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Final Report

EVALUATION OF DESIGN-BUILD PRACTICE IN COLORADO PROJECT IR IM(CX) 025-3(113)

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DEPARTMENT OF TRANSPORTATION
RESEARCH

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COLORADO DEPARTMENT OF TRANSPORTATION
RESEARCH BRANCH

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This report summarizes construction activities of the design-build project, "IR IM (CX) 025-3(113)" in Region IV. Under the Special Experimental Project No. 14 (SEP 14), FHWA approved the design-build concept to be used for the reconstruction of I-25 North of Denver in Region IV. Included in the report is an overview of the significant events, results of the activities that took place during construction, discussion of construction modification orders and quality control/quality assurance processes.

The ultimate goal of this research study was to identify and document the pros and cons of the design-build practice And to examine its overall applicability to CDOT.

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EVALUATION OF DESIGN-BUILD PRACTICE IN COLORADO PROJECT IR IM(CX) 025-3(113)

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EXECUTIVE SUMMARY

This final report summarizes the activities that took place on a design-build project in Region 4 of Colorado Department of Transportation (CDOT). Included in this report is an overview of the design-build (D-B) concept, discussion of significant events and results of a questionnaire on design-build methodology. Also, included in the report is a description of all the construction modification orders (CMO) and discussion of the revised quality control / quality assurance processes.

During the 1997 season, Region 4 of CDOT, advertised its first ever design-build contract under the FHWA's pilot program called, "Special Experimental Project 14 (SEP 14)". As part of the evaluation required by FHWA, CDOT project personnel investigated the effectiveness of using design-build concept for this project. The ultimate goal of this investigation was to identify and document the pros and cons of the design-build practice and to examine its overall applicability to CDOT.

The design-build concept combines the design and construction phases of a project into a single contract and allows for overlapping some of the design and construction. In essence, construction can begin on portions of the work before the design of the entire project has been completed. Design-build has been credited for accelerating project completion time, promoting innovation, reducing user's cost and assigning more responsibilities to the bidding firms.

Typically, the contract is awarded to a firm who provides the Best Value Offer, considering four major criteria: cost, quality, time and management capability of the bidder. The best value offer may not necessarily be the lowest bid. Awarding contracts to the lowest responsive and responsible bidders is still the only allowed method in Colorado, as it is for this design-build project. Nevertheless, CDOT is in the process of developing design-build guidelines that incorporate the best value concept, primarily for larger and more complex projects. These guidelines will supplement the existing CDOT design-build manual, which calls for awarding contracts to the lowest responsive and responsible bidder. House Bill 99-1324 was signed into law on April 9, 1999 authorizing CDOT to select contractors for design-build projects based on the best value concept. When a

balance of time, quality and price is desired, the best value concept may be more attractive than the lowest bid, since it encourages innovations in construction alternatives and scheduling, and allows the Contractors to optimize their work force, equipment and schedule.

At the end of the project, 15 contract modification orders and 24 minor contract revisions were incorporated into this design-build project. This would seem somewhat high in comparison with the traditional design-bid-build projects. However, it should be noted that unlike most of the traditional bid projects, these CMOs were primarily written as cost savings to the project or to allow changes in the proscribed construction phasing. Detailed discussions on the CMOs are presented in appendix C. It is CDOT's opinion that the overall quality of this design-build project compared favorably with the traditional design-bid-build projects of similar size. Overall cost may be slightly higher than traditional bidding methods. It is CDOT's position that for simple projects with well-defined end results, the low bid process is adequate.

Implementation Statement

The use of design-build methodology for awarding construction projects looks promising. However, there is room for improvement in a fully implemented design-build concept. When early completion of a project is of significant value, the design-build method of project delivery may be a viable alternative to traditional bidding methods. The best value concept along with extended warranties for larger and more complex projects may be an improvement to the method used on this project. Warranty clauses in conjunction with the design-build concept may lead to a higher safety factor for owners and develop higher quality standards by contractors. This may foster trust between the owners and the Contractors, which can lead to improved communication and eventually, improved quality. In addition, a clearly-defined warranty clause provides the owners with added insurance that they are getting quality products that will meet the intended design life.

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1.0 INTRODUCTION

Region 4 of the Colorado Department of Transportation (CDOT) awarded its first ever design-build contract under the FHWA's pilot program called, "Special Experimental Project 14 (SEP 14)". As part of the evaluation required by the FHWA, CDOT established a task force to investigate the effectiveness of using the design-build concept for this project. The ultimate goal of this investigation was to identify and document the pros and cons of the design-build practice and examine its overall applicability to CDOT.

According to a 1977 FHWA report called, "Innovative Practices Using Design-Build Contracting," (1) the design-build contracting method offers three major benefits. First of all, the contracting agency (owner) will have to deal with only one party for the quality, cost and overall management of a project. This reduces the owner's responsibility of coordinating activities between the designer and the builder. At the same time this diminishes project administration due to the transfer of roles to the Contractor and the designer.

Second, when the designer and the builder are jointly responsible for the overall quality of the final product, the potential for dispute and litigation between them is diminished (2). Finally, overlapping portions of design and construction can result in saving time, which eventually can translate into cost savings for both the traveling public and the contracting agency.

This final report summarizes the activities that took place during the pre-construction and construction phases of the design-build project on I-25 north of Denver. Included in this report is an overview of the design-build concept and a description of the procedure used to advertise, evaluate technical proposals and to select the successful bidder. Also included in this report is an overview of the significant events and description of construction modification orders (CMO) and quality control/quality assurance processes.

2.0 BACKGROUND

Presently, the "design-bid-build" is the primary method used by CDOT to select contractors. Under the design-bid-build, CDOT designs the project in-house or hires a consultant. The project is then advertised and awarded to the lowest bidder. Under this method, design must be complete before the project is advertised.

The "design-build" method, on the other hand, combines both the design and construction phases of a project into a single contract and allows for overlapping of some design and construction. In essence, construction can begin before design for a project has been completed.

Under the design-build method of contracting, the owner (state transportation agency) identifies the project's desired end result product. The prospective bidders are then provided with anywhere from 20 to 30 percent of the design, including mandatory requirements. In return, the bidders are asked to prepare a technical proposal and a price proposal showing how they intend to complete the remaining design and the entire construction. The submitted proposals are then reviewed and rated by a Technical Review Committee (TRC). Typically, four major criteria are used in the selection process:

Cost of the project
Quality of the proposed design/innovations
Management capability of the bidder
Time required for entire project completion

In general, the contract is awarded to a firm who provides the best value offer. The best value offer may not necessarily be the lowest bid. For example, for Utah's $1.4 billion design-build project (reconstruction of the I-15 corridor) the Utah Department of Transportation (UDOT) awarded the contract to the bidder who provided the best value offer to UDOT. The award considered not only the price, but also other factors such as design quality, timeliness, and

management capability. Utah legislators amended their procurement laws allowing UDOT the use of design-build with the best value offer (3).

It is important to note that the "best value concept" which is used in typical design-build projects was not used for this design-build project. The bidding rules of Colorado did not allow such contracting practices at the time of contract award. Awarding contracts to the lowest responsive and responsible bidders still prevailed in Colorado, as it did for this design-build project. However, with the passage of the House Bill 99-1324, CDOT will now have the option of using the best value concept in awarding projects. CDOT has now developed design-build guidelines that incorporate the best value concept, primarily for larger and more complex projects.

These guidelines will not replace the existing CDOT Design-Build Manual, which calls for awarding contracts to the lowest responsive/responsible bidder. The best value concept will be an addition to the already in place CDOT design-build manual (4). When a balance of time, quality and price is desired, the best value concept may be more attractive than the lowest bid, since it encourages innovations and allows the Contractors to optimize their work force, equipment and schedules.

3.0 OBJECTIVE

The primary objectives of this research study are to identify and document the pros and cons of the design-build practice and examine its overall applicability to CDOT. To satisfy these objectives and to address the requirement of the FHWA's SEP 14, the research team for this study established the following milestones:

Ninety days after the design-build contract is awarded, a report should be issued to discuss the procedure used to select the successful bidder and to reveal the reactions of contractors and consultants on the Design-Build concept.

Interim reports should be prepared on an annual basis or as needed to discuss progress to date, significant events and encountered problems.

A final report should be issued after the completion of the entire project. This report will identify the merits and limitations of the design build concept using the criteria established in the work plan (see appendix A) and recommendations for future design-build projects.

4.0 CDOT's DESIGN-BUILD MANUAL

CDOT, in cooperation with the Federal Highway Administration (FHWA), the American Consulting Engineers Council of Colorado and the Colorado Contractors Association, developed a set of comprehensive guidelines, "Design-Build Manual" (4) to be used for CDOT's design-build projects. These guidelines are compatible with the current CDOT policy of awarding contracts to the lowest responsive and responsible bidder. For a complete review of these guidelines refer to CDOT's Design-Build Manual.

5.0 PROJECT DESCRIPTION & SCOPE OF WORK

The project was a 17-mile concrete overlay of 4 lanes of I-25 and included some bridge and safety improvements. The project was the final of five projects completing the overlay of I-25 north from State Highway 66, a total of 57 miles. The project had an A+B spec and the Contractor bid to do the work in 260 working days over a span of two years time. The project was completed with 5 days of liquidated damages.

Overall, the project required addressing the following 20 salient features:

1. Traffic Control Design Plans and Phasing Details
2. Roadway Plans
3. Detours
4. Bond Breaker

5. Permanent Pavement Marking
6. Bridge membrane
7. Construction Traffic Control
8. Permanent Signing
9. Structures (Box Culverts, drainage pipes, et. al.)
10. Concrete Overlay
11. Lighting
12. Guardrail, Barrier, End Anchorages
13. Seeding and Mulching
14. Surveying
15. Erosion Control (Storm Water Management Plan)
16. Permits
17. Earthwork
18. Fencing
19. Frontage Road Construction
20. Snow Mitigation Removal Areas

5.1 Advertisement (Request for Proposals)

Traditionally, CDOT advertises its construction projects in a statewide business journal called the **"Daily Journal."** Concurrently, these projects are advertised electronically in CompuServe, an on-line service to notify pre-qualified Colorado contractors. In addition to the above two methods and in an effort to generate more interest and solicit more bids, the Region 4 design-build project was also pre-advertised in a national engineering magazine called "Engineering News Record" (ENR). The ENR notice (refer to Appendix B) was published approximately during the formal advertisement in the Daily Journal and on CompuServe.

Prior to advertising the project, several meetings were held with the contracting and consulting firms in order to acquaint them with the scope of work, address their comments and to acquire

their inputs and feedback. The following was the list of activities that took place in the advertisement and overall procurement process:

- Constructability Review Meeting with the Colorado Contractors Association and American Consulting Engineers Council of Colorado officials

  October 17, 1997

- Project was formally advertised — November 6, 1997

- Pre-Bid conference (Although this was not a mandatory meeting, attendance by all bidders should be required in the future to prevent uninformed Contractors from bidding.)

  November 19, 1997

- Bid opening — December 18, 1997

- Award of contract — February 24, 1998

- Notice to proceed — February 24, 1998

- Commencement of work — March 2, 1998

Typically, CDOT provides a 3-week ad period for the traditional design-bid-build projects. However, for this design-build project, the ad period was extended to six weeks to allow the proposers to establish teams and prepare bids. For future design-build projects, the ad period may be extended beyond the six-week period for Field Inspection and Review (FIR) plans that are less than 20 percent complete.

5.2 Technical & Price Proposal

The bidding packages provided the proposers with approximately 40 percent of the design, including a complete survey. Prior to consideration as a D-B eligible project, the project was originally designed in house as a traditional design-bid-build and was nearly 90% complete when changes in the project template required major changes in earthwork, drainage and related items. The plans were modified to eliminate all references to proposed quantities as originally developed.

The proposers were asked to prepare a technical proposal and a price proposal showing how they intend to complete the remaining design and the entire construction. Included in the bidding package were numerous mandatory requirements, such as the preference for concrete pavement over flexible pavement, and special bridge, lighting and signing requirements.

In general, the design-build project required the proposers to show a lump sum cost for all the 20 salient features listed above in Section 5.0 of this report. In addition to the normal requirement of pre-qualification for the Contractor, the technical proposals were also required to clearly demonstrate the qualification of the design team. Overall, the design team was required to demonstrate the following minimum qualifications:

a) Pre-qualification of the design team by CDOT.
b) Evidence of an errors & omissions insurance not less than $1,000,000.
c) Proof of successful completion of the design of one interstate project or multi-lanes divided freeway having construction or reconstruction costs in excess of $5,000,000.00 over the last 5 years.

Four prime contractors, each teamed with their own consulting engineer, prepared bids for the project. Three contractors were Colorado contractors and one was from the State of Washington. Two teams dropped out prior to project bid. This resulted in only two bids being submitted to CDOT.

Only two local Colorado firms submitted technical proposals for this project: Castle Rock Construction Company (CRCC) and Interstate Highway Construction (IHC). A Technical Review Committee (TRC) consisting of the Region's Construction, Materials and Design personnel was assembled to review the technical proposal of the apparent low bidder, (CRCC). This committee was charged with the task of assessing the overall responsiveness of the lowest bidder's technical proposal and ensuring that all the requirements of the bidding package were addressed.

Contract award was contingent upon CRCC adequately addressing any issues and concerns raised by the TRC. The TRC would have considered reviewing the IHC's technical proposal if the CRCC's technical proposal had been determined to be non-responsive. It is important to note that "best value" concept, which is used in typical design-build projects was not used on this project, because the bidding rules of Colorado did not allow such contracting practices at that time.

The Technical Proposal of the low bid Contractor, Castle Rock Construction Company, required additional submittals to adequately address some important details, including schedule and methods of construction to clarify the Contractor's proposal. This required much work by the Contractor to rewrite the TP after bid opening for approval prior to award. The present D-B process requires review only of the low bid proposal. According to the high bidder, CDOT needs to seal all technical proposals prior to opening because they are sensitive to having this information becoming public knowledge and do not want the TP to be opened and reviewed.

For CDOT's design-build project, cost was the primary consideration, subject to a responsive/responsibility determination of the bidder. Because CRCC was able to meet all the established criteria for award, there was no need for the TRC to consider the IHC 's technical proposal. As a result, the IHC's technical proposal was never opened. Under the best value method of awarding contracts, all submitted technical proposals are reviewed and the contract

was awarded to the proposer who provides the best value offer, considering not only the price, but other factors such as design quality, timeliness, and management capability.

It is the general consensus within CDOT that best value concept encourages innovation and promotes value engineering features by allowing the Contractors to optimize their work force, equipment, and schedules. In reality, the best value concept can be referred to as reaching a balance between quality, time and price.

Again, at that time the procurement laws of Colorado did not allow such contracting practices. Awarding contracts to the lowest responsive and responsible bidder still prevailed in Colorado as it did for this design-build project.

5.3 Disadvantage Business Enterprise (DBE) Goals

The contract goal for the DBE participation was established at 8 percent of the total contract amount. The Equal Employment Opportunity Representative (EEO Reps) in Region 4 worked closely with the Design Engineer to review items that were likely to be on this project and determined the DBE goals based on the total amount of the contract. The Contractor submitted documentation demonstrating how he intended to satisfy the DBE participation goals. The goals were met on the project.

5.4 Subcontracting Requirements

Subcontracting was allowed in accordance with the current CDOT requirements. Presently, CDOT typically requires the prime contractor to perform at least 50 percent of the total contract. This can be reduced in the special provisions, but was not on this project.

5.5 Right-of-Way

The existing right-of-way was clearly identified in the plans prior to advertising the project. The original design did anticipate acquisition of new right-of-way and slope easements. CDOT was in the process of obtaining easements and right-of-way at the time of advertisement and had acquired conditional clearances from the FHWA. The special provisions indicated time restrictions for the bidding Contractors before work could start at the locations of temporary easements. The Contractor was not permitted to perform any project-related work outside the existing right-of-way, without prior approval by CDOT. Where the Contractor was obligated to obtain temporary easements to facilitate their work, CDOT's concurrence was required. In such instances, the Contractor was solely responsible for all costs, environmental clearances and other permits required for the easements.

5.6 Environmental Impact Studies

The environmental clearances for the existing right-of-way were obtained by CDOT. The Contractor was required to identify any new right-of-way, staging areas, borrow areas, and stockpile locations early in the design stage. CDOT would then obtain clearances for these areas if needed.

Two wetlands were identified for this project. If due to the design, more wetland areas were located, the Contractor was required to avoid impacting them. Nevertheless, if the impacts were unavoidable, they were required to be mitigated on a 1: 1 ratio. It was intended that CDOT would assist the Contractor on wetland mitigation and obtaining the required permits. The contractor would not be allowed to perform any earthwork until the permits were obtained by CDOT. However, this project did not require additional clearances after the Contractor's design was completed.

5.7 Utilities

No major utility conflicts were identified on this project. Known existing utilities within the project limits were identified by CDOT and were listed on the plan and profile sheets.

5.8 Quality Control (QC)

The contractor was required to develop a quality control plan, clearly demonstrating the frequency of testing and sampling, qualification of the testing personnel, and reporting procedures. Incentive/disincentive clauses were incorporated into the contract in accordance with CDOT's procedures. Quality assurance (QA) remained the responsibility of the CDOT's project personnel.

Because the Contractor elected to bid the project for a two-year construction schedule, problems identified during the course of the first year in the Contractor's Quality Control program led to developing a new Quality Control program in the second year. Consequently, two different quality programs were utilized on the project for year one (QC1) and year two (QC2), allowing the opportunity to evaluate both methods used.

In the first year of construction, the Contractor's Design Engineer was not involved in Quality Control issues. A company engineer in the Contractor's office oversaw Quality Control, with inspection performed by sub-consultants, company inspection personnel and foremen of each subcontractor. The foreman provided daily documentation for work performed in a format similar to CDOT form 266 and a daily diary.

The specifications did not require the Quality Control manager to be trained in quality management. This was done purposefully to allow the Contractor to be creative in developing a Quality Control process. The Quality Control Manager the first year had been with the company primarily as a project superintendent for his 20 years in the company. Because of his lack of training, specifically in quality control, there was often a reluctance to adequately monitor

ongoing work and correct substandard work when production and schedule were an issue to the Contractor.

The level of inspection required of the Contractor was not well defined in the contract, and in the opinion of project personnel, was often inadequate. The specifications did not require a firewall between project management and Quality Control. Conflicts of interest developed within the Contractor's Management and Quality Control organizations because of this. The quality manager often accepted or was unaware of inadequate work being done, and approved continuation of operations primarily to meet production requirements. The Contractor's own quality forces chose to overlook deficiencies in work quality, becoming reliant on the old method of waiting for the owner to step in to demand corrections and make final approval for completed work items. CDOT Quality Assurance forces supplemented the Contractor's Q C forces when inadequate Quality Controls were suspected. Because of perceived problems in some Quality Control enforcement, acceptance of work tacitly became the domain of CDOT. This was not an acceptable situation for CDOT and a revised Quality Control structure was requested of the Contractor.

The Contractor's Quality Control organizational structure was then revised by the Contractor's management. In the second year the QC2 plan had the Quality Management performed under the direction of the Design Engineering company, DMJM, utilizing the same general reporting and documentation format. The Quality Control Manager was now a Professional Engineer trained in Quality Control. All of the inspector's duties were quality-related and no subcontractors were placed in the position of accepting their own work. All Quality Control operations were directly accountable to the Quality Manager, not project management. This reorganization was deemed successful and Quality Control operations followed the Quality Control Plan as was intended.

5.9 Award and Execution of Contract

The apparent low bidder was the Castle Rock Construction Company of Castle Rock, Colorado, with a bid of $26,328,000 and work to be completed in 260 working days. Only one other bid

was submitted from Interstate Highway Construction of Englewood, Colorado, for $28,430,930 in 150 days. The engineer's estimate was $24,466,585. The contract was awarded to Castle Rock Construction Company as the lowest responsive and responsible bidder on February 24, 1998. Notice to proceed was issued on February 24, 1998.

6.0 PROJECT TEAM/ PLAN DEVELOPMENT PROCESS

CDOT Region 4 had limited manpower at the time the project was advertised, and a consultant was hired to provide construction inspection and testing services or Quality Assurance (Q A) as described in the project specifications. CDOT maintained a staff of two on the project to review plans for compliance with the specifications and to review Quality Control and Quality Assurance records. The Contractor was required to provide the design and quality control (Q C). For this purpose, the Contractor hired a consulting engineer to provide design. During the first year of work, Quality Control was done under the direction of the Contractor's own Quality Control forces (supplemented by an outside testing consultant). Problems in the Contractor's Quality Control in the first year precipitated the use of professional Quality Control services by their design engineer to complete the project in the second construction season (as discussed earlier.)

6.1 Project Team Composition-CDOT, Consultants, Contractors, Disputes Review Board

- CDOT Region 4, Loveland, Colorado, Owner
- Sear Brown Group, Fort Collins, CO, Engineering Consultant Quality Assurance for CDOT
- Contractor Castle Rock Construction Company, Castle Rock, CO, Project management, Quality control Year 1
- Contractor's Engineer: DMJM, Denver, Colorado and Salt Lake City, UT, Design and construction Quality Control Year 2
- Disputes Review Board (DRB)- 3 members, one chosen by contractor, one by CDOT and one chairman mutually agreed upon by both parties

6.2. Team Organization

A Partnering workshop was held immediately after the contract award. This meeting was held primarily to introduce the team members including the Contractor, CDOT, FHWA, consultants, subcontractors and suppliers to the D-B process. Prior to starting the design process, an organizational chart was developed to define the roles of owner, the engineering design development and review process, the Contractor's quality control system, Facilitation was by joint CDOT/ Contractor personnel. The CDOT facilitator was from staff construction and had no direct stake in the project outcome. The Contractor's representative was not assigned to the project and was presumed to be neutral also.

The partnering workshop concluded with the development of a Mission Statement with goals (See Appendix C.) The Contractor agreed to write a comprehensive schedule. In accordance with the partnering workshop, CDOT and the consultant Engineer developed plans presumably with input and concurrence of the Contractor, but problems arose later upon enforcement of plans. They did not have buy-in from the sub-contractors, particularly the earthwork sub. Several major players including the Quality Manager and CDOT consultant Project Manager were not present. The Disputes Review Board had not been selected prior to the partnering meeting and were not in attendance (in the future, it would be advantageous to have DRB chosen and present.) The CEO was present, as was the project superintendent.

The Contractor's Management (over CDOT's objections) felt there were aspects of the project of no concern to CDOT for Quality Control purposes such as detour design and construction, setting the stage for Quality Control problems implementing Quality Control concepts later on during construction. CRCC also stated that the plans allowed them to borrow embankment material from anywhere they chose regardless of where the plans showed it. The plans did not specify locations of borrow, only showed the typical sections to the toes of original ground. Potential borrow areas were ultimately identified on the plans during the design development process.

6.3 Disputes Review Board

A Disputes Review Board (DRB) was specified in the contract. This consisted of 3 members experienced in construction and particularly D-B. The organization is similar to that of a CDOT Claims Review Board. The members were chosen as follow; one by the Contractor, one by CDOT and one chairman mutually agreed upon by both parties. All costs for the Board were shared equally by CDOT and the Contractor. The purpose of the Disputes Review Board was to help resolve design and construction issues before they became claims. Initially, they were invited to progress meetings every 6 weeks. As the project progressed, they met as needed or requested (by CDOT) about once every three months. The Disputes Review Board was considered an exceptionally useful method to bring potentially divisive issues to the surface and encourage timely resolution.

6.4 PLAN DEVELOPMENT/DESIGN PROCESS

The plan development process used on the project required direct coordination by the Contractor. Coordination meetings were held weekly with the Contractor, his design consultant, and the CDOT Project Manager. After design criteria and general details were agreed upon, the consultant developed plans for review. During the plan development process, the consultant sent plans to subcontractors for review. If he did not hear comments within 10 days, the plans were submitted to CDOT, which took no more than 10 working days for review. After appropriate review, the plans were returned as "Reviewed," "Reviewed as Noted," or "Revise and Resubmit." This process appeared to work because the Contractor allowed the designer the flexibility to make decisions to expedite the process. However, the designer was also allowed to make engineering decisions that directly affected cost as well as profits for the prime and his subcontractors. During construction, the Contractor or subcontractor occasionally did not agree with the plans as approved. This led to problems in construction that required plan revisions. It became apparent that some subcontractors were not thoroughly reviewing the plans in this process. A new, more effective design process was implemented in the second year of

construction. This new process was essentially similar as before, only now it required the final signature of the subcontractor responsible for the work on the Construction drawing.

The design engineer was hired as a subcontractor on a lump sum basis. Subsequently, professional responsibility rather than monetary incentive drove him to come up with the best and cheapest alternatives. Subcontractors bid the work to the prime on a unit basis, and alternatives that reduced quantities did not appeal to the subcontractor since it negatively affected payment. Consequently, the prime contractor was the primary entity on the project who would clearly benefit from innovative construction methods based on the subcontracting structure chosen by the Contractor, as no one else truly had a stake in profit sharing.

7.0 WARRANTIES

Warranty clauses, coupled with the design-build concept, can provide contracting agencies with added insurance that they are getting quality products that last their design-life. Presently, CDOT, under the Senate Bill 97-128, is evaluating the effectiveness of warranties in three pilot projects. In conforming to the law, contracts for the projects with warranty specifications required the s to guarantee their work for three years. This is a departure from current practice where CDOT is responsible for pavement maintenance and repair once the Contractor has completed the initial project (5).

Long-term maintenance was an essential part of the Utah's 1.4 billion dollar, design-build project. Originally, the Contractors were requested to provide a 25-year maintenance plan as part of their bidding package. However, to raise the comfort level of the proposers, the maintenance period was reduced to 10 years- an initial 5-year maintenance option and five-one year renewable options covering years 6 through 10 (6).

No warranties were required for this Project. The Federal Highway Administration (FHWA) regulations, "23 CFR 63 5.413 " no longer prohibits the use of warranties on the National Highway System (NHS). However, to use warranties on NHS, transportation agencies are

required to acquire an advance approval by the FHWA's Division Administrator (5). In addition, it is the FHWA's position that warranty clauses shall be used only for specific items and shall not place undue burden on the Contractor.

8.0 VALUE ENGINEERING

At the preliminary stages of the project development, it was believed that value engineering (VE) clause had no place in the design-build projects with mandatory requirements. However, further into the project development it was realized that even design-build projects with mandatory requirements could be subjected to Contractors' value engineering analysis. Value engineering was not allowed on the project.

9.0 STIPENDS

Full or partial payment of stipend to the unsuccessful proposers was not provided for on this design-build project. In essence, bidders who performed design work prior to the award, but were not awarded the project, have performed that work solely at their own cost. This could be a deterrent for the potential proposers.

Potential bidders indicated to the Project Engineer that the cost of preparing the bid was increased by a factor of up to four compared to regular design-bid-build projects. The cost was estimated to be in the range of $100,000 to $150,000. Some subcontractors expressed concern that high cost associated with their bid preparation prevented them from participating in the bids.

UDOT took the position that payment of stipend to the unsuccessful proposers allowed them access to their innovations, which could in turn be applied to the project. The stipend also provided UDOT with competitive price proposals and overall improved project quality and delivery. UDOT reimbursed the two unsuccessful proposers a stipend in the amount of $950,000 each to cover a portion of their proposal preparation cost (approximately 50 percent). Since there is no best value proposal involved in this type of project, ownership of unsuccessful bidder's

ideas may not be of value to CDOT related to potential cost savings. However, if stipends are used on future projects, CDOT should limit any stipend to serious bids only to prevent abuse by contractors submitting frivolous bids.

10.0 CONSTRUCTION MODIFICATION ORDERS (CMO)

At the completion of the project, 15 contract modification orders were incorporated into this design-build project. This would seem somewhat high in comparison with the traditional design-bid-build projects. However, it should be noted that unlike most of the traditional bid projects, these CMOs were primarily written as cost savings to the project. High mast lighting called for on the plans specifically called for a certain number of masts at a specific height. the Contractor proposed to provide the same lighting with a different configuration and pole height. Since this proposal varied from the proscriptive specification, the change required a CMO and reimbursement to the state for the cost savings of the approved work.

Another example was work not identified in the plans but necessary for completion of the project. The Contractor was required to provide drainage from a ditch into an existing culvert at a location where drainage had never been adequate within the right-of-way but outside the toes of the slope and therefore outside the scope of the bid. The costs incurred for these features were negotiated with the project engineer and confirmed by the Cost Estimate Unit of Staff Design.

The specifications do not establish how to determine the costs of deleted work. On a traditional project, the bid tab provides the cost basis for most over or under-run items. On a D-B project, there is no tabulation, making negotiations more difficult. In the opinion of the CDOT project manager, costs offered to the State for deleted work were low and costs for added work were usually well above the Cost Data Book. An illustration of this occurred when a change in the type of guardrail end sections was ordered. The Engineer estimated the costs (from Cost Data information) to be on the order of $120,000, but the Contractor stated he would do the work for $230,000. When negotiations broke down, the work was done by force account at a final cost of

approximately $90,000. There were additional costs for inspection and administration, but overall the Contractor's price versus the actual cost was substantially different.

11.0 QUALITY CONTROL / QUALITY ASSURANCE

The project special provisions required the Contractor to submit a Quality Control Plan (QCP) as part of his technical proposal. The QCP describes the procedures to be utilized to verify, independently check, and to review all material tests and construction inspections. The Contractor had the flexibility to come up with his own Quality Control process. The Contractor developed the project Quality Control plan, which initially was considered to be a "living document" that would change as the work progressed. The Quality Control plan developed by the Contractor was considered by CDOT to be too loose in some specifics, i.e. qualification of Quality Control inspectors (initially sub-contractors were Quality Control inspectors with oversight from Quality Manager), but was given a chance to succeed the first year. The documentation process (modeled after CDOT's Forms 266 and 305 with a daily diary) did not necessarily independently verify standards being met. It will be necessary on future D-B projects to have strong language limiting Quality Control personnel to work independently of the subcontractor.

Historically, contractors in the state of Colorado have relied on CDOT to provide some level of Quality Control. Quality Assurance, Independent Assurance Testing and Material Acceptance have been the responsibility of CDOT. The original specifications for this design-build project required the Contractor to be fully responsible for QC and CDOT to make random inspections, verifying the Contractor's QC performance as stated in the QCP.

The sampling and testing must be performed by qualified laboratories and qualified personnel. For this design-build project, the Contractor was required to utilize an independent testing firm supervised by a registered professional engineer to perform all sampling and testing.

The quality of the material had to be validated by verification testing performed on samples that were taken independently of the quality control samples. The revised specification requires an independent sampling schedule.

The quality control sampling and testing must be evaluated and approved by an Independent Assurance Testing Program. The revised specification requires reviewing quality of sampling and testing personnel and the testing equipment.

Quality control problems arose at times when the Contractor chose to make substantive changes in the field without the knowledge or input from the designer or owner. The Quality Manager made specification changes and allowed field changes without consulting his Engineer or CDOT to determine the acceptability of this. For example, the Quality Manager did not follow the approved quality plan and allowed a subcontractor to borrow embankment from locations even where it was not shown in the plans. This bypassed Engineering review and caused significant drainage problems that required subsequent and numerous design and field reviews to correct. This typical lack of adherence to the Quality Control Plan was a key factor in the contractor's Management decision to change of Quality Control personnel for the second year of construction.

The Contractor had no clear acceptance process outlined in the Quality Plan; the work was always "ongoing" with the request for approval by CDOT only at the end of the project, with little input from the owner. CDOT requested that the Quality Control plan be updated to include a process, but this was never adequately addressed. Most work was not approved by Quality Control until the end of the project. This created some problems for the Contractor and CDOT when the request for final acceptance was submitted at the end of the project. At this time, Quality Assurance personnel did not agree that the all work accepted by the Contractor was acceptable by CDOT standards.

12.0 ADVANTAGES AND DISADVANTAGES OF DESIGN-BUILD

Advantages: Advancement of construction money

- Owner should have less construction personnel on project for quality assurance

- Control of quality requirements become the Contractor's responsibility
- Owner has fewer responsibilities for inspection, testing and quality control

Disadvantages:

- Cost. Based on Negotiated prices, the cost of the project is higher.
- Quality Control is viewed differently by Contractors for items that are inspection intensive vs. test intensive, inspection is more of an owner's viewpoint.
- CDOT loses control of design preferences unless specifications written carefully.
- CDOT pre-bid design team must established and committed to the Design/Build process in plan development stage. Short turn around times may make this difficult.
- Contractor reluctant to following quality plan and verification process.
- Level of inspection left up to the Contractor by the specifications.
- Tendency of Contractor to believe that plans are only a guideline and field changes can be made without the review process.

Neutral:

- Construction time to completion doesn't seem to change above a traditionally bid project.
- Great deal of thought must be given to the design requirement specifications.

13.0 DESIGN-BUILD PROJECT MANAGEMENT COST SAVINGS

This project was exempted from the P.E. pool in order to track the actual Engineering costs for the project.

Engineering costs are broken down in the following categories

Preconstruction	$773,943
Contractor design (per Contractor's pay schedule)	$450,000
Contractor Quality Control (per Contractor's pay schedule)	$300,000
CDOT construction administration Quality Assurance	$1,417,077

Total Engineering	$2,941,170

This project was originally conceived as a traditional design-bid-build. CDOT initially prepared plans and developed quantities to a 70% level. The project was then converted to a Design/Build project, and the plans were modified. Had the project began as a design-build, probably CDOT PS&E costs would have been less (estimated to be $500,000.) The Contractor's Engineer developed plans and billed the Contractor $450,000 for the work. The total design cost, including CDOT (@$500k) is estimated to be $950,000.

The construction bid items including planned force account and incentives is $27,758,250. Deducting costs for Contractor design and construction administration ($750,000), the construction total is $2,9031,227.

Engineering percentage for the construction phase for CDOT only is 4.88% and both CDOT and the Contractor is 5.9%. The total Engineering cost for design and construction is 10.13%. It should be noted that in the opinion of CDOT project manager, the Contractor's Quality Control was supplemented by CDOT forces and should have cost the Contractor more, CDOT less, but overall the percentage should be the same.

Projects of similar scope and cost have Engineering percentages ranging between 8% and 12%, so this project theoretically saved money; however, actual cost savings are hard to determ

14.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the activities that took place in the second phase (construction phase) of the CDOT's Region 4 design-build project and the literature reviewed, the following conclusions and recommendations are presented:

14.1 Conclusions

The design-build method of contracting has the potential of promoting innovation, reducing the overall project time and as a result reducing user's costs; however, the design-build concept does not necessarily reduce the overall agency costs.

For simple design-build projects with well-defined end results, the low bid process is ideal, since it minimizes review of voluminous technical proposals. Awarding contracts to the lowest responsible bidders still prevails in Colorado, as it did for this design-build project.

For larger and more complex design-build project the best value concept is more appropriate, since it encourages innovations and allows the Contractors to optimize their work force, equipment and schedule. Pursuance of the best value concept by CDOT for larger and more complex projects is a step in the right direction. The passage of the HB 99-1324 now authorizes CDOT to award contracts to contractors who provide the best-value offer.

Warranty clauses, coupled with the design-build concept, can provide contracting agencies with added insurance that they are getting quality products that last their designed-life. HB 99-1324 also authorizes CDOT to include a warranty provision that requires the design-build firm to perform maintenance services on the completed transportation project if needed.

14.2 Recommendations

To improve the bid process, and because of the limited time allowed for bid preparation, CDOT should make an effort to provide as much information as possible on the existing field condition prior to bid.

To optimize cost and manpower requirements, unnecessary duplication of efforts in quality control/quality assurance processes should be eliminated.

To encourage more participation and to promote innovation, stipends should be granted to unsuccessful bidders. This would compensate Firms for taking the risk of losing not only the contract but also, the expense involved with submitting a detailed technical proposal. In addition, payment of a stipend will allow transportation agencies access to the bidding firm's innovations, which could in turn, be applied to the project.

CDOT needs to define the scope of projects that will qualify for design-build bidding. Projects of limited complexity and of lower cost may not gain from the advantages of the D-B process. CDOT needs to establish guidelines for the maximum percentage of design completed prior to advertisement for D-B. This project had many items designed prior to advertisement, and the Contractor relied on some of the quantities shown in the tabulations even though they were shown as "For information only". This may not be desirable since incorrect quantities might translate to unintended added costs

CMOs should not necessarily be considered by CDOT as a negative process, if the intent is to improve finished product and to promote innovations.

Value engineering (VE), whenever appropriate should be applied to the design-build projects, even for projects with mandatory requirements. However, it is believed that the best way to incorporate a VE feature in a construction project is with a warranty clause.

Risks should be assigned in a balanced manner to the party who can best manage them. CDOT through its design-build guidelines has tried to limit the risk to the bidder by addressing high-risk items such as right-of-way, and environmental clearances. Items involving latent damages that need repair but cannot be assessed at the time of bid, such as bridge decks under existing pavement, should be treated as a force account item.

Where extra work was warranted, negotiation of the unit prices became a cumbersome task, because of the absence of unit prices. This could lead to higher costs for CDOT. To eliminate

such occurrences, it is imperative to either improve the accuracy of the scope of work or where extra work was warranted have predetermined unit prices (bid tabulation) available.

There is a need to have a clear definition of "Engineer" in the project documents. The standard specifications list duties of the "Engineer". However, when construction problems arose, the Contractor was not sure who was responsible to solve them, their Engineer or CDOT's. This confusion was resolved by clarifying roles in the plan development process. The CDOT Engineer "approved" plans as being compliant during the review process and when plans were issued for construction, it became the domain of the Contractor to follow these plans as they would any other CDOT plans. Questions arising in the field were to be addressed by the Contractor's Engineer. Substantive changes were to be approved by CDOT (or as assigned to the CDOT consultant) prior to final implementation. The Contractor's Engineer addressed bridge rehabilitation items with prior concurrence by CDOT Staff Engineering recommendations (this was a cumbersome process).

The contractor was sometimes confused by having both a CDOT Project Manager on site as well as his consultant Project Engineer. The CDOT manager was on site for plan development, while the consultant was for performing construction Quality Assurance duties. Early in the project, the Contractor would go to the CDOT manager for final decisions regarding construction in the field rather than approaching the CDOT consultant. Subcontractors would approach either Manager to answer questions on the intent of the design, and this sometimes caused confusion from conflicting interpretations. As the project progressed, these conflicts were reduced as roles were more clearly defined. Progress meetings reinforced the roles to all project personnel.

The plans need to be clear of the required separation of the Contractor's Quality Control program from the Contractor's Project Management. After the partnering session developed the roles of project management and project Quality Control, the Contractor's partnering facilitator was assigned by company management to be the project Quality Control manager shortly after scheduling problems arose in construction during the first season. As Quality Manager, he took on duties that, in the opinion of CDOT, were clearly production-related, with Quality Control

secondary to his mission. In the second year, this same person ultimately took the role of project superintendent, with roles highly compromised. To prevent conflicts, it is recommended that partnering facilitator(s) should always be an outside, neutral person, who has no bias. The Quality Control Manager should communicate with, but not report to, the project superintendent. Both should report to the Contractor's Management.

It is very apparent from the experiences on this project that Quality Control needs to be done by Quality Control professionals, and that there is a need to have the work inspected directly by independent Quality Control personnel responsible to someone other than the Superintendent. CDOT needs to have a "boiler plate" Quality Control plan for guidance related to D-B projects, which requires the Contractor to fill in blanks and elaborate as needed for the specifics of the project. This "boiler plate" approach should require the inclusion of acceptance procedures that outline a process that describes the handoff from Contractor acceptance through CDOT concurrence and final acceptance.

The specifications presently require the Contractor to certify the work based on his own Quality Control and he cannot rely on CDOT Quality Assurance test results. CDOT accepts work on traditional projects by Quality Assurance results only (except for paving items.) The specifications should allow acceptance based on his results, or allow CDOT tests to be utilized in his Quality Control process.

Quality Control/Quality Assurance testing duplications. The schedule from the Materials Manual is the same for Quality Control/Quality Assurance. Newer specifications allow for reduced QA testing and this should always be utilized as appropriate.

The plans need to clarify responsibilities of the Contractor related to the amount of flexibility in design. Sometimes the specifications did not elaborate on what constitutes an adequate design. The contractor/consultant proposed solutions insisted that the scope of work limited some of the solutions to temporary fixes and that maintenance would be needed in the long-term for some areas. As an example, some consultant proposed outlet protection designs fell short of solving the

erosion problems. The plans call for reasonable economic alternatives to Engineering problems. However, the Contractor should be limited by specifications in passing problems on to maintenance areas to obtain acceptable quick fixes.

The M-Standards for the project need to be supplemented with tolerances for the construction of items as anticipated for the project. In one example, a slope protector pipe was shown in the M-Standards to extend to the flowline of the ditch below. The Contractor placed the pipe according to the standard, but stopped the pipe one to three feet above the flow line, (the tolerance was not shown in the M-standards) and the Quality Control personnel accepted it as "closely conforming to the specifications". In the opinion of CDOT this work was not within specification and subsequent work was required to correct. To avoid this kind of conflict in the future, the project specifications should require language in the Quality Control Plan that addresses how the acceptability of a completed item will be established, with concurrence of the owner prior to acceptance by the Quality Manager. The bid documents should identify specific tolerances in the plans for miscellaneous standard items or have default language directing the Contractor to request such tolerances prior to construction and completion of such items.

In Region 4, some traffic control items are generally required on concrete overlay projects that are not shown in the M-standards. Special Region requirements such as rumble strips or detour lighting need to be standardized and shown in the plans so these items will clearly be included in the bid.

In addition to these other requirements, there is a need to develop concise "cannot exceed tolerances" for critical items such as sign heights and pole lengths. The Contractor placed sign panels below the M-Standard minimum height and accepted these without CDOT review. This non-conformance was discovered by CDOT after CDOT Quality Assurance measurements contradicted the Contractor's inspection reports. The bid documents need to require the Contractor to have reporting standards that require actual measurements be shown and report all deviations from standards so the owner has review authority prior to Contractor acceptance.

The M-standards need to be tailored to clear up what is optional and what is required. Some language in the M-Standards says "at the direction of the Engineer or plans". Since the plans are now developed by the Contractor, anything "extra" or not specified will default to the cheapest alternative, or to add the higher standard will be considered an extra cost.

Some items do not lend themselves well to a D-B project. Items in which work may be required but cannot be quantified during the bid process should be bid on a planned force account basis. An example of this would be Bridge rehabilitation items. The contract called for replacement of bridge membrane and HBP overlay material. The Contractor was only told in the plans to correct all deficiencies that were tabulated. Upon removal of the HBP on the bridge decks, some damage to the bridges was found (latent damage) that was not addressed in the plans. Others had no damage where there was some listed. The Contractor had difficulty bidding the work, and his bid reflected the worst case condition to eliminate his risk. Incorporating a force account item for this work as well as outlining who will be responsible for determining the work to be performed will save costs. The present field evaluation process was not clearly defined in the specifications. CDOT should review Contractor's engineer's repair proposals, ensuring control of the decision making process.

The bid documents need to specify a clear method to determine fair costs for change orders. Since the project is a lump sum, there were no unit prices, making it difficult to establish costs for added work. Prices were negotiated based on CDOT Cost Data costs, not costs provided contractually by the Contractor. Some added work had to be done by force account due to excessive costs proposed by the Contractor. In the future, perhaps the Contractor should tabulate unit costs in the bid package. In combination with a specification that clearly defines "extra work", these costs could be used to negotiate added work.

The bid documents need to outline the necessary documentation for work requiring agreements with outside agencies. The plans required the Contractor to carry railroad insurance for work within the BNSF Railroad's ROW. The Contractor "worked out" an informal agreement with the local railroad official. No written agreement was forwarded to CDOT until the end of the

project, and this letter, co-authored by the railroad and contractor, indicated only that "all work was acceptable", without specifying the actual work performed. The local railroad authorities accepted an informal agreement from the Contractor, whereas on design-bid-build projects, CDOT would be required to provide a formal agreement. It is not clear that the Contractor's informal agreement resulted in a savings to the project or that it was a shortcut that resulted in a windfall to the Contractor for short circuiting CDOT's normal agreement process.

The bid documents should include language that requires the Contractor to conduct specific additional surveying at areas known to be problems. A preliminary survey was included in the bid package. However, during construction, additional surveying was not conducted to properly tie in bridges to the new roadway as is normally done on a CDOT Design-Bid Build project. As a result, some concrete pavement and approach slabs had to be removed or repaired at the Contractor's expense. This extra work could have been avoided with additional surveying and inspection. The problem was exacerbated when the Contractor held his own consultant responsible for the errors. Also, the Contractor did not require the earthwork sub-contractor to field verify of grading out of compliance with the plans. The Quality Control manager did not have the survey crew verify designs, as would a CDOT crew. The specifications should be supplemented to have a design intent verification process in place so preventable problems are addressed before the work is completed.

D-B projects should incorporate more end-result specifications rather than proscriptive specifications. This will encourage innovations in designs. Exceptions to this might be CDOT preferences such as concrete vs. asphalt surfacing.

When possible, it would be desirable to award the project up to 6 months before construction to allow for advanced design and Quality Control Plan development. This would allow the Contractor time to fully develop his project management and quality control strategies.

The specifications should explicitly direct the Contractor to which documentation will be required at he completion of the project. Presently there is contradictory information specified

and different Engineers may have different standards for accepting a project. The As-Constructed plan documentation requirements should be detailed in the specifications

The specifications should indicate the documentation that should be retained by the Contractor at the end of the project. The Contractor submitted all diaries, correspondence, tickets, survey notes and test results to CDOT and retained very little for his own records. The Contractor's Engineer turned in design notes and final terrain conditions, but it was not specified what to retain for his own records. CDOT accepted information from the Contractor at the end of the project with the condition that the documentation submitted was only back up documentation. CDOT's position was that it not be held responsible for missing information should a future audit be required, and the Contractor would be in possession of his own information.

CDOT needs to have a design-build Finals process established. Presently, the Contractor's acceptance process may not be in compliance with traditional Finals procedures. The design-build plans do not require a strict accounting of all of the quantities which is inconsistent with traditional final requirements. Requirements to verify pay quantities are not necessarily important to the Contractor, who is more interested in payments according to his progress schedule. These issues need to be integrated into the specifications during the initial design with the concurrence of the Finals Engineer.

The bid documents need to clarify the work that is additional as a result of the hydraulic review. The hydraulic review was completed as outlined in the specifications. The project is a lump sum bid, but this review occurs after the project is awarded. The results showed need for outlet protection, but the contract documents did not address specifically who pays for this. An item should be set up to pay for these unknowns, possibly as a force account item. The plans also stated that the Contractor will not be reimbursed for designs required by the hydraulic review, and this makes the Contractor subsidize the costs for designs that he is not aware he will need to develop at the time of bid.

The project documents need to hold CDOT harmless for disapproval of design proposals that incorporate unproven practices and innovation. On this project the Contractor was directed to remove and replace the bridge membrane. There is no standard for this work and it was left to the Contractor to determine how this should be accomplished. The project specifications requiring replacement of bridge membrane was a new process for contractors in Colorado. This work was specified as "...Existing asphalt on the decks and approach slabs shall be removed and the surface of the decks will be sandblasted clean per the specifications." This process proved to be all but impossible to remove membrane without damaging the underlying bridge deck and ended up costing the Contractor a considerable amount of time and money to complete. In general, when CDOT plans direct the Contractor to perform a task that has not been proven to be successful on other projects, or no specifications apply, the project specifications need to require the Contractor to produce specifications and require specific outcomes. These specifications submitted by the Contractor should require approval by CDOT prior to commencing the work.

Innovations should be allowed under conditions that meet certain minimum guidelines outlined in the specifications (i.e., industry standards). A statement in the plans should provide for some kind of warrantee and hold CDOT harmless for proposals that are not accepted.

The Contractor needs be required to have a minimum level of Quality Control personnel to ensure the work is adequately inspected. CDOT's opinion may differ from the Contractor in determining what level this is for any given Contractor or construction operation. There needs to be a standard to address what constitutes minimum coverage.

Some items had no cost associated with them and upon testing, occasionally required price adjustments. Since it was a lump sum bid, there was no cost basis for this. The contract documents need to include a single page in the specifications that summarizes the cost basis for all price incentives/ disincentives and price reductions, including HBP and Concrete items.

Region policies that deviate from standards need to be outlined to ensure fair bidding. There is a need to separate personal preference from requirements (i.e. Region 4 disallows "beaver slide" embankment protectors, the M-standards don't.)

Presently mobilization payments are automatic in PCPAL (CDOT's contractor payment software package) and are a separate salient feature in the Contractor's pay request. Accurate payment cannot be made to the Contractor based on a percentage of work completed because of the large contract total and the fact that PCPAL can only carry decimals out 3 places, which caused substantial rounding errors.

Due to the two-year duration of the project, the M-standards changed during the life of the project. Large projects may last several years and may need to update some items after the project is awarded. On this project, the M-Standards for median end sections changed and this did not get incorporated into the plans at the time of bid. Project personnel were notified of the change late in construction and added the work by CMO.

The bid documents need to specify a minimum number of "salient features" to show in the payment schedule. These features would help to break down items logically for both CDOT and the Contractor.

The bid documents need to clarify what the Contractor's certification requirement means as it relates to the Engineer's certification. Presently (and rightly so) the Contractor is willing to certify anything the Engineer will sign off. This appears to be a redundant requirement.

The sub contractors bid specific portions of the project on a unit cost, and did not share in the profits if there were underruns in the items. This method of subletting work caused problems with certain items being left out of the bid in areas of sub contractor overlap. For example, at approach slab replacements on the mainline, one sub contractor removed the old slabs; another reconditioned the sub grade prior to placement of new slabs. The Prime Contractor did not have any sub-contractor responsible to place the required base course under the new slabs and

pavement. This caused problems for the Prime Contractor, since this directly reduced his profits as he had to place the material at his own expense. This is a Contractor-related problem that affects CDOT only in that the lost Contractor profits translate into scrimping elsewhere on the project. Pitfalls such as this may be something that contractors will learn over time, or they could be discussed at the pre-bid conference.

The original plans allowed the Contractor to choose the method of leveling under the overlay. It was assumed that the traditional method of prepaving with HBP or concrete would be proposed. The Contractor proposed the use of millings under asphalt, since this was allowed on another CDOT project in another region. This was a new process and acceptability needed to be determined by CDOT. Design-build projects should not be in the position of deviating from standards as establishing new minimum requirements. Specifications that list grading, compaction requirements and anything untried or unused by CDOT need to be reviewed well in advance by CDOT.

CDOT needs to track added costs and deductions during negotiation with the Contractor to keep a balance on the project. Since design/build is still a low bid process, there is in reality little give and take. In the opinion of CDOT, the Contractor expects to keep most of the savings while passing on most perceived costs to the owner.

The bid documents need to address a process that will be developed during the project to deal with the repair of deficient work. For example, the Contractor would fix spalls at the edges of concrete slabs without CDOT's knowledge or approval, often inadequately. Many spall repairs ultimately failed prior to project acceptance and CDOT directed correction. The Contractor took the approach that once a repair was complete, the work was acceptable whether it was adequate or not. There also appears to be a need to outline approval and scheduling processes. An example would be shoulder damage due to earth haul operations with scrapers. The Contractor ignored extensive damage to the shoulder and CDOT Quality Assurance had to step in to direct corrective actions. The plans need to outline a process to receive written requests from the

Contractor for an acceptable repair procedure to be submitted and approved prior to commencement of the remediation.

There is a need to have specifications that define the difference between uncompleted work and punchlist items.
The Contractor's punchlist was 7 items long and vague when they requested final acceptance. CDOT had a list of over 150 specific uncompleted items at the time of requested final acceptance. Such a discrepancy points out the need for more clarity regarding acceptance of items.

The Contractor did not adequately stake slopes as designed and approved. The sub-contractor changed historic drainage contrary to the plan requirements and had to replace excavated material from ditches with embankment. The QC1 process did not verify that earthwork contractor was following the plans.

The contract documents should state that the Disputes Review Board needs to have a final meeting to settle all outstanding issues prior to their release, and if there are unresolved issues, come up with process to settle issues. The Contractor was reluctant to use Disputes Review Board whereas CDOT strongly encouraged their use to settle issues.

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Appendix A

INNOVATIVE CONTRACTING PRACTICES
SPECIAL EXPERIMENTAL PROJECT NO. 14

COLORADO PROJECT NO. IM-IR(CX) 025-3(113)
OWL CANYON NORTH
WORK PLAN

I. INTRODUCTION

A. The Project

The Colorado Department of Transportation proposes to procure both the design and construction of Interstate 25 North of Owl Canyon with a single contract. The Project is the final portion of the reconstruction of the concrete pavement from State Highway 66 to the Wyoming State line. A narrative Project summary and location map is included as Appendix A.

B. Approach and Scope of this Proposal and Work Plan

The nature and scope of this project makes it a good candidate for design/build contracting. This proposed Work Plan will:

- Describe the innovations CDOT proposes to use.
- Outline the currently planned project time line.
- Describe the parameters planned for evaluation.
- Describe the proposed evaluation methods.
- Describe the reports proposed to document the evaluation.

These elements are further detailed within the Project Special Provisions Sections 103 and 110.

II. PURPOSE/DESCRIPTION

A. The Innovations to be Evaluated

This will be CDOT's first use of design/build for a partially designed highway project. It will be an excellent opportunity to directly evaluate the methods of design/build for Colorado highway projects. This project can be used to compare with another approved CDOT design/build project IM-IR(CX) 070-4(143). Use of design/build on this project will allow CDOT to gain experience on the advantages and disadvantages of partially designed proposals.

CDOT will be able to evaluate the administrative and institutional impacts for administering this type of project. In addition, CDOT will evaluate resource requirements for the initial development of the bid and compare it to anticipated design/build construction cost savings.

Additionally, many of the technical aspects of the concrete reconstruction warrant use of innovative design and construction practices. CDOT will evaluate the effectiveness of performance specifications, and their impacts on reducing project costs, accelerating the schedule, and producing a quality end product.

CDOT is proposing an incentive/disincentive clause to enhance the overall quality and savings of the final product and control long term costs.

B. Specific Items to be Evaluated

1. Evaluate current design/build ideals. Available experiential data and generally recognized construction industry sources say that design/build is advantageous and preferable to design/bid/build in terms of the following factors:

- Reducing project delivery time
- Reducing change orders and claims and therefore additional contractor compensation
- Reducing total project costs
- Enhancing quality
- Providing user satisfaction
- Stimulating innovation
- Permitting flexibility in designs, materials, and methods

CDOT proposes to evaluate each of these measures within the framework discussed in Section V. below.

2. Effectiveness of Design/Build Methodology. There are specific procurement and contracting methodologies that will be applied and evaluated in CDOT's design/build process. These include the following:

   - The contractor selection process, such as the appropriateness of the selection criteria, the responsiveness of the contracting community, and the competitiveness between proposals.

   - Coordination of technical disciplines, value engineering, and conventional practices for a highway project that features extensive roadway design and construction.

   - Cost plus time bidding procedures

   - Combining elements partially designed by CDOT with those exclusively designed by the contractor.

   - A low bid award approach combined with review of the technical proposal to fully evaluate the contractor's capabilities.

   - Use of performance specifications to increase accountability for costs and quality.

3. Product improvement through incentive/disincentive payments. Final product performance and construction phasing will be enhanced by providing the design/build contractor incentives to provide quality materials, products and construction methods in the completed facility with minimal disruption to the traveling public.

III. SCOPE

A. Low Bid Approach

CDOT has selected this project as design/build because of the opportunity to reduce administrative burden and promote innovative project financing. The low bid procurement approach will be used to determine the eligible design/build firm. The CDOT Design/Build Manual (Appendix B), details the bid evaluation criteria. The design/build contractor's effort level will be determined

according to performance specifications. The contractor will need to verify CDOT designed items for accuracy and completeness.

CDOT will provide all prospective design/build contract teams with preliminary plans and project specifications (Appendix C) at a constructability meeting. These plans are subject to minor revisions prior to advertisement period. The contractors will be given final plans and survey data at the time of project advertisement.

All contractors interested in bidding on the contract must be on CDOT's pre-qualified list. The pre-qualification criteria will be consistent with current procedures, including bonding issues. The design/build contract teams attendance is required at the pre-bid conference to review and discuss project plans and other related items.

The contractor must provide several items with the bid proposal including: technical proposal, price proposal, qualifications of the design team members, financial standing of the contractor, and the design/builder's understanding of the design/build project. The price proposal will be used to determine the apparent low bidder. The technical proposal will be reviewed by a committee to determine if the low bidder complies with the requirements of the bidding package and verify the responsiveness of the combined proposal. This detailed analysis is described within the CDOT Design/Build Manual (Appendix B). Failure to meet the minimum criteria will result in disqualification of the bid.

B. Physical Description

The project is described in narrative and graphic form in Appendix A.

Anticipated project cost for the improvements is $25 million. This estimate is based on current CDOT engineering and economic indicators.

IV. SCHEDULE

The projected opening of the new facility in November, 1998. In order to meet this opening deadline, CDOT has established the following project milestones:

Milestones:

Preliminary Notice for interest	October 1997
Advertise Project officially	November 1997
Pre-bid Conference	November 1997
Receive proposals (Bid Opening)	December 1997
Award Contract	January 1998
Project Open to Traffic	November 1998

V. MEASURES

The following is a summary of the project parameters, baseline indicators and future anticipated project accomplishments.:

Parameter	Baseline	Project Accomplishment
Total design and construction time	CDOT's experience with project of comparable size and complexity	Compare project with traditional low bid practices, and evaluate completion times for design and construction activities
Change orders and claims	CDOT's experience with change orders and claims for projects with similar scope of work	Evaluate level of change orders and claims resulting from design/build process
Total project cost	CDOT's preconstruction costs for projects with similar scope of work	Evaluate project cost reductions (or increases) using design/build process
Quality	CDOT experience with comparable projects constructed using traditional contracting methods	CDOT and contractor will assess the achieved level of quality using design/build procurement
User satisfaction	CDOT experience for projects with similar scope of work	Evaluate future user satisfaction
Stimulation of innovation; Flexibility in design, materials, and methods	Current state-of-practice for design and construction techniques	Evaluate design and construction practices used and determine successfulness of applications
Design/builder selection process	CDOT Design/Build Manual "Prequalification Requirements"	Evaluate effectiveness of evaluation criteria and employ possible changes for future design/build procurements
Coordination of disciplines and trades	CDOT and consultant experience for projects with similar scope of work	Evaluate effectiveness of contractor/consultant/ CDOT coordination methods used in design/build
Performance specifications	Not applicable	Evaluate cost and quality improvements using performance specifications. Identify effective performance specifications and determine applicability for future use.
Best value procurement	Not applicable	Evaluate the cost plus time process applied for this project
Overall design/build process	Not applicable	Evaluate proven beneficial design/build elements and recommend application on future projects
CDOT design items	CDOT and consultant knowledge on projects with similar scope of work	Determine effectiveness of integrating CDOT design elements with contractor's final proposal

VI. REPORTING

Three reports will be prepared by the CDOT during the design/build project for evaluation purposes.

Initial Report - The initial report will be prepared within 90 days after the design/build contract is awarded. The report will include a comparison of proposals received to design proposals and construction bids under a conventional design/bid/build; a discussion of differences in the proposals; documented reactions of the industry to the process; a description of the procedure used to select the contractor; and a discussion of any problems or issues that have developed as a result of the design/build process

Interim Report - Interim reports will be submitted annually and in the event of a significant development related to the design/build process. The interim report will include project progress to date, design/build problems or issues, and a comparison of the current project status compared to the project status using a conventional design/bid/build process.

Final Construction Report - An final report will be prepared for review within 90 days after the completion of the initial project performance testing. This report will provide an evaluation of the design/build process as applied to this project. The project will also be evaluated using appropriate sections of the criteria established in the MEASURES section of this proposal. Recommendations for future use of the design/build process will also be included in the report. The report will summarize beneficial items, improvement areas, and items not recommended for future projects.

Appendix B

CRCC/CDOT
Owl Canyon North Builders
Project Charter

February 19, 1998

WE, THE MEMBERS OF THE CRCC/CDOT HIGH FIVE PROJECT, ARE COMMITTED TO WORKING TOGETHER IN A SPIRIT OF COOPERATION, TRUST, RESPECT, INTEGRITY, HONESTY AND FAIRNESS TO SUCCESSFULLY COMPLETE THIS PROJECT BY ACHIEVING THESE GOALS:

- Safety – No injuries.
- Quality – Maximum incentives, highest Quality Level possible.
- Win the ACPA awards (local and national).
- Win the Marvin M. Black Partnering Award.
- Have fun.
- Earn a profit/stay within budget.
- No use of the Dispute Resolution Board
- Project will be a model for future Design/Build work.
- Positive public relations.
- No complaints.
- Full use of PR tools.
- Earn the maximum incentive for time.

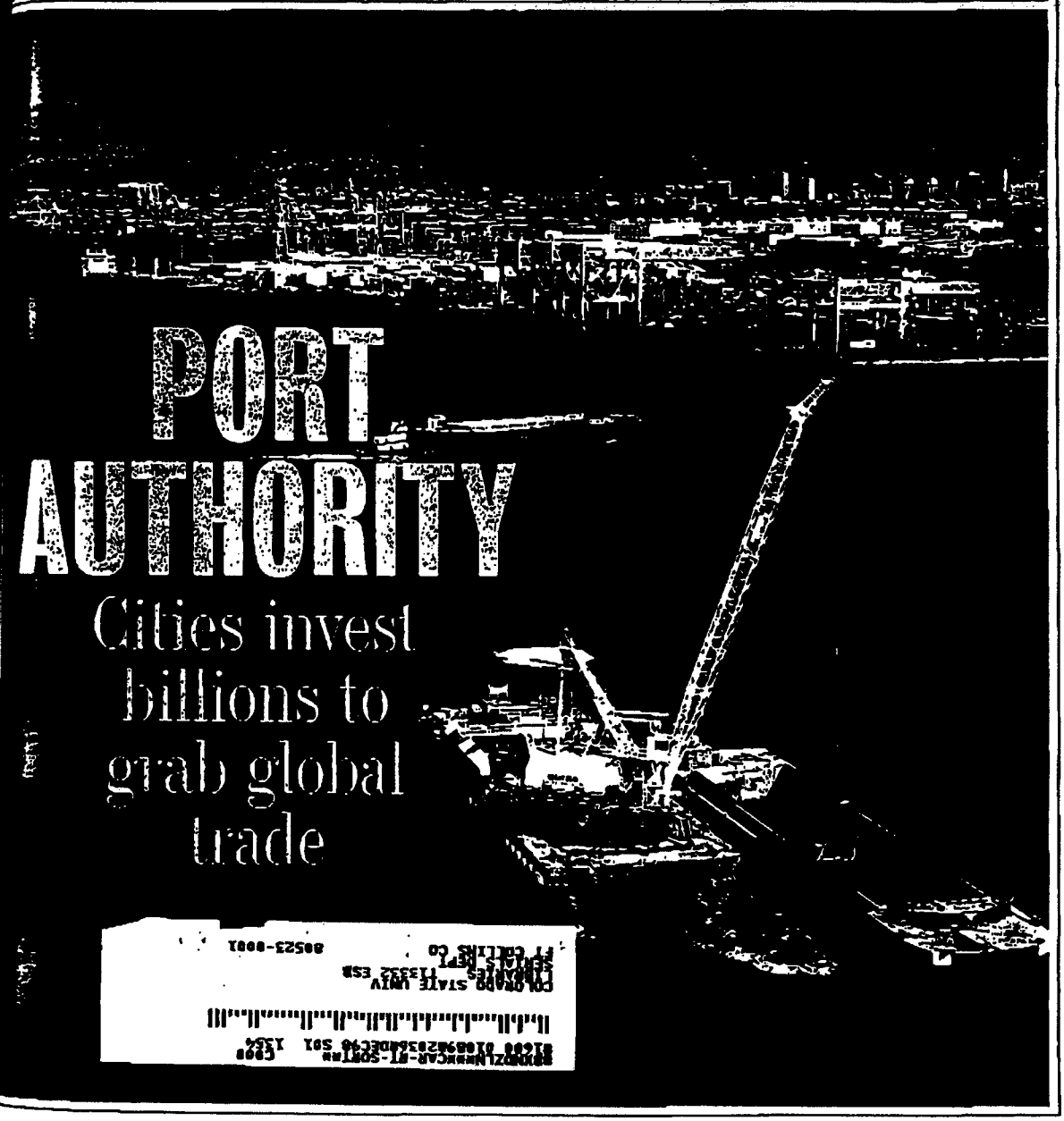
E CONSTRUCTION WEEKLY

ENR
Engineering News-Record

▶ **TRADE:** Clinton and China's Jiang agree to open China's nuclear power market to U.S. vendors

▶ **PROCUREMENT:** Tensions simmer in Greenville, S.C., as contractors fight to force county to preserve competitive bidding

A PUBLICATION OF THE McGRAW-HILL COMPANIES NOVEMBER 10, 1997



PORT AUTHORITY

Cities invest billions to grab global trade

THE MIDDLE EAST DESALINATION RESEARCH CENTER

Announcement of Availability of Tender Package (RFP)

On October 5, 1997; Mr. Eric R. Jenkel, Director of the Middle East Desalination Research Center located in Muscat, the Sultanate of Oman, announced in Madrid, the availability of tender package, series 97-A, which included ten (10) specific research projects in the field of desalination technology and related fields. The Center will provide 50% funding for selected proposals and requires at least one (1) partner on the proposal from the Middle East/North Africa (MENA) region.

Interested persons, firms and institutions can download the tender package over the internet at http://www.medrc.org.om, or may contact the Center via fax at (968 - 697107). Contact Person: Mrs. May Cook, Middle East Desalination Research Center, Wav 2840, Villa 2985, Shati Al Qurm, Tel: 968 695 351, 968 607 661, Fax: 968 697 107, E-mail: mcook@mail.medrc.org.om, http://www.medrc.org.om

The Middle East Desalination Research Center was conceived as a result of the Middle East Multi-Lateral Peace Process. The Center is dedicated to basic and applied sponsored research in the area of desalination technology.

Initial funding was obtained through significant contributions from the founding members: The Sultanate of Oman, the State of Israel, the United States of American, Japan and the Republic of Korea. The European Union has also pledged funds for research and is expected to become a member of the Center.

CLASSIFIEDS

MTA-New York City Transit Notice CM-1076

The New York City Transit Authority will require the services of several Engineering Consultants for the design of various Station Structural Remediation, Platform Roof and Canopy type projects (including subways, elevated and embankments/out structures in the NYC Rapid Transit System for the 1996-1999 and 2000-2004 construction award program. The Authority intends to facilitate the Consultant selection process by establishing a pre-qualified pool of eligible Consultant firms. In accordance with the procedure briefly outlined below, these pre-qualified firms will be asked to submit proposals for the various projects as the need arises. Generally, the work under these projects will provide engineering and architectural services incidental to the design and preparation of contract documents in order to restore deteriorated components of each station to a State of Good Repair, cure water leakage conditions, incorporate applicable provisions of the Americans with Disabilities Act, including elevators/escalators if required. Associated with this work will be design for station elements impacted by the proposed work, including but not limited to: station lighting, public address systems, signage, and finishes. Where opportunities exist, the specific scope requirements for a project may call for improving station operations and appearance, and removing abandoned or obsolete conduit, pipe and equipment. Estimated breakdown of work is approximately 50% Structural/Civil, 15% Architectural, 10% Mechanical/Hydraulics, 10% Electrical, 5% Signals/Communications, and 5% Estimating. Up to 10 projects will require consultant design services. Up to 6 contracts will be awarded from the pool. The stations may be grouped in packages of more than one station. Duration of each contract will be 48-60 months, including 9 to 12 months for design.

Construction cost range of each station remediation is estimated from $2.0 to $40.0 million.

Consultants desiring to be included in this pool must respond by submitting a letter of interest and one copy of SF254/SF255 forms completed in accordance with the directions contained therein, referencing File Number CM-1076. The submission must be received by the Authority no later than 12:00 Noon, Tuesday, November 25, 1997. Based on the submittals received, an initial "short list" of up to 20 consultants shall be prepared. The consultants on the initial short list will be asked to provide various submittals required by NYCT and make a brief presentation to the Authority. Based on that, a pre-qualified pool of up to 10 consultants shall be established. Consultants shall be randomly ranked within this pool and 3 to 4 consultants shall be sequentially selected to propose, as projects and funding become available. Not all consultants in the pool will be awarded contracts.

The Authority reserves the right to implement the selection process to optimally meet its needs including the right to remove a consultant from the pre-qualified pool if conditions that led to the firm's selection have changed.

Please note: In evaluating a Consultant's response to this advertisement, the Authority will consider only the information furnished on the Federal SF254/255 forms in accordance with the directions and requirements contained therein, and information contained on Transit Authority prior performance evaluation forms, if any. The Authority therefore requires all Consultants to refrain from submitting anything other than what has been requested.

Send submission to:
New York City Transit Authority
Procurement
Capital Program Management
130 Livingston Street, Room 6031e
Brooklyn, NY 11201
Attn: Joy C Bennett

State of New York Department of Transportation

Sealed bids for the following projects will be received in an envelope annotated with project name and number until 10:30 am on December 11, 1997 at the Contract Management Bureau, NYS Dept of Transportation, Bldg 5, 1st Floor, 1220 Washington Avenue, Albany, NY 12232 and will then be publicly read. A certified or cashier's check payable to the NYS Dept of Transportation for the sum specified in the proposal or a bid bond, Form CONR 391, representing "25% of the bid total" as specified in the contract proposal, must accompany each bid. Plans and proposals can be obtained from the Sale of Plans Unit, Rm 109A, at the above address; the Department of Transportation, One Hunters Point Plaza, 47-40 21st St, Long Island City, NY 11101; and the Regional Offices noted below. The right is reserved to reject all bids.

Reg 10, C Siracusa, Reg Dir, NYS Office Bldg, Veterans Memorial Hwy, Hauppauge, NY 11788

D257476, Nassau Co, FA Projs 315-0756-085, 33D-0756-085, Rehabilitation of Doughty Blvd Bridge (Atlantic Beach Bridge) over Reynolds Channel in the Villages of Lawrence and Atlantic Beach, PIN 0756.85. Bid Deposit $1,500,000, Plans $49, plus $6 Postage. A pre-bid meeting will be held at the regional office. Bidders are strongly advised to attend.

Reg 11, R Maitino, Reg Dir, 47-40 21st St, Long Island City, NY 11101

D257477, Bronx Co, Installation of a Traffic Management System on Various Routes in New York City, PIN X726.84, Bid Deposit $750,000, Plans $49, plus $6 Postage. This contract requires night time work. A pre-bid meeting will be held at the regional office. Bidders are strongly advised to attend.

Colorado Design/Build Project

The Colorado Department of Transportation (CDOT) is proposing to advertise on November 6, 1997, a design/ build project IM-IR (CX) 025-3(113) to reconstruct 17 miles of Interstate 25 north of Denver. The project is approximately 8 miles north of Wellington beginning at MP 282 and extending north to the Wyoming border. The design/build work includes the placement of a 10 inch concrete overlay. Other work elements include interchange modifications, side slope flattening, ramp lighting, guardrail, signing, minor structures, and drainage. Preliminary plans and survey information in electronic form will be available to be provided to interested parties on or about Oct 27, 1997. Plans are subject to change up to the official ad date, but the survey data is in its final form. The award will go to the low bidder. Time and cost will be the basis of the low bid. Mainline traffic is required to back into the present four lane configuration by November 1, 1998. The current budget for the project is $25,000,000. For additional information please contact Pete Graham at (970) 667-4670 or Mac McKee at (970) 350-2142 or Internet e-mail at peter.graham@dot.state.co.us.

Appendix C

Explanation of Contract Modification Orders (CMO) on the project

CMO #2 - Buckeye Interchange Closure (No Cost to project)

This CMO was written to allow the Contractor to close an interchange during the construction to facilitate construction phasing. The plans allowed for the closure of the Carr interchange but not the Buckeye interchange. the Contractor proposed the closure of the Buckeye interchange instead of the Carr Road interchange due to the fact that it could be serviced from the south by the existing paved frontage road. Traffic counts of both interchanges revealed that the ADT of both was low, Carr was 50 ADT and Buckeye was about 100 ADT. This essentially means that closure of either interchange has nearly the same impacts. There were no additional costs related to this change. The detour signing and traffic management would be similar for either the Carr or the Buckeye detour. Signing on I-25 remains the same and local detour signing would need to be posted at the same proximity to the detour route regardless of location.

This change did not affect the overall schedule of the project above that originally allowed in the plans. Closing of the Buckeye Interchange involves the same type and amount of work operations as the closing of the Carr Interchange. Due to this, no change in the project time count was warranted.

CMO # 3 - Modify High Mast Lighting (Cost savings $84,140)

This CMO was executed to allow the Contractor to provide lighting consistent with the plans at an overall cost savings to the project. The original plans showed six 80 foot high mast lights at each of the two interchanges on the project. The lighting requirement for the design was to allow for minimal lighting. This level of lighting was to be obtained utilizing the 80 foot masts. the Contractor proposed replacing the several eighty foot masts with 120 foot poles in conjunction with 40 foot posts to obtain minimal lighting at a substantial savings to the project.

CMO # 4 -Modified Bridge Approach Slabs (Cost to project $28,149)

This Item was added to the project to minimize maintenance of the several approach slabs on the project. The bridge plans showed 14 foot wide approach slabs that were to be placed at all bridges. Several structures are skewed. In accordance with Region 4 policy, approach slabs are to be "squared off" to eliminate acute corners on the slab and reduce potential random cracking. the Contractor was compensated for the additional materials and work required by this change.

CMO # 5- Bicycle Detour Signs (Cost to project $19,736)

This CMO was written to direct the Contractor to provide a bicycle detour on the project during two lane operations. A bike route detour was not required by the project documents and this CMO added the work with additional compensation to the Contractor.

To construct the project, traffic will be detoured to two lanes in either the northbound or southbound lanes while the other side was being rebuilt. While the traffic was detoured, there only a four-foot shoulder on the interior lane for southbound bicycle traffic during the 1998 season and northbound bikes in the 1999 season. During two lane operations, traffic on the highway will be constrained in their lanes by tubular cones, which are placed on the yellow line place over the present skip lines. These cones prevent traffic from "shying" away from objects such as bicycles when they are encountered on the road. The weather patterns in northern Colorado at the project site are predominately windy. The speed limit in the construction zone was 65 mph. It was determined that given the volume of trucks on the highway, the wind drag caused by the trucks as well as the wind on the bikes will cause conditions which would be extremely dangerous to all traffic.

The traffic control specifications did not indicate to the Contractor during the bidding process that signing for a bicycle detour would be needed. the Contractor was directed to place a detour, and this CMO compensates the Contractor for the additional work. The attached spreadsheet provides a force account analysis of the work. The work includes placement of the signs over 50-mile round trip locations off of the project.

CMO # 6 –Modify Weather Monitor (Cost to project $10,447)

This item was added to the project to compensate the Contractor for work not identified in the plans as part of the scope of work. the Contractor was directed to replace an existing weather monitor's roadway

and bridge sensors removed during reconstruction operations. The bridge temperature sensor was epoxied into a bridge deck and it was impossible to reuse it after it was removed during milling and paving operations. A roadway sensor was also imbedded in the adjacent existing concrete pavement and had to be replaced.

CMO # 7 – Not Used

CMO # 8 – Closure of the Carr Ramps (Cost savings $15,000)

This CMO was written to allow the Contractor to perform a short term closure of ramps to facilitate construction, incorporating a disincentive to ensure a minimal time frame of the closure. The change order also added specifications for fast track concrete to the contract.

The Contractor proposed paving the mainline through the existing northbound Carr Exit on and off ramps in one complete operation to provide a better riding surface on the northbound mainline. This operation avoided placing gaps on the mainline in the ramp areas where ramp traffic would be maintained during construction as shown in the plans. The plans call for slip ramps that traverse the mainline, requiring the paving machine to leave a gap in the concrete to maintain ramp traffic temporarily. This gap would then be filled with concrete in the second phase of this operation while traffic was routed on a new alignment over the newly paved mainline. The advantage to CDOT to do this in one phase was that it eliminates in two headers at the gap location that generally require grinding to correct the resulting bumps resulting from the two phase method.

This option resulted in a cost savings to CDOT. The original plan required the Contractor to place two temporary ramps, and these were eliminated by the CMO.

CMO # 9 – Contract Time (No Cost to project)

This CMO was written to correct language in the Contract (form #85) regarding contract time. The last paragraph on page 5 of the Contract incorrectly indicated that work must be completed within 260 *calendar* days. This CMO revises the paragraph to state that substantial completion must be accomplished within 260 *working* days per the Project Special Provisions.

The project was bid as an "A+B" contract. Section 103.01, page 27a, of the Revised Project Special Provisions states that a bid adjustment will be made for the value of time. "This adjustment will be made using the Contractor's proposed number of working days to substantially complete the project..." the Contractor submitted a bid with the intent that substantial completion will occur within 260 working days.

CMO #10- Core Shoulders for Thickness (No Cost to project)

This item was added to the project to assure proper thickness of the shoulders due to the Contractor's method of leveling. The plans originally called for the entire roadway surface to be overlaid with concrete. In 1992, the driving lanes were overlain with two to four inches of HBP tapering off into the 4' and 10' shoulders. This left a wedge for the Contractor to level prior to PCCP placement on the project. The method of filling the wedge was left to the Contractor.

The Contractor elected to mill down portions of the driving lanes and to level the shoulder areas with millings to control the amount of concrete in the overlay. This method added the possibility of thinner than planned shoulders after placement of leveling course that was not accounted for in the original specifications. The project specifications do not provide for verification coring of the shoulders. This CMO added thickness coring on the 10-foot shoulder in addition to the driving lanes to verify planned thickness. The frequency of coring was also increased to ensure that the driving lane thickness was verified at rates per the original intent of the specifications. This added coring was done at no additional cost to the project.

CMO # 11- Dowel Bar reimbursement (Cost savings to project $30,876)

This CMO was written to reimburse CDOT for the deficiency of dowel bar placement. When the Contractor began paving the north bound pavement, it was discovered by the Contractor's Quality Control personnel that the Automatic dowel bar inserter was not set at the correct configuration as shown in the plans. The insertion was incorrectly set 1 foot away from the 10 foot joint, leaving one dowel out of the pavement on the 4-foot shoulder joint. This lack of a dowel bar in the driving lane will result in a shortened theoretical design life for the pavement. the Contractor agreed that an appropriate value for this omission to CDOT would be the cost required to actually retrofit the dowel bar into the joint. This

cost was based on the work it would take (present value) to saw slots in the pavement, place dowels into the concrete and grout them in.

CMO # 12- Add Steel Sign Posts (Cost to project $20,561)

This CMO was written to change the timber sign posts on the northbound side of the interstate to meet the current design standard of steel posts. The contract required the Contractor to place timber sign posts on all of the signs within the project limits. During the first phase of the southbound work all Class I and II signs were replaced with timber posts. After completion of the southbound sign placement, use of steel sign posts had become the standard in the Region because they are easier to maintain. the Contractor was compensated for the incremental costs to change materials.

CMO # 13, C-A-T End Anchorages (Cost to project $89,647)

This CMO was added to the project to change from the existing type 3F end sections in the median guardrail locations to the new C-A-T terminals. New M-Standards were issued after project award that replaced 3F end anchorages shown in the plans with the newer and safer "C-A-T" or "Brakemaster" terminals. The CDOT Specifications Unit stated that the 3F's were no longer specified and that the "C-A-T" or "Brakemaster" terminals were desired. the Contractor was compensated for the incremental costs required by the change.

CMO #14, Mainline Concrete Repair Work (No cost to the project)

This CMO was added to set conditions for the repair of damaged, misplaced or thin PCCP on the project. the Contractor moved his batch plant off site and needed to make repairs using material from another supplier who did not have a fast track mix that incorporated a maturity meter. The CMO allows strength to be determined by cylinder breaks and adds a reasonable allowable time period for the work to return traffic to normal.

CMO # 15, Additional Paving and Patching on the Frontage Rd. (Cost to project $441,453)

This CMO was added to the project to pave the frontage road at various locations between Owl Canyon Road and Buckeye Road within the project limits. This work was not originally outlined in the project requirements. Portions of the frontage road were seriously deteriorated requiring patching and paving.

the Contractor was directed to perform the work, including related shouldering and striping as well as added traffic control.

CMO # 16, Added Unit Costs for Price Reduction Calculations (Cost savings to project $2,108)

This CMO added unit costs for out of specification work. During the project, test results indicated that price reductions were required for several items. Because this was a design build project, there were no unit costs set up in the bid tabs for this. To address this issue, CDOT and the Contractor negotiated costs to be applied in the price reduction formulas.

REPORT PUBLICATION LIST
CDOT RESEARCH

2001-1 Stone Matrix Asphalt in Colorado
2001-2 Review Of The Public-Private Initiatives Program Of The Colorado Department Of Transportation
2001-3 Evaluation of Design-build Practice in Colorado, Project IR IM(CX)025-3(113)
2001-4 Bicycle Friendly Rumble Strips

2000-1 PCC Texturing Methods - Final Report
2000-2 Early Evaluation of SPS-2 Experiment in Colorado
2000-3 Life Cycle Cost Analysis: State of The Practice
2000-4 Interstate Asphalt Demonstration Project NH0762-038 (Rubbilization) - Construction
2000-5 Performance of Geosynthetic-Reinforced Walls Supporting the Founders/Meadows Bridge and Approaching Roadway Structures
2000-6 Bicycle and Walking in Colorado: Economic Impact and Household Survey Results
2000-7 Long-Range Cost Estimation Research Project
2000-8 Rehabilitation Strategies for Asphalt Pavement
2000-9 Calculation of Bridge Pier Scour using the Erodibility Index Method
2000-10 Effects of De-Icing Agents on Corrosion of Vehicles
2000-11 Enviromental Liability Study
2000-12 Evaluation of Caliber M1000 DeIcer
2000-13 Review of the Public- Private Initiatives Program of the Colorado Department of Transportation
2000-14 Improvements to Mobility Performance Measure Calculations
2000-15 Estimating Link Travel Time On I-70 Corridor: A Real-Time Demonstration Prototype

99-1 Colorado Rockfall Simulation Program Update
99-2 Effects of Magnesium Chloride on Asphalt Pavements: Quick Study
99-3 Effects of Geometric Characteristics on Interchanges on Truck Safety
99-4 Initial Curing of Portland Cement Concrete Cylinders
99-5 Evaluation of Design/Build Practices in Colorado
99-6 Improving Colorado Transportation through Investigation and Innovation: Status Report on Research Activities
99-7 Common Performance Measures Practitioner's Guidebook
99-8 Cracking in Bridge Decks: Causes and Mitigation
99-9 Using Ground Tire Rubber in Hot Mix Asphalt Pavement Final Report
99-10 Studies of Environmental Effects of Magnesium Chloride

REPORT PUBLICATION LIST
CDOT RESEARCH

Deicer in Colorado

99-11 Why Do Cattails Dominate Wetlands on the Western Great Plains?

98-1 I-76 Truck Study
98-2 HBP Pilot Void Acceptance Projects in Region 2 in 1997
98-3 1997 Hot Bituminous Pavement QC for Day Pilot Project with Void Acceptance
98-4 Hot Bituminous Pavement QC & QA Project Constructed in 1997 Under QPM2 Specification
98-5 Final Report Evaluation of Iowa Vacuum Tester
98-6 Simulation of 12 High Geosynthetic Reinforced Retaining Walls Under Surcharge Loading by Centrifuge Testing
98-7 Colorado Study on Transfer and Development Length of Pre-stressing Strand in High Performance Concrete Box Girders
98-8 Particulate Matter from Roadways
98-9 Evaluation of Design Build Practice in Colorado - Construction Report
98-10 Whitetopping Thickness Design in Colorado

97-1 Avalanche Forecasting Methods, Highway 550
97-2 Ground Access Assessment of North American Airport Locations
97-3 Special Polymer Modified Asphalt Cement (Final Report)
97-4 Avalanche Detection Using Atmospheric Infrasound
97-5 Keyway Curb (Final Report)
97-6 IAUAC - (Interim Report)
97-7 Evaluation of Design-Build Practice in Colorado (Pre-Construction Report)
97-8 HBP Pilot Void Acceptance Projects Completed in 1993-1996 (Interim Report)
97-9 QC & QA Projects Constructed in 1996 Under QPM2 Specifications (Fifth Annual Report)
97-10 Loading Test of GRS Bridge Pier and Abutment in Denver, CO

97-11 Faulted Pavements at Bridge Abutments

96-1 Long-Term Performance Tests of Soil-Geosynthetic Composites
96-2 Efficiency of Sediment Basins: Analysis of the Sediment Basins Constructed as Part of the Straight Creek Erosion Control Project.

REPORT PUBLICATION LIST
CDOT RESEARCH

96-3 The Role of Facing Connection Strength in Mechanically Stabilized Backfill Walls
96-4 Revegetation of MSB Slopes
96-5 Roadside Vegetation Management
96-6 Evaluation of Slope Stabilization Methods (US-40 Berthod Pass) (Construction Report)
96-7 SMA (Stone Matrix Asphalt) Colfax Avenue Viaduct
96-8 Determining Asphalt Cement Content Using the NCAT Asphalt Content Oven
96-9 HBP QC & QA Projects Constructed in 1995 Under QPM1 and QPM2 Specifications
96-10 Long-Term Performance of Accelerated Rigid Pavements, Project CXMP 13-006-07
96-11 Determining the Degree of Aggregate Degradation after Using the NCAT Asphalt Content Oven
96-12 Evaluation of Rumble Treatments on Asphalt Shoulders

95-1 SMA (Stone Matrix Asphalt) Flexible Pavement
95-2 PCCP Texturing Methods
95-3 Keyway Curb (Construction Report)
95-4 EPS, Flow Fill and Structure Fill for Bridge Abutment Backfill
95-5 Environmentally Sensitive Sanding and Deicing Practices
95-6 Reference Energy Mean Emission Levels for Noise Prediction in Colorado
95-7 Investigation of the Low Temperature Thermal Cracking in Hot Mix Asphalt
95-8 Factors Which Affect the Inter-Laboratory Repeatability of the Bulk Specific Gravity of Samples Compacted Using the Texas Gyratory Compactor
95-9 Resilient Modulus of Granular Soils with Fine Contents
95-10 High Performance Asphalt Concrete for Intersections
95-11 Dynamic Traffic Modeling of the I-25/HOV Corridor
95-12 Using Ground Tire Rubber in Hot Mix Asphalt Pavements
95-13 Research Status Report
95-14 A Documentation of Hot Mix Asphalt Overlays on I-25 in 1994
95-15 EPS, Flowfill, and Structure Fill for Bridge Abutment Backfill
95-16 Concrete Deck Behavior in a Four-Span Prestressed Girder Bridge: Final Report
95-17 Avalanche Hazard Index for Colorado Highways
95-18 Widened Slab Study