



Project Summary

Organization:

KASL Consulting Engineers

Solution:

Cadastre and Land Development

Location:

Orangevale, CA

Project Objectives:

- Prepare site/civil design for Sacramento Metropolitan Fire District Fire Station No. 29
- Minimize visual impact of 15,000-gross-square-foot structure with 30-foot roof ridge line
- Limit peak stormwater discharge to pre-development conditions

Products Used:

InRoads Suite, CivilStorm, and ProjectWise

Fast Facts

- CivilStorm was used to dynamically design and analyze detention pond, outlet structure, and size of storm drain utilities
- Modeling in InRoads provided client with better visualization of finished product prior to its being built
- ProjectWise provided real-time file sharing among various design consultants and client, facilitating better coordination and collaboration

ROI

- Cost savings to the client were reflected in reduced design fees
- Modeling tools allowed for quick design changes without undue additional cost
- CIM reduced errors and omissions, and automated and sped up plan production
- Use of models resulted in additional savings from reduced change orders during construction

KASL Engineering Quickly Delivers Up-to-Date, Accurate Site Plans Using CivilStorm and InRoads

Sustainable Stormwater Management Limits Runoff From Urban Fire Station

Dynamic Design Produces Sophisticated Structures

Orangevale is a small but densely populated, unincorporated community in Sacramento County, Calif. The Sacramento Metropolitan Fire district retained KASL Consulting Engineers of Citrus Heights, Calif., to design a new fire station that would serve this growing urban area in a sustainable way. KASL utilized Bentley's computer modeling technology to prepare, analyze, visualize, and rapidly revise the site/civil design.

Completed in early 2009 at a capital cost of \$4.5 million, Metro Fire Station No. 29 is a 12,800-square-foot, single-story fire station with enough paved area for three drive-through bays and a back-in bay for the battalion chief. The facility also features a standby generator, truck wash building, and plenty of paved parking.

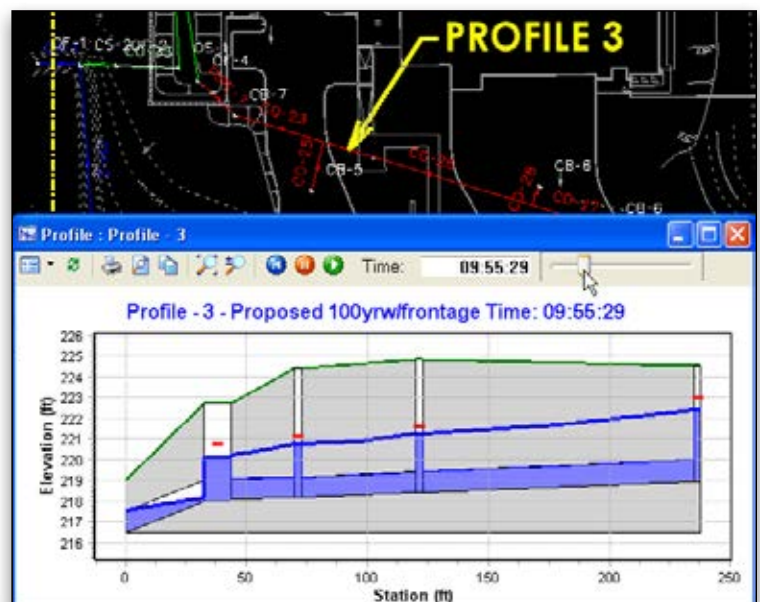
The project's most significant design challenge was the requirement to limit stormwater runoff from the site to pre-development levels. The rapid shedding of stormwater by new impermeable areas is a factor common to all urban development projects. But at this site, the community required sustainable stormwater control and low-impact development methods to be used. No heavy metals, oils, or other contaminants could be allowed to enter the stormwater drainage system. In addition, the stormwater management structures had to be aesthetically pleasing and fit into the landscaping plans.

KASL knew that sophisticated tools and techniques were needed to balance these many requirements. The firm decided to deploy civil information modeling (CIM) software from Bentley to efficiently create and change the site designs.

"This was a pilot project for us. We have been producing digital terrain models and 3D surface models for a while, of course. But this time, we started to utilize civil information models to hydraulically design and produce our 2D plan and profiles for the site's underground utilities," explained KASL Principal Derek Rayner, P.E. "This worked very well, even though many of our partners on this project were a little behind the curve on the use of 3D models."

Rayner found that using the CIM models to drive design and plan production resulted in substantial cost savings for the client, mainly in reduced design fees. "One major benefit is when changes are required, the tools allow for a quick remedy without undue additional cost," he said. "Modeling also provides the client with a better picture of the finished product prior to its being built."

KASL used CivilStorm® to dynamically design and analyze all stormwater structures, including a detention pond, outlet, and other utilities.

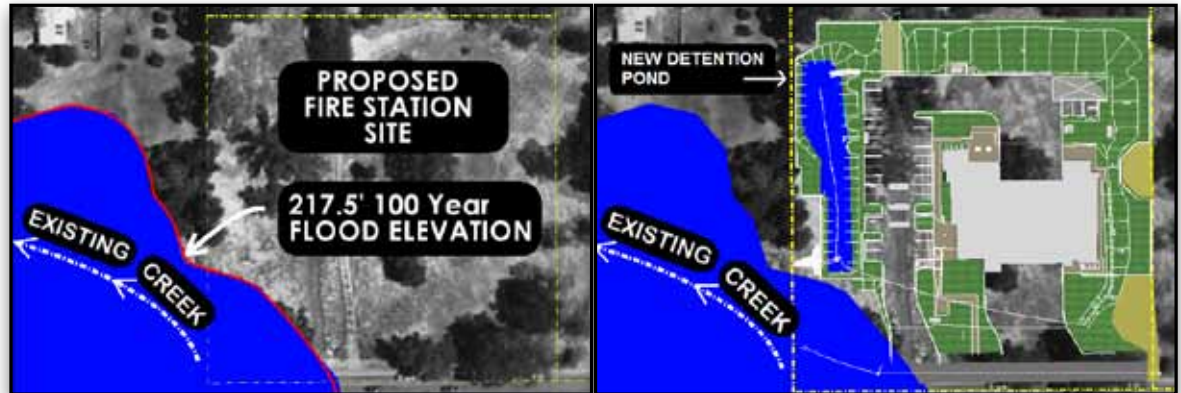


This is a CivilStorm profile showing results from the 100-year storm.



The tools give design engineers greater confidence. We know that changes are being captured in the model database and will automatically be reflected in all the plans.

– Derek Rayner, P.E., Principal, KASL Consulting Engineers



A pond was added to reduce downstream impacts as depicted in this screen capture.

Accurately modeling every aspect of the stormwater system, CivilStorm performed a full range of analysis necessary for verifying hydraulic capacity and demonstrating stormwater compliance.

CivilStorm was used in conjunction with InRoads to develop landscape contours, determine earthwork quantities, produce the design, and model the underground utilities in 3D. The resulting stormwater design was sophisticated and sustainable, including grassy swales used as bio-filters, mechanical filters for stormwater runoff from pavement, and an on-site detention pond to reduce peak flows.

Regression Analysis Resolves Complex Design Geometry

The powerful regression analysis features in InRoads, combined with its unique element design capability, enable users to resolve complex design geometry efficiently and accurately in accordance with unique engineering design criteria. These played an important role in this project due to its various design challenges.

For example, the truck wash building presented some unique problems. Since by design the runoff water from the trucks was likely to be especially high in contaminants, the water needed to be routed directly to the sanitary sewer system to collect and treat for toxins before water ended up in the Sacramento River. On the other hand, designers did not want to overburden the sanitary sewer system with relatively clean rainwater. So drains in the truck wash building lead to the sanitary sewer system, and an all-weather cover built tall enough to accommodate ladder trucks routes rainfall to the stormwater system.

Site aesthetics posed another challenge to designers. Though just a single-story building, the fire station is nearly 30 feet high.

Nearby residents wanted the visual impact of the station reduced. Also, KASL worked under a mandate to retain as many native oak trees as possible. Since existing above and below ground utilities passing through the site needed to be rerouted and a new 12-inch water main for Orange Vale Water Company had to be brought in, designers needed to find ways to move a lot of earth without destroying trees or making the fire station too prominent.

“There was a residential subdivision behind the new fire station site,” Rayner explained. “The design team had to consider the view from that area. We were able to use the digital terrain model and a SketchUp model from the architect to visualize the roofline appearance, and ended up going with a design that lowered the finished floor elevation considerably. Unfortunately, this meant that we ended up exporting quite a bit of soil, which we’re usually able to avoid when balancing the earthwork on our projects’ sites by comparing pre- and post-developed surface models (digital terrain models). But it was the right solution for this project.”

The KASL team developed the digital terrain model in InRoads and automatically generated design profiles with the utilities database.



InRoads was used to model underground utilities in 3D.

"This project convinced us that this is the way to go. It saves errors and omissions, it automates and speeds up plan production, and now that we're applying it on bigger jobs, we're seeing far fewer design errors and more production out of our design staff."

— Derek Rayner, P.E., Principal,
KASL Consulting Engineers



A 3D model aerial view of Metro Fire Station No. 29.

Utility interferences were detected and resolved with automatic tools from the software. Since the software enabled rapid changes and revisions, the team was able to compare and contrast numerous different utility designs and site geometries. To minimize tree loss—about half of the lot's trees were ultimately preserved—and viewscape impact, KASL reconfigured historic drainage patterns, used cut slopes and retaining walls to lower the building pad, and excavated significant amounts of soil. Stormwater structures were also designed and placed with an eye to managing appearances.

Visualization Communicates Design Aesthetics

To verify conclusions and communicate with the public, KASL imported its digital terrain model (surface models) into Google Earth and referenced in a 3D SketchUp model of the building provided by the architect. This combined site work, surrounding real-world information, and the proposed building into one visualization.

Together with ProjectWise® and 3D PDF files, visualization proved to be an effective way to communicate rapidly developing information with all stakeholders. ProjectWise gives InRoads users the security to store, distribute, track, and manage InRoads data and models across unlimited users, offices, project team members, and locations. Rayner said that one enormous benefit of a model-based design approach is the assurance it gives designers.

"The tools give design engineers greater confidence. We know that changes are being captured in the model database and will automatically be reflected in all the plans." Rayner added that another major source of savings resulting from the use of the model was reduced change orders during construction. "Because people are looking at a model when giving approvals, and because the plans are always up to date, there are far fewer surprises once site work begins."

Once this relatively small project was completed, Rayner noted that KASL began to use model-based design routinely. "This project convinced us that this is the way to go. It saves errors and omissions, it automates and speeds up plan production, and now that we're applying it on bigger jobs, we're seeing far fewer design errors and more production out of our design staff."

In fact, the only challenge that KASL is facing with 3D modeling is that customers are still relatively unfamiliar with it. "It's fascinating where the technology is going. But not all of our clients and consultants appreciate it, and consequently it's not a typical request on all our projects," concluded Rayner. "But it's happening—more people are working with building information modeling, and as owners start to see the advantages of having CIM (site) models included with their BIM models for operating their facilities, they'll start to demand it."

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