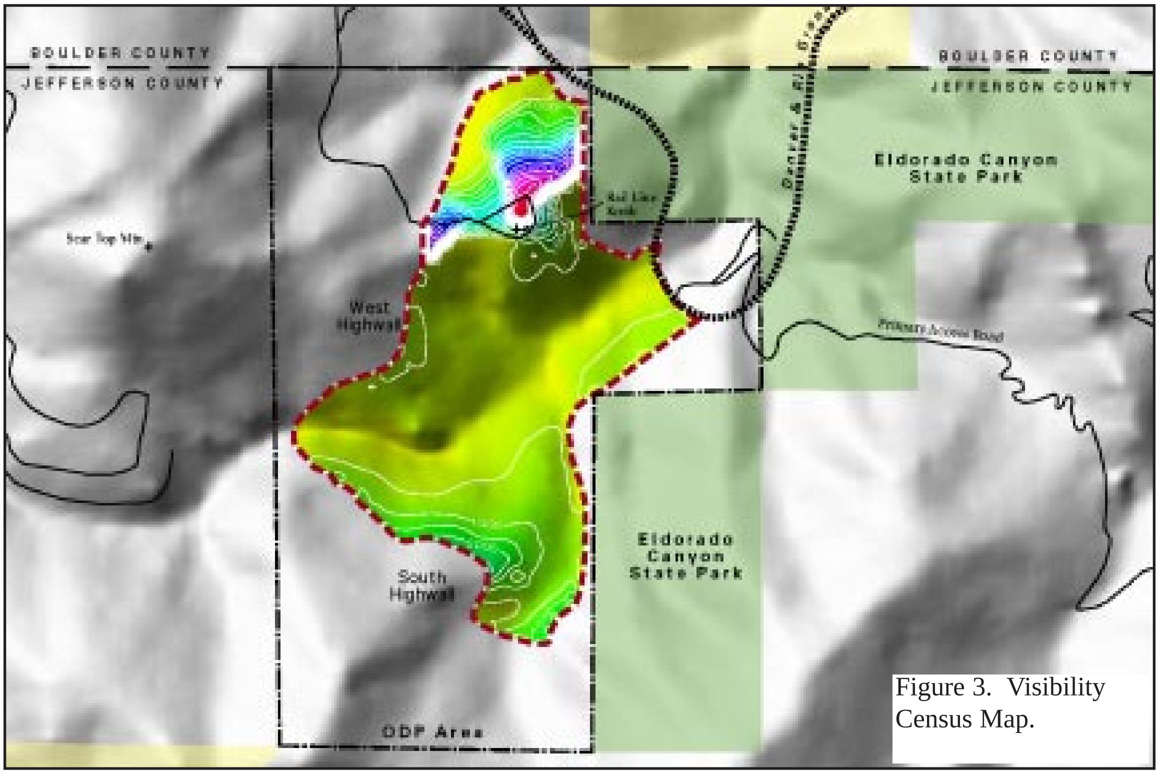


Figure 3. Visibility Census Map.

project by avoiding the most visible areas within a property. Figure 3 shows the extremely high visibility of the “Rail Line Knob” - the red area in the northern portion of the proposed quarry. Avoiding a feature such as this greatly reduces the ultimate visual impact.

Finally, to form a link between the abstract and the concrete, we performed visual simulations from a number of locations, utilizing post-mining contour information from the quarry applicant. This was one of the most effective public relations tools - giving people a realistic view of the future. Visual simulations are easily understood by people with limited cartographic background who may have difficulty understanding the viewshed mapping results. Figure 4 shows “before and after” renderings of the quarry site. The pit configuration is based on post-mining contours from the applicant; the pit color is based on the color of an exposed railroad cut. This photograph was taken from a neighboring residence.

Often, decisions on “undesirable” land uses are made without access to important analysis and information. Emotions or political influence can often turn the tide when quantifiable evidence is unavailable, and decisions based on subjective factors seldom benefit the public over the long haul. We’d like to think that projects such as this will help to change the way the land use decision-making process occurs in the future.

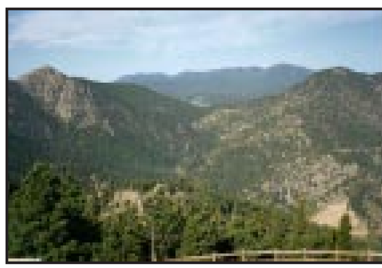


Figure 4a. Site Photo

Figure 4b. Computer Model

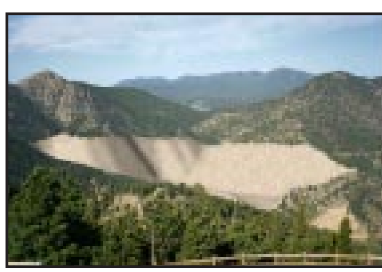


Figure 4c. Composite of computer model and site photo.

Orthorectifications

Orthorectification is an image processing technique used to match aerial photography to a local coordinate system - thus making it a useful layer in an existing digital database. What makes it superior to other rectifications is that it greatly reduces image displacements caused by topographic relief. An orthorectified image (orthophoto) has the geometric characteristics of a map, while at the same time shows the detail of the aerial photograph.

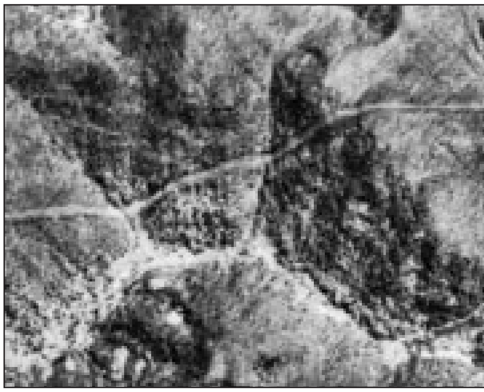


Figure 1. Aerial image prior to rectification. Note the displacement of a utility right-of-way due to topographic relief.

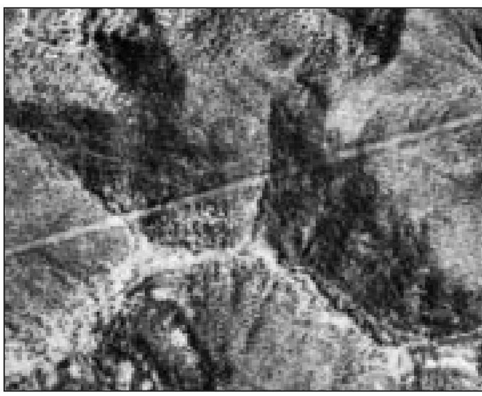


Figure 2. Same aerial image as in Figure 1, after orthorectification.

Three things are needed to generate an orthophoto.

1). A digital aerial photograph
2). A digital elevation model (DEM)
3). The camera's orientation parameters.

Digital Image. Most aerial surveys use a 9" x 9" film format that can be purchased as prints or transparencies. Transparencies will produce "cleaner", more resolute images as compared to prints, but either format is suitable for digital scanning. One thing to remember, if scanning the imagery in-house, is the full 9"x 9" is needed in order to orthorectify the image. The fiducial marks (the black marks on all 4 sides, and sometimes in the corners, of the photograph) are a key component in the orthorectification process.

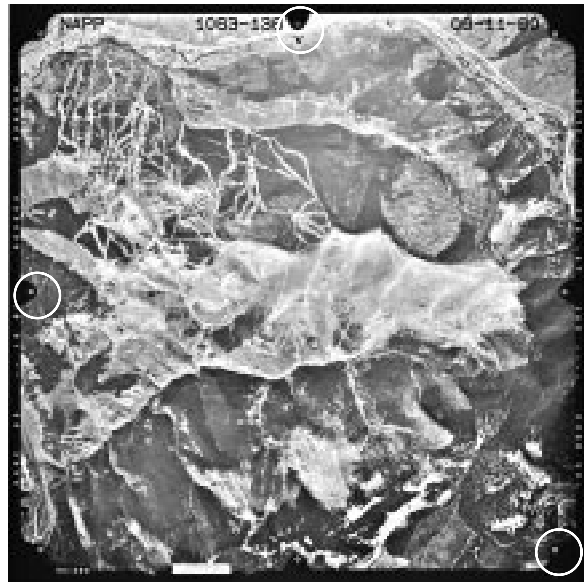


Figure 3. Fiducal marks are used in the orthorectification process. It is important that they be included when digitizing the image.

DEMs. The DEM is used to remove any terrain distortion present in the image. It is mapped pixel by pixel to the aerial photograph to calculate, then remove, the amount of displacement caused by topographic relief. If site specific elevation data is not available, DEMs can be purchased from the USGS for most of the U.S. on a 7.5 min quadrangle basis. Because the amount of relief displacement removed from the image is base solely on the DEM, the more accurate the elevation model, the more accurate the resulting orthophoto.

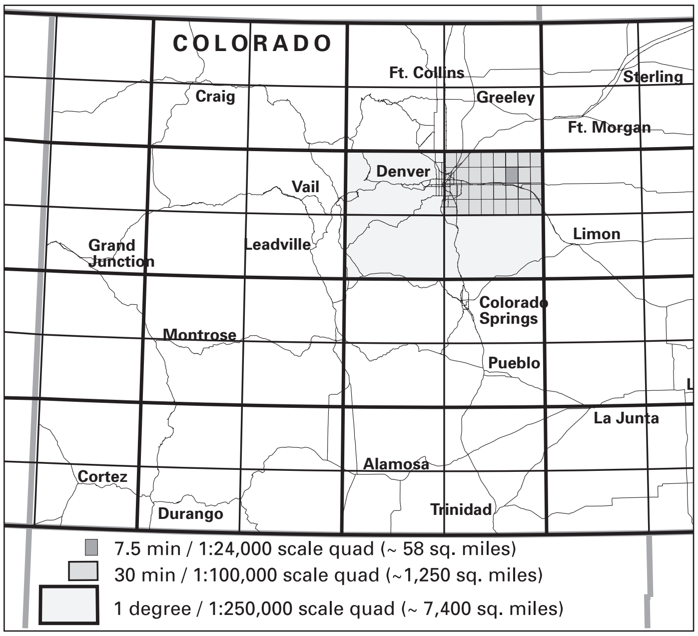
Camera Orientation. This information can be obtained from the company that took the aerial photograph. The "camera log" contains all the needed information used in an orthorectification. It includes the pitch, yaw, roll and altitude of the aircraft as well as the internal and external geometry of the camera itself.

When all three components exist - orthophotos are usually the most accurate form of rectified imagery. But, if a DEM or, most commonly, a camera log is not available, don't despair. CTM's Exact.O.Warp for imagery comes in a competitive second in accuracy, and sometimes surpasses orthorectifications when the DEM is of poor quality.

Spatial Bytes

Resolution Recipes

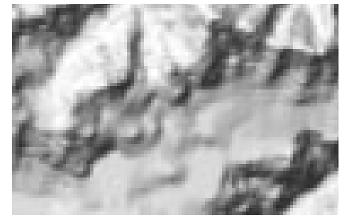
The USGS offers a wide range of digital elevation model (DEM) resolutions for the U.S. The big question is - which resolution works best for your project? There are two things to keep in mind when choosing the appropriate resolution: 1) how big is the study area and 2) what resolution is required for your application? Even the highest resolution USGS DEMs (10 m) are generally not suitable for site specific work. A more detailed DEM should be generated from surveyed contours.



10 meter USGS 7.5 min data

30 meter USGS 7.5 min data

30 meter gridded from 1:100,000 scale contour data



90 meter 1:250,000 scale data

The USGS has 5 resolutions available for the United States: the 7.5 min quads @ 10 meter resolution and 30 meters, 15 min quads @ 60 meters for Alaska, 1:250,000 scale quads @ 90 meters and a single nation wide coverage @ 1 km resolution.

US coverage is complete for all but the 10 meter and 30 meter data sets. The 30 meter data sets are available for most of the US, but there are still a few quads missing while the 10 meter data coverage is very sparce.

One other option is to grid the USGS 1:100,000 scale contour data to generate 30 meter DEMs. Not all the 1:100,00 scale quads have contour data available though, so this is not always an option.

Douglas County Environmental / Visual Study Wins Colorado Smart Growth Award

CTM teamed with ERO Resources and Douglas County's planning staff to complete the "Four Part Environmental and Visual Study. The results have been used extensively by the County's staff in working with municipalities and in their current master planning process.

The visual portion of the study produced a comprehensive inventory of the County's most visually significant lands. The study won Colorado's Large Counties - Smart Growth Award for 1998.

ONLINE :

Looking for USGS data?

The best index for USGS data can be found at edcwww.cr.usgs.gov/webglis
If you have ftp access (edcftp.cr.usgs.gov then go to /pub/data) several of the digital data files can be downloaded for free in SDTS format, including the 30 meter and 10 meter DEMs. CTM now has a working translator for the DLG & DEM SDTS formats. Call for more information or email us at ctm@ctmap.com.

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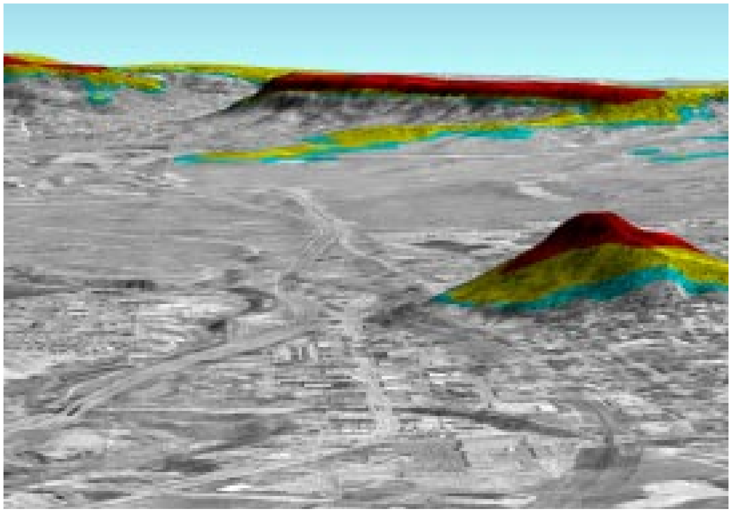
These protection zones were based on visibility criteria, not on an arbitrary elevation range or slope steepness cutoff (figure 2). Consequently, only development in the most visually critical areas was impacted. These overlay zoning boundaries were distributed to interested landowners and developers in digital form so that they could readily determine which, if any, portions of their properties would be subject to the regulations.



No one can predict what the next geologic or political era will bring to Castle Rock. If the past is any indication, turbulence and turmoil are bound to be involved. On the other hand, we hope that projects like this - where developers, environmentalists and concerned citizens all work together to preserve the quality of life for a community - usher in a new era of cooperation and recognition of the importance of scenic issues.

The ordinance enacting these regulations is available online along with the final map delineating the overlay zoning district. The URL is:

http://www.ctmap.com/gis_journal/planning.html

CTM can be found on the web at www.ctmap.com/ctm
email: ctm@ctmap.com | phone: 303-444-1670 | fax: 303-443-4856

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Inside View: