

## COMPANY

**Huitt-Zollars, Inc.**

## LOCATION

**Orange County, California**

## SOFTWARE

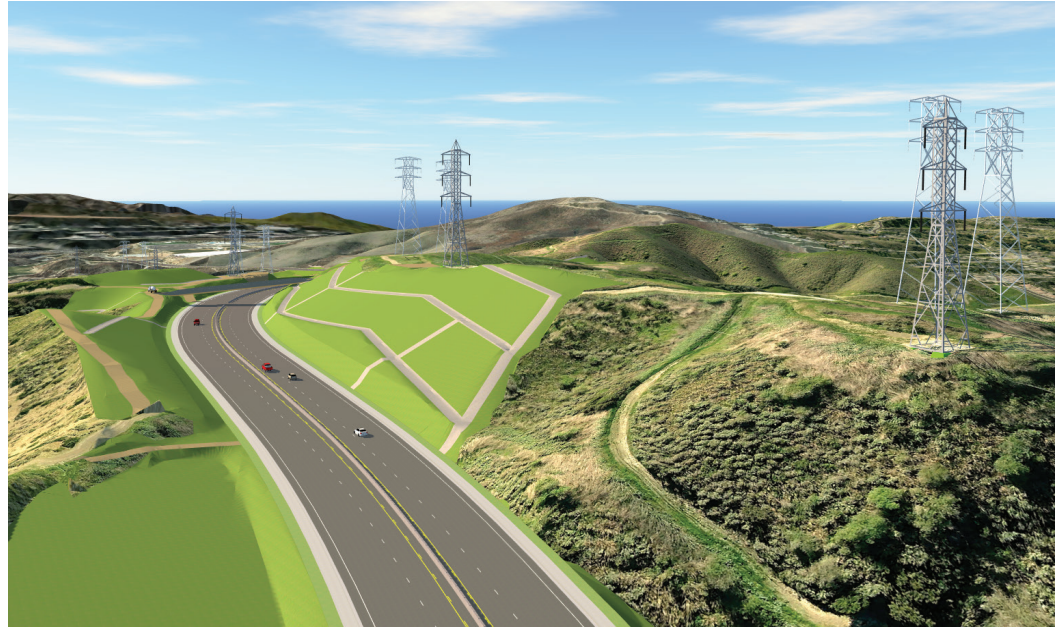
**AutoCAD® Civil 3D®****Autodesk® InfraWorks™**

# Designing out cost

## Huitt-Zollars uses AutoCAD Civil 3D to help significantly reduce the cost of a road project in Southern California

The ability to study so many alternative designs in such a short amount of time helped save an estimated \$10 million on this project. These cost savings were made possible with help from Civil 3D.

—**Scott Reed, P.E.**  
Associate  
Huitt-Zollars, Inc.



This area shows over 90' of cut just below critical electrical transmission towers, as well as bridge overcrossing provided for utility access and trail users. Image courtesy of Huitt-Zollars, Inc.

### Project Summary

California's Orange County has just started a \$72.2 million roadway project in the hilly terrain between the cities of San Juan Capistrano and San Clemente. The La Pata Avenue Gap Closure and Camino Del Rio Extension project will 'close the gap' between two existing roadway segments and create a north/south access between the two cities—improving local access to schools, residential communities, commercial centers, and recreational amenities in the area, as well as providing residents an alternative emergency access route.

The existing La Pata Avenue was built in the 1970s as a dead-end access road from a major highway in San Juan Capistrano to an Orange County landfill. The project plans involve widening that 1.8-mile road from three to five lanes (which includes a climbing lane for trucks) and building almost two miles of a new four-lane road that will cut southward through the middle of the landfill to connect with existing road networks in San Clemente. A secondary arterial roadway, Camino Del Rio, will also be extended a quarter-mile from its current terminus to meet the gap closure portion of La Pata Avenue in the

City of San Clemente. The project also includes: a recreational trail alongside the road; a diamond interchange for access to the landfill; five 30-foot diameter structural plate underpass structures for use by the landfill's heavy equipment; a decorative overpass to serve as an entry monument for San Clemente and provide connectivity for recreational use as well as access for local utility companies; six water quality detention ponds; and improvements to three signalized intersections.

In 2011, the County approved the project's preliminary design and final environmental impact report, and Huitt-Zollars was selected as the lead design engineer for the project's final design. Founded in 1975, Huitt-Zollars provides architecture, engineering, construction management, and surveying services to clients throughout the United States. The firm has been using Autodesk® AutoCAD® Civil 3D® software for almost a decade to help improve its public works, roadways, transportation, and land development projects.

# Investigating less costly design alternatives saves an estimated \$10 million

## The Challenge

The project already had its environmental clearance when we began final design,” explains Huitt-Zollars’ civil engineering associate Scott Reed. “Therefore, the road’s alignment and footprint were pretty well defined.” But as the firm began to meet with the project stakeholders, some stakeholders wanted several changes that would require redesigning large sections of the roadway. “Our main challenge on this project was to assist the County in appeasing these stakeholder requests in a cost-effective manner and without violating the already-approved environmental clearances,” says Reed. The major changes to the project’s preliminary design included:

- A redesigned interchange (tight diamond) for landfill access, which included lowering the roadway profile over 35’ below existing ground for a half mile.
- Remedial grading to remove approximately 750,000 cubic yards of waste beneath nearly a quarter-mile of new roadway.
- Reduction of nearly 2,500,000 cubic yards of embankment that was previously needed to buttress a major landslide, and over 1,000,000 cubic yards of reduced cut and fill throughout other areas of the project.
- The over-all typical roadway section was modified to reduce the standard parkway, shoulder, and median widths by 20 feet, so that a two and a half mile long meandering sidewalk could be added within a new 20-foot wide parkway along the east side of the roadway.

The geography of the area, which quickly rises from the Pacific Ocean into the foothills of the Santa Ana Mountains, posed another challenge for the firm. “The terrain in this area is very difficult,” explains Harry Persaud, Orange County Project Manager. “Although the road is a little less than four miles, it crosses hillside ridges and valleys, geological landslides, as well as several streams and other ecologically sensitive habitats. On top of that, the road traverses an active landfill and passes through a major electrical transmission corridor.”

## The Solution

Huitt-Zollars used AutoCAD® Civil 3D® software and its dynamic modeling capabilities to create automatically adjusting 3D surfaces, alignments, profiles, and corridors for terrain, roads, utilities, and grading. The firm used this intelligent project model to develop many different alignment and grading alternatives, producing earthwork and cost estimates for each alternative, to more cost-effectively meet the needs of the client and other project stakeholders. “I was impressed with Huitt-Zollars’ ability to quickly study numerous concepts and report on quantities and estimated costs. That really helped us in reaching equitable solutions with our project stakeholders.” Harry Persaud, Orange County Project Manager.

### Explore design alternatives

“On a project of this magnitude, where time and money have already been spent on feasibility studies, preliminary design, and an environmental impact report, the final design usually builds directly off that effort with very little exploration of design alternatives,” says Reed.

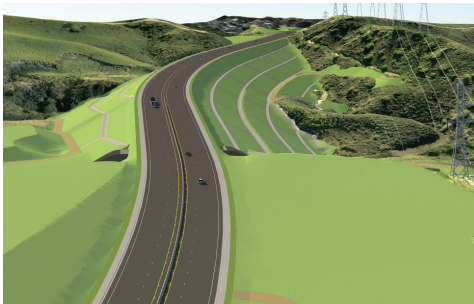
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Project Manager  
Orange County

But on this project, the County was very concerned about the budget. So even though there was a tight schedule, Huitt-Zollars and the County agreed to allot time at the beginning of the project to study design alternatives—finding ways to save costs and satisfying the stakeholders’ interests.

“If we had been using traditional 2D design tools, we would not have dreamed of suggesting some of the major design changes that we did,” says Reed. “It would have been much too time consuming. But based on our successes with Civil 3D on other projects, we knew that the software’s 3D modeling environment would help uncover cost savings and keep the project on schedule.” says Reed.

Huitt-Zollars’ designers spent 12 weeks investigating design alternatives. Their initial Civil 3D project model incorporated overlays of important design information, including the preliminary road plan and environmental clearances, digital terrain models of the existing topography, geological landslide data, existing water features, existing utilities and utility easements, as well as GIS land use, water, and parcel data. Using this 3D model, Huitt-Zollars interactively modified various aspects of the preliminary design—the horizontal alignment,



[Left] This section of roadway cuts through a major landslide (over 350’ deep) and then crosses a drainage way with an embankment over 140’ high. The project requires over 10m cubic yards of earthwork with some excavations reaching over 200’ from the proposed roadway surface. [Right] New intersection of Camino Del Rio and La Pata Avenue will be built atop 120’ of embankment. The intersection will have pedestrian median refuges and specially designed curb ramps to accommodate various trail users. Images courtesy of Huitt-Zollars, Inc.



vertical profile, roadway sections, the grading, and so forth—and produced earthwork volumes and quantities for other improvements such as storm drain, pavement, etc. to quickly assess the design alternatives and associated costs. In the end, the team proposed half a dozen major design changes (all related to cost savings) and they were all accepted by the County.

### Boost productivity

“With Civil 3D, we were able to carry out design iterations and implement design changes more efficiently because we didn’t have to waste time manually updating related elements of the design,” explains Russell Hanson, Designer at Huitt-Zollars. “If we lowered the alignment in a certain area, the Civil 3D software automatically updated the grading and cross sections, helping to save us time and to reduce the risk of manual updating errors.”

Moreover, the Huitt-Zollars team could alter the design without having to spend time manually updating their drawings because the design and documentation are intelligently connected and the software updates drafting and annotation as changes are made. “If we changed the grading in a certain area, the software corrected the affected plan, section, and detail sheets, right down to the elevation labels, contour lines, and station call outs.” Marty Krebs, Designer at Huitt-Zollars.

### Accommodate stakeholders

Once the project entered its final design stage, the City of San Clemente requested that two and half miles of the preliminary design be modified to add an eight-foot wide meandering trail, which needed a 20-foot parkway instead of the normal 8-foot parkway. Huitt-Zollars used Civil 3D to investigate design alternatives to reduce the overall width of the roadway, making room to expand the parkway enough on one side to incorporate the trail and still keep the grading within the approved environmental footprint area.

Changing the width of the roadway impacted just about every part of the design,” says Reed. “We were able to accommodate such an extensive change with help from



This area shows one of three grade separation crossings provided for landfill operations. In all, the project includes five 32’ diameter structural steel multi-plate undercrossings and a diamond interchange for landfill ingress/ egress and operations. Image courtesy of Huitt-Zollars, Inc.

Civil 3D. The ability to interactively modify one part of the design and have the software dynamically update the road corridor was absolutely essential.”

### Improve access and permitting

The proposed road alignment passes through the center of a local landfill. The active portion of the landfill is on the west side of road and landfill facilities are on the east side, necessitating access to the landfill from both sides of the road. The preliminary design kept the roadway alignment at its present grade, rising to a ridge on top of old waste in a filled portion of the landfill and requiring a very tall embankment south of the ridge where the land drops off. A raised median separating the two directions of traffic limited landfill access to a right-in/right-out configuration, with a very narrow overpass structure. The landfill agency requested better access to the landfill, both for their own operations as well as for residents and commercial haulers.

“Taking advantage of the dynamic 3D modeling features of Civil 3D, we played with the vertical profile in this area to investigate alternative interchanges and analyze costs,” recalls Reed. “When all was said and done, we ended up dropping the roadway profile approximately 35-feet, adding a grade-separated diamond

interchange above the new roadway, and eliminating the need for such a tall embankment. This satisfied the landfill agency and reduced earthworks costs.” This solution also proved beneficial for environmental permitting and the project schedule. Just south of this interchange, the road alignment crosses several small watercourses that merge to form a stream that flows through San Clemente and discharges into the Pacific Ocean.

A model-based design approach and dynamic sections was huge in helping us investigate the landslide area in much greater detail—calculating volumes, achieving acceptable factors of safety for separate portions of the landslide, and isolating watercourses to pinpoint areas for earth removal.

—**Scott Reed, P.E.**  
Associate  
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# Grading scheme helps reduce preliminary earthwork by approximately four million cubic yards in one area

The areas around the headwaters of this stream are under the jurisdiction of the US Army Corps of Engineers (USACE). Unfortunately, the fill required for the tall embankment spilled over into the boundaries of USACE's jurisdiction. Lowering the roadway dramatically reduced the fill area and therefore the project's impact on USACE waters, enabling an expedited USACE permitting process.

## Minimize earthworks

The project's preliminary design included nearly two million cubic yards of landslide removal (down to the slide plane) and recompaction within the top of one of the project's numerous major landslide complexes, and another two million cubic yards to buttress the toe of this single landslide. Since the new roadway alignment cuts through the middle of this massive landslide (approximately 1,000 feet long and 350 feet deep), finding a design to stabilize the roadway and accommodate future landfill build-out was one of the most complex grading challenges on the project.

"It would have been too costly to remove and recompact the top portion of the landslide and buttress the toe, not to mention, the permitting requirements would have been immeasurably more difficult," says Reed. "So instead we used Civil 3D to develop a more cost-effective grading scheme for the slide that still achieved acceptable factors of safety, did not limit future landfill use, provided material to balance the whole project, reached compliance with the regional water quality regulations, and created an opportunity for a much easier permitting process. We must have looked at a dozen design schemes for this one landslide complex within a matter of days, and within a couple of weeks, the team settled on a grading solution that reduced the preliminary earthwork for this one area of the project by approximately four million cubic yards."

There were several ridges and valleys within the slide, making some areas less stable than others. In addition, small streams run through the area. "Because the landslide is so big, it didn't make sense to treat it as a uniform mass with uniform grading," says Reed. "A model-based design approach and dynamic sections helped us investigate the landslide area in much greater detail—calculating volumes and isolating watercourses to help pinpoint areas for earth removal." As a result, Huitt-Zollars' new grading plan unloads the slide for safety, lessens

the impact to some of the streams, and reduces the total grading for this one landslide by four million cubic yards of dirt.

## Protect water quality

California has very aggressive water pollution control efforts and in this part of the state, regional water quality regulations require that the post-project condition (discharge rate and volume of stormwater runoff) must match the existing condition within each stream crossing the project. Since the road crosses numerous valleys containing natural watercourses that will be filled in and blocked by the new road, Huitt-Zollars needed to produce a detailed hydromodification management plan.

"The 3D modeling environment of Civil 3D helped us develop complex upstream grading to create acceptable conditions on the downstream side and successfully design a stormwater drainage system (keeping road runoff separate from cross drainage) with six water quality ponds to provide load reductions and detain runoff," says Reed. A crucial part of the design process was the ability to interactively adjust the location and shape of the basins and the grading within the context of the overall design, to better understand and minimize the impact on other parts of the road project.

"It was like trying to piece together a moving three dimensional puzzle," explains Reed. "If we change the shape of this basin, does the grading extend beyond the environmental clearance limits? How far into this landslide can we grade without having to stabilize it? Will this location interfere with the utility structures or easements? Questions like these could be more quickly answered by using the Civil 3D model-based design environment."

## The result

At the end of 2013, County officials awarded the construction contract for the La Pata Avenue Gap Closure project and the County broke ground on the project in March of 2014.

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This image shows one of six water quality ponds designed for flood control, water quality and hydromodification. Image courtesy of Huitt-Zollars, Inc.

We are now piloting the use of Autodesk InfraWorks as a way to build models to communicate with all the stakeholders on a project. This tool helps us tell the story in a way that they can see the changes for themselves versus trying to understand 2D design plans.

To learn more about BIM for Civil Infrastructure, visit, [www.autodesk.com/ids](http://www.autodesk.com/ids) or [www.autodesk.com/civil3d](http://www.autodesk.com/civil3d).