

Laser Scanning

By Martin C. Dunn, LS

Laser Scanning for Everyday Survey Work

The successful use of laser scanning/high-definition surveying for industrial plant as-builts was well-documented when our company, METCO Services, first began to look into the technology. Believing that automobile assembly plants in our area might provide fertile opportunities for scanning services, our company demonstrated an early interest in getting into laser scanning. METCO, a moderate-sized civil engineering and surveying company, first began to rent scanners in 1999 from a local instrument/CAD dealer, Sterling Systems, for suitable projects.

Our hunches were correct. The auto companies were definitely interested in laser scanning technology for fast, accurate plant as-builts. Unfortunately, what we didn't foresee was that those companies were already tended to by a cadre of AE service suppliers who knew their factories well, making it very difficult to compete successfully for this type of work.

Although the plant as-built work did not materialize as anticipated, we remained optimistic about the technology. We redirected our focus on topographic surveys and met with some success. We continued to rent as needed and in September 2003 we acquired a Cyrax 2500 scanner, Leica's second generation version. We found that for challenging topographic projects the technology was cost-effective compared to conventional methods, but these types of projects were hard to find.

One successful example during this time was an ALTA/ACSM Land Title Survey for the International Center



Party chief Gil Mattson combines scripting with full FOV to greatly increase productivity on site.

Building in downtown Detroit. We used the 2500 to survey around the seven-story building (with a zero set-back), located on half of a city block. The scanner was used to locate all encroachments along vertical walls up to the top of the structure. We were also able to accurately locate an electrical transformer without climbing or using a man-lift.

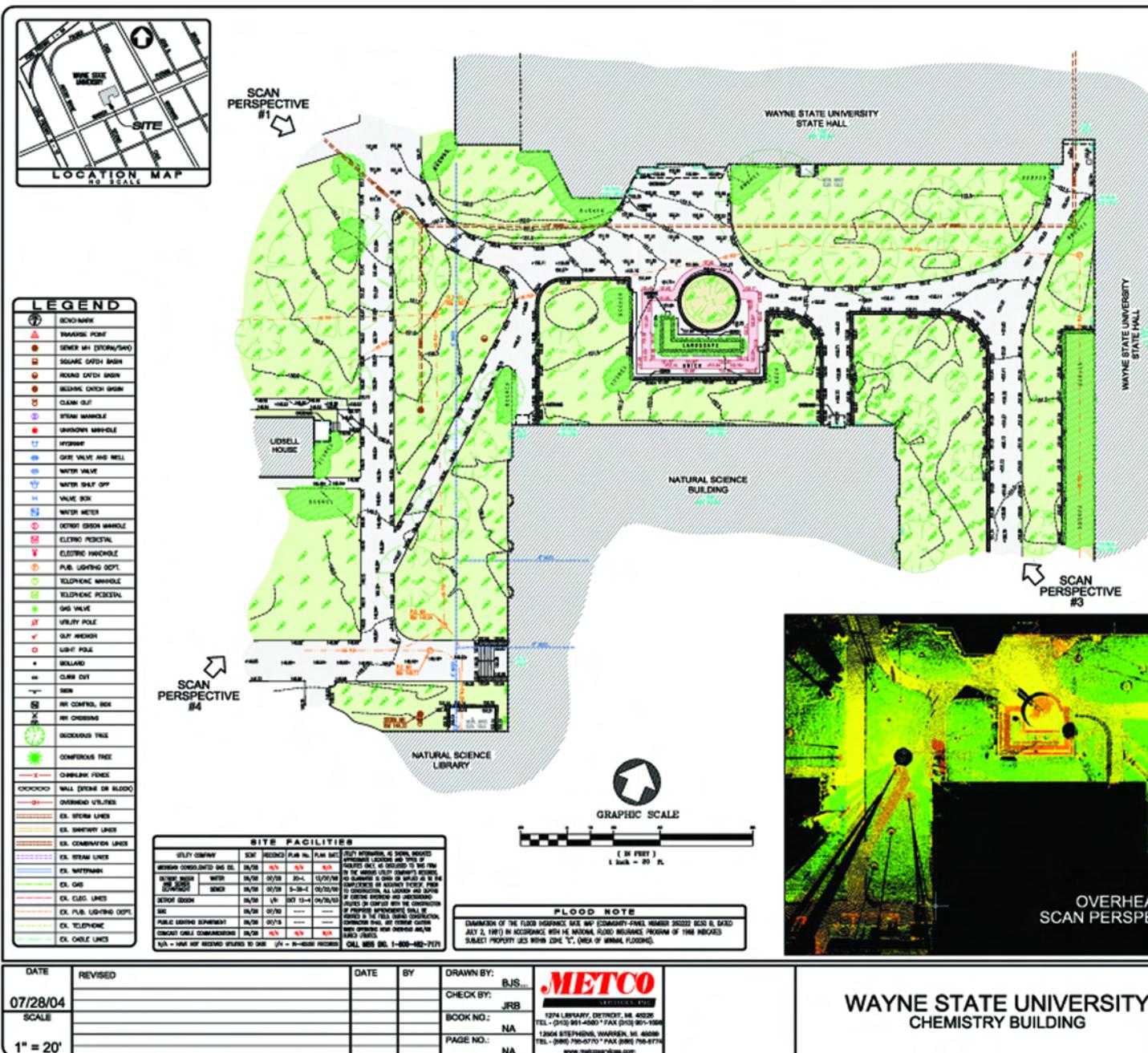
Up to this point our field and office labor costs had been keeping us from using scanning for "everyday" topographic surveys. Although scanning represented added value for our clients, in terms of the richness of the data, we found that our market wouldn't bear a significantly higher price for topos based on scanning. We needed to find a way to sharply reduce our project

labor hours/costs. Fortunately, this happened fairly soon.

Scripting and Full FOV

The first part of our needed labor reduction was made possible by a Leica HDS3000 high-accuracy, time-of-flight scanner, which we acquired in June 2004. This scanner represented a big productivity advance over the prior generation Cyrax 2500, thanks to the HDS3000's full horizontal and vertical field-of-view ($360^\circ \times 270^\circ$), compared to the prior generation's $40^\circ \times 40^\circ$ FOV. We also learned how to take full advantage of "scripting," whereby you can program the scanner at each set-up to automatically survey various parts of the site at different densities. For exam-

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This WSU survey took one day in the field and less than a day in the office.

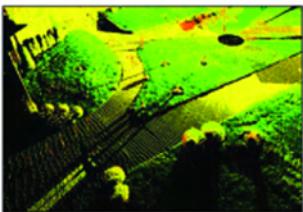
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ple, drainage areas, targets, and what would be considered traditional “hard shots” are scanned at higher densities than natural ground shots, top of banks, etc. Scripting is very quick, then scanning is fully automatic. In essence, scripting over a full field-of-view turns the HDS3000 into an “unmanned, robotic reflectorless station,” collecting hundreds of thousands of points at different densities in minutes.

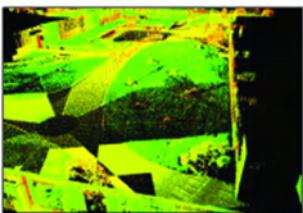
Scripting combined with the HDS3000's full FOV enabled our party chief to be much more productive on site. In some cases, he could leave the scanner basically unattended, while he used another instrument to pick up points, such as buried utilities, that the scanner couldn't capture. Overall, we quickly found that for many standard site surveys we could consistently realize field labor savings as large as 75% (as compared to doing these surveys traditionally) by using our HDS3000 scanner and "filling in" with conventional tools.

The second breakthrough for METCO was making our office procedures more efficient for working with point clouds to create final 2D maps. As many people know, working with point clouds in the earliest days of this technology often meant many extra hours of office processing. Today, scanning office efficiencies are in line with office efficiencies for conventional site surveys. Together, the combination of significant field labor savings plus office efficiencies on par with traditional methods has proven to be a big winner for our company and our clients.

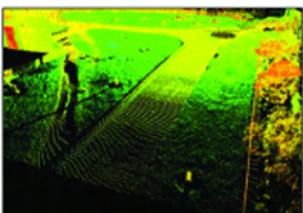
SCAN
PERSPECTIVE #2



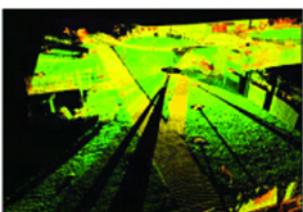
SCAN PERSPECTIVE #1



SCAN PERSPECTIVE #2



SCAN PERSPECTIVE #3



SCAN PERSPECTIVE #4

TOPOGRAPHIC SURVEY

CLIENT: WAYNE STATE UNIVERSITY

JOB NUMBER
04-074
SHEET NUMBER
1 OF 1

Field Workflow

METCO's survey department has a complete set of the latest tools, including Leica GPS1200 System and Leica TPS1100 robotic total stations. Our party chiefs have autonomy to use equipment best suited for the job. Today, for many of our everyday site surveys, a combination of a laser scanner and conventional instruments is used.

First, the entire job is walked for optimum horizontal and vertical control placement. Primary horizontal control is established with static GPS sessions and vertical control with differential level

runs from the closest bench marks. While reconning the site, consideration is given to scanner position and target placement. Targets are needed for georeferencing and/or tying multiple scans together, and we've found target placement to be a critical factor for accurate work. The HDS3000's large field-of-view greatly simplifies the placement of scanning targets and the location of the scanner. After control and targets are placed, scanning commences.

Part of METCO's scanning procedure uses Leica HDS3000's internal, high-resolution digital camera to first capture full 360°x270° panoramic images of the scene. These help the operator script the scanning.

While the HDS3000 is scanning, the one-man crew uses a robotic total station or RTK GPS to measure targets and control points, draw sketches, take notes, and obtain invert elevations.

We also use the scanner on boundary surveys with zero set-back, where property lines are building lines. There's no need for prism offsets to measure building corners. We scan the fascias and in the office create two intersecting planes from scan data to establish exact building corners.

Office Workflow

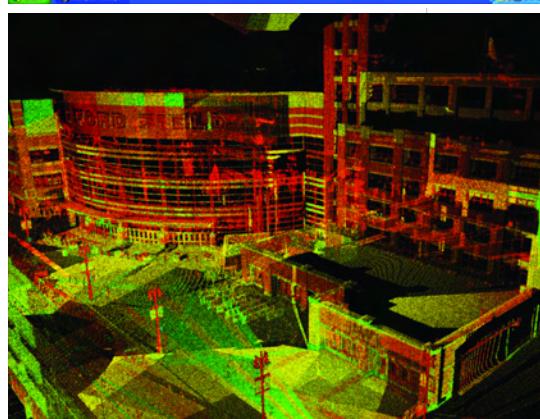
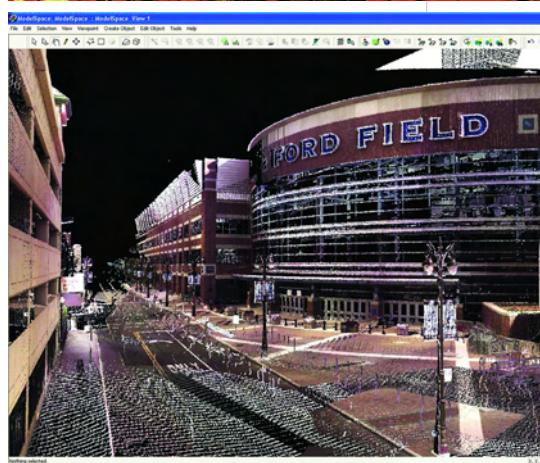
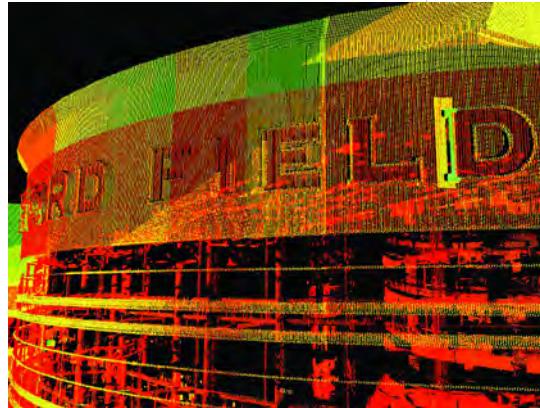
Once scans are registered and placed onto a solid horizontal and vertical control system, the scanning database is transferred to the drafting department. Draftsmen use Cyclone software's Virtual Surveyor module to walk through (virtually) a point cloud "collecting" data on features throughout a site.

Each point that is "collected" is assigned a line and point code that matches those used by field crews in their traditional methods. This allows for data to be imported just as any other file for any other topo job would be. After all the data is "collected" and exported to an ASCII file, a fieldbook (.fbk) file is created utilizing the Autodesk Survey module and then imported into Land Development Desktop for final drafting.

Putting Our Knowledge to Work

One example of a typical topographic survey performed by one person with an HDS3000 is the Wayne State University (WSU) Site Survey. It took a

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Point clouds of the main entrance of Ford Field, home of the NFL's Detroit Lions, may be used for future renovations.

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day in the field and less than a day in the office. Overall, field labor for this project was one-fourth of what it would have been if we'd done the project conventionally.

Although the WSU project did not take full advantage of the HDS3000's 270° vertical FOV, METCO has taken advantage of the full 360°x 270° on other projects. For example, we surveyed the interior of a high school auditorium in which a structural beam 80' in the air was suspected of having a camber. For this, the full 360°x 270° vertical FOV was invaluable. We used the 360° to capture targets at tripod level and, without having to touch the scanner set-up, we used the HDS3000's top window to scan the structural beam directly overhead.

Another project was a Site & Building survey for the main entrance of Ford Field, home of the NFL's Detroit Lions, which was needed for future renovations and possible additions. Existing brick pavers were to be extended, so the client wanted to be sure that they would be accurately located and could be dimensioned if necessary. METCO obtained enough data to map the area while collecting a series of extremely dense scans on specific areas of client interest in the paving patterns. A conventional 2D drawing was prepared showing the location of all utilities, paving types, and existing conditions in the area. This survey was also done with significant labor savings.

Beyond Site Surveys

METCO has fully adopted laser scanning for use in everyday site surveys, and we are always interested in trying scanning on other types of projects. One such recent project was linear in nature, as we wanted to compare the time needed to complete this type of job with our HDS3000 to the time needed for conventional methods.

The project consisted of topos on two separate sites for designing a new water main for a residential street in Detroit. The length of the surveys was 1500 feet. Overall, we found that even for this type of linear survey, the cost to perform with HDS versus conventional survey methods based on walking in a cross-sectional manner gave us a nice 10 percent savings.

We believe we can further reduce our costs for this type of survey by at

least another 20 percent. For example, reductions in the drafting time could be realized by only showing the grades that we use in conventional surveying and not adding so much information "just because you can." For example, on this project, our draftsman discovered from the scan data that the true crown in the road surface was not in the geometric center of the road. Even though the true crown location was not requested by the client, our draftsman had taken the initiative to locate it, selecting an additional three points that defined it for each section.

Investment Payback

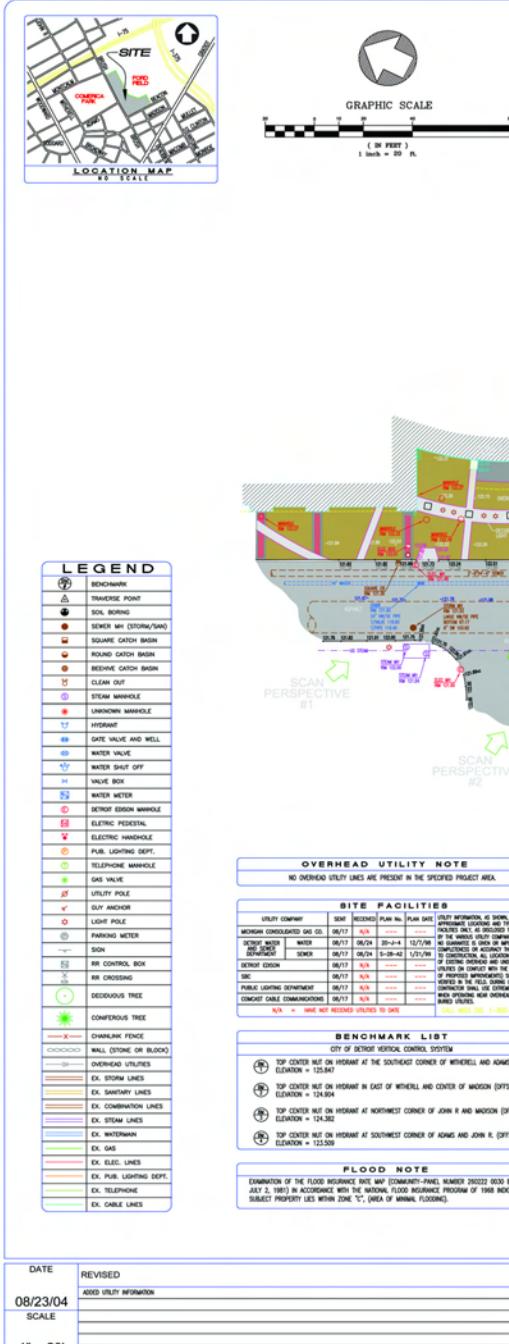
Over time we've found lump-sum pricing to be an optimal approach for surveys that include laser scanning. This approach avoids the need to add a separate line item for hourly "scanner usage", which some clients find confusing and may not react well to.

The lump sum approach also enables METCO to basically price these types of scanning-based site surveys at the same price as conventional and then apply our significant labor savings gain on each project toward paying back the investment in the scanner. Our client is very happy because for the same survey price, the client receives significant added-value. The survey is turned around faster, plus the client knows that if there's a need for additional data, then rich survey data is available to him/her almost immediately without having to re-mobilize a crew to revisit the site. In addition, the richness of scan data gives the client even further confidence that our survey is accurate and complete.

For METCO, this type of approach allows us to pay back the scanner over a period that is just like the payback period for investments in conventional equipment, even though laser scanning systems cost more than \$100,000. This is a real win-win situation.

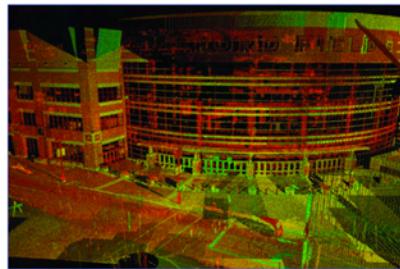
Today, we just plug our Leica HDS3000 scanner into many of our everyday topo, as-built and site surveys. Using scanners as "just another tool in the tool kit," two of our six Detroit field crews are equipped with laser scanning systems and conventional equipment. There are no "scan jobs," only topos, as-builts, and design surveys to be completed using the appropriate tools.

In many cases the only way a client knows that we've used scanning is by

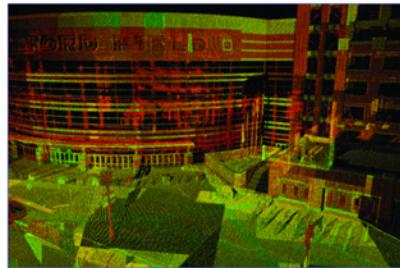


Scan images provide a unique perspective when added to traditional maps for METCO's clients.

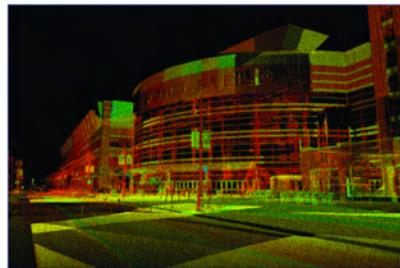
the perspective scan images (instead of photos) that we now place on their maps. Otherwise, the maps are identical to what we've always provided. When clients ask about those "interesting images" on their new map (and they always ask), we explain the many value-added aspects of how we did the survey. Once clients understand these



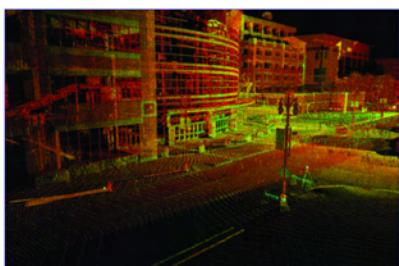
SCAN PERSPECTIVE #3



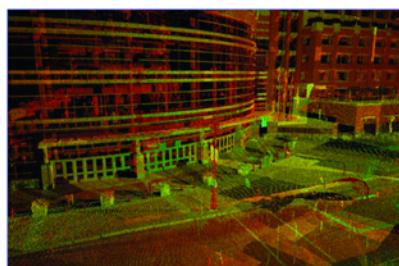
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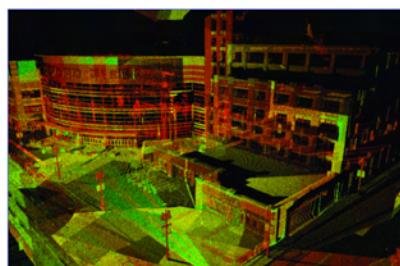
SCAN PERSPECTIVE #5



SCAN PERSPECTIVE #1



SCAN PERSPECTIVE #2



SCAN PERSPECTIVE #6

DATE	BY	DRAWN BY:	JRB
08/04/04		CHECK BY:	GM/SRJ
		BOOK NO.:	439
		PAGE NO.:	59

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EMBASSY SUITES AT FORD FIELD

CLIENT: TURNER CONSTRUCTION

JOB NUMBER
04-120
SHEET NUMBER
1 OF 1

benefits, they are very appreciative and start to ask for their next surveys to be done with "that scanner thing."

Using laser scanning adds a great deal of insurance to a survey project. A wealth of data is available that can be retrieved later if a client finds the need. Building setbacks, overhead utility line heights, existing conditions of the various surface types and any other feature that is within the scan can be gathered without revisiting the site. We also have a permanent record of the existing conditions that were in place at the time of

the survey to quickly resolve any questions. A surveyor can also sleep better at night without waking up wondering, "Did I miss something?"

The ability to realize these added-value benefits for topographic surveys on a daily basis and pay back our scanning investment in a very timely way has made this a real success for METCO and our clients. We have only begun to explore the different applications that can use high-definition surveys for everyday operations. As we become more

familiar with the laser scanner and its software, surveys will be completed faster and costs will continue to be reduced.



Martin Dunn is a licensed surveyor and Vice President of METCO Services in Detroit, Michigan. Founded in 1983, METCO is a moderate-sized civil engineering and surveying company, with a primary focus on water and wastewater projects for local public and private clients.