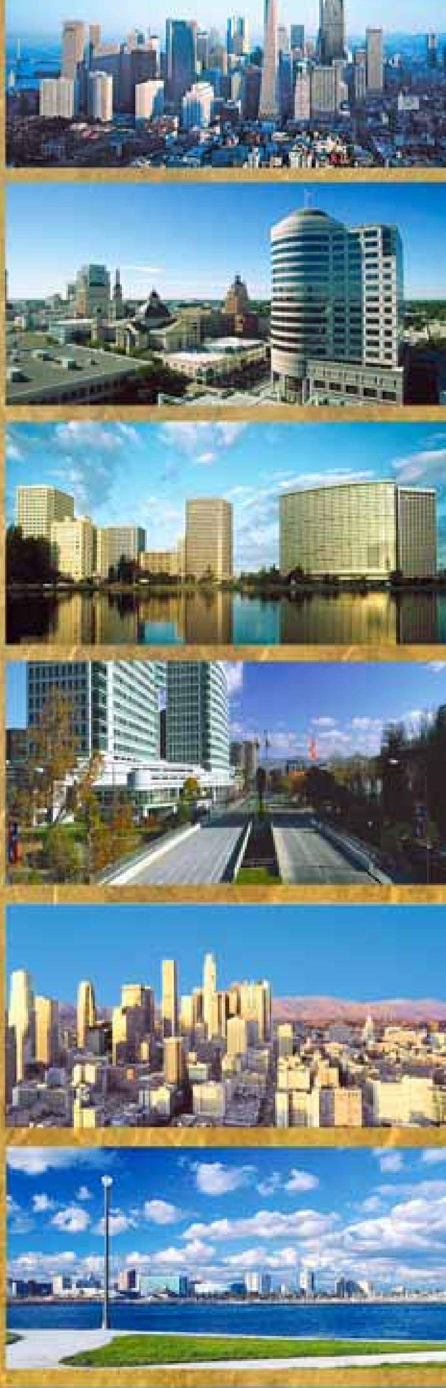
CIP Benchmarking Study

California Multi-Agency CIP Benchmarking Study

Annual Report - Update 2005



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Department of PUBLICWORKS CITY OF SACRAMENTO

OAKLAND PUBLIC WORKS AGENCY

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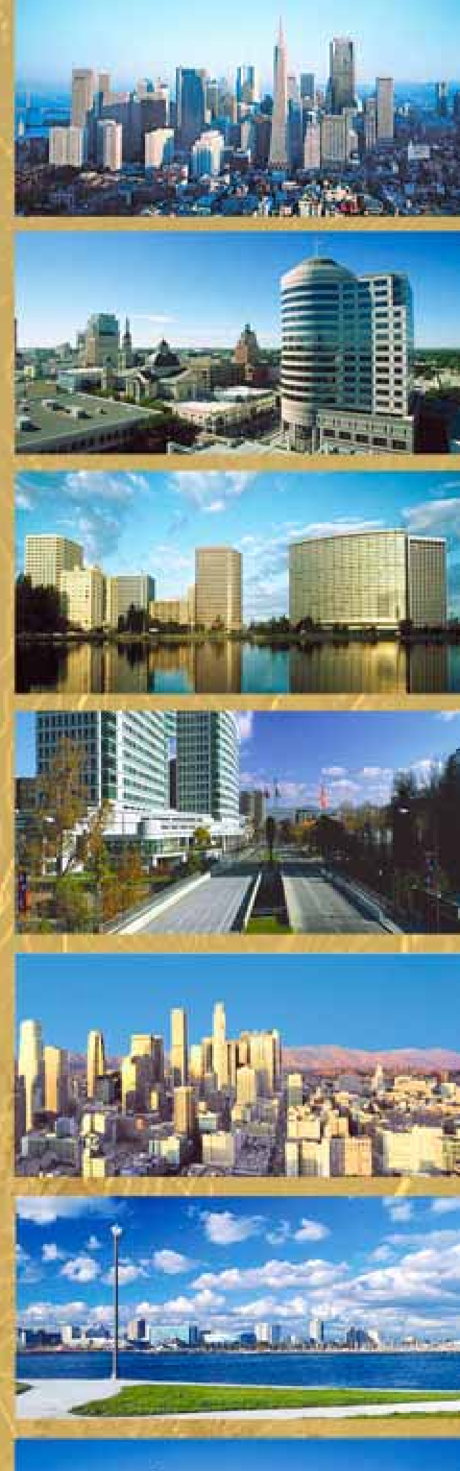

CHAPTER 1

Executive Summary

A. INTRODUCTION

Seven of the largest municipalities in California have been working together over the last four years to quantify and document the actual cost of delivering capital projects and to identify and implement Best Management Practices (BMPs) to improve the efficiency of capital project delivery. The *California Multi-Agency CIP Benchmarking Study* (Study) published in 2002 presented design and construction management cost data on 239 completed projects with a total construction value of $490 million, and has been growing with each annual update. The *Update 2005* analysis includes 642 projects with a total construction value of $993 million.

The agencies participating in the study are the Cities of Long Beach, Los Angeles, Oakland, Sacramento, San Diego, and San Jose, and the City and County of San Francisco. By participating in this effort, these agencies have demonstrated their sincere interest in improving project delivery. They have assembled real project delivery data with which to make decisions and gauge performance. They have identified BMPs for implementation and they have mutually benefited by sharing their procedures and experiences.

This is the fourth year of a continuing study. This *Update 2005* documents the agencies' progress on the following goals:

1. Improve the quality of the performance data and the functionality of the database.
2. Track the implementation of BMPs by each participating agency.
3. Continue sharing information with one another through the online discussion forum.
4. Classify change orders.
5. Perform special studies on topics of interest.

B. PERFORMANCE BENCHMARKING

Performance benchmarking involves collecting documented project costs and creating data models of the component costs of project delivery versus the total construction cost. Project delivery costs are defined as the sum of all agency, internal client, and consultant costs associated with the planning, design, bid, award, construction management, and closeout activities on projects.

The *Update 2005* study performance curves include projects completed between January 1, 1999 and January 1, 2005. Outlier projects were identified and eliminated. The remaining 642 projects used in this analysis were all delivered using the design-bid-build delivery method and each have a total construction cost of greater than $100,000.

The *Update 2005* performance data shows that relative project delivery costs appear to be increasing with completion year. Some agencies attribute this to the increased cost of compliance with more stringent environmental requirements and the move toward greater community involvement and coordination. It is also likely that improved data collection and reporting of project delivery costs is contributing to this appearance that project delivery costs are increasing. Through the diligent focus required by this study itself, the agencies are getting better at tracking and capturing all of the costs associated with project delivery.

Project delivery costs as a percentage of Total Construction Cost (TCC) tend to be higher on smaller projects. Between 1999 and 2004, the average and median construction value of the projects included in the study decreased. The influence of project size on the relative project delivery cost is clear from the performance curves.

The Study Team also collected design cost and contract award data on over 200 projects with a total awarded value of over $460 million. These projects were awarded between approximately July 1, 2003 and June 30, 2004 and have not yet been completed, so they are not included in the *Update 2005* database nor analyses. The award data provided indicate that design costs as a percentage of construction contract award ranged from 8 to 50 percent for these projects. These projects will be added to the database as they are completed by the agencies.

Performance curves produced for this Study are regressions of data, demonstrating how close of a relationship exists between the dependent variable (y-axis) and the independent variable (x-axis). A best-fit logarithmic curve is calculated using the least-squares method in Excel®, and a R^2 value is displayed. The R^2 value, also called the regression coefficient, is a value between 1 and 0, with a value approaching 0 indicating a poor model and a value approaching 1 indicating a highly-predictable relationship.

As in prior years, data was collected on four project types and fourteen project classifications. Project performance data were analyzed at both the Project Type level and the Project Classification level. The results of the analyses are presented in **Table 1-1** and in the performance curves included in Appendix A .

The table and best-fit curves provide an average of the projects that can be used as a starting point for budgeting an entire program of projects, or for comparison of performance among the agencies. Caution and use of professional judgment is suggested if the best-fit curve is used to budget an individual project.

Preliminary curves on change orders were developed using the data on approximately one-third of the projects in the database. There was poor correlation between the value of total change orders on a project and the project size. The analysis indicated that projects generally averaged change orders of 10 percent of TCC regardless of the relative amount spent on design.

The agencies plan to continue the analysis of change orders and have now defined three categories into which all changes will be classified. The agencies agreed to provide change order data on all future project contributions as follows:

1. Changed/Unforseen Conditions
2. Changes to Bid Documents
3. Client-Initiated Changes

The Study Team conducted a special analysis of consultant usage as it relates to project performance. While the agencies agree that consultant usage is generally increasing and will continue to escalate in the future, consultants were used in less than half of the projects included in the *Update 2005* analysis.

Regressions were performed comparing projects for which consultant use exceeded 25 percent of project delivery cost and projects on which there were no consultant costs. The agencies expected project delivery costs to be lower on projects that included consultant usage, which was true in only selected cases. From these regressions, the agencies made the following observations:

- Generally, the design cost for projects on which consultant usage exceeded 25 percent of project delivery was 6 or 7 percent higher than for projects with no consultant usage.

TABLE 1-1 — SUMMARY OF PERFORMANCE MODELS

PROJECT TYPE Classification	TCC	Design Cost (% of TCC)	CM Cost (% of TCC)	Project Delivery Cost (% of TCC)
Municipal Facilities				
Libraries	TCC< $0.5M	36 to 44 %	26 to 33 %	61 to 75 %
	$0.5M<TCC<$3M	19 to 35 %	15 to 26 %	34 to 61 %
	TCC> $3M	9 to 19 %	8 to 15 %	17 to 34 %
Police/Fire Station	TCC< $0.5M	26 to 32 %	14 to 17 %	40 to 49 %
	$0.5M<TCC<$3M	18 to 26 %	10 to 14 %	29 to 40 %
	TCC> $3M	7 to 18 %	5 to 10 %	13 to 29 %
Community Bldg/Rec Ctr/ Child Care/Gym	TCC< $0.5M	23 to 25 %	17 to 22 %	36 to 48 %
	$0.5M<TCC<$3M	21 to 23 %	11 to 17 %	32 to 36 %
	TCC> $3M	19 to 21 %	6 to 11 %	26 to 30 %
Streets				
Widening/New/ Grade Separation	TCC< $0.5M	27 to 33 %	13 to 14 %	39 to 46 %
	$0.5M<TCC<$3M	17 to 27 %	10 to 13 %	27 to 39 %
	TCC> $3M	7 to 17 %	8 to 10 %	15 to 27 %
Bridge	TCC< $0.5M	38 to 55 %	17 to 19 %	58 to 76 %
	$0.5M<TCC<$3M	22 to 38 %	14 to 17 %	37 to 58 %
	TCC> $3M	2 to 38 %	10 to 14 %	12 to 37 %
Reconstruction	TCC< $0.5M	21 to 24 %	18 to 27 %	38 to 50 %
	$0.5M<TCC<$3M	17 to 21 %	6 to 18 %	24 to 38 %
	TCC> $3M	16 to 17 %	5 to 6 %	21 to 24 %
Bike/Pedestrian	TCC< $0.5M	22 to 39 %	15 to 18 %	37 to 55 %
	$0.5M<TCC<$3M	7 to 22 %	13 to 15 %	20 to 37 %
	TCC> $3M	NA	NA	NA
Signals	TCC< $0.5M	15 to 22 %	16 to 21 %	27 to 42 %
	$0.5M<TCC<$3M	9 to 15 %	10 to 16 %	20 to 27 %
	TCC> $3M	NA	NA	NA
Pipes				
Gravity System	TCC< $0.5M	17 to 23 %	16 to 19 %	34 to 41 %
	$0.5M<TCC<$3M	11 to 17 %	14 to 16 %	24 to 34 %
	TCC> $3M	9 to 11 %	10 to 14 %	14 to 24 %
Pressure Systems	TCC< $0.5M	14 to 15 %	13 to 15 %	26 to 30 %
	$0.5M<TCC<$3M	13 to 14 %	10 to 13 %	24 to 26 %
	TCC> $3M	NA	NA	NA
Pump Station	TCC< $0.5M	20 to 22 %	25 to 28 %	46 to 50 %
	$0.5M<TCC<$3M	16 to 20 %	18 to 25 %	35 to 46 %
	TCC> $3M	13 to 16 %	14 to 18 %	28 to 35 %
Parks				
Playgrounds	TCC< $0.5M	18 to 25 %	17 to 23 %	35 to 47 %
	$0.5M<TCC<$3M	12 to 18 %	10 to 17 %	21 to 35 %
	TCC> $3M	11 to 12 %	9 to 10 %	20 to 21 %
Sportfields	TCC< $0.5M	18 to 21 %	14 to 20 %	33 to 41 %
	$0.5M<TCC<$3M	17 to 18 %	7 to 14 %	25 to 33 %
	TCC> $3M	NA	NA	NA
Restrooms	TCC< $0.5M	18 to 23 %	20 to 35 %	38 to 60 %
	$0.5M<TCC<$3M	23 to 30 %	35 to 49 %	60 to 80 %
	TCC> $3M	NA	NA	NA

Notes: The values in this table apply to the best-fit logarithmic regression curve for each Project Classification. Caution and review of the report text are urged in using this information. Refer to Appendix A for the corresponding regression curves, R^2 values, and N values for more details. Highlighted values indicate those for which R^2 values were exceptionally low, below 0.10.

- For Municipal Facilities projects with a TCC greater than $5 million, design costs were lower when more than 25 percent of project delivery costs could be attributed to consultant use.
- The R^2 values were consistently higher for projects where consultant usage exceeded 25 percent of project delivery cost versus those where these was no consultant usage. This indicates less scatter and therefore more predictability and consistency in financial performance. This may be because the scope must be better-defined when consultants are hired and because consultants' fees are limited by contract.
- The increase in design costs associated with using consultants on smaller or more specialized projects may be justified in cases where consultants offer specialized technical expertise, the projects are complex, there is an aggressive project schedule, there are peak workload demands that can't easily be met using in-house staff, or there are other resource limitations on in-house staff.

C. BEST MANAGEMENT PRACTICES

Since the inception of the Study in 2002, the agencies have examined over 100 practices used in the design and construction management phases of project delivery. Thirty-nine of these practices were identified as those which all participating agencies do not already use, but should be fully implemented as BMPs. Thirty-one of these thirty-nine targeted practices directly influence the cost of design or construction management and, ultimately, efficient project delivery.

Over the last three years, the participating agencies have implemented many of the BMPs. BMP implementation has been tracked and project delivery performance data continues to be collected by year of project completion. It is anticipated that the performance data will eventually demonstrate that as BMPs were implemented, project delivery costs were reduced. However, it is recognized that "processes" become effective "practices" only after a learning curve and full implementation on projects. Therefore, obtaining empirical evidence of this trend is expected to take several years.

In Update 2005, the agencies continued to exchange ideas regarding strategies for implementing various BMPs using both the networking opportunities at the quarterly meetings and the online discussion forum. Table 1-2 summarizes BMPs that have been implemented by the participating agencies, as well as the priorities of those that are planned for implementation.

While continuing to track the implementation of BMPs identified in previous years, the team also continued their efforts to identify new BMPs consistent with their goal of continuous improvement in project delivery.

The implementation of BMPs by the agencies was exceptionally challenging over the past year. Cities in California, like the state itself, had difficulty securing budgets and addressing unusual winter and spring storm damage. The ability of the agencies to implement particular BMPs as planned was adversely impacted. Implementation was delayed in many cases.

The participating agencies encountered a number of regulatory challenges this year, which they also believe, have impacted capital project delivery. As these challenges surfaced, the agencies began to strategize ways to minimize the impact on project delivery cost. It is anticipated that new BMPs related to these regulatory issues will be identified and implemented as the team continues to work together.

It is acknowledged that regulatory changes in our communities will continue. It is also rec-

TABLE 1-2 — IMPLEMENTATION OF BMPS

Process Category	Ref:*	BMP	LA	LB	OK	SC	SD	SF	SJ	Notes
Planning	1.a.	Define capital projects well with respect to scope and budget including community and client approval at the end of the planning phase	✓	✓	✓	DGS: ✓ DT: ✓ DU: PI	PI 2006 ④	✓	✓	SD: Some Divisions only SC DU: Community involved after project is better-defined, typically at 30% design.
	1.b.	Complete Feasibility Studies on projects prior to defining budget and scope	✓	✓	✓	✓	PI 2006 ③	✓	✓	LB: When applicable SD: Result of CIP Benchmarking SF: When applicable SJ: Some exceptions
	1.d.	Have a Board/Council project prioritization system	NI	NI	2006	DGS: 2006 ① DT: ✓ DU: PI	2006 ①	NI	NI	SD: Result of CIP Benchmarking SC DU: Getting closer to approved Asset Mgt system that would facilitate this BMP, but project drivers vary (permit requirements, projects in other departments, etc)
	1.e.	Resource-load all CIP projects for design and construction	✓	PI 2006 ①	✓	DGS: 2006 ② DT: ✓ DU: 2006	2006 ②	NI	✓	SD: Result of CIP Benchmarking LB: Software in development. SC DU: Not sure in what form this will be implemented.
	1.f.	Have a Master Schedule attached to the CIP that identifies start and finish dates for projects	✓	✓	✓	✓	NI	NI	✓	LB: Software in development. SC DU: Program managers select finish date for approved budget document.
	1.i.	Show Projects on a Geographical Information System	✓	✓	PI 2006	✓	✓	✓	✓	LB: Infrastructure only

Legend:

✓: Implemented
PI: Partially implemented
NI: No plans to implement at this time
TBD: To be determined
yyyy: Will be implemented in calendar year "yyyy",
⊗ = Priority x for implementation
* Reference to Process Questionnaire in Appendix C of 2002 Study.
N/A indicates this BMP was added after the 2002 Study.

LA: Los Angeles
LB: Long Beach
OK: Oakland
SC: Sacramento
DGS: Department of General Services
DT: Department of Transportation
DU: Department of Utilities

SD: San Diego
SF: San Francisco
SJ: San Jose

Table 1-2 — Implementation of BMPs (Cont'd)

Process Category	Ref:*	BMP	LA	LB	OK	SC	SD	SF	SJ	Notes
Design	2.b.	Provide a detailed clear, precise scope, schedule, and budget to designers prior to design start	✓	✓	✓	✓	PI 2006 ⑤	✓	✓	
	2.f.	Define requirements for reliability, maintenance, and operation prior to design initiation	✓	✓	NI	DGS: 2006 DT: ✓ DU: NI	✓	✓	✓	SD: Some Divisions only
	2.i.	Adapt successful designs to project sites, whenever possible (e.g. fire stations, gymnasiums, etc.)	✓	✓	✓	✓	✓	✓	✓	SD: Some Divisions only, where applicable SC DU: This is key to low delivery costs. Std special provisions are updated continuously for lessons learned, new requirements, changing technology, etc.
	N/A	Train in-house staff to use Green Building Standards	✓	TBD	✓	✓	✓	✓	✓	This BMP was found to improve client satisfaction (quality) and may not reduce project delivery cost directly. SF: When applicable
	N/A (2004)	Limit Scope Changes to early stages of design	2006 ②	✓	✓	DGS: PI DT: ✓ DU: NI	✓	2006 ①	✓	SC DU: Control and minimize, but difficult to eliminate, since clients and engineers come up with new/better solutions.
	N/A (2004)	Require scope changes during design to be accompanied by Budget and Schedule approvals	2006 ③	✓	PI 2006	DGS: PI DT: ✓ DU: NI	✓	2006 ②	2006 ⑤	

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Table 1-2 — Implementation of BMPs (Cont'd)

Process Category	Ref:*	BMP	LA	LB	OK	SC	SD	SF	SJ	Notes
Quality Assurance / Quality Control	3.I.a.	Develop and use a standardized Project Delivery Manual	✓	2006 ②	2006	DGS:✓ DT: 2005 ② DU:✓	PI 2006	✓	✓	SD: incorporated into PM training manual and std Primavera schedule template/descr. Details available as needed. SC DU: Badly needs updating.
	3.II.b.	Perform a formal Value Engineering Study for projects larger than $1 million	✓	✓	NI	✓	✓	✓	✓	LA: For projects > $10M LB: On an as-needed basis SC: As needed, not >$1M. SF: On an as-needed basis SJ: For projects > $5 million
	3.III.a.	Use a formal Quality Management System	✓	2006 ③	NI	DGS: 2006 DT: ✓ DU: NI	✓	✓	2006 ④	SD: Some Divisions only
	3.III.b	Perform and use post-project reviews to identify lessons learned	✓	TBD	✓	DGS: 2006 DT: ✓ DU: ✓	✓	✓	✓	SC DU: For selected projects in one-on-one meetings with design and construction staff. Also includes feedback from client. Intended to promote candid discussion.

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TABLE 1-2 — IMPLEMENTATION OF BMPS (CONT'D)

Process Category	Ref:*	BMP	LA	LB	OK	SC	SD	SF	SJ	Notes
Construction Management	4.I.a.	Delegate authority to the City Engineer/Public Works Director or other departments to approve change orders to the contingency amount	✓	✓	✓	DGS: NI DT: NI DU: ✓	✓	✓	✓	SF: At Bureau level SJ: Individual CO < $100,000 SD: Individual CO < $200,000
	4.I.m.	Classify types of change orders	✓	✓	✓	✓	PI 2006	✓	2006 ③	LA: Draft Special Order prepared. SD: Only for scope changes versus other types
	4.II.a.	Include a formal Dispute Resolution Procedure in all contract agreements	✓	NI	✓	DGS: ✓ DT: ✓ DU: NI	✓	✓	✓	
	4.III.a.	Use a team building process for projects greater than $5 million	✓	✓	✓	DGS: ✓ DT: ✓ DU: NI	✓	✓	✓	LB: As-needed SD: As-needed SF: As-needed SJ: For projects > $10 M
	4.IV.a.	Involve the Construction Management Team prior to completion of design	✓	✓	✓	DGS: 2006 ③ DT: ✓ DU: ✓	✓	✓	✓	SD: Some Divisions only
	N/A (2003)	Delegate authority below Council to make contract awards under $1 million	✓	✓	NI	NI	✓	✓	2006 ①	
	N/A (2003)	Establish a pre-qualification process for contractors on large, complex projects	✓	NI	✓	DGS: ✓ DT: NI DU: ✓	✓	✓	✓	
	N/A (2003)	Make bid documents available online	TBD	✓	TBD	DGS: NI DT: 2006 DU: 2006	TBD	TBD	✓	LA: Not enough bids to make this useful. Resistance from smaller contractors who do not use the internet to conduct business. SD: Options being evaluated

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TABLE 1-2 — IMPLEMENTATION OF BMPs (CONT'D)

Process Category	Ref:*	BMP	LA	LB	OK	SC	SD	SF	SJ	Notes
Project Management	5.I.f.	Assign a client representative to every project	✓	✓	✓	DGS: ✓ DT:2006 DU: ✓	✓	✓	✓	SD: Only for large projects
	5.II.a	Provide formal training for Project Managers on a regular basis	✓	2006 ④	✓	DGS: ✓ DT: 2006 DU: NI	✓	✓	✓	SD: Yearly PM academy, as funds allow
	5.III.a.	Adopt and use a Project Control System on all projects	✓	✓	✓	DT:✓ DU: NI	✓	✓	✓	SD: Project controls incorporated into Primavera schedule
	N/A (2003)	Create in-house project management team for small projects	NI	NI	✓	DGS: ✓ DT: NI DU: NI	✓	NI	✓	SD: Some Divisions only SC DU: Not enough PMs to justify this. Don't want to restrict staff to small, less-rewarding projects.
	N/A (2004)	Institutionalize Project Manager performance and accountability	2006 ①	2006	PI 2006	DGS: 2006 DT:✓ DU: NI	NI	TBD	2006	SD: Only non-standardized goals SC DU: There is interest but no definite plans.
Consultant Selection and Use	6.c.	Include a standard consultant contract in the RFQ/RFP with a standard indemnification clause	✓	✓	✓	✓	✓	✓	✓	SD: Some Divisions only
	6.e.	Delegate authority to the Public Works Director/City Engineer to approve consultant contracts under $250,000 when a formal RFP selection process is used	NI	NI	NI	NI	✓	✓	2006 ②	SC DU: Threshold is $100,000.
	6.g.	Implement and use a consultant rating system that identifies quality of consultant performance	✓	2006 ⑤	✓	DGS: ✓ DT:NI DU: ✓	✓	✓	✓	SJ: Need to incorporate more post-project review. SC DU: Track performance for those selected for "support services."

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ognized that regulatory changes are made with the intent of improving the quality of life for residents. The challenge for responsible agencies, the participants in this study, is to deliver capital projects compliant with the regulatory changes while keeping the cost of compliance from having an overwhelming impact on the cost of project delivery. Working together to develop effective BMPs, which reduce the impact and disruption of compliance, remains a goal of the agencies.

D. ONLINE DISCUSSION FORUM

Among the primary benefits accruing to the participating agencies during this ongoing Study has been the opportunity to discuss the challenges of public works project delivery with their peers. These successful open forum communications included online discussions of over thirty topics that influence project delivery efficiency. The following discussion topics are summarized in Chapter 5 Online Discussion Forum:

- Construction Traffic Control Management
- Street Construction Coordination
- Construction Cost Estimating
- Bond Measure Considerations
- Online Bid Advertising, Bid Documents, and Bidding
- Cost Impacts of LEED Certification and In-House Green Design Teams
- Environmental Approvals Processes
- Consultant Selection, Management, and Fees
- As-Built Record Documents

An archive of the full discussion forum is posted on the Study website. To maintain the confidentiality of the communications, this archive can only be accessed by the participants.

E. CONCLUSION

The results of the performance benchmarking showed there are outstanding data gaps that should be filled in the medium size project range. The performance models are currently driven by a large number of very small projects and can be made more reliable for medium-sized and larger-sized projects if more data are collected.

It is also observed that the agencies do not contribute data equally to the various classifications. More reliable models will be developed as the distribution of the number of projects becomes more uniform among all classifications for each agency.

To further improve the R^2 values, it is recommended that outlier analysis be performed on the whole dataset, identifying projects submitted throughout the Study phases for possible elimination from analysis. Re-evaluation of P-values is also recommended. P-values indicate whether or not enough data were used for statistically-significant conclusions to be drawn from analyses.

Other observations include:

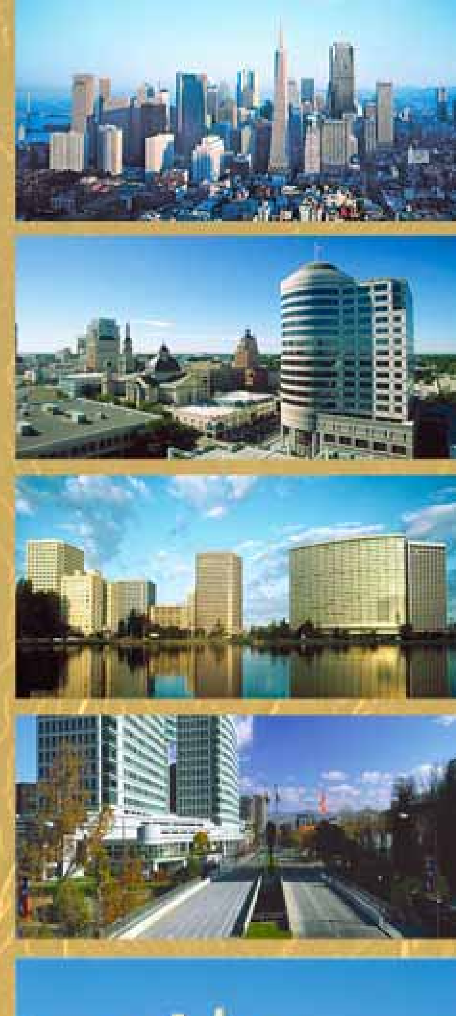
- Improvement in project delivery percentages due to implementation of BMPs cannot yet be directly linked. “Processes” become effective “practices” only after a learning curve and full implementation on projects. Therefore, obtaining empirical evidence of trends is expected to take several years.
- Generally, the relative cost of design, construction management, and overall project delivery decreases as total construction cost increases. This is consistent with what is intuitively expected.
- Median and average TCC values of projects included in the Study have decreased slightly over time. This may be because agencies can more easily assign

small projects to one project classification than large projects, which may include broader scopes and components. Another reason may be that the agencies complete small projects more often than large projects and can therefore submit more of them to the Study.

- Project delivery costs as a percentage of TCC are increasing. This may be because project delivery costs as a percentage of TCC tend to be higher on smaller projects than larger ones, so some of the increase in project delivery costs may be explained by the decreasing average TCC of projects discussed above. Agencies also report that as time goes on, it costs more money to meet more stringent regulatory and municipal requirements. Better data tracking and collection may have also resulted in higher reported project delivery costs.
- Change orders may be limited automatically by the project's contingency budget, typically 10 percent of TCC.
- The design cost when consultant usage exceeded 25 percent of project delivery was generally around 6 or 7 percent higher than when there was no consultant usage.
- The increase in design costs associated with using consultants on smaller or more specialized projects may be justified in cases where consultants offer specialized technical expertise, the projects are complex, there is an aggressive project schedule, there are peak workload demands that can't easily be met using in-house staff, or there are other resource limitations on in-house staff.

Chapter 2

Introduction



CHAPTER

2 Introduction

Seven of the largest municipalities in California have been working together over the last four years to study the actual cost of delivering capital projects and how to make project delivery more efficient. The *California Multi-Agency CIP Benchmarking Study* (Study) published in 2002 presented design and construction management cost data on 239 completed projects with a total construction value of $490 million. In the Study's *Update 2003*, the list grew to 453 projects with a total construction value of $830 million, and *Update 2004* included project delivery cost data on 595 projects with a construction value of just over $1 billion. Following a revision of criteria for analysis and elimination of selected projects from the database, the *Update 2005* analysis included 642 projects with a total construction value of $993 million.

The analysis of actual project data gives municipal decision-makers a valuable tool to more accurately anticipate the true total cost of public projects. The study of the practices used in delivering projects and determining the effectiveness of those practices is valuable in reducing project delivery costs. Best Management Practices (BMPs) identified as most effective are targeted for implementation. The implementation of new BMPs, which will reduce project delivery cost, continues to be an important goal for the participating agencies.

The Study is intended to be a continuing effort. In future annual updates, refinements and improvements of the conclusions and recommendations will be made as additional project data are collected.

A. BACKGROUND

In October 2001, the City of Los Angeles, Department of Public Works, Bureau of Engineering initiated the Study with several of the largest cities in California. These cities joined together to form the Project Team for the Study. After working together for four years, this team agrees that they benefit from collaborating and pooling their knowledge and experience regarding project delivery.

The Study initially involved six agencies, with a seventh (City of Oakland) joining the team in 2003. The participating agencies currently include:

- City of Long Beach - Department of Public Works
- City of Los Angeles, Department of Public Works - Bureau of Engineering
- City of Oakland - Public Works Agency
- City of Sacramento - Department of General Services, Department of Transportation, and Department of Utilities
- City of San Diego - Engineering & Capital Projects
- City and County of San Francisco, Department of Public Works - Bureau of Engineering, Bureau of Architecture, and Bureau of Construction Management
- City of San Jose, Department of Public Works - City Manager's Office

Table 2-1 summarizes some of general characteristics of the participating agencies and/or of specific departments.

Table 2-1 — Agencies' Overall Information

Information	Population	Area (sq. mi.)	Website	Government Form	FY 04-05 to FY 06-07		
					No. of FTE[1]	No. of Projects	Total Value ($M)[2]
Long Beach	491,564	50	http://www.longbeach.gov	Council-Manager-Charter	72	68	$78
Los Angeles	3,912,200	472	http://eng.lacity.org	Mayor-Council	784	414	$1,312
Oakland	399,484	66.25	http://www.oaklandpw.com and www.oaklandnet.com	Mayor-Council-Administrator	112	157	$257
Sacramento	452,959	98	http://www.cityofsacramento.org	Council-Manager			
Dept. of General Services					23	72	$250
Dept. of Transportation					86	46	$55
Dept. of Utilities					29	114	$48
San Diego	1,277,168	342	http://www.sandiego.gov	Mayor-Council	504	181	$629
San Francisco	801,377	46.7	http://www.sfdpw.com	Mayor-Board of Supervisors (11 members)	414	151	$343
San Jose	944,857	178	http://www.sanjoseca.gov	Mayor-Council-Manager	284	535	$1,793

Notes: [1] Authorized full time staff involved with delivery of Capital Improvement Projects.
[2] Total Value equals total project cost with construction contracts to be awarded from FY 2004-2005 to FY 2006-2007.

In 2002, upon initiation of the Study, it was agreed that published data provided by Study participants should remain anonymous in order to create a positive, non-competitive team environment, conducive to meeting the Study's goals. Therefore, no projects are identified by name in this document or in the project database, and agencies are referred to by an alias (such as "Agency A") when anonymity is appropriate.

B. BENEFITS OF PARTICIPATION

The sponsoring agencies have been very supportive of the Study efforts over the years. The Study is possible only because the agencies believe they are benefiting from their continued participation. The benefits have been experienced by the agencies in a variety of ways, including the following:

- Los Angeles believes staff is more focused on delivering projects on time and within budget. The Study report was also used to support project planning and to demonstrate efforts being made to improve project delivery performance.
- Long Beach has benefited from participation through the use of project delivery data to negotiate agreements with the Long Beach Redevelopment Agency. Several BMPs have been implemented on the basis that they are commonly used by the other participating agencies to improve project delivery efficiency.
- According to San Francisco, the greatest benefit is the ability to share information between agencies doing similar work. The agencies learn from each other and use the online discussion forum and the quarterly meetings as a sounding board for ideas.
- San Diego's chief benefit is having data to support expectations of project delivery costs. It has allowed San Diego to demonstrate that its performance falls within the range of project delivery achieved by other cities in California. In addition, collaboration through the online discussion forum and the quarterly meetings on BMPs has helped them improve their project delivery processes.
- Sacramento has benefited by using data to establish business performance benchmarks and BMPs. Having a forum to discuss practices and ideas relating to project delivery is invaluable with respect to gaining from the experience of others, avoiding pitfalls, expanding an agency's knowledge base, and developing long-term goals. Validation of its current practices and access to project delivery data for comparison is also of significant value. The study has helped Sacramento stay focused on improvements that are contemplated but may otherwise have been ignored.
- Oakland says the benefits of participating in the Study have exceeded its expectations. The opportunity to freely discuss challenges and successes has been both enlightening and empowering. The collected data have allowed staff to objectively measure their capital project delivery efficiency. Perhaps most importantly, the efforts to develop BMPs have helped staff make improvements where needed.
- As a result of participation, San Jose has a greater awareness of how other cities operate and enjoys the opportunity to seek information and advice from other participants, as well as gaining information through the discussion forum. Reporting project delivery costs for the Study has prompted a more critical look at its budgeting and accounting procedures.

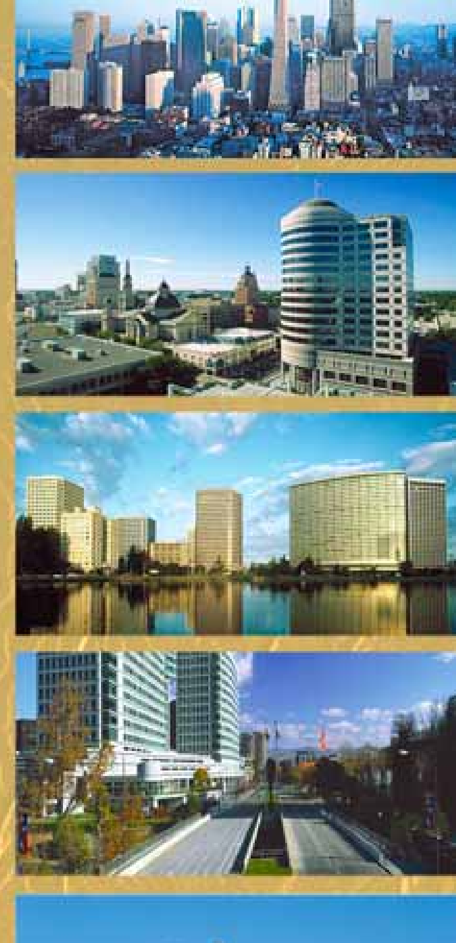
C. STUDY GOALS

The Study Methodology is described in detail in the 2002 report, and modifications to that method have been documented in subsequent Study reports. In *Update 2005*, the agencies made progress on several goals:

1. **Improve the quality of the performance data and the functionality of the database.** The agencies continued their efforts to capture complete project delivery costs for the database. Performance curves were developed for projects falling into 14 classifications among 4 project types. Regressions were done for design, construction management, and overall project delivery costs as a function of total construction costs. The Performance Questionnaire was modified to acquire additional data. Agencies verified and corrected randomly-selected project data, and made presentations on their data collection process. A statistical outlier analysis was also performed.
2. **Track the implementation of BMPs by each participating agency.** This information will be used in linking these practices to improvement of capital project performance over time.
3. **Continue sharing information with one another through the online discussion forum.** The participating agencies use an email list to pose questions or request information from one another. The agencies agreed that one of the primary benefits of participation in the Study is the opportunity to discuss issues and practices with one another.
4. **Classify change orders.** To help the agencies better understand what drives change orders and to facilitate change order analysis in the future, the agencies defined three change order categories to be used: changed conditions, changes to bid documents, and Client-initiated changes. All null (blank) values were also corrected in the database.
5. **Perform special studies on topics of interest.** This year's special study was of the relationship between consultant usage and project delivery performance. The participants are generally finding that to deliver growing capital programs, work is contracted to consultants more frequently. Because of this, it is important to understand if and how project delivery costs are affected, and to identify and implement BMPs to help make consultant usage more effective.

Chapter 3

Performance Benchmarking



CHAPTER 3

Performance Benchmarking

Performance benchmarking involves collecting documented project costs and plotting the component costs of project delivery against the total construction cost. All of the actual project costs are collected by the agencies using a Performance Questionnaire created in Microsoft Excel®. Data is then compiled from the questionnaire in Excel® using a Visual Basic for Applications (VBA) code and transferred into the database, where the data is reviewed and vetted. The 2002 Study report includes a comprehensive listing of project delivery cost components and a copy of the Performance Questionnaire can be found in the *Update 2004* report.

A. STUDY CRITERIA

The following criteria applied to *Update 2005* performance benchmarking analyses:

- **Total Construction Costs** – All projects included in the analyses have a total construction cost exceeding $100,000. The Total Construction Cost (TCC) is the sum of the awarded construction contract, change orders, utility relocation, and construction by agency forces. TCC does not include, land acquisition, environmental monitoring and mitigation, design, or construction management costs.
- **Completion Date** – Projects included in the Study analyses were completed on or after January 1, 1999. Projects with earlier completion dates were kept in the database, but excluded from the analyses.
- **Outlier Elimination** – Statistical outliers were identified using the method described in the *Update 2004* report. All project data were evaluated against the full database. Potential outliers were then eliminated from the analysis only if the respective agency confirmed that the project delivery process was not representative of the procedures normally used to deliver projects. All outliers were kept in the database, but excluded from the analyses.
- **Project Delivery Method** – All projects in this Study were delivered through the traditional Design-Bid-Build delivery method. Projects delivered using other methods are not included in this Study at this time.
- **Change Order Classification** – In order to perform meaningful change order analyses in the future, the agencies agreed to classify change order costs into one of three classifications:

  1. Changed/Unforeseen Conditions
  2. Changes to Bid Documents
  3. Client-Initiated Changes

B. DATA COLLECTION AND CONFIRMATION

The success of the Study is dependent upon accurate data coming from each agency on each project. Continuous emphasis was placed on the importance of accurate and complete data collection.

Agencies committed to submit complete project delivery data to capture the total construction costs and project delivery costs of projects. Project delivery costs are defined as the sum of all agency, internal client, and consultant costs associated with the planning, design, bid, award, construction management, and closeout activities on projects.

Each agency was asked to present an explanation of its data collection method to the rest of the agencies, demonstrating how values entered into the Performance Questionnaire were obtained. The goal of these presentations was to confirm that the agencies were completing the questionnaires with comparable, complete, and accurate values.

In addition, each agency was asked to confirm the data submitted for 5 randomly-selected projects submitted in earlier project phases. The confirmations were collected, corrections, if required, were made, and the results of the confirmation were shared with the agencies. The overall impact of the revisions upon the analyses was inconsequential.

These exercises resulted in increased attention to the data sources and the collection methods, which are both crucial to the credibility of the study.

C. PERFORMANCE DATA DATABASE

A special effort was made this year to eliminate projects from the database that the agencies agreed did not fit the Study criteria of either TCC equal to or greater than $100,000 or projects fitting clearly into one of the fourteen project classifications. A total of 51 projects were deleted from the database this year for these two reasons.

Outlier projects and projects completed prior to January 1, 1999 were also identified and, while kept in the database, excluded from analysis in regressions.

Table 3-1 summarizes the number of projects included in the database and in the analysis. While the database contains 796 projects, it was determined that 642 projects fit the Study criteria and were used for analysis.

I. Data Submission Challenges

Only 170 projects were submitted for the *Update 2005* Study, about one-third less than in any previous year. The agencies identified a number of issues that impacted the number of projects that were submitted in *Update 2005*.

TABLE 3-1 — UPDATE 2005 DATABASE

Study Phase[1]	Submitted for Study	Deleted		Net Increase	Excluded from Analysis		Analyzed
	(a) Total	(b) TCC <$100K	(d) Non-Representative	(d)=(a)-(b)-(c)	(e) Comp. Date <1999	(g) Outliers	(h)= (d)-(e)-(f)-(g)
I	239	25	41	173	7	13	153
II	286	0	31	255	6	25	224
III	262	0	13	249	0	28	221
IV	170	17	34	119	51	24	44
Total	**957**	**42**	**119**	**796**	**64**	**90**	**642**

Note: [1]Study Phase indicates the number of projects corresponding to Study Years I = 2002, II = 2003, III = 2004, and IV = 2005

Some common issues included:

- Capital funding shortfalls reducing the number of projects that could be built
- Budget constraints affecting the availability of personnel to perform project closeout and produce reports
- Heavy workloads causing difficulty to meet data submission schedules

The agencies acknowledged that it is vital to the success of the Study to continue increasing the size of the data set as much as possible, thereby increasing the confidence, consistency, and reliability of results. In the Study 2002 report, the number of projects required to achieve statistically significant results was recommended to be at least 1,000 distributed evenly among classifications and ranges of total construction cost. The agencies will continue to work toward that objective.

II. Projects Distribution Matrix

There are 4 project types (Municipal Facilities, Streets, Pipe Systems, and Parks) and 14 project classifications included in this Study. **Table 3-2** summarizes the distribution of projects included in the *Update 2005* analysis.

The number of projects in the database for Municipal Facilities showed a slight net decrease from *Update 2004* due to the database cleanup efforts. The number of Streets and Pipe Systems projects increased the most, indicating that municipalities are probably focused more on building these types of critical infrastructure in the face of growing populations and aging infrastructure. The net increase in the number of Parks projects since last year's Study was slight.

Table 3-3 summarizes characteristics of the 642 projects included in the *Update 2005* analysis by project completion year, and shows trends in the average TCC values, median TCC values, design costs, construction management costs, and overall project delivery costs.

The agencies have reported that the sizes of individual projects are growing larger, yet the median TCCs of projects in this Study have been getting smaller over time. Between project completion dates from 1999 to 2004, the average and median TCC of projects in the Study decrease, as shown in Table 3-3. Part of the decrease may be because the agencies find it easier to assign small projects to one project classification than large projects, since large projects tend to have broader scopes and include more components. Another reason may be that the agencies complete small projects more often than large projects and can therefore submit more of them to the Study. This is reasonably supported by the fact that the median TCC of projects in the Study completed between 1999 and 2004 is below the average TCC. The skew indicates that more projects have a TCC below the average than above the average. As larger projects are completed and submitted to the Study, the gap between the median TCC and average TCC will close.

Project delivery costs as a percentage of TCC have increased with project completion year, also shown in Table 3-3. Project delivery costs as a percentage of TCC tend to be higher on smaller projects than larger ones, so some of the increase in project delivery costs may be explained by the decreasing average TCC of projects as discussed above. Agencies also report that as time goes on, it costs more to meet increasingly stringent regulatory and municipal requirements. Better data tracking and collection may have also resulted in higher reported project delivery costs.

Table 3-4 summarizes the average cost of design, construction management, and project delivery costs by agency, along with the use of in-house staff versus consultants for project delivery, for projects included in the *Update 2005* analysis.

Table 3-2 — Projects Distribution Matrix

Agency	Long Beach	Los Angeles	Oakland	Sacra-mento	San Diego	San Francisco	San Jose	Total
Municipal Facilities	**8**	**37**	**14**	**15**	**6**	**16**	**25**	**121**
Libraries	0	23	3	1	2	2	2	33
Police/Fire Station	2	6	6	2	2	8	5	31
Comm./Rec. Center/ Child Care/Gym	6	8	5	12	2	6	18	57
Streets	**16**	**12**	**31**	**31**	**49**	**27**	**31**	**197**
Widening/New/Grade Separation	1	0	2	9	9	2	5	28
Bridges New/Retrofit)	0	11	0	0	5	2	1	19
Reconstruction	8	1	10	5	5	5	2	36
Bike/Pedestrian	2	0	8	6	9	4	7	36
Signals	5	0	11	11	21	14	16	78
Pipe Systems	**2**	**67**	**18**	**14**	**69**	**32**	**20**	**222**
Gravity System (Storm Drains/Sewers)	2	54	18	11	43	22	20	170
Pressure Systems	0	0	0	0	23	5	0	28
Pump Stations	0	13	0	3	3	5	0	24
Parks	**6**	**1**	**10**	**1**	**7**	**13**	**64**	**102**
Playgrounds	2	0	8	0	1	11	51	73
Sportfields	1	1	1	1	3	0	4	11
Restrooms	3	0	1	0	3	2	9	18
Total	**32**	**117**	**73**	**61**	**131**	**88**	**140**	**642**

Notes: Projects included in Update 2005 analysis. Completed on or after January 1, 1999.

TABLE 3-3 — UPDATE 2005 PROJECT COUNT AND PROJECT DELIVERY BY COMPLETION YEAR

Project Completion Date	Project Type					Project Delivery Data				
	Municipal Facilities	Parks	Pipe Systems	Streets	Total	Average TCC ($M)	Median TCC ($M)	Design Cost (% of TCC)	Construction Mgmt Cost (% of TCC)	Project Delivery Cost (% of TCC)
1999	17	5	9	26	57	$ 1.41	$ 0.76	18%	16%	34%
2000	15	6	31	21	73	$ 2.23	$ 1.04	17%	16%	32%
2001	18	10	45	10	83	$ 1.79	$ 0.62	16%	16%	32%
2002	41	11	73	49	174	$ 1.87	$ 0.92	17%	16%	33%
2003	22	51	50	52	175	$ 1.22	$ 0.45	20%	16%	36%
2004	7	19	13	38	77	$ 0.75	$ 0.47	24%	14%	38%
2005	1		1	1	3	$ 1.55	$ 1.56	17%	8%	25%
Total	**121**	**102**	**222**	**197**	**642**	**$ 1.55**	**$ 0.64**	**19%**	**16%**	**34%**

TABLE 3-4 — UPDATE 2005 PROJECT DELIVERY PERFORMANCE BY AGENCY

AGENCY	DESIGN					CONSTRUCTION MANAGEMENT					PROJECT DELIVERY				
	In-House		Consultants		Total % of TCC[2,3]	In-House		Consultants		Total % of TCC	In-House		Consultants		Total % of TCC
	($)	% of Design[1]	($)	% of Design		($)	% of CM	($)	% of CM		($)	% of PD	($)	% of PD	
Agency A	19,224,452	78.0%	5,410,475	22.0%	21.6%	16,955,429	97.8%	384,859	2.2%	15.3%	36,179,881	86.2%	5,795,334	13.8%	36.8%
Agency B	6,146,123	51.0%	5,913,667	49.0%	17.8%	5,957,256	66.7%	2,975,625	33.3%	12.0%	12,103,379	57.7%	8,889,292	42.3%	29.8%
Agency C	15,964,212	81.1%	3,727,966	18.9%	14.6%	16,108,000	96.4%	602,984	3.6%	15.2%	32,072,212	88.1%	4,330,950	11.9%	29.8%
Agency D	33,576,726	64.0%	18,870,304	36.0%	17.5%	46,353,542	93.2%	3,377,651	6.8%	17.6%	79,930,268	78.2%	22,247,955	21.8%	35.0%
Agency E	2,117,850	41.8%	2,944,010	58.2%	19.9%	2,240,066	83.3%	448,234	16.7%	15.4%	4,357,916	56.2%	3,392,244	43.8%	35.3%
Agency F	14,144,295	69.8%	6,106,712	30.2%	20.1%	14,538,094	95.1%	743,465	4.9%	18.3%	28,682,389	80.7%	6,850,177	19.3%	38.5%
Agency G	9,395,025	63.3%	5,443,274	36.7%	17.0%	8,774,903	99.0%	91,944	1.0%	13.4%	18,169,928	76.6%	5,535,218	23.4%	30.5%
OVERALL	100,568,683	67.5%	48,416,408	32%	18.7%	110,927,290	92.8%	8,624,762	7.2%	15.8%	211,495,973	78.8%	57,041,170	21.2%	34.4%

Notes: [1] In-House and Consultant costs are calculated as percentages of total agency Design, CM (Construction Management), and PD (Project Delivery) costs.
[2] TCC (Total Construction Cost) is the sum of construction contract award, change orders, utility relocation cost, and city forces construction cost.
[3] Design, CM, and PD costs as percentages of TCC are unweighted, arithmetic averages of projects by agency.

III. Construction Contract Award Data

Design costs and construction award amounts for bid awards made by the participating agencies were collected for the period approximately covering July 1, 2003 to June 30, 2004. This was done so that the Study Team could anticipate the number of projects that would be submitted in future Study phases. Only projects that were expected to meet Study criteria were provided by the agencies. Please see **Table 3-5** for a summary of the information collected.

Together, the agencies awarded over $460 million in construction on more than 200 projects over the period of interest that met Study criteria and will be added to the database in future years. The project sizes ranged from $100,000 in construction to over $19 million. Both the average and median construction contract awards are larger than those of projects included in the *Update 2005* Study.

D. PERFORMANCE DATA ANALYSES

Performance curves produced for this Study are regressions of data, demonstrating how close of a relationship exists between the dependent variable (y-axis) and the independent variable (x-axis). For instance, a curve of design cost as a percentage of total construction cost would be prepared to evaluate how much of the variability in design cost can be predicted by the total construction cost value.

A best-fit logarithmic curve is calculated using the least-squares method in Excel®, and a R^2 value is displayed. The R^2 value, also called the regression coefficient, is a value between 1 and 0, with a value closer to 0 indicating a poor model and a value closer to 1 indicating a highly-predictable relationship.

Project performance data were analyzed using the custom database application at both the Project Type level and the Project Classification level. The database application was used to filter and plot data, as well as calculate R^2 values of the different regressions for the *Update 2005* Study. The curves for design, construction management, and project delivery as a percentage of construction versus total construction cost can be found in Appendix A. Project delivery costs are defined as the sum of design and construction management costs. A table summarizing R^2 values is also included in this appendix for reference.

The results of the regression analyses are presented in **Table 3-6**. The ranges of design, construction management, and project delivery costs as percentages of TCC shown are for the

Table 3-5 — Construction Contract Awards

Agency	Count of Projects by Project Type					Total Awards ($M)	Avg. Award ($M)	Median Award ($M)
	Municipal	Streets	Pipes	Parks	Total			
Long Beach	0	1	0	0	1	$ 0.4	$ 0.4	$ 0.4
Los Angeles	14	3	15	1	33	$104.4	$ 3.2	$ 1.6
Oakland	3	6	5	2	16	$ 22.9	$ 1.4	$ 0.9
Sacramento	9	11	8	0	28	$ 68.4	$ 2.4	$ 1.0
San Diego	3	37	35	0	75	$108.5	$ 1.4	$ 0.6
San Francisco	7	9	1	4	21	$ 34.2	$ 1.6	$ 1.0
San Jose	8	8	11	13	40	$123.6	$ 1.8	$ 0.6
Total	**44**	**75**	**75**	**20**	**214**	**$462.4**	**$ 1.9**	**$ 0.9**

TABLE 3-6 — SUMMARY OF PERFORMANCE MODELS

PROJECT TYPE Classification	TCC	Design Cost (% of TCC)	CM Cost (% of TCC)	Project Delivery Cost (% of TCC)
Municipal Facilities				
Libraries	TCC< $0.5M	36 to 44 %	26 to 33 %	61 to 75 %
	$0.5M<TCC<$3M	19 to 35 %	15 to 26 %	34 to 61 %
	TCC> $3M	9 to 19 %	8 to 15 %	17 to 34 %
Police/Fire Station	TCC< $0.5M	26 to 32 %	14 to 17 %	40 to 49 %
	$0.5M<TCC<$3M	18 to 26 %	10 to 14 %	29 to 40 %
	TCC> $3M	7 to 18 %	5 to 10 %	13 to 29 %
Community Building/Recreation Center/Child Care/Gym	TCC< $0.5M	23 to 25 %	17 to 22 %	36 to 48 %
	$0.5M<TCC<$3M	21 to 23 %	11 to 17 %	32 to 36 %
	TCC> $3M	19 to 21 %	6 to 11 %	26 to 30 %
Streets				
Widening/New/Grade Separation	TCC< $0.5M	27 to 33 %	13 to 14 %	39 to 46 %
	$0.5M<TCC<$3M	17 to 27 %	10 to 13 %	27 to 39 %
	TCC> $3M	7 to 17 %	8 to 10 %	15 to 27 %
Bridge	TCC< $0.5M	38 to 55 %	17 to 19 %	58 to 76 %
	$0.5M<TCC<$3M	22 to 38 %	14 to 17 %	37 to 58 %
	TCC> $3M	2 to 38 %	10 to 14 %	12 to 37 %
Reconstruction	TCC< $0.5M	21 to 24 %	18 to 27 %	38 to 50 %
	$0.5M<TCC<$3M	17 to 21 %	6 to 18 %	24 to 38 %
	TCC> $3M	16 to 17 %	5 to 6 %	21 to 24 %
Bike/Pedestrian	TCC< $0.5M	22 to 39 %	15 to 18 %	37 to 55 %
	$0.5M<TCC<$3M	7 to 22 %	13 to 15 %	20 to 37 %
	TCC> $3M	NA	NA	NA
Signals	TCC< $0.5M	15 to 22 %	16 to 21 %	27 to 42 %
	$0.5M<TCC<$3M	9 to 15 %	10 to 16 %	20 to 27 %
	TCC> $3M	NA	NA	NA
Pipes				
Gravity System	TCC< $0.5M	17 to 23 %	16 to 19 %	34 to 41 %
	$0.5M<TCC<$3M	11 to 17 %	14 to 16 %	24 to 34 %
	TCC> $3M	9 to 11 %	10 to 14 %	14 to 24 %
Pressure Systems	TCC< $0.5M	14 to 15 %	13 to 15 %	26 to 30 %
	$0.5M<TCC<$3M	13 to 14 %	10 to 13 %	24 to 26 %
	TCC> $3M	NA	NA	NA
Pump Station	TCC< $0.5M	20 to 22 %	25 to 28 %	46 to 50 %
	$0.5M<TCC<$3M	16 to 20 %	18 to 25 %	35 to 46 %
	TCC> $3M	13 to 16 %	14 to 18 %	28 to 35 %
Parks				
Playgrounds	TCC< $0.5M	18 to 25 %	17 to 23 %	35 to 47 %
	$0.5M<TCC<$3M	12 to 18 %	10 to 17 %	21 to 35 %
	TCC> $3M	11 to 12 %	9 to 10 %	20 to 21 %
Sportfields	TCC< $0.5M	18 to 21 %	14 to 20 %	33 to 41 %
	$0.5M<TCC<$3M	17 to 18 %	7 to 14 %	25 to 33 %
	TCC> $3M	NA	NA	NA
Restrooms	TCC< $0.5M	18 to 23 %	20 to 35 %	38 to 60 %
	$0.5M<TCC<$3M	23 to 30 %	35 to 49 %	60 to 80 %
	TCC> $3M	NA	NA	NA

Notes: The values in this table apply to the best-fit logartihmic regression curve for each Project Classification. Caution and review of the report text are urged in using this information. Refer to Appendix A for the corresponding regression curves, R^2 values, and N values for more details. Highlighted values indicate those for which R^2 values were exceptionally low, below 0.10.

best-fit logarithmic regression curve. Because the correlation coefficients and, in many cases, the number of relevant data points are quite low, the reader is cautioned that this table is to be used as a reference and not for prediction of performance. Readers are urged to review the curves in Appendix A in conjunction with using this table.

The curves display the upper bound of the 50 percent confidence interval for all of the data points shown. The confidence interval indicates the level of certainty in a data set, and how likely it is that a random sample from the data set will fall within the interval. The wider the distance between the upper and lower bounds of a confidence interval, the less certainty in the model and greater the need to collect more data before drawing conclusions from the data set.

The best-fit curve provides an average of the projects that can be used as a starting point for budgeting an entire program of projects, or for comparison of performance among the agencies. Caution and use of professional judgment is required to use the best-fit curve to budget an individual project.

The results of the analysis show that the R^2 values for the data are improving somewhat with continued additions of data to the database and repetition of the outlier analysis.

The shape of most of the best-fit curves is consistent with what is intuitively expected. The dependent variable (i.e., design, construction management, and project delivery) has higher average values and greater scatter at the low values of TCC. This decrease in both average value and variability as TCC increases, exhibits an inverse relationship.

The agencies theorized that one of the reasons R^2 values varied by project type and classification is that Pipe and Municipal Facilities projects, for instance, were better-defined at the beginning of a project and thus allow for the design effort to be more focused. This would lead to more consistent performance and therefore higher R^2 values. They also observed that Construction Management exhibited higher variability in relative cost than Design for the same project types and classifications

Regressions for the Restrooms classification showed a direct relationship between the dependent variable and TCC. That is, as the TCC increased, the average of the dependent variable also increased. This is true of the regressions of design, construction management, and project delivery. The agencies commented that more expensive restrooms tend to require more complex features and elaborate architectural design elements, explaining some of the trend. Also, the relatively low number of data points overall and clustering of nearly all data points in the range of less than $500,000 TCC may contribute. One data point that is relatively high in both project delivery percentage and TCC skews the best-fit curve to a positive slope. Without that data point included, the best-fit curve is relatively flat.

Based upon the results of an evaluation performed in the *Update 2004* report, the Study Team agreed that normalization of the cost data for differences in overhead rates was not necessary at this time. Please see the *Update 2004* report for more details on the overhead rate analysis and Appendix B of this report for a summary of overhead rates.

E. CHANGE ORDER CLASSIFICATION

The agencies discussed the benefit of classifying change orders and the necessity of clear definitions of change order classifications. Some of the participating agencies are beginning to implement change order classification as a BMP (see Chapter 4 Best Management Practices) as well as to facilitate data submission for this Study. Los Angeles presented a draft of its Special Order, requiring change order classification in the Bureau of Engineering, to the agencies. The definitions used in this Special Order were proposed for use by the agencies in classifying change orders for this Study.

The agencies agreed to classify change orders into the three categories in preparation for future analyses as follows:

1. Changed/Unforeseen Conditions
2. Changes to Bid Documents
3. Client Initiated Changes

I. Changed/Unforseen Conditions

This type of change is necessitated by discovery of actual job site conditions that differ from those shown on the contract plans or described in the specifications. These are conditions a designer could not have reasonably been expected to know about during the design of the project, including:

- Differing site conditions, such as soil conditions different than shown in the geotechnical report or structural building elements different than shown on record drawings.
- Undocumented presence of substructures, buried utilities, or unknown elements within building walls.
- Substructures, buried utilities, or utilities within building walls found in a different location than shown on the plans.
- Known structures discovered to be materially different than shown on the plans.
- Industry-wide strikes (to document time extensions).
- Unusually severe weather (to document time extensions).
- Acts of God, defined as earthquakes in excess of a magnitude of 3.5 on the Richter Scale and Tidal Waves (to document time extensions).
- Acts of Government subsequent to receipt of bids that affect the project's cost, but not its physical elements. If physical changes are required, the change order should be categorized as a "Client-Initiated Change."
- Reduction of the scope of work.
- Expansion of the scope of work.

II. Changes to Bid Documents

This type of change is necessitated by a mistake or oversight in the original contract documents and is required to correct the plans and specifications. These are things that the designer should have known about and dealt with successfully during the design of the project, including:

- Interference with existing improvements or other elements of the project.
- Ambiguities or inconsistencies in the contract documents which are typically resolved in response to the contractor's Request for Information (RFI).
- Conflicts between the contract plans and specifications.
- Plans or specifications that are impossible or impractical to construct or perform.
- Incomplete design documents.
- General project or design optimization.

III. Client-Initiated Changes

This type of change results from additions, deletions or revisions to the physical work, including:

- Unit price quantity adjustments. If the discrepancy is very large, the change should be categorized as a "Change to Bid Documents."

- Fixed-cash allowance item adjustments (additions or deletions).
- Change in the nature of the work or design intent, such as landscaping an area originally shown as paved.
- If the request is a result of the designer not having consulted with the Owner during the design phase, the change should be categorized as a "Change to Bid Documents."
- Regulatory changes resulting in physical modifications to the equipment, process or facility. Regulatory changes, which result in added costs, but do not require physical modifications to the project should be categorized as a "Changed/ Unforseen Condition."
- Material or equipment substitutions requested by the contractor.
- Construction incentive proposals requested by the contractor.

The agencies agreed that they were most interested in the study of change orders arising from changes to the bid documents, with the hope that the results of the analysis will help establish a standard of care to be expected from the design team.

The Study Team examined and presented preliminary curves to the agencies on change orders. The curves indicated there was very poor correlation between the value of total change orders on a project and the project size. The analysis also seemed to indicate that projects generally averaged change orders of 10 percent of TCC, regardless of the relative amount spent on design. Observing this, the group discussed the idea that approved change orders are usually limited in practice by the project's contingency budget. When a contingency is exceeded, often the agencies must go to their Councils or Boards for approval to increase the existing contract or establish a whole new contract. This encourages the agencies and their contractors to work within the allotted limits. In addition, when a new contract is established to pay for a change order, the cost is no longer linked to the original project.

The Study Team will continue to work with the agencies to collect reliable change order data in preparation for a future Special Study on change orders, and re-classify if needed.

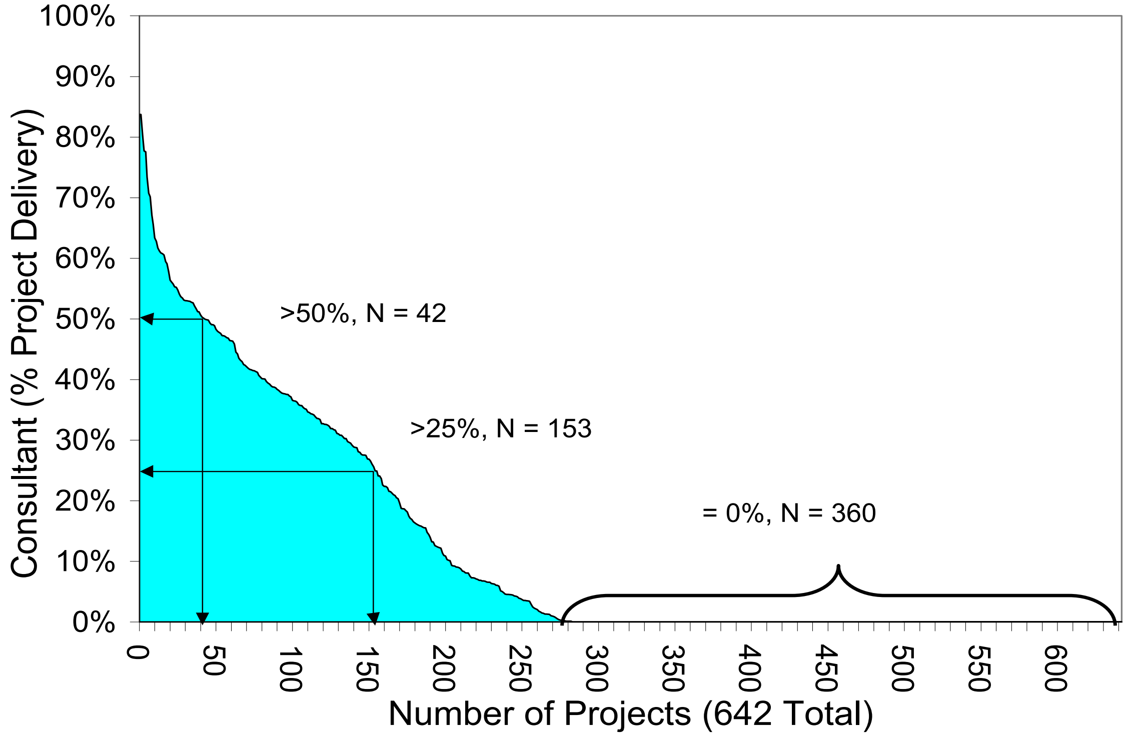
F. SPECIAL STUDY: CONSULTANT USAGE

The Study Team conducted a special analysis of consultant usage as it relates to project performance. A histogram of the *Update 2005* projects was prepared showing consultant usage as a percentage of project delivery cost, to identify potential groupings of consultant usage rates to compare. The histogram is shown in **Figure 3-1**.

While the agencies agree that consultant usage is generally increasing and will continue to escalate in the future, consultant costs are included in less than half of the projects in the *Update 2005* analysis. Of the projects on which consultants were used, 153 projects had consultant costs that exceeded 25 percent of the project delivery cost. And of these, only 42 exceeded 50 percent of project delivery costs, too few for analysis. Therefore, regressions were performed comparing projects for which consultant use exceeded 25 percent of project delivery cost and projects on which there were no consultant costs.

Since consultant use in construction management by the agencies was quite low overall, only design performance data (as a percentage of construction) were evaluated. Given that the overall number of data points in the comparison was low, performance was evaluated by Project Type

FIGURE 3-1 — CONSULTANT USAGE HISTOGRAM



and not by Project Classification. The resulting curves are not shown pending further refinement of the analysis in a future study phase.

The preliminary analyses showed that on Municipal and Parks projects, more projects involved consultant usage than not. On Streets and Pipe Systems projects, far more were delivered solely by Agency staff. In addition, the slope of the best-fit curve for projects using consultants for over 25 percent of project delivery costs was steeper than for no consultant usage. At lower TCC values, design as a percentage of construction tended to be higher on projects where consultants were used.

The agencies expected project delivery costs to be lower on projects that included consultant usage, but this was true only in particular cases. The agencies generally agreed that while there were no clear conclusions that could be drawn from the analyses due to low R^2 values, limited data, and the wide variety of projects making up the data set, the following observations could be made:

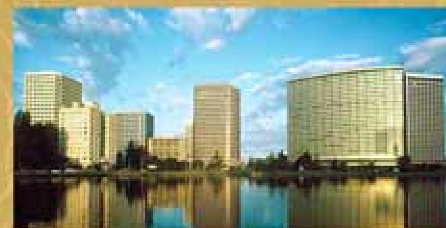
- Generally, the design cost for projects on which consultant usage exceeded 25 percent of project delivery was 6 or 7 percent higher than for projects with no consultant usage.
- For Municipal Facilities projects with a TCC greater than $5 million, design costs were lower when more than 25 percent of project delivery costs could be attributed to consultant use.
- The R^2 values were consistently higher for projects where consultant usage exceeded 25 percent of project delivery cost versus those where these was no consultant usage. This indicates less scatter and therefore more predictability and

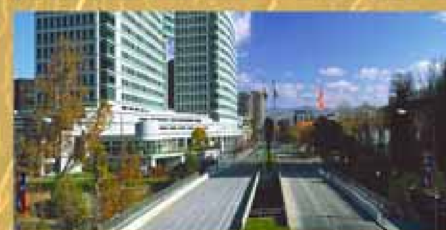
consistency in financial performance. This may be because the project scope must be better-defined when consultants are hired and because consultants' fees are limited by contract.

- The increase in design costs associated with using consultants on smaller or more specialized projects may be justified in cases where consultants offer specialized technical expertise, the projects are complex, there is an aggressive project schedule, there are peak workload demands that can't easily be met using in-house staff, or there are other resource limitations on in-house staff.

Chapter 4

Best Management Practices





CHAPTER

4 Best Management Practices

Since the inception of the Study in 2002, the agencies have examined over 100 practices used in the design and construction management phases of project delivery. Thirty-nine of these practices were identified as ones which the participating agencies do not already commonly use, but should be fully implemented as BMPs. Thirty-one of these thirty-nine targeted practices directly influence the cost of either design or construction management and, ultimately, efficient project delivery.

A. PROGRESS ON BEST MANAGEMENT PRACTICE IMPLEMENTATION

Over the last four years, the participating agencies have implemented many of the BMPs. BMP implementation has been tracked and project delivery performance data includes the project completion date. It is anticipated that the performance data will eventually demonstrate that as BMPs were implemented, project delivery costs were reduced. However, it is recognized that "processes" become effective "practices" only after a learning curve and full implementation on projects. Therefore, obtaining empirical evidence of this trend is expected to take several years.

In *Update 2005*, the agencies continued to exchange ideas regarding strategies for implementing various BMPs using both the networking opportunities at the quarterly meetings and the online discussion forum. The agencies' progress on actual BMP implementation since the last Study update and BMPs targeted for future implementation are summarized below:

I. City of Long Beach

Implemented June 2004 to May 2005:

- Have a Master Schedule attached to the CIP that identifies start and finish dates for projects
- Define requirements for reliability, maintenance, and operation prior to design initiation
- Limit Scope Changes to early stages of design
- Require scope changes during design to be accompanied by Budget and Schedule approvals
- Classify types of change orders
- Involve the Construction Management Team prior to completion of design
- Make bid documents available online.
- Adopt and use a Project Control System on all projects

Targeted from June 2005 Onward:

- Resource-load all CIP projects for design and construction
- Develop and use a standardized Project Delivery Manual
- Use a formal Quality Management System
- Provide formal training for Project Managers on a regular basis
- Implement and use a consultant rating system that identifies quality of consultant performance

II. City of Los Angeles

Implemented June 2004 to May 2005:

- Perform a formal Value Engineering Study for projects larger than $10 million (original BMP is $1 million)
- Perform and use post-project reviews to identify lessons learned
- Classify types of change orders

Targeted from June 2005 Onward:

- Limit Scope Changes to early stages of design
- Require scope changes during design to be accompanied by Budget and Schedule approvals
- Institutionalize Project Manager perfor mance and accountability

III. City of Oakland

Implemented June 2004 to May 2005:

- Define Capital projects well with respect to scope and budget including community and client approval at the end of the planning phase
- Train in-house staff to use Green Building Standards
- Limit Scope Changes to early stages of design
- Require scope changes during design to be accompanied by Budget and Schedule approvals
- Establish a pre-qualification process for contractors on large, complex projects
- Adopt and use a Project Control System on all projects
- Create in-house project management team for small projects

Targeted from June 2005 Onward:

- Have a Board/Council project prioritization system
- Show Projects on a Geographical Information System
- Develop and use a standardized Project Delivery Manual
- Institutionalize Project Manager perfor mance and accountability

IV. City of Sacramento

Implemented June 2004 to May 2005:

- Define Capital projects well with respect to scope and budget including community and client approval at the end of the planning phase
- Adapt successful designs to project sites, whenever possible (e.g. fire stations, gymnasiums, etc.)
- Limit scope changes to early stages of design
- Require scope changes during design to be accompanied by Budget and Schedule approvals
- Use a formal Quality Management System
- Delegate authority to the City Engineer/ Public Works Director or other departments to approve change orders to the contingency amount
- Perform and use post-project reviews to identify lessons learned
- Provide formal training for Project Managers on a regular basis
- Adopt and use a Project Control System on all projects
- Create in-house project management team for small projects
- Institutionalize Project Manager perfor-

mance and accountability
- Implement and use a consultant rating system that identifies quality of consultant performance

Targeted from June 2005 Onward:

- Have a Board/Council project prioritization system
- Resource-load all CIP projects for design and construction (targeted by two departments)
- Develop and use a standardized Project Delivery Manual
- Involve the Construction Management Team prior to completion of design

V. City of San Diego

Implemented June 2004 to May 2005:

- Define requirements for reliability, maintenance, and operation prior to design initiation
- Adapt successful designs to project sites, whenever possible (e.g. fire stations, gymnasiums, etc.)
- Limit Scope Changes to early stages of design
- Require scope changes during design to be accompanied by Budget and Schedule approvals
- Use a formal Quality Management System
- Create in-house project management team for small projects
- Include a standard consultant contract in the RFQ/RFP with a standard indemnification clause

Targeted from June 2005 Onward:

- Define capital projects well with respect to scope and budget including community and client approval at the end of the planning phase
- Complete Feasibility Studies on projects prior to defining budget and scope
- Have a Board/Council project prioritization system
- Resource-load all CIP projects for design and construction
- Provide a detailed clear, precise scope, schedule, and budget to designers prior to design start

VI. City & County of San Francisco

Implemented June 2004 to May 2005:

- Show Projects on a Geographical Information System
- Use a formal Quality Management System
- Establish a pre-qualification process for contractors on large, complex projects

Targeted from June 2005 Onward:

- Limit Scope Changes to early stages of design
- Require scope changes during design to be accompanied by Budget and Schedule approvals
- Implement and use a consultant rating system that identifies quality of consul tant performance

VII. City of San Jose

Implemented June 2004 to May 2005:

- Resource-load all CIP projects for design and construction
- Perform a formal value engineering study for projects larger than $1 million

- Limit Scope Changes to early stages of design
- Perform and use post-project reviews to identify lessons learned
- Implement and use a consultant rating system that identifies quality of consultant performance

Targeted from June 2005 Onward:

- Require scope changes during design to be accompanied by Budget and Schedule approvals
- Perform a formal Value Engineering Study for projects larger than $1 million
- Use a formal Quality Management System
- Classify types of change orders
- Delegate authority to the City Engineer/ Public Works Director or other departments to approve change orders to the contingency amount

Table 4-1 summarizes the BMPs that have been implemented by the participating agencies, as well as the priorities of those that are planned for implementation.

B. NEW BEST MANAGEMENT PRACTICES

The agencies continued efforts to identify new BMPs consistent with their goal of continuously improving project delivery. Following are examples of new BMPs that may be considered for future development and implementation:

- Prevent Scope Creep – The scope of a project should be memorialized as early as is possible. Stakeholders (including the agency's internal client) might prepare the scope, document it and send it to the Project Manager who would develop a budget based on the scope. This would be returned to the stakeholders for discussion, agreement, and written confirmation.
- Improve the Quality of Bid Documents – Design consultants should be rigorously pre-qualified based upon past performance on similar projects. Evaluations of design schedule compliance and the amount of change orders related to errors and omissions might be two of the criteria used.
- Promote Collaboration Between Team Members – Sharing project documentation (RFIs, change orders, etc.) in "real time" through an expanded use of online project management software and including stakeholders in design and construction progress meetings, would enhance collaboration and improve project delivery.
- Reduce the Budget Impact of Problem Bids – BMPs related to decreasing the number of bid irregularities should be identified and implemented. It was noted that some agencies experienced bid irregularities on 12 percent of their bids in 2003 and on 29 percent of their bids in 2004.
- Establish Minimum Qualifications for Defining a "Responsive" Bidder – Some agencies have implemented specific definitions for "responsive" bidders. Bidders on some projects must have five years of experience building similar projects and must document that experience to the agency prior to bid.
- Provide resources to Perform "Check Estimates" on Change Orders – Project Managers might receive additional training or resources might be made available to procure "check estimates" from independent third parties.

TABLE 4-1 — IMPLEMENTATION OF BMPS

Process Category	Ref:*	BMP	LA	LB	OK	SC	SD	SF	SJ	Notes
Planning	1.a.	Define capital projects well with respect to scope and budget including community and client approval at the end of the planning phase	✓	✓	✓	DGS: ✓ DT: ✓ DU: PI	PI 2006 ④	✓	✓	SD: Some Divisions only SC DU: Community involved after project is better-defined, typically at 30% design.
	1.b.	Complete Feasibility Studies on projects prior to defining budget and scope	✓	✓	✓	✓	PI 2006 ③	✓	✓	LB: When applicable SD: Result of CIP Benchmarking SF: When applicable SJ: Some exceptions
	1.d.	Have a Board/Council project prioritization system	NI	NI	2006	DGS: 2006 ① DT: ✓ DU: PI	2006 ①	NI	NI	SD: Result of CIP Benchmarking SC DU: Getting closer to approved Asset Mgt system that would facilitate this BMP, but project drivers vary (permit requirements, projects in other departments, etc)
	1.e.	Resource-load all CIP projects for design and construction	✓	PI 2006 ①	✓	DGS: 2006 ② DT: ✓ DU: 2006	2006 ②	NI	✓	SD: Result of CIP Benchmarking LB: Software in development. SC DU: Not sure in what form this will be implemented.
	1.f.	Have a Master Schedule attached to the CIP that identifies start and finish dates for projects	✓	✓	✓	✓	NI	NI	✓	LB: Software in development. SC DU: Program managers select finish date for approved budget document.
	1.i.	Show Projects on a Geographical Information System	✓	✓	PI 2006	✓	✓	✓	✓	LB: Infrastructure only

Legend:

✓: Implemented
PI: Partially implemented
NI: No plans to implement at this time
TBD: To be determined
yyyy: Will be implemented in calendar year "yyyy",
⊗ = Priority x for implementation
* Reference to Process Questionnaire in Appendix C of 2002 Study.
N/A indicates this BMP was added after the 2002 Study.

LA: Los Angeles
LB: Long Beach
OK: Oakland
SC: Sacramento
DGS: Department of General Services
DT: Department of Transportation
DU: Department of Utilities

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SF: San Francisco
SJ: San Jose

Table 4-1 — Implementation of BMPs (Cont'd)

Process Category	Ref:*	BMP	LA	LB	OK	SC	SD	SF	SJ	Notes
Design	2.b.	Provide a detailed clear, precise scope, schedule, and budget to designers prior to design start	✓	✓	✓	✓	PI 2006 ⑤	✓	✓	
	2.f.	Define requirements for reliability, maintenance, and operation prior to design initiation	✓	✓	NI	DGS: 2006 DT: ✓ DU: NI	✓	✓	✓	SD: Some Divisions only
	2.i.	Adapt successful designs to project sites, whenever possible (e.g. fire stations, gymnasiums, etc.)	✓	✓	✓	✓	✓	✓	✓	SD: Some Divisions only, where applicable SC DU: This is key to low delivery costs. Std special provisions are updated continuously for lessons learned, new requirements, changing technology, etc.
	N/A	Train in-house staff to use Green Building Standards	✓	TBD	✓	✓	✓	✓	✓	This BMP was found to improve client satisfaction (quality) and may not reduce project delivery cost directly. SF: When applicable
	N/A (2004)	Limit Scope Changes to early stages of design	2006 ②	✓	✓	DGS: PI DT: ✓ DU: NI	✓	2006 ①	✓	SC DU: Control and minimize, but difficult to eliminate, since clients and engineers come up with new/better solutions.
	N/A (2004)	Require scope changes during design to be accompanied by Budget and Schedule approvals	2006 ③	✓	PI 2006	DGS: PI DT: ✓ DU: NI	✓	2006 ②	2006 ⑤	

Legend:

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TABLE 4-1 — IMPLEMENTATION OF BMPs (CONT'D)

Process Category	Ref:*	BMP	LA	LB	OK	SC	SD	SF	SJ	Notes
Quality Assurance / Quality Control	3.I.a.	Develop and use a standardized Project Delivery Manual	✓	2006 ②	2006	DGS:✓ DT: 2005 ② DU:✓	PI 2006	✓	✓	SD: incorporated into PM training manual and std Primavera schedule template/descr. Details available as needed. SC DU: Badly needs updating.
	3.II.b.	Perform a formal Value Engineering Study for projects larger than $1 million	✓	✓	NI	✓	✓	✓	✓	LA: For projects > $10M LB: On an as-needed basis SC: As needed, not >$1M. SF: On an as-needed basis SJ: For projects > $5 million
	3.III.a.	Use a formal Quality Management System	✓	2006 ③	NI	DGS: 2006 DT: ✓ DU: NI	✓	✓	2006 ④	SD: Some Divisions only
	3.III.b	Perform and use post-project reviews to identify lessons learned	✓	TBD	✓	DGS: 2006 DT: ✓ DU: ✓	✓	✓	✓	SC DU: For selected projects in one-on-one meetings with design and construction staff. Also includes feedback from client. Intended to promote candid discussion.

Legend:

✓: Implemented
PI: Partially implemented
NI: No plans to implement at this time
TBD: To be determined
yyyy: Will be implemented in calendar year "yyyy",
⊗ = Priority x for implementation
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Table 4-1 — Implementation of BMPs (Cont'd)

Process Category	Ref:*	BMP	LA	LB	OK	SC	SD	SF	SJ	Notes
Construction Management	4.I.a.	Delegate authority to the City Engineer/Public Works Director or other departments to approve change orders to the contingency amount	✓	✓	✓	DGS: NI DT: NI DU: ✓	✓	✓	✓	SF: At Bureau level SJ: Individual CO < $100,000 SD: Individual CO < $200,000
	4.I.m.	Classify types of change orders	✓	✓	✓	✓	PI 2006	✓	2006 ③	LA: Draft Special Order prepared. SD: Only for scope changes versus other types
	4.II.a.	Include a formal Dispute Resolution Procedure in all contract agreements	✓	NI	✓	DGS: ✓ DT: ✓ DU: NI	✓	✓	✓	
	4.III.a.	Use a team building process for projects greater than $5 million	✓	✓	✓	DGS: ✓ DT: ✓ DU: NI	✓	✓	✓	LB: As-needed SD: As-needed SF: As-needed SJ: For projects > $10 M
	4.IV.a.	Involve the Construction Management Team prior to completion of design	✓	✓	✓	DGS: 2006 ③ DT: ✓ DU: ✓	✓	✓	✓	SD: Some Divisions only
	N/A (2003)	Delegate authority below Council to make contract awards under $1 million	✓	✓	NI	NI	✓	✓	2006 ①	
	N/A (2003)	Establish a pre-qualification process for contractors on large, complex projects	✓	NI	✓	DGS: ✓ DT: NI DU: ✓	✓	✓	✓	
	N/A (2003)	Make bid documents available online	TBD	✓	TBD	DGS: NI DT: 2006 DU: 2006	TBD	TBD	✓	LA: Not enough bids to make this useful. Resistance from smaller contractors who do not use the internet to conduct business. SD: Options being evaluated

Legend:

✓: Implemented
PI: Partially implemented
NI: No plans to implement at this time
TBD: To be determined
yyyy: Will be implemented in calendar year "yyyy",
⊗ = Priority x for implementation
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Table 4-1 — Implementation of BMPs (Cont'd)

Process Category	Ref:*	BMP	LA	LB	OK	SC	SD	SF	SJ	Notes
Project Management	5.I.f.	Assign a client representative to every project	✓	✓	✓	DGS: ✓ DT:2006 DU: ✓	✓	✓	✓	SD: Only for large projects
	5.II.a	Provide formal training for Project Managers on a regular basis	✓	2006 ④	✓	DGS: ✓ DT: 2006 DU: NI	✓	✓	✓	SD: Yearly PM academy, as funds allow
	5.III.a.	Adopt and use a Project Control System on all projects	✓	✓	✓	DT:✓ DU: NI	✓	✓	✓	SD: Project controls incorporated into Primavera schedule
	N/A (2003)	Create in-house project management team for small projects	NI	NI	✓	DGS: ✓ DT: NI DU: NI	✓	NI	✓	SD: Some Divisions only SC DU: Not enough PMs to justify this. Don't want to restrict staff to small, less-rewarding projects.
	N/A (2004)	Institutionalize Project Manager performance and accountability	2006 ①	2006	PI 2006	DGS: 2006 DT:✓ DU: NI	NI	TBD	2006	SD: Only non-standardized goals SC DU: There is interest but no definite plans.
Consultant Selection and Use	6.c.	Include a standard consultant contract in the RFQ/RFP with a standard indemnification clause	✓	✓	✓	✓	✓	✓	✓	SD: Some Divisions only
	6.e.	Delegate authority to the Public Works Director/City Engineer to approve consultant contracts under $250,000 when a formal RFP selection process is used	NI	NI	NI	NI	✓	✓	2006 ②	SC DU: Threshold is $100,000.
	6.g.	Implement and use a consultant rating system that identifies quality of consultant performance	✓	2006 ⑤	✓	DGS: ✓ DT:NI DU: ✓	✓	✓	✓	SJ: Need to incorporate more post-project review. SC DU: Track performance for those selected for "support services."

Legend:

✓: Implemented
PI: Partially implemented
NI: No plans to implement at this time
TBD: To be determined
yyyy: Will be implemented in calendar year "yyyy",
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* Reference to Process Questionnaire in Appendix C of 2002 Study.
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C. IMPLEMENTATION CHALLENGES

The implementation of BMPs by participating agencies was exceptionally challenging over the past year. Cities in California, like the State itself, had difficulty securing budgets and addressing unusual winter and spring storm damage. The ability of the agencies to implement particular BMPs as planned was impacted and implementation had to be delayed in many cases.

As San Francisco put it:

> *"Most public works agencies focus their time addressing the day-to-day challenges of running their agency and carrying out their missions. In doing so, they often place on the back-burner the important, but not necessarily urgent, task of seeking ways to improve the way they do business. Thus, the one big challenge in implementing BMPs is simply being able to allocate resources to make improvements in the face of competing (public) demands."*

While implementation was challenging, participants remain determined. For example, Oakland implemented most of the BMPs it had targeted and will continue to implement the rest in the next 12 to 18 months. Oakland commented that:

> *"These BMPs have benefited us to become a more effective organization in delivering capital projects. However, due to competing demands for resources, it is challenging to allocate staff to implement some of the practices that are more time-consuming, such as developing a standardized Project Delivery Manual. Another challenge is to streamline the award process for small consulting and construction contracts (those under $150,000 and $250,000, respectively) for more responsive service."*

Los Angeles targeted implementing the BMP of performing Value Engineering on projects with a construction value of $1 million or greater. However, this BMP was implemented only on projects $10 million and larger or when it was otherwise necessary on smaller projects, for example, after unexpectedly high bids were received.

Also, Los Angeles chose not to make bid documents available online because it was felt that the number and size of projects, as well as the low prevalence of internet use by contractors responding, did not warrant implementation of this BMP at this time.

When Sacramento is unable to implement a BMP, the delay was usually associated with not having followed basic project management practices to pursue the BMP. In contrast, Sacramento noted that its success in implementing a Project Management Manual was associated with making this BMP into a project and assigning it a schedule, budget, and a responsible project manager.

While Sacramento has found that implementation of BMPs has fostered teamwork and ensures that projects have a higher level of quality from start to finish, it is sometimes a challenge to convince staff that the new practices will result in direct benefits to them and the quality of their projects. Reporting on the results of BMP implementation in a quantifiable way is an important step in the implementation process.

San Diego sees a tremendous benefit in implementing BMPs for project delivery improvement, but as other agencies have reported, resource limitations present a major challenge. In addition, San Diego desires to turn some of the BMPs into citywide policy for all departments, rather than just those departments involved in the Study. This requires the approval of its city council and can be a time-consuming process leading to delays in BMP implementation.

San Jose's biggest challenges in BMP implementation are finding the time to properly develop, plan, and gain approval for making such changes. Implementing new BMPs in an organization as large as San Jose is difficult and requires substantial effort to be successful.

The agencies will continue to identify and implement BMPs to improve project delivery. Their progress will be documented to support the agencies' efforts to identify links between process and performance.

D. REGULATORY CHALLENGES

The participating agencies encountered a number of regulatory challenges this year, which they believe have impacted capital project delivery. As these challenges surfaced, the agencies began to strategize ways to minimize the impact upon project delivery cost. It is anticipated that new BMPs related to these regulatory issues will be identified and implemented as the team continues to work together.

Until mid-2005, San Francisco encountered challenges in the use of as-needed consulting services. San Francisco's Administrative Code limited these types of contracts to a 3-year term with no option for extensions. If a design task order was given to the consultant in the last year of the term, the contract sometimes expired before the design was completed. This provision often prevented use of the same consultant in design and construction phases, leading to a lack of continuity. To address this, San Francisco recently amended its code to allow consultants to complete task orders after the expiration of a 3-year contract if they were issued in the last year of the contract.

Another regulatory challenge for San Francisco is the federal requirement for historic and cultural investigation on excavations deeper than the pavement structural section. In roadway projects where San Francisco wants to incorporate sewer replacement work, the sewer excavation is often in areas that contain compacted fill from the original sewer construction. Archaeological or cultural resources would not normally be expected in such excavations. However, due to the federal requirement, project durations, schedules, and costs are adversely impacted.

Agencies often want to acquire Leadership in Energy and Environmental Design (LEED) building certification from the US Green Building Council. Los Angeles has found that these types of projects have delivery costs that are greater than those of standard buildings.

San Diego requires all new buildings to obtain LEED certification at the silver level to emphasize higher energy efficiency and use of recycled materials. Building costs, especially for equipment and façades, have increased as a result.

Sacramento finds that environmental awareness and an emphasis on sustainability, procedures, and scorecards drives many of their activities. Its council set a goal that all significant city buildings should meet standards at the gold level of LEED certification. This creates the challenge for Sacramento staff to increase training and adopt new design practices while identifying additional funds for projects that were started before the adoption of LEED practices.

Los Angeles commented that new Federal Highway Administration and Caltrans funding regulations can be time-consuming and difficult to follow. It can be difficult to predict the results on funding applications, impacting Los Angeles' ability to plan, design, and build its streets projects.

New regulations also require that Los Angeles submit a Bridge Evaluation and Historical Properties Survey Report to Caltrans for all bridges that are at least 50 years old. This adversely impacts costs associated with Los Angeles' ongoing

Bridge Program because consultant contracts are already in place for design. These changes require approvals of new task orders for consultants. This requirement, combined with a Caltrans' requirement that an individual certified by Caltrans shall complete the report, leads to schedule delays and increased costs.

Project delivery in Long Beach has been impacted by additional requirements for public outreach during both design and construction. The required outreach, which typically includes community meetings, commission reviews, and direct notification, has increased costs and lengthened project delivery schedules. Other regulatory impacts on project delivery include regularly-contested California Environmental Quality Act approvals and compliance with National Pollutant Discharge Elimination System (NPDES) regulations.

New stormwater runoff requirements, in addition to a new tree protection ordinance, has caused San Diego's project delivery to be impacted by increased schedule durations, costs, and resource needs.

During the holiday season from Thanksgiving Day to New Year's Day, Sacramento does not allow construction in downtown Sacramento right-of-ways and in designated "primary streets." This leads to increased costs by forcing projects to be delayed into the winter. In addition, construction projects in the extensive list of designated primary streets are restricted from 7:00 am to 8:30 am, and again from 4:00 to 5:30 pm, also increasing project delivery as well as total construction costs.

Inconsistency in Caltrans permitting caused difficulties for a recent Sacramento project. Single-pass HOBAS pipe had been allowed by Caltrans in the past and, following preliminary discussions with Caltrans, Sacramento believed it would be allowed on a microtunneling project. During permit procurement in construction phase, Caltrans disallowed its use and Sacramento was required to use another type of pipe construction. This led to increased costs in order to change the construction contract documents to conform to the approved method.

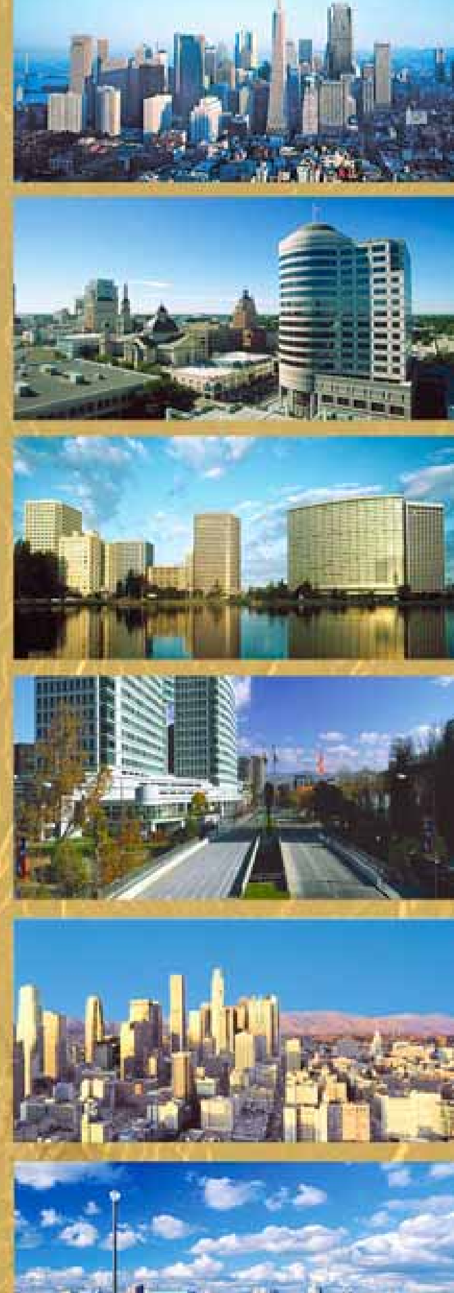
Sacramento encountered difficulties with Storm Water Pollution Prevention regulations, which have become more stringent since they were introduced in 1990 Project delivery and construction costs increase for projects disturbing over 1 acre because additional plans and inspections are required. The Sacramento Department of Utilities employs 2 full-time staff members for inspecting and citing violations, which increases overhead costs.

Recently, Sacramento has also found it harder to obtain permits from the U.S. Army Corps of Engineers, under Section 404 of the Clean Water Act for detention basin and channel improvement projects. This permit allows discharge of dredged or fill materials into waters of the US. Stricter enforcement of permit procurement requirements has resulted in significant delays, leading to significantly increased land acquisition costs. In one case, the permit was not approved and the project was canceled entirely. Similarly, permitting difficulties have also arisen for Sacramento on projects involving the California Public Utilities Commission (CPUC), adding cost and significant schedule delays. Sacramento is making an effort to involve the CPUC early in the project to avert these issues.

It is acknowledged that regulatory changes in our communities will continue. It is also recognized that regulatory changes are made with the intent of improving the quality of life for residents. The challenge for responsible agencies is to deliver capital projects compliant with regulatory changes while keeping the cost of compliance from having a detrimental impact on the cost of project delivery. Working together to develop effective BMPs to reduce the impact and disruption of compliance remains a goal of the agencies.

Chapter 5

Online Discussion Forum



CHAPTER 5

Online Discussion Forum

Among the primary benefits accruing to the participating agencies during this multi-year Study has been the opportunity to discuss the challenges of public works project delivery with their peers. These successful open forum communications included online discussions of over thirty topics that influence project delivery efficiency:

- Tracking/coordinating street and utility work to avoid re-work (including street cut moratoriums)
- Design error and omissions cost recovery
- 3-D design tools
- Impacts of SUVs on roads
- Bond measures for infrastructure
- Consultant selection, management, and fees
- Public works cost estimating
- Insurance challenges and solutions for MBE, DBE, and WBE firms
- Pavement aggregate gradation for slip resistance
- Enforcement of truncated domes in pedestrian ramps
- Obtaining approval of property use within existing utility easements
- Subdivision review procedures (using peer reviewers)
- Maintenance and management requirements for Wetlands Mitigation Projects
- Environmental approvals processes
- Online bid service providers and software
- ISO certification for public agencies
- Making contract documents available on line to bidders
- Cost impacts of LEED certification of buildings and in-house "green" design teams
- Contract awards and insurance requirements
- Bidder experience requirements
- Payment of prevailing wages on projects
- In-house geotechnical services
- Indemnification clauses for professional services contracts
- Staff performance incentives
- QA/QC of plans and specifications
- Parking standards on streets
- Construction traffic control management
- Use of rubberized asphalt concrete
- Utility markings
- Classification of change orders
- Bid opening process
- As-Built Record Documents

Following are examples of the type of information exchanged in those discussions. The discussions and solutions to issues are provided herein in the hope that they may be helpful to agencies struggling with similar issues and concerns. The following discussion topics are summarized in this chapter:

- Construction Traffic Control Management
- Street Construction Coordination
- Construction Cost Estimating

- Bond Measure Considerations
- Online Bid Advertising, Bid Documents, and Bidding
- Cost Impacts of LEED Certification and In-House Green Design Teams
- Environmental Approvals Processes
- Consultant Selection, Management, and Fees
- As-Built Record Documents

A. CONSTRUCTION TRAFFIC CONTROL MANAGEMENT

Sacramento is experiencing a significant growth cycle in its downtown area with several large projects concurrently under construction. Five additional projects are also planned in the next few years. It took advantage of its participation in the Study by posting the following questions to the agencies:

1. Generally, what is your process for managing traffic control in downtown areas related to construction and encroachment permits (street, lane, or pedestrian closures)?

2. What department and section approves traffic control plans and street, lane, and pedestrian closure permits?

3. How many staff members and at what classifications are dedicated for review, approval and enforcement of traffic control plans, street, lane, and pedestrian closures?

4. Who decides working times for street, lane, and pedestrian closures, and determines other requirements related to traffic control plans?

5. Do you have a typical standard for working hours and the number of lanes that must remain open in your downtown area? If there are no set standards, what criteria do you use to approve working hours and lane closures?

6. Do you have citation authority or the ability to fine "permitees" for failure to comply with traffic control plans or permit requirements? If so how much are your fines and how many staff have enforcement/citation authority?

7. How long does it typically take for a permit to be issued after being requested?

8. Do you have a hotline for citizens to call to report traffic problems or concerns?

9. What special provisions to traffic control and right-of-way management do you apply to high-rise construction? Do you allow full street closures for these types of projects?

10. Do you have a traffic operations control center and, if so, how is it used for construction traffic control management?

In addition to posting the questions, Sacramento described its current response to the growth cycle. Sacramento explained that it has a Right-of-Way Management Group comprised of two staff members in the Street Division. Their responsibilities are to coordinate construction activities, review traffic control plans, and monitor safety, noise, and other issues associated with construction citywide. Because of a large amount of construction work, particularly in their downtown area (office buildings, a light rail extension, and major utilities), they have also re-assigned a Supervising Engineer and a Construction Inspector to manage construction traffic control and right-of-way issues downtown. They are also in the process of evaluating their overall construction traffic control management program. The review and approval of traffic control permits is coordinated with the Traffic Engineering Services Section. There are also

28 inspectors who monitor and inspect projects citywide. Sacramento has an administrative penalty ordinance that allows a levy of $500 fines for traffic control plan violations.

Members of the agencies responded as follows:

San Diego:

Coincidentally, San Diego was also looking for improvements in the way that traffic control plans were developed on projects. Currently the traffic control permits are obtained by preparing and including traffic control drawings as part of the design of municipal projects.

In San Diego, traffic permits for downtown projects are handled the same way as other permits, except that there are moratoriums during holiday seasons and during large events. Coordination of work in the downtown area is encouraged through the downtown partnership group, Paradise in Progress. You can see the web site at: http://www.downtownsandiego.org/index.cfm/fuseaction/about.abt_pp

The Development Services Department issues permits for projects by developers. Permits for CIP projects are handled by the its Field Engineering Division. The Field Division traffic control staff is comprised of one half-time senior engineer, one associate engineer, and assistant engineers. Its Developer Services Department has a similar number of staff.

The conditions of each permit (working times, number of lanes, etc.) are decided by the respective Development Services Department or Engineering and Capital Projects Group. In San Diego, there are no published standards for the conditions applicable to each permit. These are decided on a project-by-project basis, using the volume-versus-capacity of road. In general, major streets may be closed between 8:30 am and 3:30 pm, and other streets may be closed between 7:00 am to 3:30 pm. If the daytime traffic volume cannot be supported with the requested lane closures, night work is permitted between 10:00 pm and 5:00 am. San Diego is looking at establishing standards for these as part of the proposed changes to the shop drawing process.

The length of time it takes to get a traffic control permit in San Diego depends on what method is used. Prepared design sheets take several months during design to develop but only take one week to permit during construction if the contractor does not propose changes. Shop drawings or changes to design traffic control drawings usually take 45 days to get approved.

Paradise in Progress has a hotline for work in downtown, but this is for information only, since it does not issue the permits.

High rise construction permits are evaluated like all other permits on a case-by-case basis. So, unless extra capacity exists in the existing road to handle all hours of traffic demand, continuous (day and night) closures are rare. Again, coordination through Paradise in Progress is encouraged.

San Diego does not have a traffic operations control center.

San Francisco:

In 1964, San Francisco passed an ordinance granting authority for establishing the “Regulations for Working in San Francisco Streets.” This guide, called the “blue book,” is now in its 6th edition and available at www.sfgov.org/sfbluebook. It is used by other San Francisco agencies, utility crews, private contractors and others doing work in San Francisco streets to help convey the general rules under which work is conducted.

Section 1 of the blue book discusses the different types of permits required. For major construction projects, a street space meeting is typically held before street space permits are issued. At this meeting, held by the Department of Public Works (DPW), street space needs and allowances are discussed. The Department of Parking and Traffic (DPT) administers (in cooperation with police enforcement) a program to issue Special Traffic Permits when work is required outside the limits of the street space permits.

The Construction Section and the Special Projects and Street-Use Section of the DPT's Traffic Engineering Division typically approve traffic control plans and, for San Francisco projects, draft contract provisions and specifications that dictate traffic control requirements as they relate to street, lane, and sidewalk usage.

In the Special Projects and Street Use Section, for example, there are five staff members responsible for permit administration, review and approval. Not all staff members are dedicated full time to the permitting responsibilities. Staff includes a half-time clerk, an assistant engineer, an associate engineer, a full engineer, and a senior engineer who is the section head. Enforcement of the permits is done by the San Francisco Police Department through a separate program administered by DPT called the "Safe Paths of Travel" ("SPOT") program. Several officers have been trained to enforce the provisions of the "Regulations for Working in San Francisco Streets" and do so as funding permits. Enforcement is funded in part by paid citations. One Sergeant Inspector manages deployment of the enforcement officers.

Working times for various streets have long been established based on the input of various departments in the San Francisco and are tabulated in the "Regulations for Working in San Francisco Streets." The needs of the contractors and various projects are balanced with DPT's duty to move goods and people safely and efficiently. When exceptions are granted to the basic street space provisions, they are typically authorized by the DPW via Additional Street Space or by the DPT via a Special Traffic Permit. Often, San Francisco and contractors also solicit the input of the neighboring community when developing the traffic control plans so as to minimize impacts.

San Francisco has a standard for working hours and the number of lanes that must remain open. The "Regulations for Working in San Francisco Streets" specifies hours and lane requirements citywide. Furthermore, the streets of major traffic importance have additional restrictions based on scheduled events, time of year and time of day.

Under Section 194.3 of the San Francisco Traffic Code, the San Francisco Police Department may cite those who fail to comply with the provisions of the "Regulations for Working in San Francisco Streets." Any person and/or business entity violating any provision of this section shall be deemed guilty of an infraction and upon conviction thereof shall be punished by a fine of $500 for the first offense, $750 for the second offense within one year, and $975 for the third offense within one year. Any person and/or business entity that obstructs traffic in violation of the provisions of this section four or more times within one year shall be deemed guilty of a misdemeanor and upon conviction thereof shall be punished by a fine of $1,000 unless the fourth or subsequent violation is for obstruction of traffic without a valid Special Traffic Permit, in which case they shall be guilty of a misdemeanor and upon conviction thereof shall be punished by a fine of $5,000 and/or a term of up to one year in jail. Under San Francisco contracts, the construction inspector can typically assess damages for failure of the contractor to comply with the provisions of the specifications including the traffic control plans.

To issue Special Traffic Permits, the DPT requests a minimum of 48 hours to process a permit application. In some cases, depending on the complexity of the request, more time may be needed to legislate traffic control changes, to notice and effect tow-away no parking, or discuss with other municipal agencies.

The DPT does not maintain a hotline for the purposes of reporting concerns related to Special Traffic Permits or work permitted under that process.

The same traffic engineering principles apply to high rise construction as to other projects. When these projects cannot comply with the rules for working in the streets, variances are considered on a case-by-case basis. Full street closures are allowed in San Francisco often for special events but typically not for the duration of a construction project due to the nature of our dense city and the many needs of various street users. Under certain conditions with adequate detouring and traffic control, street closures are allowed for brief periods. The DPT also attempts to accommodate pedestrian traffic near construction sites.

The DPT is presently developing an Integrated Transportation Management System and Traffic Management Center. The DPT's mission, vision and goals of the "SFgo" team can be found at http://www.sfgo.org.

San Jose:

Traffic control plans in the downtown area are reviewed by the Project Inspector, the Principal Construction Inspector (PCI), and the Department of Transportation (DOT) Downtown Coordinator. The DOT Downtown Coordinator is responsible for managing the traffic operations which impact the downtown area. For long-term sidewalk closures and lane closures, a revocable encroachment permit is required and reviewed by the project inspector, the PCI, the project engineer, and Re-Development Agency (RDA) as required.

The Department of Public Works (DPW) and the DOT review traffic control plans for downtown. Public Works approves them and then issues revocable encroachment permits for any long-term lane and sidewalk closures.

Working times and closures are dictated by the Traffic Ordinance in San Jose Municipal Code, but can be modified with input from the inspectors and DOT and if approved by the project engineer.

The typical working hours in the downtown area are 8:30 am to 3:30 pm or, if the project is near a signalized intersection, 9 am to 3 pm. Typically, on streets with two or more traffic lanes in each direction, only one lane can be closed.

The San Jose Police Department can issue citations according to the Municipal Code, Chapter 11.14, "Limitation of Hours of Construction in City Streets." Otherwise there are no other citations given for failure to comply. Contractors that do not comply are required correct the problem or shut down operations.

There is no specific traffic hotline. Citizen concerns can be directed to the Help Desk (408-277-4000), DOT (408-277-4373) or directly to the DPW Storm/Utility Section at 408-998-6090.

In the case of high-rise construction, full street closures are rarely necessary. For certain crane and concrete pumping operations, there are requests to take more than one lane and for longer working hours, such as for 12 to 24-hour concrete placements. There are also requests to close the sidewalk or take a traffic lane to set up a crane or trailers in the street for long-term use. In these cases, a revocable permit is required after a plan is submitted showing things like re-striping of lanes, K-rail installation, or traffic signal modifications. Placing trailers in the street is not encouraged. On temporary lane closures where more than one lane will be taken, such as for material deliveries that necessitate a crane and for concrete pumping operations, traffic control plans are reviewed in the field with the developer's contractors, DOT, RDA, and DPW inspectors. If a pedestrian-covered walkway is needed next to the site, the developer's engineer submits a plan to DPW for review prior to receiving a revocable permit.

In San Jose, the DOT functions as the traffic operations center.

Los Angeles:

In Los Angeles, an applicant applies for a permit online or at the Public Counter. Depending on specifics, the applicant will be asked to obtain Transit and Transportation Construction Traffic Management Committee (TCTMC) approval. TCTMC meets weekly and it accepts both walk-ins and agenda items. Complicated permits are taken under advisement where both the Los Angeles Department of Transportation (LADOT) and Los Angeles Bureau of Street Services (LABSS) are allowed adequate time to review plans and perform field investigations prior to recommending for approval at a subsequent TCTMC meeting.

The LADOT approves traffic control plans and makes street lane requirements. The LABSS issues street use permits that impact pedestrian paths of travel.

A Traffic Engineer approves Traffic Plans. A Civil Engineer Associate III approves Utility Plans. A Senior Inspector in Contract Administration performs inspections. The TCTMC Chair is a Civil Engineer/Civil Engineering Associate III. The Street Use inspector is a Senior Street Service Investigator II.

The TCTMC approves work hours based on traffic conditions and other project schedules. For example, if construction of a significant project was scheduled to close a street for pile installation, then no other construction work would be approved along the detour routes of that project.

Typical work hours are 9:00 am to 3:30 pm during weekdays (non-peak hours) and 8:00 am to 6:00 pm on Saturdays. LADOT typically requires that a minimum of one lane of traffic be maintained in each direction.

If the contractor does not have TCTMC approval, inspectors will shut down the work until TCTMC approval is obtained. TCTMC's fee is $220/lane reduction/day/block impacted. Also, the LABSS can shut down the project and either issue a Notice to Pay the Fee to Obtain the Permit or a citation which is resolved by the court with a bail fee.

For small projects, permits are issued on the same day at the TCTMC meeting. Others may take a week. If the traffic plans require review by LADOT, it can take a couple of weeks.

Los Angeles has a hotline to process complaints on an expedited basis, which can be reached by dialing 311 within Los Angeles. However, committees overseeing major construction projects have public relations offices to address public complaints. Public complaints can also go to City Council Offices and Council field offices.

For high rise projects, LADOT determines detours and may allow full street closure. Full street closure requires Board of Public Works (BPW) approval for major streets. BPW approval can take as long as a month or more.

LADOT has a Traffic Operation Center (TOC). Typically LADOT requires CCTV cameras along major transportation construction projects. During construction, LADOT monitors traffic from TOC and corrects traffic impacts by either controlling signal timing or instructing contractors to remove legal/illegal traffic lane closures.

Other Comments:

During the discussions on the construction traffic control issues, San Jose made additional inquiries and received responses as follows:

1) Do your Municipal Code, policies, or prac-

tices direct who is qualified to direct traffic at construction sites?

San Francisco responded that its codes and policies do not explicitly state who is qualified. However, the agency recognizes the need to certify its own personnel and are investigating a course to be set up through the Technology Transfer Program at the University of California, Berkeley's Institute of Transportation Studies. The curriculum would be California Occupational Safety and Health Administration (OSHA)-compliant and incorporate requirements from the new Manual on Uniform Traffic Control Devices and its California Supplement.

2) Do you require the contractor to have a Certified Flagger (if so, what certification?) or do you require police officers to direct traffic under certain situations?

San Francisco responded that generally it is the contractor's responsibility to staff personnel with the proper training. However, it is its expectation that the training follow a curriculum similar to that developed by the National Safety Council and that the training have a certification process that is compliant with California OSHA and the California Code of Regulations.

San Francisco chooses to use either officers or flaggers depending on the individual location. Following are some examples.

- When lane closures reduce capacity such that a longer green light is needed at the intersection to serve a phase, police officers or parking control officers will be deployed to manually override the traffic signal and/or direct traffic in the intersection.
- When double-parking must be prohibited around a site, officers will be deployed to discourage double-parking in the area.
- When pedestrian volumes are heavy and strict control is required, officers will be assigned to the site.
- When a reversible lane situation is established, traffic will be controlled using flaggers on residential streets or minor streets. Officers may be added if the work is on a major collector or arterial.
- When a contractor needs to close the sidewalk for brief periods (e.g., when hoisting rebar off a flatbed and over the sidewalk for 45 seconds or less), one or two flaggers are required to control pedestrians. Likewise, when a sidewalk section is closed and pedestrians must be redirected to the other side of the street, flaggers are typically stationed at the corners. San Francisco's experience is that flaggers and officers are equally capable of following the engineer's traffic control instructions on the permit and directing vehicular and pedestrian traffic, but that officers gain a modicum of better compliance because they are more authoritative and the public responds better to them. This can be important for pedestrian control.

Oakland responded that it requires the contractor receiving the permit to take responsibility for traffic control and it has no specifications that qualify who can direct traffic. The police department rarely gets involved in traffic control and the flaggers are required at locations meeting Work Area Traffic Control Handbook standards.

B. STREET CONSTRUCTION COORDINATION

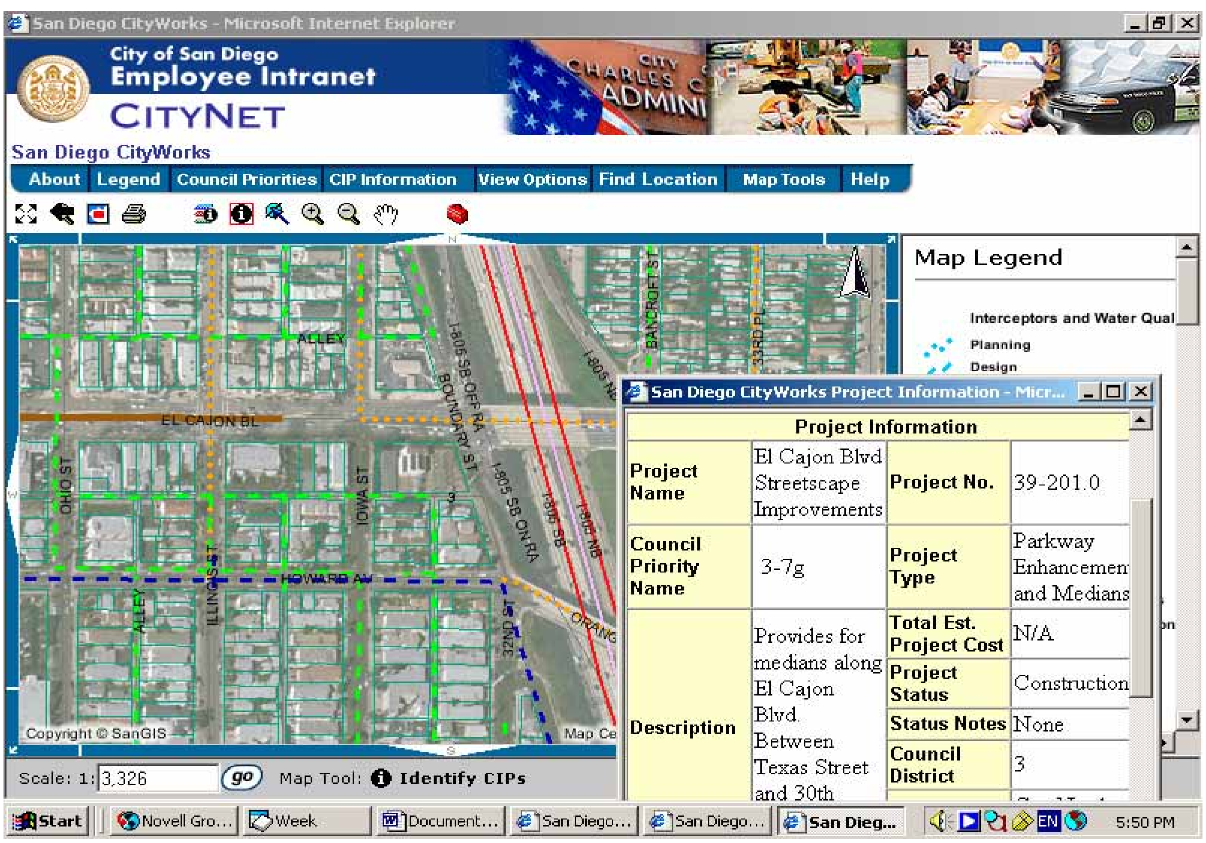
San Francisco initiated a discussion of coordination of construction within right-of-ways. The excavation of newly constructed or re-paved streets was a problem faced by many of the agencies. Some agencies implement time-specific "moratoriums" on work within a right-of-way after improvements are completed.

San Francisco explained that its DPW has a Street Construction Coordination Committee to coordinate all street excavation work in the public right-of-way. The committee maintains a database of all pending capital streets projects in a five-year plan. Utility companies and others are required to provide project information to populate the database. The purpose is for everyone to know what is planned and to prevent utility companies from trenching newly paved streets.

For paving and sewer projects, San Francisco tracks work in the street segments as well as within intersections. Individual street segments and intersections now have unique identification numbers.

San Diego responded that it has a CIP project coordination system it developed called CityWorks to enhance coordination efforts between various departments and provide information on projects. Using a Geographical Information System (GIS)-based format and drawing from the various San Diego data resources, information about a particular project can be obtained by simply clicking on the icon that represents the project or by searching for particular aspect of the project, such as the name, type of project, phase of the work, or CIP number. Originally developed as an internal tool, access to a version of the system has recently been made available to the public on the internet. This is accessible at www.sandiego.gov. Through this, anyone can find out basic information for an area about current or planned projects. Please see **Figure 5-1** for an image of the CityWorks internet site.

Figure 5-1 — San Diego's CityWorks



C. CONSTRUCTION COST ESTIMATING

San Diego's Engineering and Capital Projects Department, Water and Sewer Design Division initiated a survey of agencies to evaluate their current methods and to implement practices that would improve their Construction Cost Estimating. They were particularly interested in the tools and resources used in preparing accurate estimates.

The responses to San Diego's survey by some of the agencies are summarized in **Table 5-1**.

TABLE 5-1 — COST ESTIMATING SURVEY

1. On an average, how close are your engineer's estimates to the actual bid?	Agencies target the accuracy of their estimates to 105 percent of the anticipated low bid. The agencies have been successful meeting this target on 80 to 90 percent of their estimates, but acknowledge that recent escalations in concrete and steel prices have affected their accuracy.
2. What resources or tools do you use for preparing the cost estimates?	Historical information from recent bids is used to guide the development of estimates. The estimate is then adjusted, taking into account factors such as location, underground work, traffic, working hours, and complexity. Means and Saylor references are frequently used on non-routine items, Caltrans on transportation projects, and local historical bid data when appropriate. Relationships with suppliers and manufacturers are maintained and they are often consulted to verify estimated costs on included items.
3. Do you use software for preparing estimates? If yes, what software do you use and how was it helpful/successful?	Most of the participant agencies use Microsoft Excel® to perform and track their estimates. One agency is in the process of implementing specialized software that has been found to be helpful but has not yet been fully evaluated.
4. Do you have a dedicated staff for cost estimating or QA/QC? If yes, how was their service helpful?	One of the participant agencies has a dedicated staff to perform cost estimating or QA/QC of the plans. This team of two engineers is responsible for reviewing the estimate and the plans. They also visit the site and then meet with the design team to review the estimate. Most agencies participating in the study require that their project managers do the cost estimate and QA/QC the documents.
5. What is your experience with cost estimating consultants?	While design and construction management consultants have provided estimating support on projects, the agencies generally do not use estimating consultants. One agency is starting to use them, and has also found that design and construction management consultants are able to provide detailed estimating support as an additional service.
6. Do you have a dedicated staff for cost estimating? How many staff?	None of the participating agencies maintain staff dedicated exclusively to cost estimating. One agency has staff that perform cost estimating and QA/QC of documents, but these staff are not dedicated.
7. How do you maintain and make use of the bid results?	Most design sections maintain the historical bid results in project files, master hard copy files, or an electronic database. Some agencies make the data available to all sections through an intranet.
8. What other best management practices have you implemented to improve your cost estimating?	a) Analyze bid results particularly for projects with major cost discrepancies; b) Minimize the number of alternate bid items to minimize the opportunity for unbalanced bids; c) Attract and hire staff with special cost estimating skills by paying the employee a 5 percent pay premium when that person is assigned cost estimating tasks; d) Perform peer review of design and constructability review prior to bid; e) Target estimate for middle bidder instead of low bidder; and f) Update the cost estimating guidance documents and integrate it with the scope of work approval and resource estimating processes.

D. BOND MEASURE CONSIDERATIONS

Long Beach was considering a bond measure for various infrastructure improvements and looked for information to present to its Council on what types of bond measures other cities have passed, what amounts were approved, and when the bond measures were approved. The participating agencies responded and Long Beach assembled the matrix shown in **Table 5-2**.

E. ONLINE BID ADVERTISING, BID DOCUMENTS, AND BIDDING

There were three online discussion topics relating to making effective use of the internet with respect to bidding. Many of the agencies currently make bid notices available to potential bidders on their websites or on internet bidding service sites. At least two of the agencies also make bid documents available to contractors online. The requirement for signed and notarized bid bonds is a current challenge faced by the agencies in accepting actual bids online.

Long Beach has a contract with "Planet Bids" (www.planetbids.com), which has customized its software to meet Long Beach's needs. Using this program, Long Beach provides online notices to vendors and contractors inviting bids and makes the bid documents themselves available. In addition, Long Beach now accepts bids online for contracts less than $100,000. Projects over $100,000 require bid bonds and Long Beach has not been able to create a workable solution to accept bid bonds online.

After an initial learning curve for Long Beach, vendors, and contractors, Long Beach has observed that the online bid system has increased the number of notices being received by potential bidders and notices have been received much more quickly than by the more traditional trade publications or newspaper ads.

Long Beach has noted that a peripheral benefit of making bid notices and documents available on line is that a database of contractors interested in doing work for the agency is easily created.

At this time, most agencies do not issue plans and specifications electronically. Paper sets of plans and specs are issued and contractors are charged, usually based on the estimated value of the project.

F. COST IMPACTS OF LEED CERTIFICATION AND IN-HOUSE GREEN DESIGN TEAMS

San Francisco initiated a discussion on the promotion of Green Design on new and existing facilities. The primary questions explored whether agencies had adopted ordinances requiring that designs meet or exceed LEED certification requirements and, if so, how had their design budgets been impacted.

It was found that at only one of the agencies had a Council-adopted ordinance that required LEED design as a standard, and in this instance it was only required on projects over 7,500 square feet. Other agencies had completed LEED projects or had LEED projects underway, some of the projects having received statewide or national recognition. Agencies were inclined to find a way to train in-house personnel to certify the projects. Agencies were also budgeting between 2 and 5 percent more for LEED projects. The agencies will continue to study this issue.

Table 5-2 — Bond Measures (1999-2004)

City	Type	Value (in $M)	Year	Additional Information
Sacramento	GO - Gas Tax	Unknown	Unknown	Interchange for King's arena
Sacramento	GO	Unknown	Unknown	3-year general fund projects
Los Angeles	GO - Prop F Fire Facilities	$532	2000	Construction and rehabilitation of fire stations ($379 million) and animal shelters ($153 million)
Los Angeles	GO Prop Q Public Safety	$600	2002	Renovation, expansion, and construction of public safety facilities, including police and fire stations
Los Angeles	GO - Stormwater	$500	Proposed	November 2004 election item
San Jose	GO	$228	2000	Safe Neighborhood Parks and Recreation Dept. Bond. Includes 73 neighborhood parks, 9 community centers, 5 regional parks, and 5 trail projects
San Jose	GO	$212	2000	Neighborhood Libraries Bond, funding 20 projects
San Jose	GO	$159	2002	Public Safety Bond; funds capital projects for driver training program, 911 communications center, fire fighting training center, police substation, new and relocated fire stations, community policing centers, and upgrades to existing fire facilities
San Jose	Measure I	$343	1996	Provided the associated cost of development and construction; does not require additional taxes; no funds diverted from other programs
San Francisco	GO	$299	1999	Laguna Honda – Public Health
San Francisco	GO	$87.5	2000	Academy of Sciences – Cultural Facilities
San Francisco	GO	$110	2000	Recreation and park facilities
San Francisco	GO	$105.9	2000	Branch libraries
San Francisco	GO	$60	Proposed	Rehabilitate historical and cultural buildings
San Diego	GO	$5.9	2003	Piper Ranch Business Park
San Diego	GO	$62.2	2000	Mello-Roos Community Facilities Districts, Area 1
San Diego	GO	$4.8	2000	Mello-Roos Community Facilities Districts, Area 3
San Diego	GO	$10.5	2004	Mello-Roos Community Facilities Districts, Area 4
San Diego	GO	$299	2000	Ballpark and Redevelopment Project
San Diego	GO	$30	2002	Fire and Life Safety Improvements Program
Oakland	Measure DD GO	$198.3	2003	Lake Merritt Channel, Oakland Estuary waterfront, creeks, and other cultural and recreational facilities
Oakland	Sewer Revenue Bonds 2004 Series A	$62.2	2004	Sanitary sewer capital improvement program

G. ENVIRONMENTAL APPROVALS PROCESSES

San Diego initiated a discussion of environmental approval processes associated with public works projects. Questions with summarized responses are presented in **Table 5-3**.

Table 5-3 — Environmental Approval Processes

1. What is the average cost that projects incur for preparation, circulation, and evaluation of environmental documents and permits? (Include only the internal portion of the costs, not consultant costs.)	Environmental documents vary widely as do the costs associated with preparation, review, and permitting. Categorical Exemptions are the minimum level of effort, with costs averaging below $100. Negative Declarations may cost between $1,000 and $2,500. Full Environmental Impact Reports (EIRs) average between $10,000 and $50,000, but may run as high as $250,000 in some cases. Permit applications are prepared in-house by most agencies and the cost may range between $3,000 and $15,000. It was noted that closer proximity of projects to water bodies and sensitive habitats increase the issues to address in (and therefore costs associated with) preparing environmental documents and permits.
2. How long does this review evaluation process take (on average) from the time that the project information is submitted, until the time that the document is ready for presentation and certification by Council?	Exemptions take between 2 and 10 days. Negative Declarations may take from one to six months. Full EIRs normally take up to a year and in some cases, 2 years or more.
3. Is the staff responsible for reviewing your CEQA/NEPA documents within the City Engineer's organization, or within a separate department?	The review of environmental documents requires a cooperative effort between Planning and Engineering Departments in most agencies.
4. If the reviewing staff is within a separate department, what mechanism is in place to insure that the project schedules are adhered to?	Environmental, Planning, and Engineering work together to define and commit to a schedule for review and processing. Normally, the approval schedule is dictated by the public during the review and comment process.
5. If the reviewing staff is within a separate department, are the submittal procedures between the departments cumbersome? Are multiple submittals required? If so, how many?	Departments go through a multiple draft cooperative review process. One agency, for example, has a 3-step formal submittal process: an administrative draft, a preliminary draft, and a draft that is issued to the public for comment. The formality of the submittal process varies among agencies and with the complexity of the project.
6. If the reviewing staff is within the City Engineer's organization, what measures are in place to ensure the objective independence of the reviews? Have there been any issues raised in this regard?	Only one of the participating agencies had the environmental reviews performed by staff within the City Engineer's organization and in that case, it was a separate "Division" exercising independent judgment as required by CEQA. No issues had been raised regarding their "independence."
7. Do the reviewers also review private (development) projects as well? If so, how are the reviews assigned: geographically, by resource availability, by specialty, or otherwise?	The Planning or Building Departments normally addresses project reviews for private developments.

TABLE 5-3 — ENVIRONMENTAL APPROVAL PROCESSES (CONT'D)

8. Is the process for obtaining environmentally based permits (404, coastal, etc.) any different from the CEQA/NEPA process with regards to who is in the lead?	For most agencies, leadership in the permitting process is provided by the Planning Departments. This does not vary significantly.
9. From a project scheduling perspective, does your organization typically run the final design and environmental processes in parallel for non-federal projects? Or, do you follow the Federal Local Assistance process by waiting for the environmental document to be certified before continuing any final design or ROW acquisition negotiations?	Preliminary design and environmental processes typically run in parallel. In non-controversial projects, the complete design may be completed concurrent with the permitting process but it was recommended, and practiced, by the agencies that environmental clearances be obtained before completing final design.
10. Overall, how would you rate the effectiveness of the system you have in place (good, average, poor) with regards to producing a quality environmental document in a timely and cost effective manner?	All of the responding agencies rated their effectiveness as "good."

H. CONSULTANT SELECTION, MANAGEMENT, AND FEES

There were several discussion topics relating to the hiring and use of consultants. Topics of particular interest included selecting consultants, outsourcing entire projects to consultants, augmenting staff with consultants, and determining consultant fees.

The agencies agreed that consultant selection must include consideration of experience on similar projects of similar size and a review of past performance, particularly schedule and budget performance.

It was generally found that design fees were usually based on a percentage of the construction value. Additional services were based on hourly rates, which were found to be between 250 percent and 325 percent of the base salary of the personnel. The higher multipliers appeared to apply to specialized services and the lower to routine architecture and engineering.

The agencies intend to continue studying the complex issues of consultant use and fees in the future.

I. AS-BUILT RECORD DOCUMENTS

Sacramento initiated a discussion in search of a more efficient way to create as-built record documents. Within most agencies, the responsibility for coordinating and ensuring that record drawings are created and maintained rests with the Construction Manager on the project.

In San Diego, the Construction Manager typically makes sure that the "redline documents" (or "redlines") are produced by the construction contractor. The contractor is sometimes required turn the redlines over to the Construction Manager as work is completed, but often the redlines are reviewed monthly and then the entire set is turned over at completion. Once received by the Construction Manager, they are transmitted to the Project Manager who updates the electronic files, marks them "as-built," and files them with the records section.

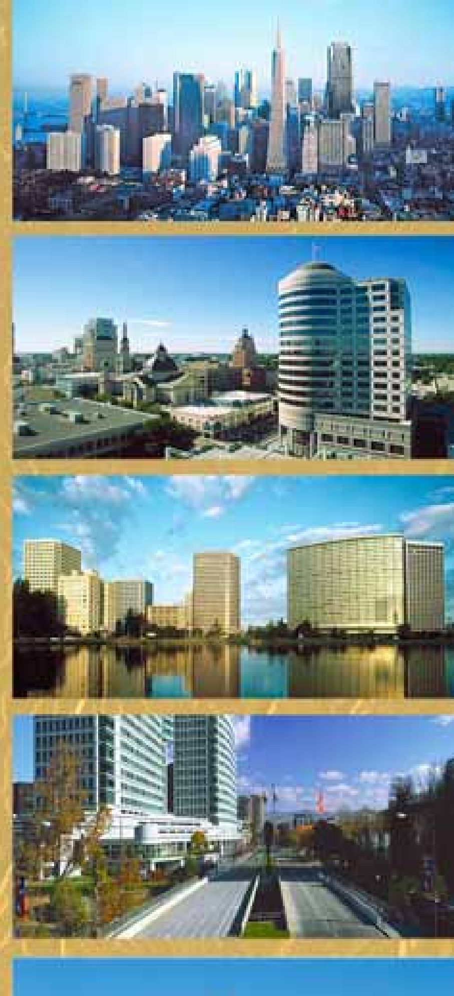
In Sacramento's Department of Utilities, the redlines are received from the contractor and checked by the Construction Inspector and Construction Manager. A Project Manager approves the redlines and a Supervising Technician tracks the drafting effort (in-house or by consultant) to digitally update the electronic files. When the update is complete, the as-builts are used by the GIS group to update the Facility On-line Information System and maps.

In Long Beach, Project Managers are responsible for delivering as-built drawings to the records section. If the drawings were done in-house, the AutoCAD® files are updated to as-built, signed, and filed. If an outside consultant did the drawings, the consultant's contract requires them to produce the as-built drawings and submit them to Long Beach.

San Francisco's current procedure is to scan the contractor's redlines and archive both the hard copy redlines and scanned file in its records management system. San Francisco has found that eliminating the step of transferring the changes via AutoCAD® saves time and effort. For most types of projects, the likelihood of needing an updated AutoCAD® drawing in the future is low. If a need arose, San Francisco would incorporate the changes at that time. Under this procedure, the as-built information is not lost; it is just not digitized. For certain types of projects, such as sewer and traffic signal project, the changes are incorporated onto the AutoCAD® file if the client department requires it for their asset management purposes. This service would be included in the fees charged to the client department.

Chapter 6

Conclusion



CHAPTER 6 Conclusion

A. PERFORMANCE DATA IMPROVEMENT

The results of the performance benchmarking showed there are outstanding data gaps to be filled. Most agencies provide a large number of small projects (less than $5 million) and a few large projects (more than $10 million). As a result, there are data gaps in the medium size project range in nearly all the graphs. The performance models are mainly driven by a large number of very small projects. The models can be made more reliable for medium-sized and larger-sized projects if more data are collected.

It is also observed that agencies do not contribute data equally to the various classifications. More reliable models will be developed as the distribution of the number of projects becomes more uniform among all classifications for each agency.

Monitoring and correcting the data collection procedures by the participating agencies is important to improve confidence in the data and obtain consistent results from the analysis.

It is recommended that to further improve the R2 values, outlier analysis be performed on the whole dataset, identifying projects submitted throughout the Study phases for possible elimination from analysis. Re-evaluation of P-values is also recommended. P-values indicate whether or not enough data were used for statistically-significant conclusion to be drawn from an analysis. This was originally done in a special analysis included in the Study 2002 report and has not been repeated. Generally speaking, the selection of desirable P-values is purely subjective. Typically, P values in the range of 0.10 to 0.05 or lower are considered desirable.

B. UPDATE 2005 OBSERVATIONS

- Improvement in project delivery percentages due to implementation of specific BMPs cannot yet be directly linked. "Processes" become effective "practices" only after a learning curve and full implementation on projects. Therefore, obtaining empirical evidence of trends is expected to take several years.
- Generally, the relative cost of design, construction management, and overall project delivery decreases as total construction cost increases. This is consistent with what is intuitively expected.
- Median and average TCC values of projects have decreased over time. This may be because agencies can more easily assign small projects to one project classification than large projects, which may include broader scopes and components. Another reason may be that the agencies complete small projects more often than large projects and can therefore submit more of them to the Study.
- Project delivery costs as a percentage of TCC are increasing. This may be because project delivery costs as a percentage of TCC tend to be higher on smaller projects than larger ones, so some of the increase in project delivery costs may be explained by the decreasing average TCC of projects discussed above. Agencies also

report that as time goes on, it costs more to meet increasingly stringent regulatory and municipal requirements. Better data tracking and collection may have also resulted in higher reported project delivery costs.

- Change orders may be limited automatically by the project's contingency budget, typically 10 percent of TCC.
- The design cost, when consultant usage exceeded 25 percent of project delivery, was generally around 6 or 7 percent higher than when there was no consultant usage.
- The increase in design costs associated with using consultants on smaller or more specialized projects may be justified in cases where consultants offer specialized technical expertise, the projects are complex, there is an aggressive project schedule, there are peak workload demands that can't easily be met using in-house staff, or there are other resource limitations on in-house staff.

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Some of the Study Team Members

Some of the Project Team Members

Appendix A

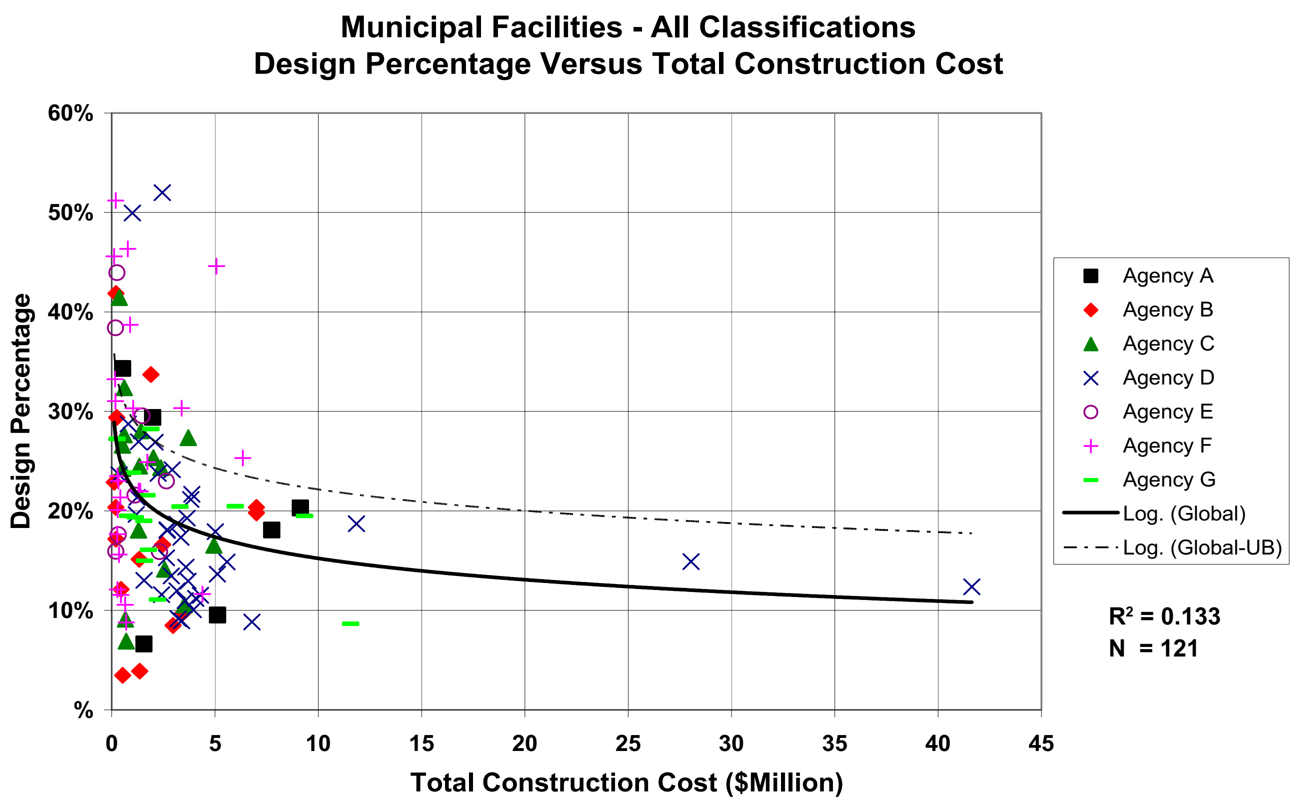
Performance Curves

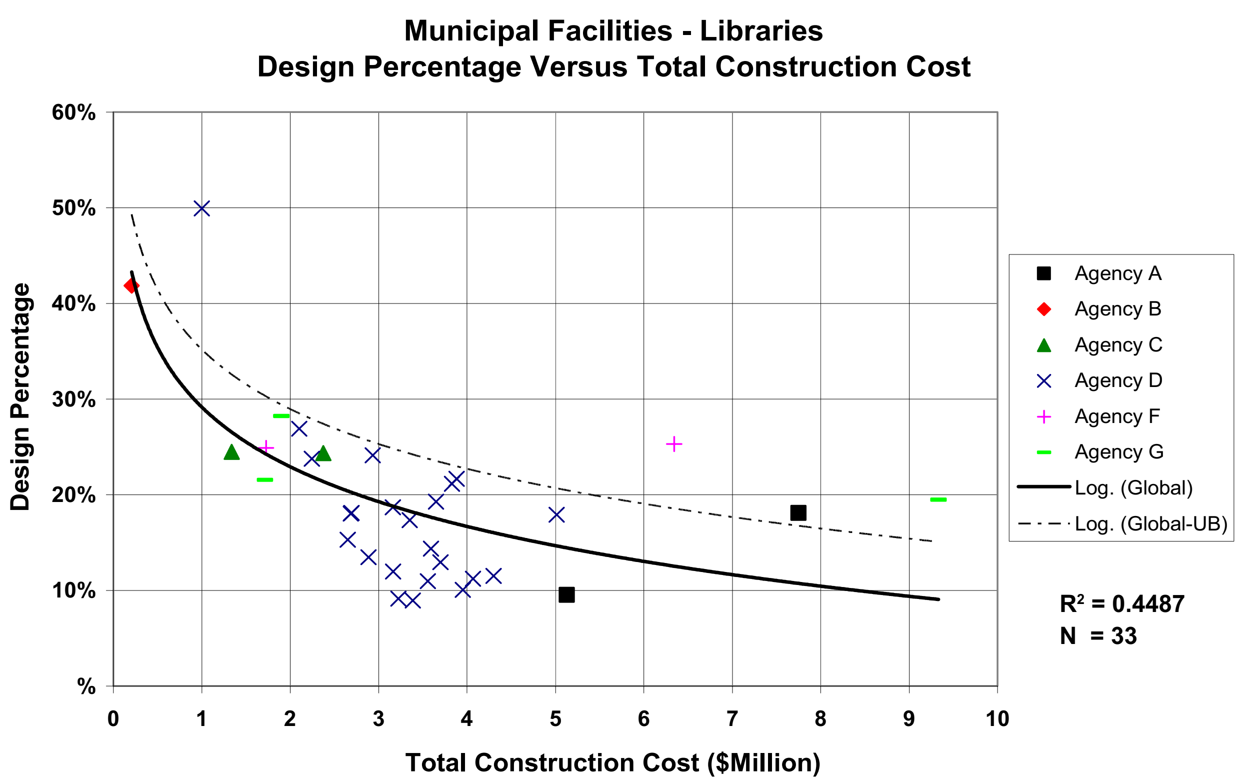
CURVES GROUP 1

Design as Percentage of
Total Construction Cost

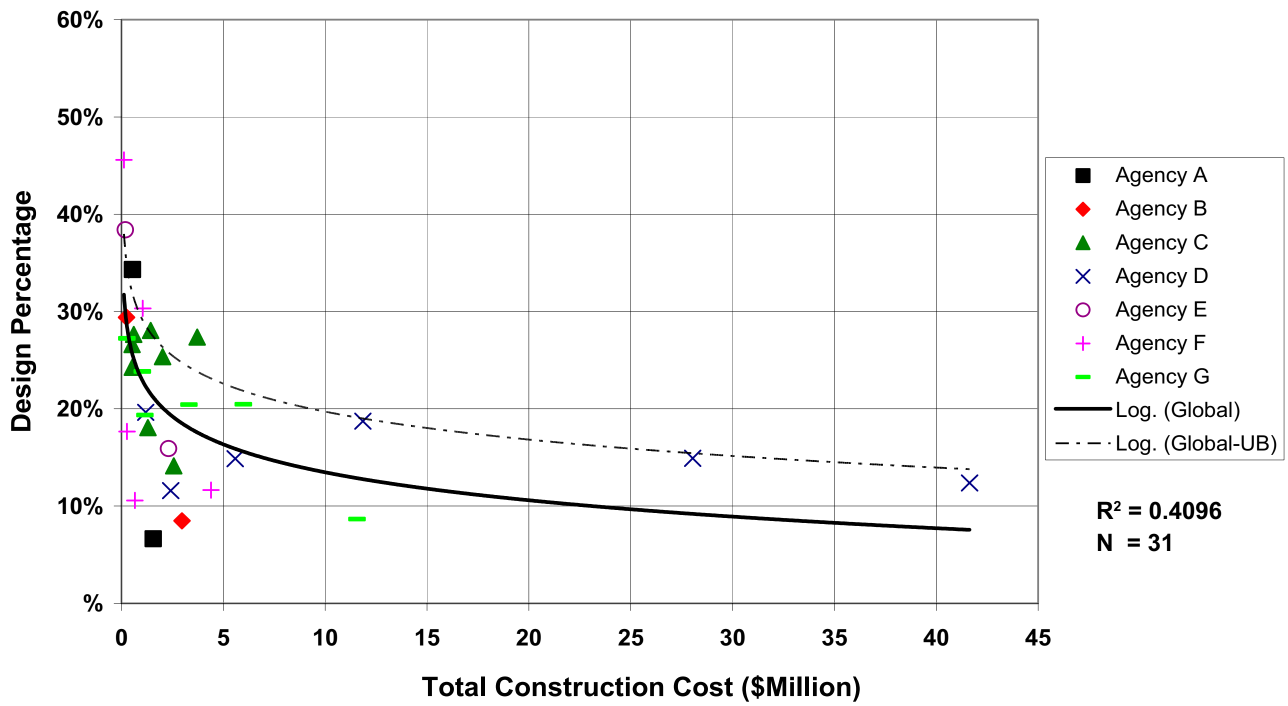
Versus

Total Construction Cost

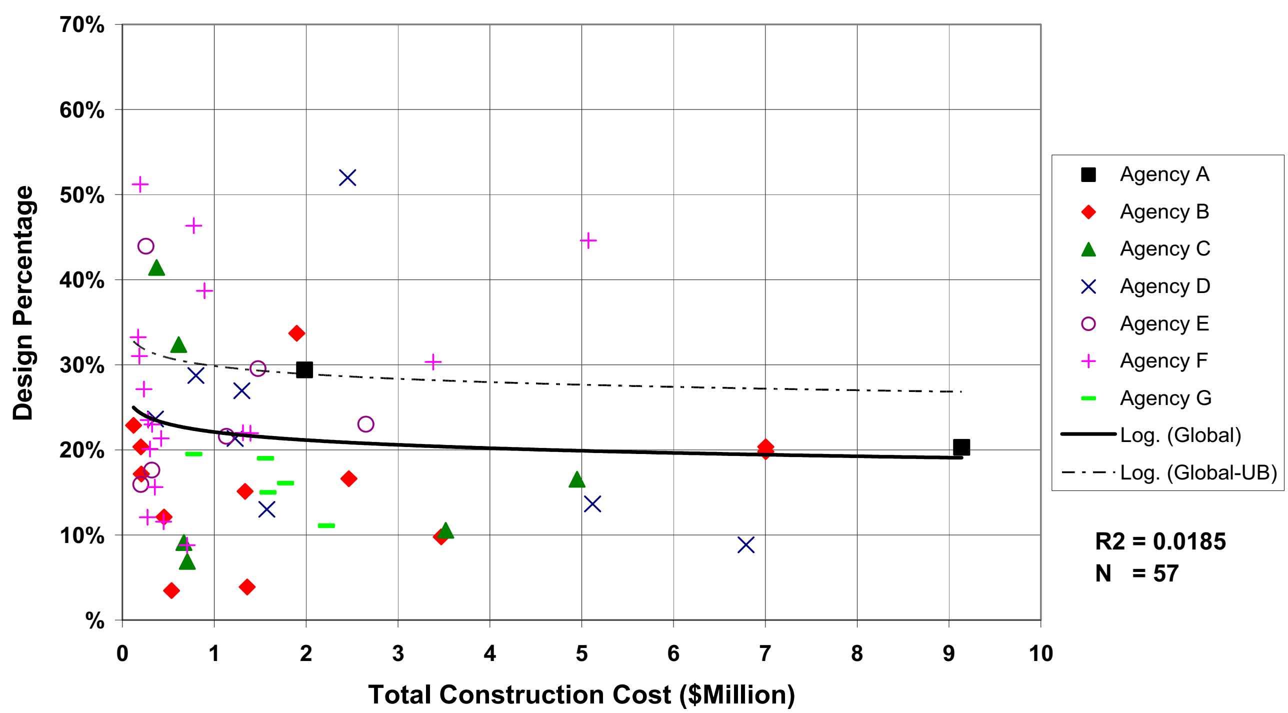

Municipal Facilities - All Classifications
Design Percentage Versus Total Construction Cost
60%
50%
40%
30%
20%
10%
%
0
5
10
15
20
25
30
35
40
45
Design Percentage
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.133
N = 121

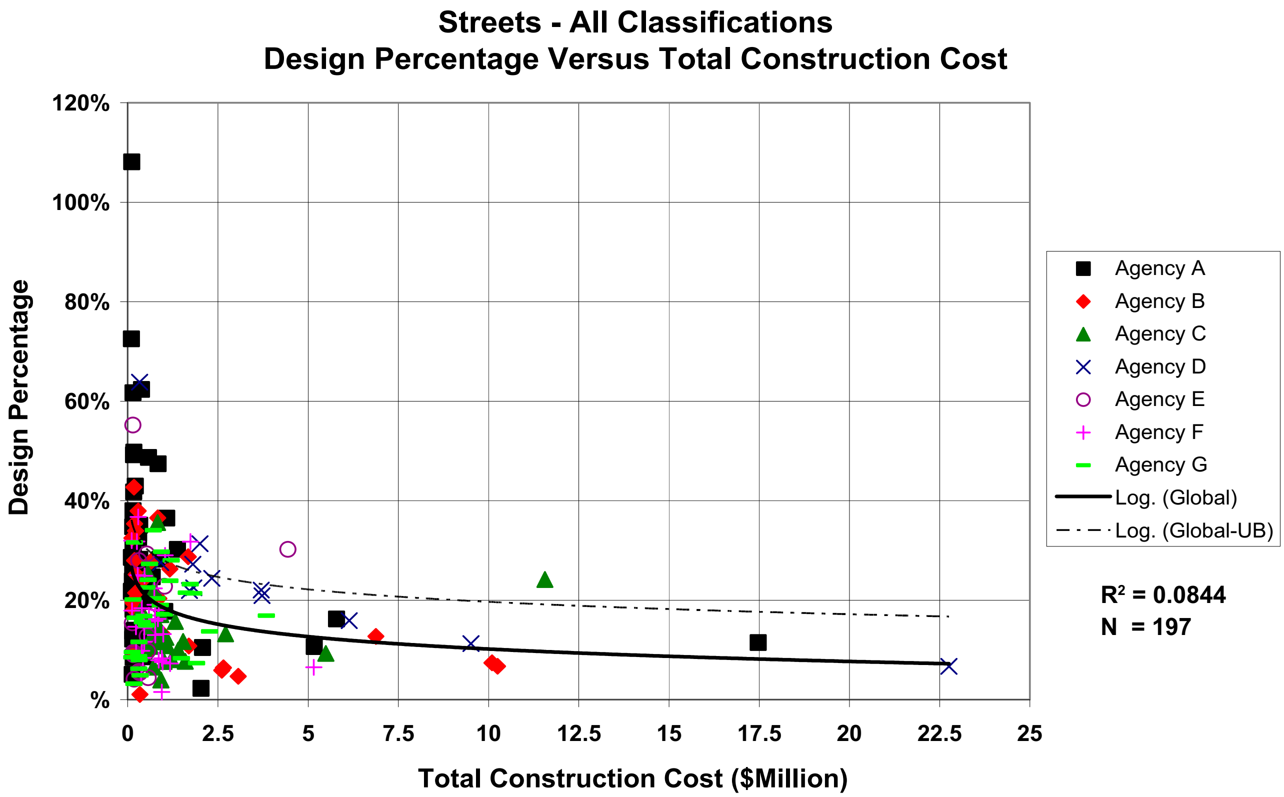

Municipal Facilities - Libraries
Design Percentage Versus Total Construction Cost
60%
50%
40%
30%
20%
10%
%
0
1
2
3
4
5
6
7
8
9
10
Design Percentage
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.4487
N = 33

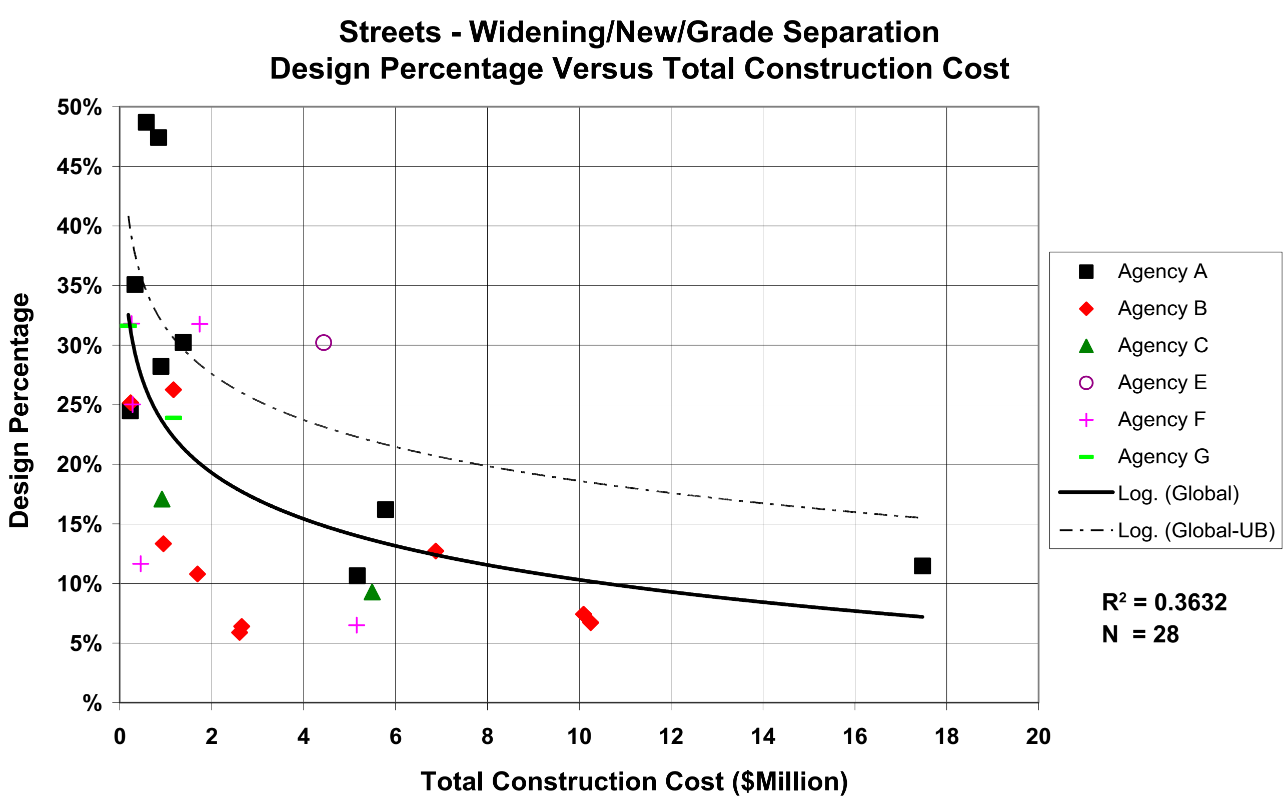
Municipal Facilities - Police/Fire Station
Design Percentage Versus Total Construction Cost

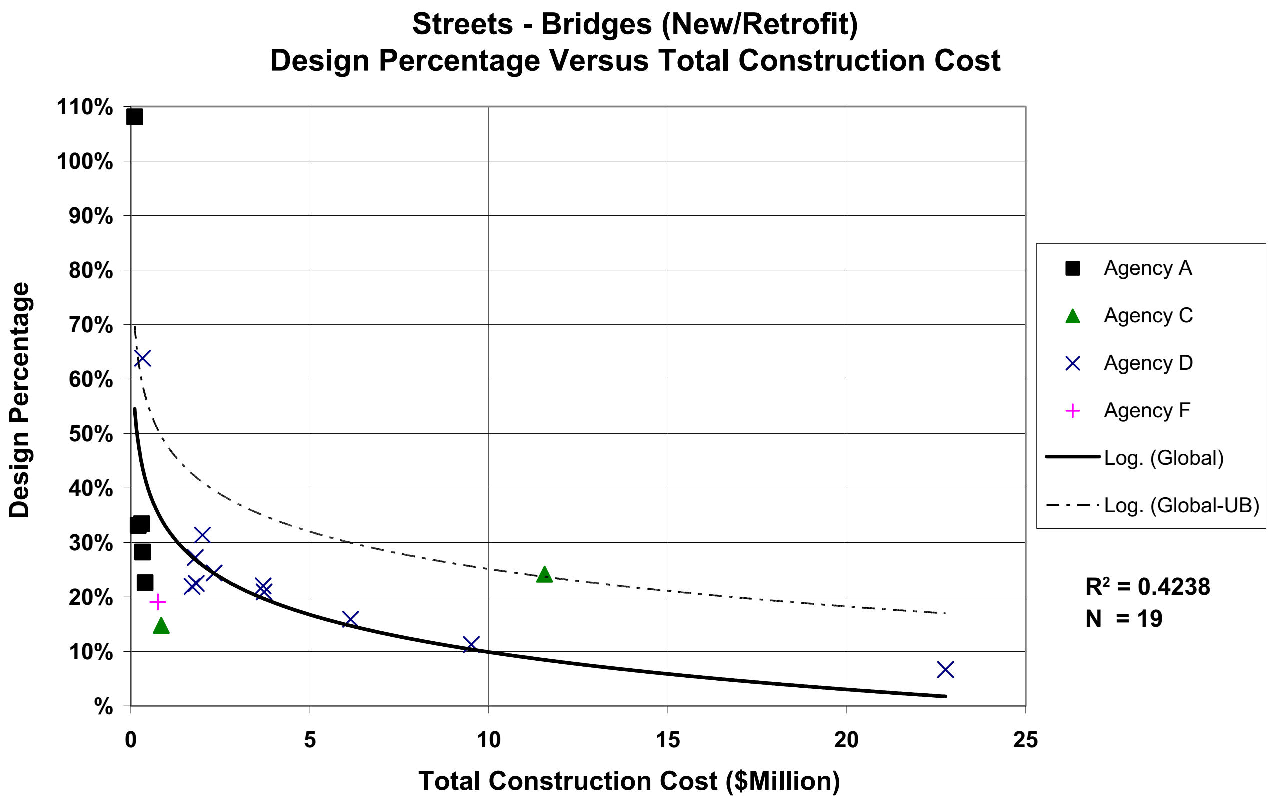


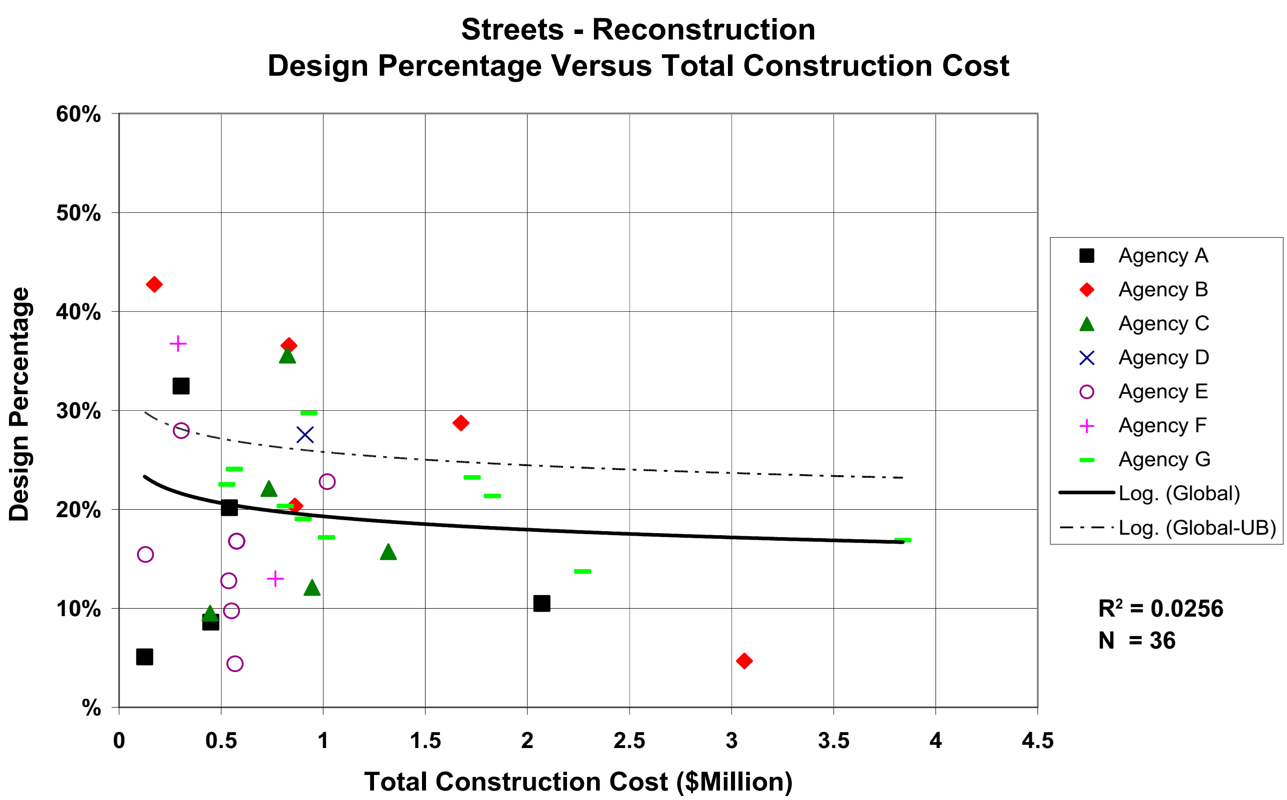
Municipal Facilities - Comm./Rec. Center/Child Care/Gym
Design Percentage Versus Total Construction Cost

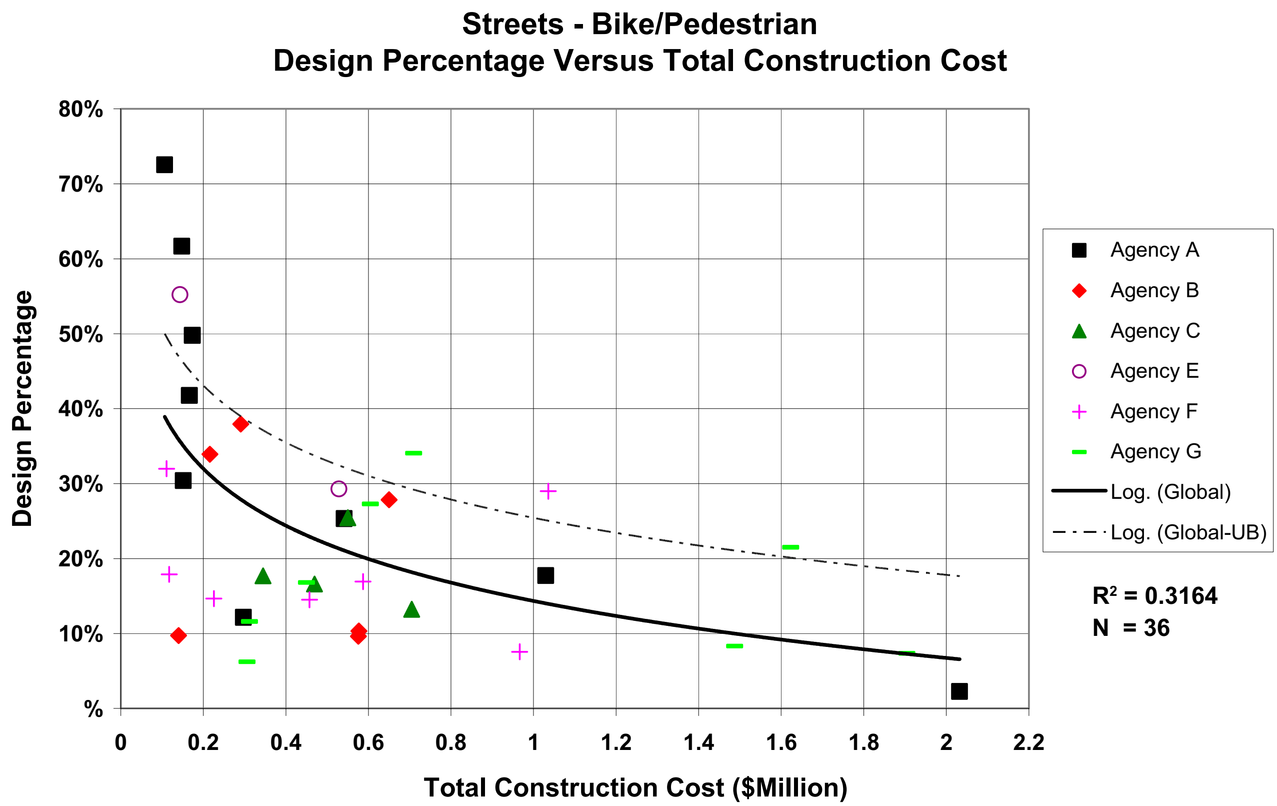


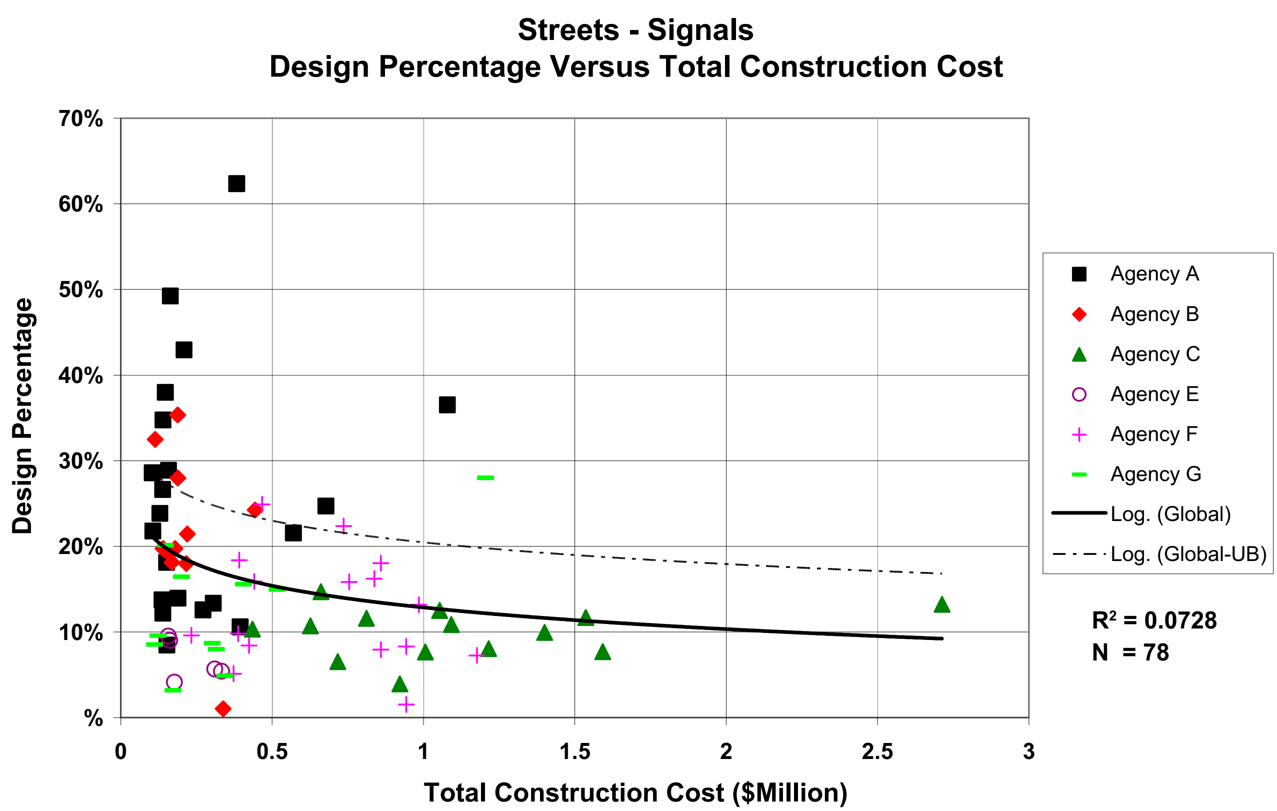

Streets - All Classifications
Design Percentage Versus Total Construction Cost
Design Percentage
120%
100%
80%
60%
40%
20%
%
0
2.5
5
7.5
10
12.5
15
17.5
20
22.5
25
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.0844
N = 197


Streets - Widening/New/Grade Separation
Design Percentage Versus Total Construction Cost
Design Percentage
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
%
0
2
4
6
8
10
12
14
16
18
20
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.3632
N = 28

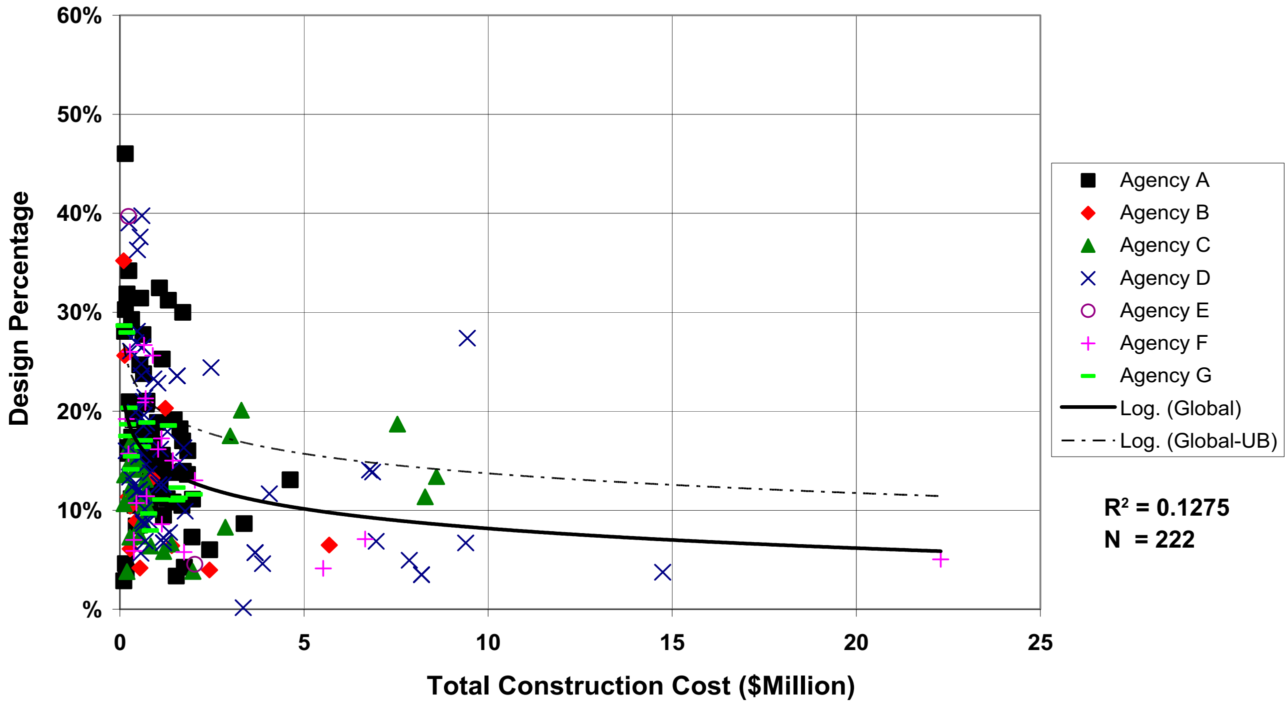

Streets - Bridges (New/Retrofit)
Design Percentage Versus Total Construction Cost
Design Percentage
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
%
0
5
10
15
20
25
Total Construction Cost ($Million)
Agency A
Agency C
Agency D
Agency F
Log. (Global)
Log. (Global-UB)
R² = 0.4238
N = 19


Streets - Reconstruction
Design Percentage Versus Total Construction Cost
Design Percentage
60%
50%
40%
30%
20%
10%
%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.0256
N = 36

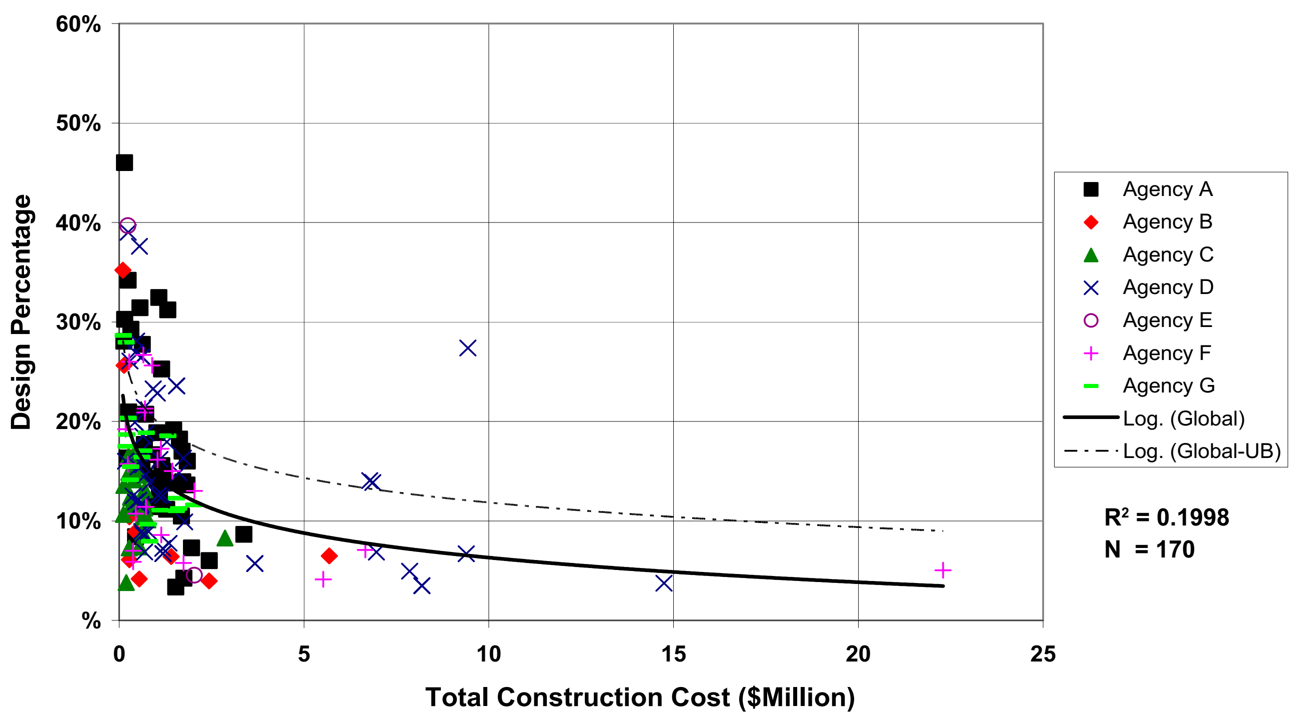

Streets - Bike/Pedestrian
Design Percentage Versus Total Construction Cost
80%
70%
60%
50%
40%
30%
20%
10%
%
Design Percentage
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R^2 = 0.3164
N = 36

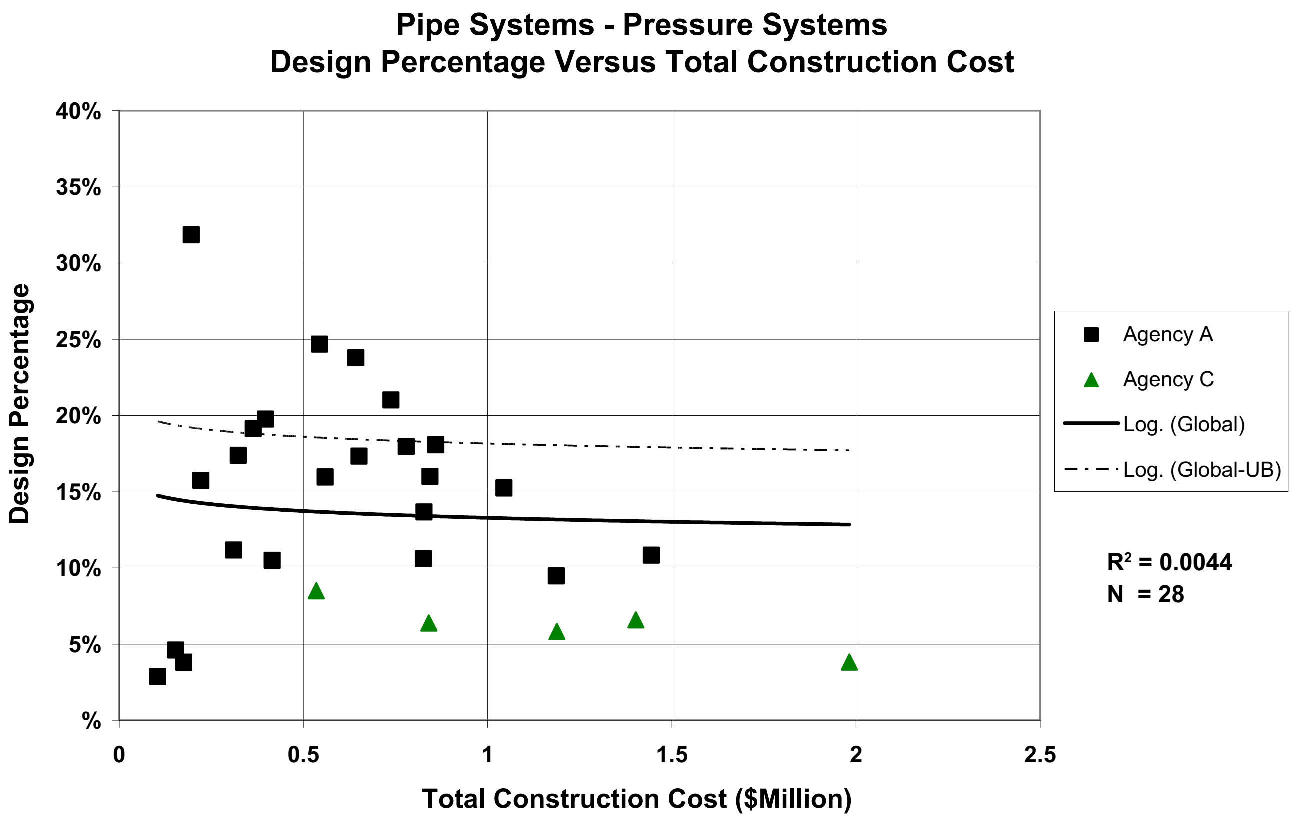

Streets - Signals
Design Percentage Versus Total Construction Cost
70%
60%
50%
40%
30%
20%
10%
%
Design Percentage
0
0.5
1
1.5
2
2.5
3
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R^2 = 0.0728
N = 78

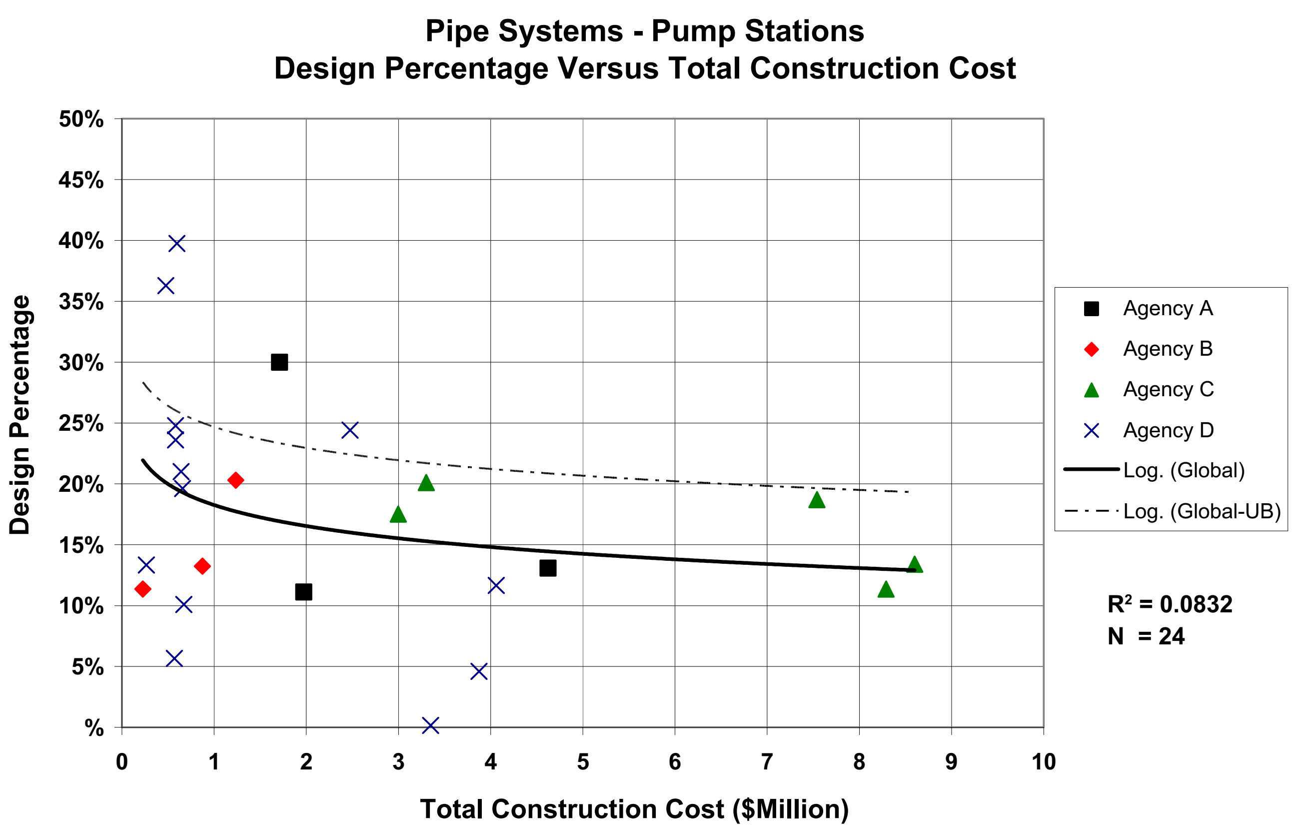
Pipe Systems - All Classifications
Design Percentage Versus Total Construction Cost

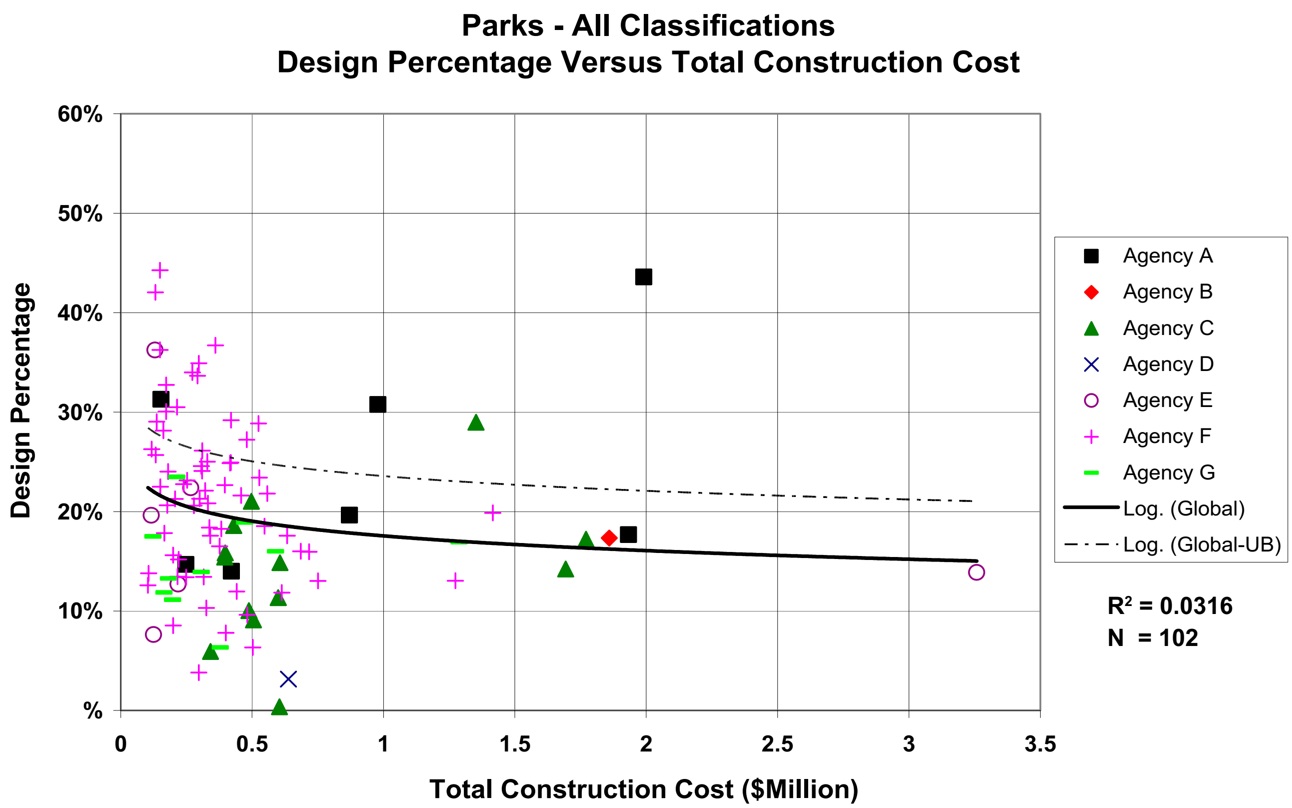


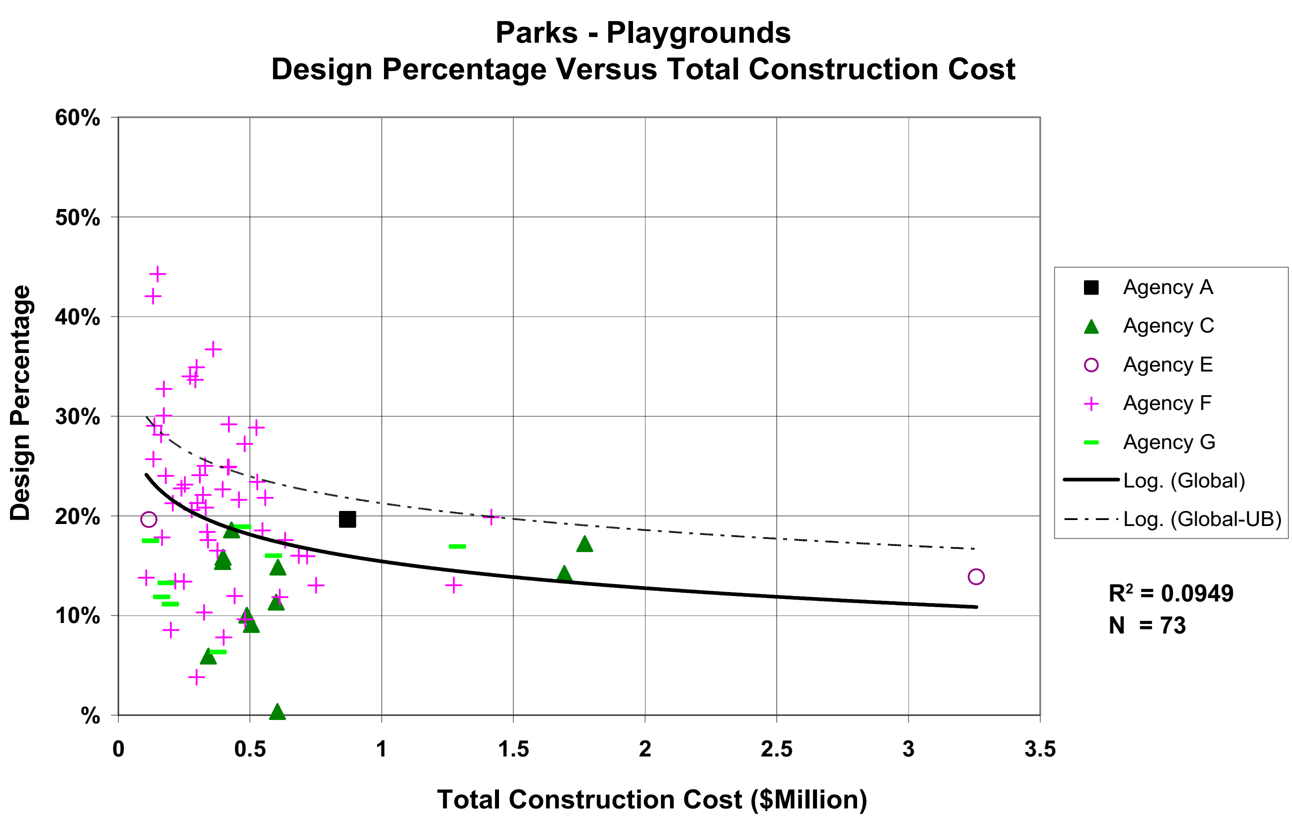
Pipe Systems - Gravity System (Storm Drains/Sewers)
Design Percentage Versus Total Construction Cost



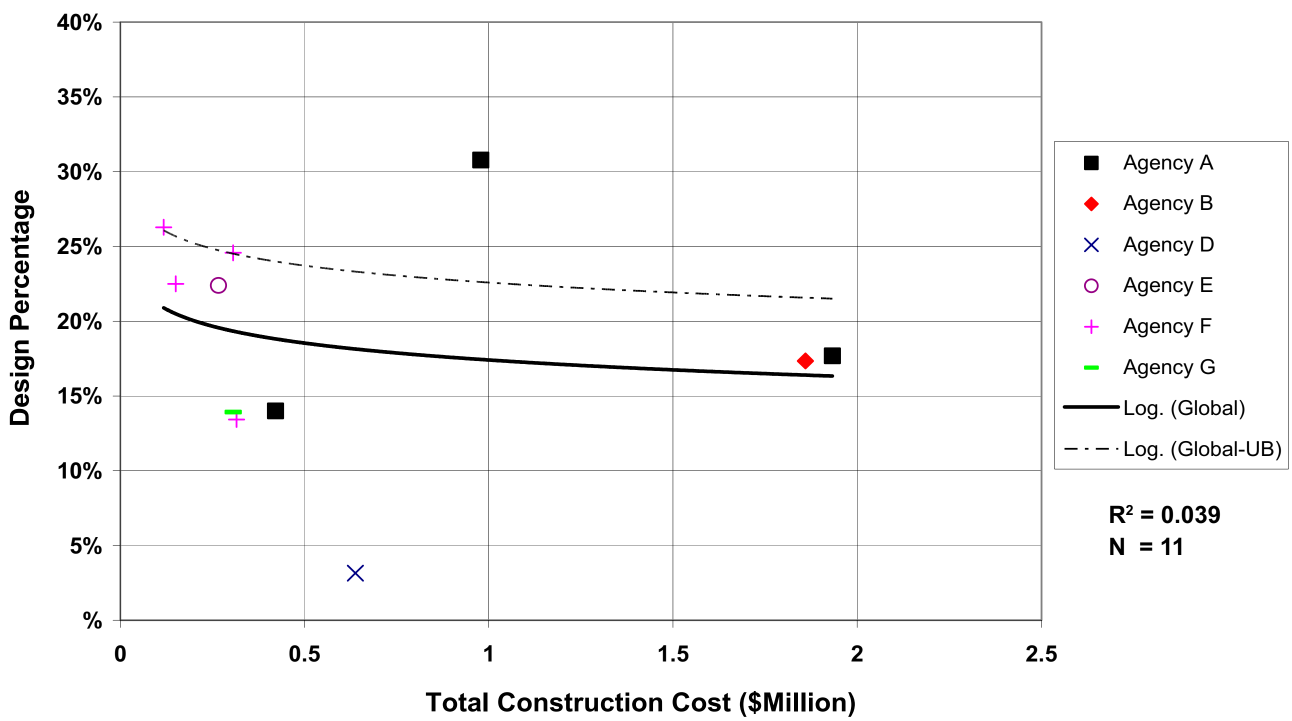

Pipe Systems - Pressure Systems
Design Percentage Versus Total Construction Cost
Design Percentage
40%
35%
30%
25%
20%
15%
10%
5%
%
0
0.5
1
1.5
2
2.5
Total Construction Cost ($Million)
Agency A
Agency C
Log. (Global)
Log. (Global-UB)
R² = 0.0044
N = 28


Pipe Systems - Pump Stations
Design Percentage Versus Total Construction Cost
Design Percentage
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
%
0
1
2
3
4
5
6
7
8
9
10
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Log. (Global)
Log. (Global-UB)
R² = 0.0832
N = 24

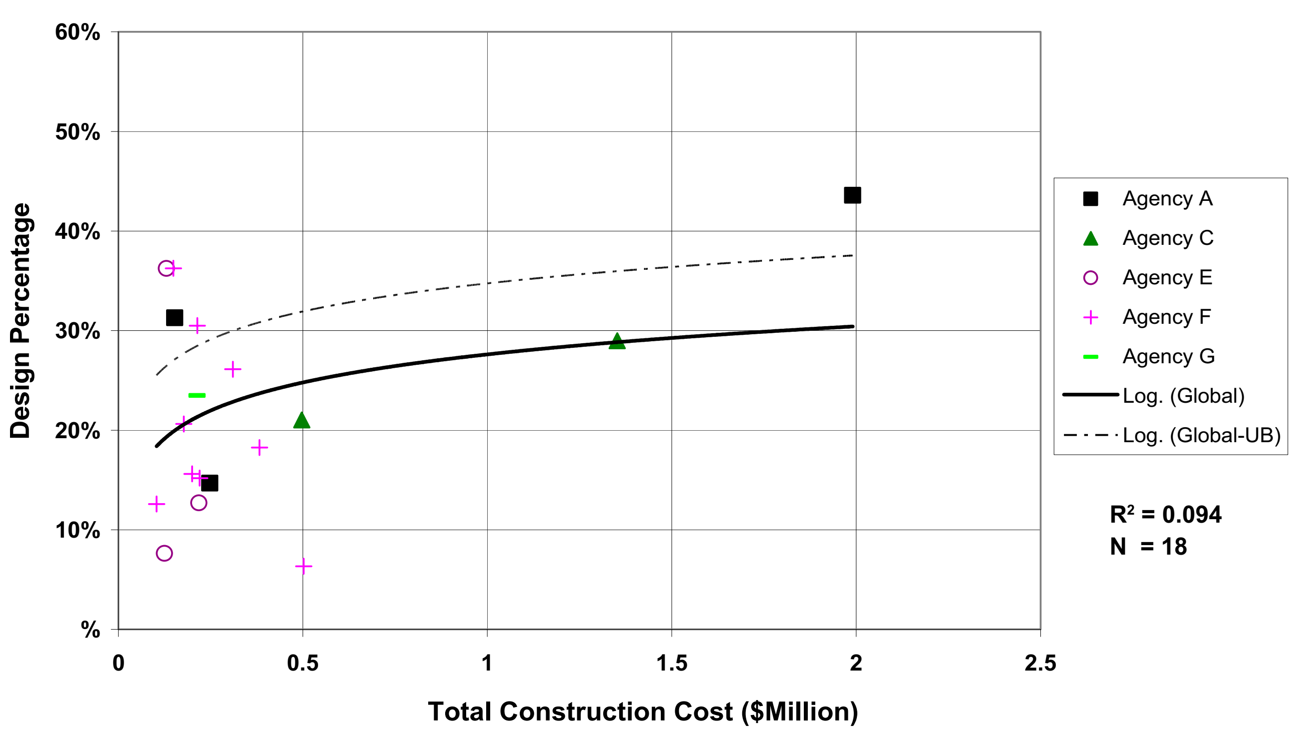

Parks - All Classifications
Design Percentage Versus Total Construction Cost
Design Percentage
60%
50%
40%
30%
20%
10%
%
0
0.5
1
1.5
2
2.5
3
3.5
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.0316
N = 102


Parks - Playgrounds
Design Percentage Versus Total Construction Cost
Design Percentage
60%
50%
40%
30%
20%
10%
%
0
0.5
1
1.5
2
2.5
3
3.5
Total Construction Cost ($Million)
Agency A
Agency C
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.0949
N = 73

Parks - Sportfields
Design Percentage Versus Total Construction Cost



Parks - Restrooms
Design Percentage Versus Total Construction Cost

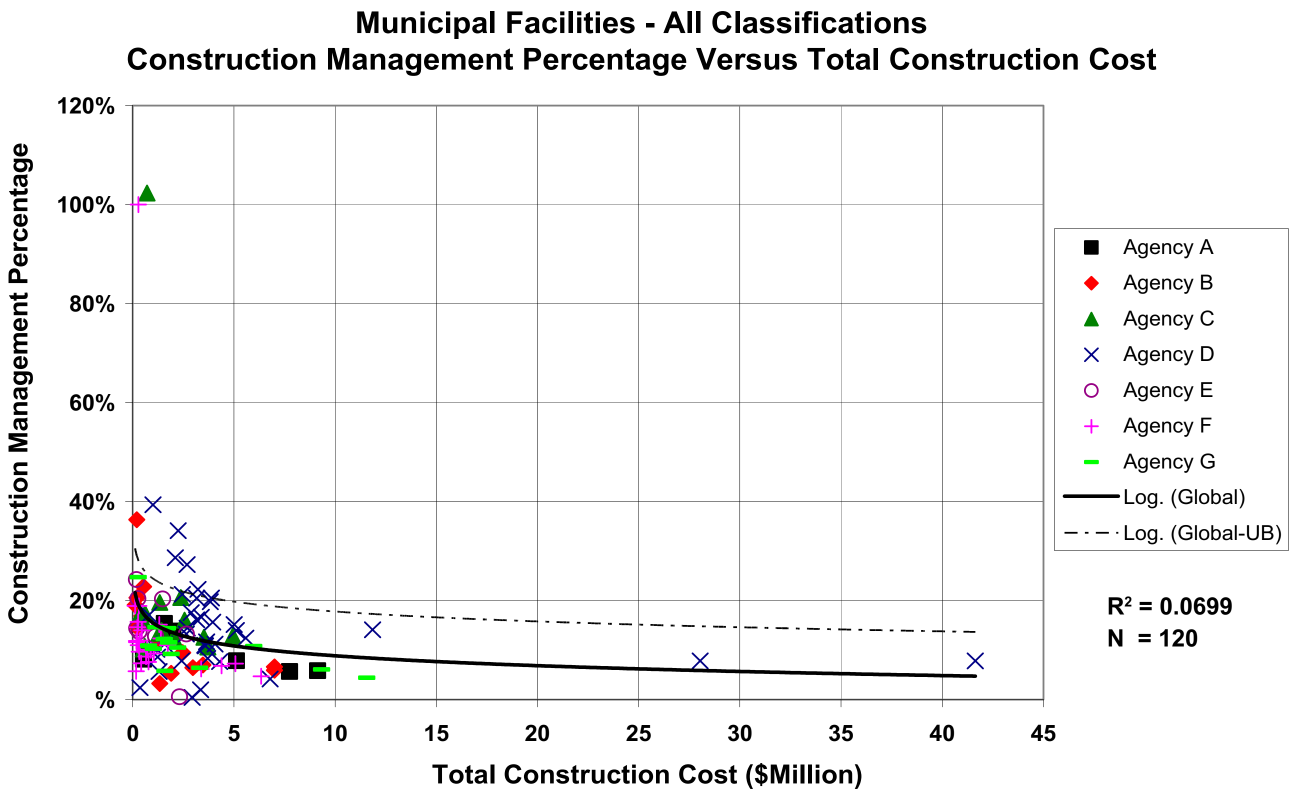


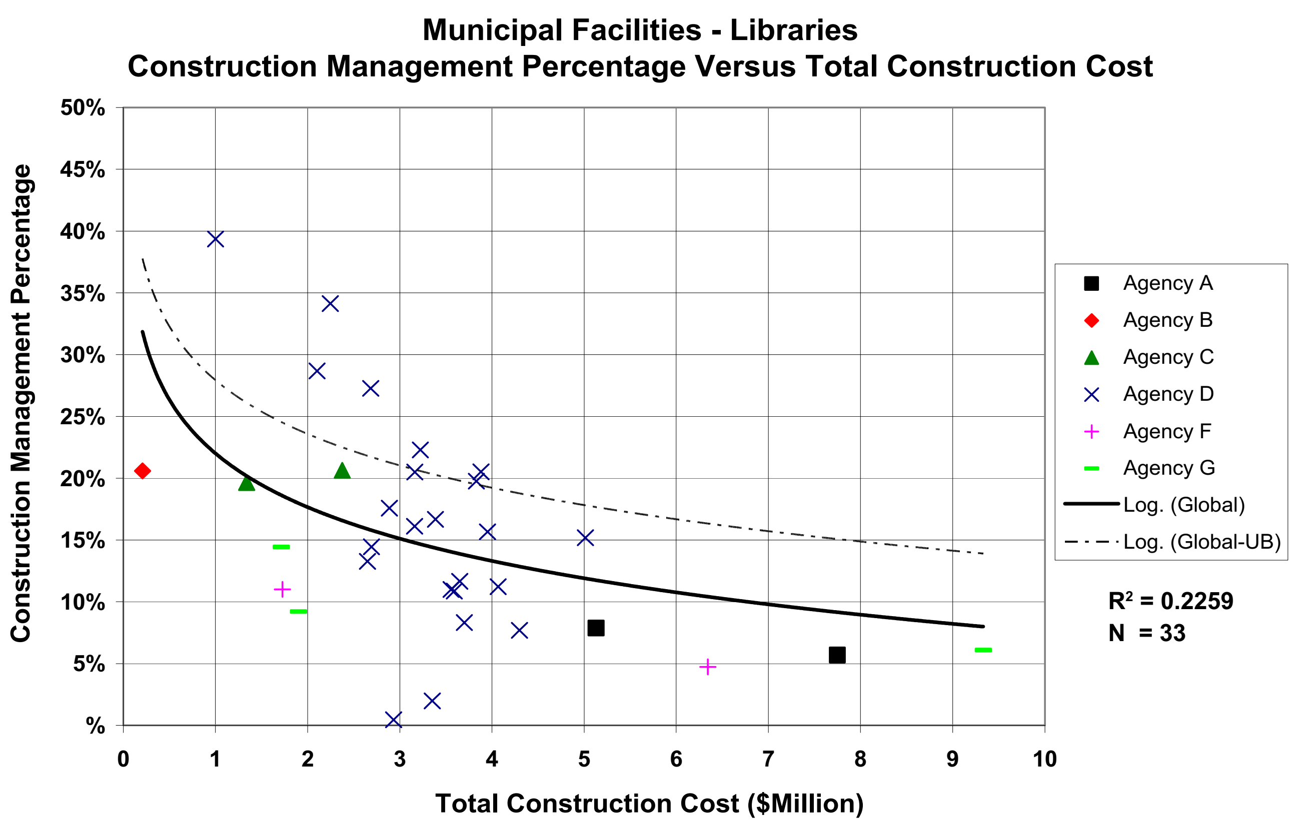
CURVES GROUP 2

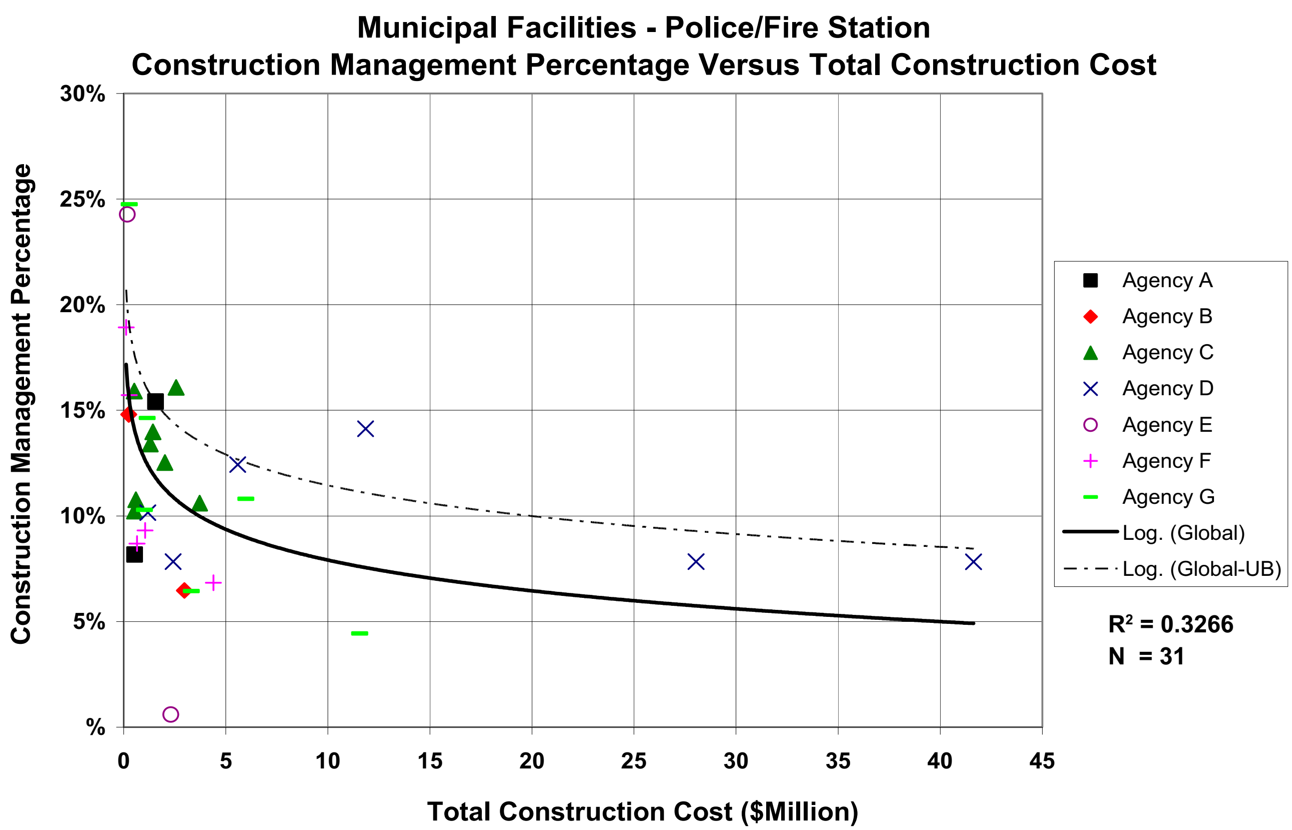
Construction Management as Percentage of Total Construction Cost

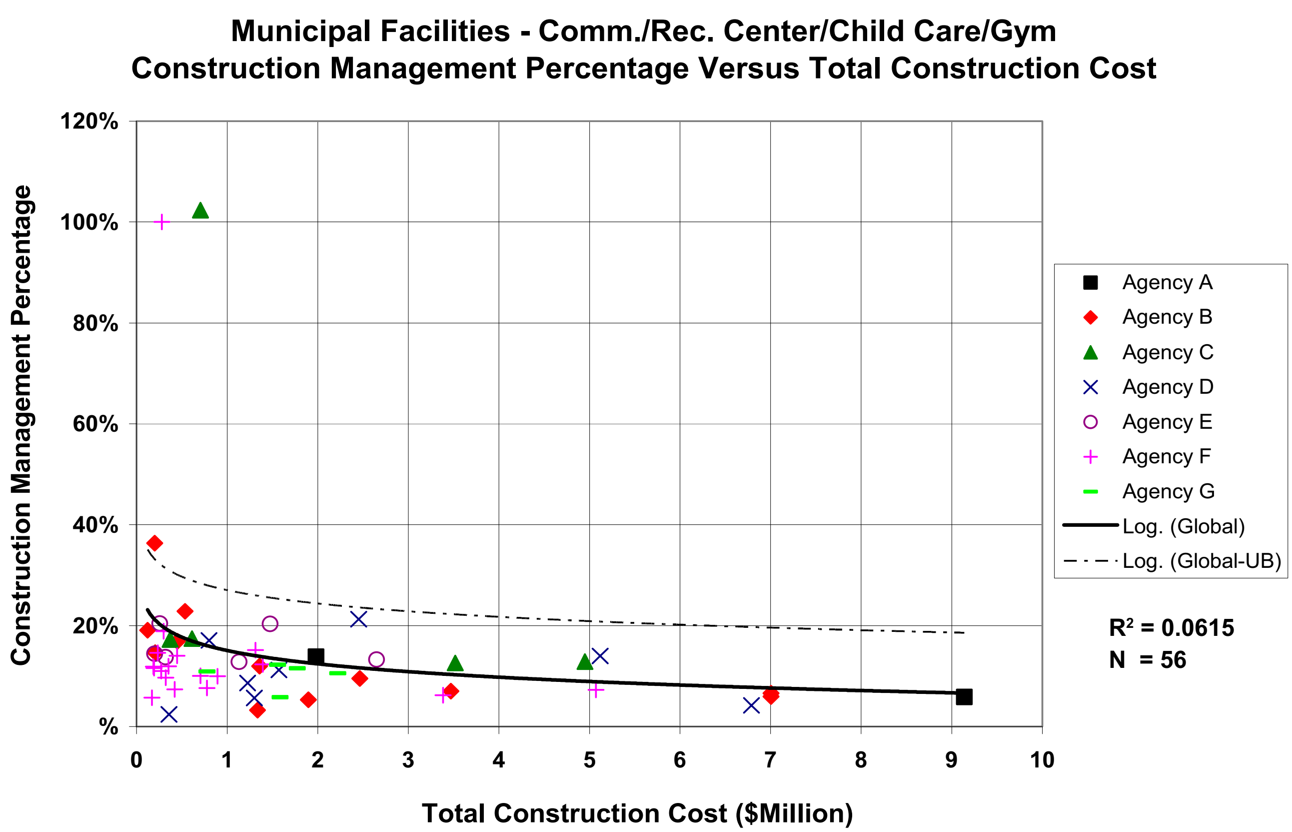
Versus

Total Construction Cost


Municipal Facilities - All Classifications
Construction Management Percentage Versus Total Construction Cost
Construction Management Percentage
120%
100%
80%
60%
40%
20%
%
0
5
10
15
20
25
30
35
40
45
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.0699
N = 120

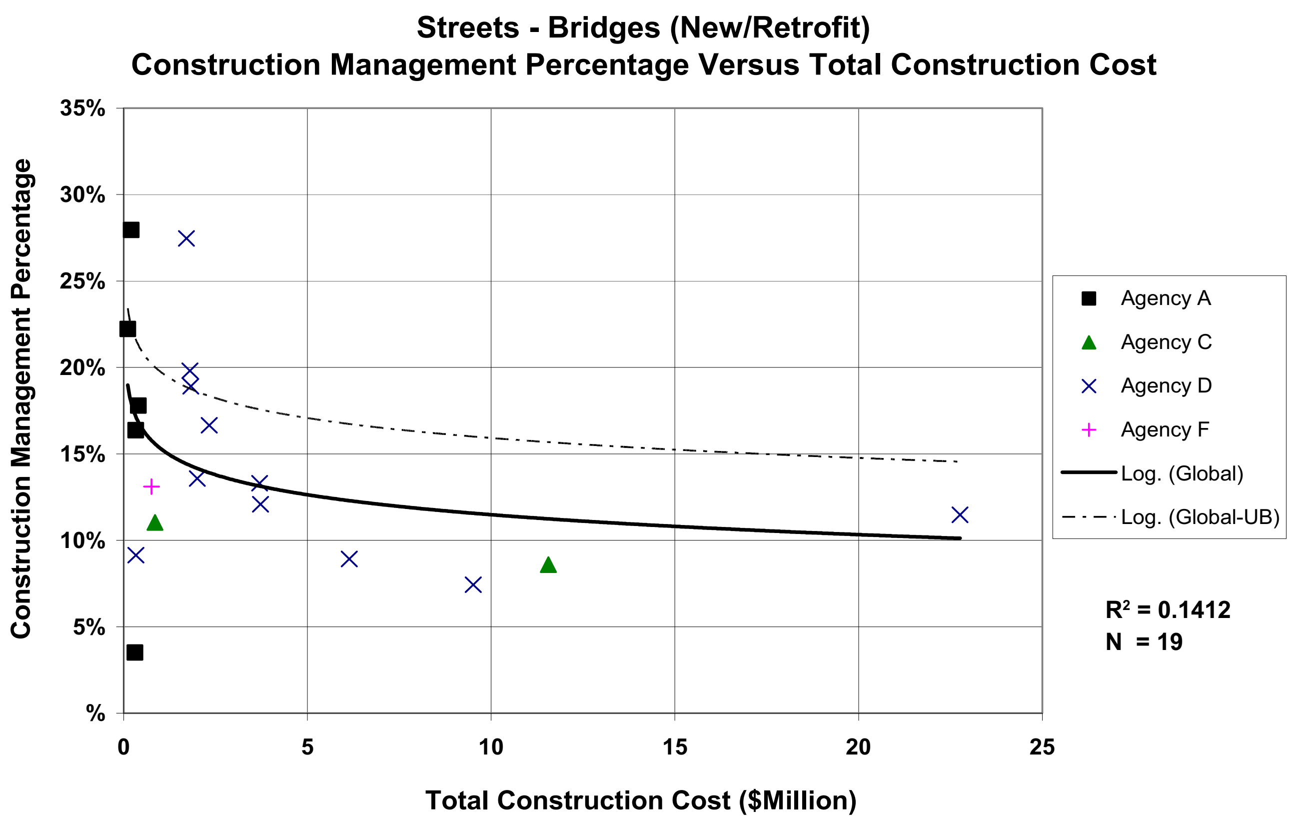

Municipal Facilities - Libraries
Construction Management Percentage Versus Total Construction Cost
Construction Management Percentage
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
%
0
1
2
3
4
5
6
7
8
9
10
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.2259
N = 33


Municipal Facilities - Police/Fire Station
Construction Management Percentage Versus Total Construction Cost
Construction Management Percentage
30%
25%
20%
15%
10%
5%
%
0
5
10
15
20
25
30
35
40
45
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.3266
N = 31

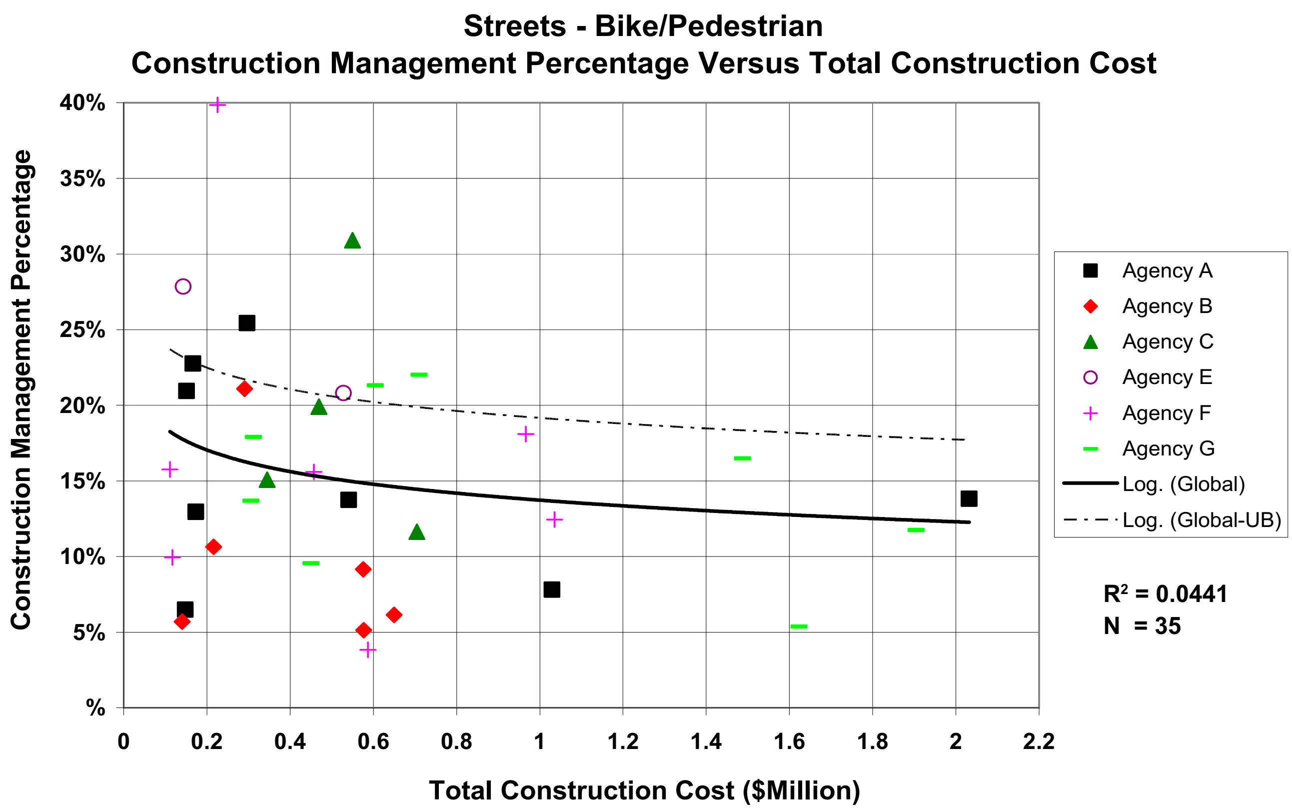

Municipal Facilities - Comm./Rec. Center/Child Care/Gym
Construction Management Percentage Versus Total Construction Cost
Construction Management Percentage
120%
100%
80%
60%
40%
20%
%
0
1
2
3
4
5
6
7
8
9
10
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.0615
N = 56


Streets - All Classifications
Construction Management Percentage Versus Total Construction Cost
Construction Management Percentage
90%
80%
70%
60%
50%
40%
30%
20%
10%
%
0
5
10
15
20
25
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.11
N = 195

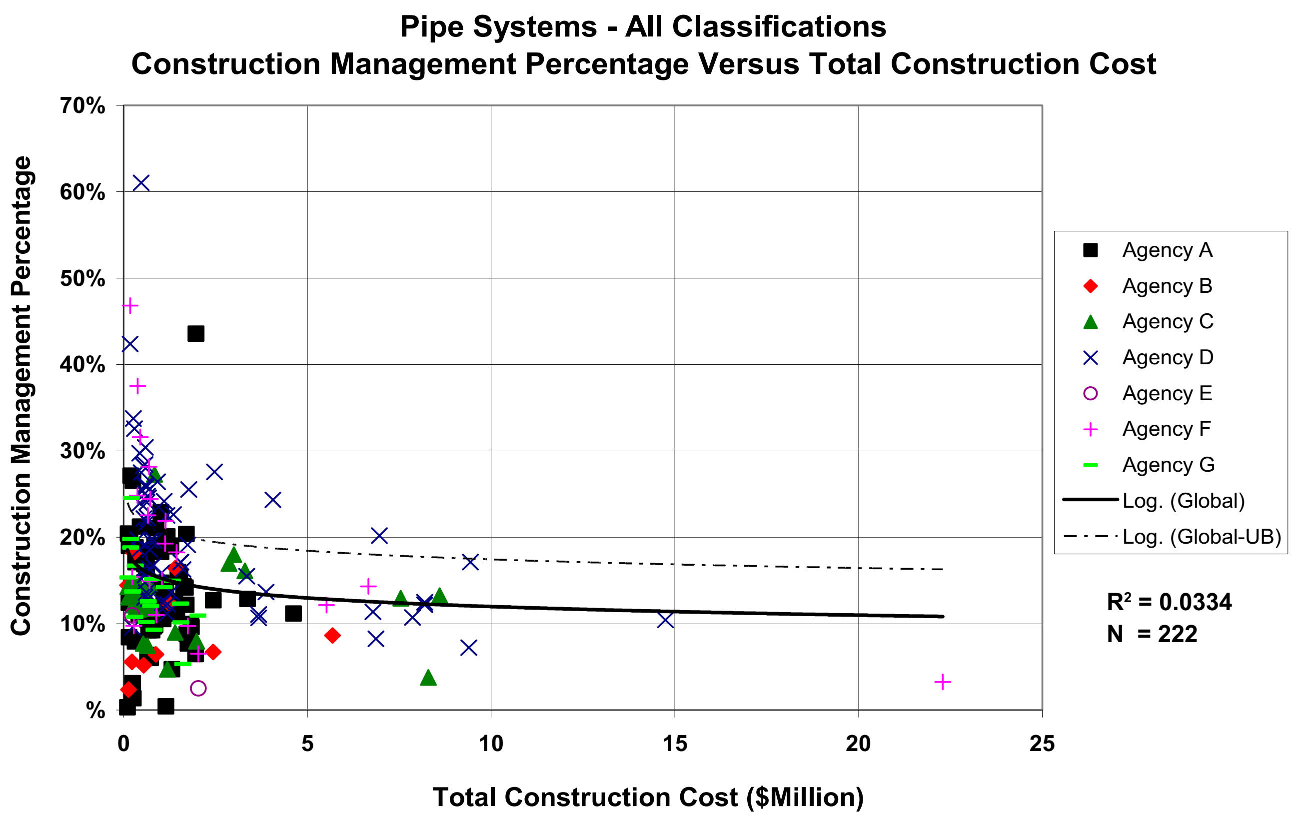

Streets - Widening/New/Grade Separation
Construction Management Percentage Versus Total Construction Cost
Construction Management Percentage
25%
20%
15%
10%
5%
%
0
2
4
6
8
10
12
14
16
18
20
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.1278
N = 27

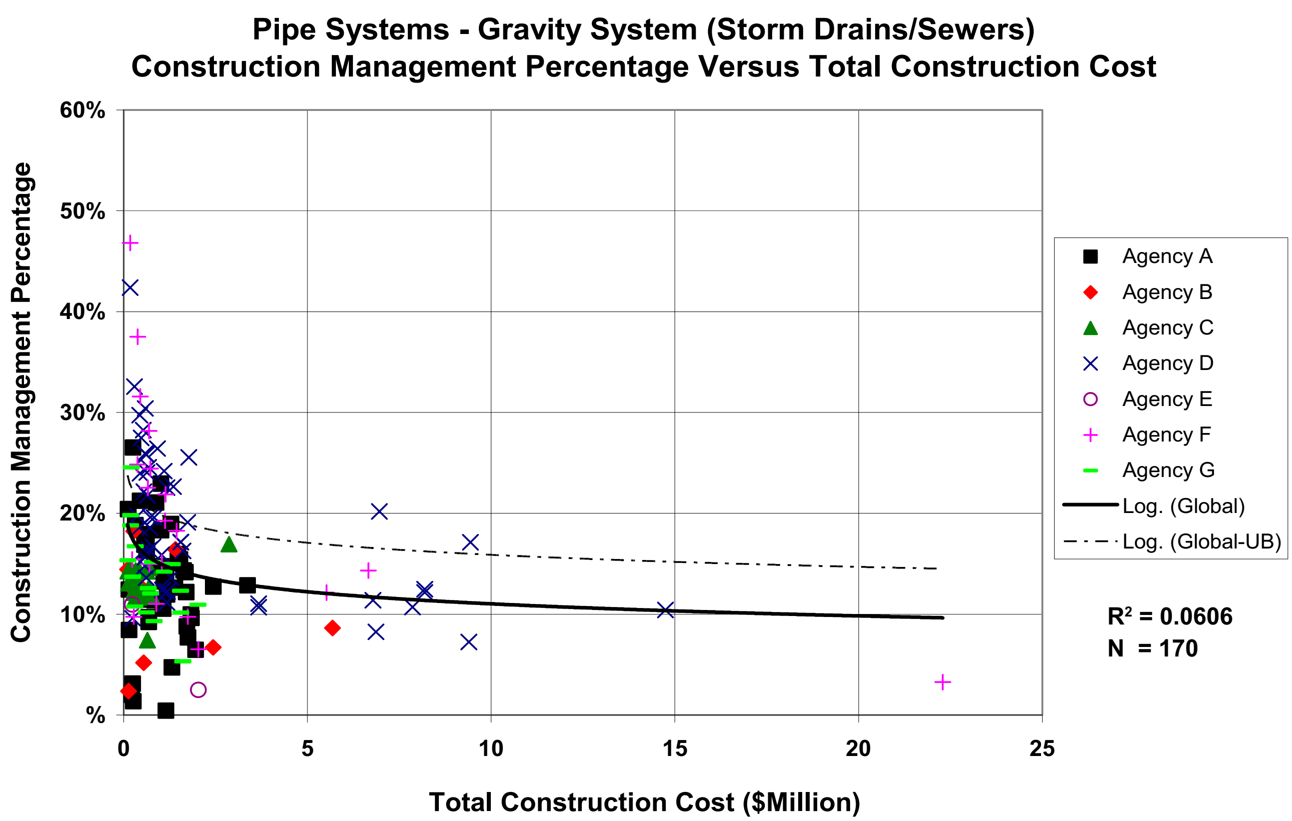

Streets - Bridges (New/Retrofit)
Construction Management Percentage Versus Total Construction Cost
Construction Management Percentage
35%
30%
25%
20%
15%
10%
5%
%
0
5
10
15
20
25
Total Construction Cost ($Million)
Agency A
Agency C
Agency D
Agency F
Log. (Global)
Log. (Global-UB)
R² = 0.1412
N = 19

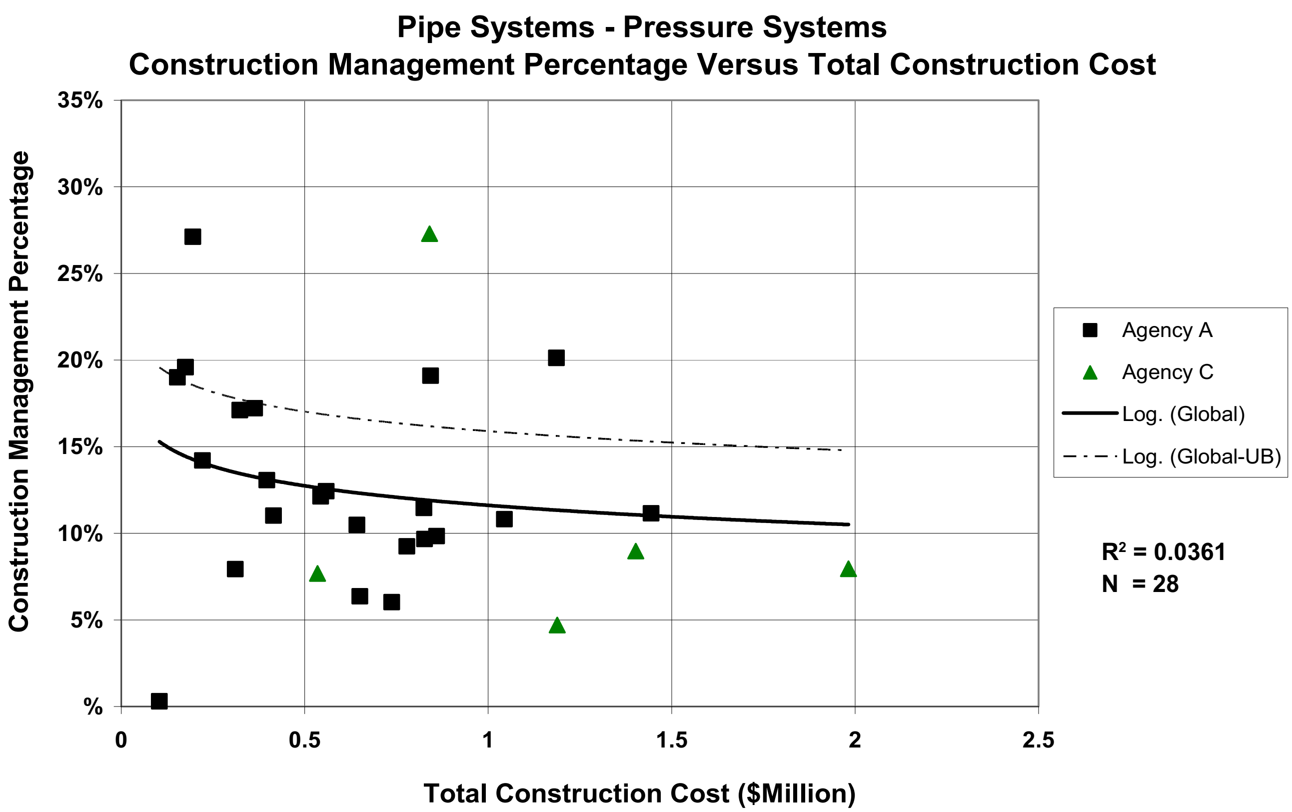

Streets - Reconstruction
Construction Management Percentage Versus Total Construction Cost
Construction Management Percentage
60%
50%
40%
30%
20%
10%
%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.3553
N = 36

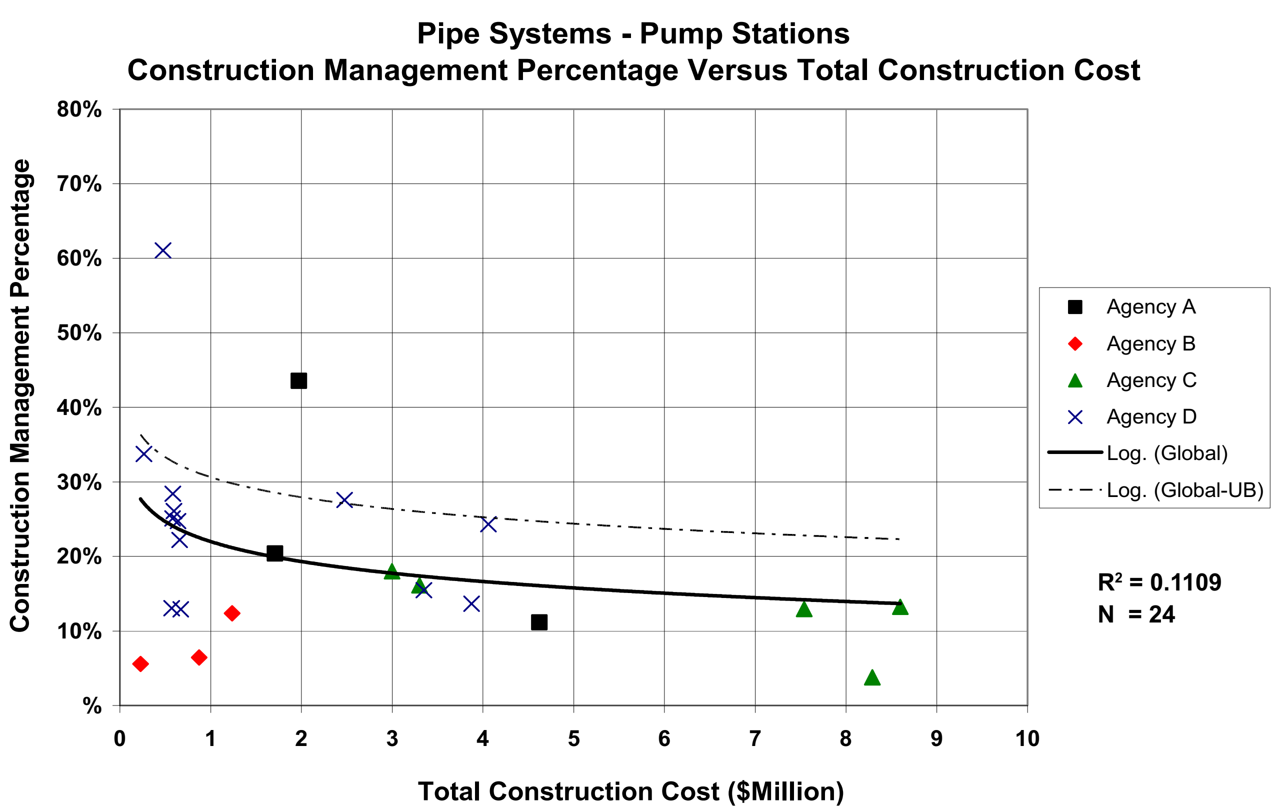

Streets - Bike/Pedestrian
Construction Management Percentage Versus Total Construction Cost
Construction Management Percentage
40%
35%
30%
25%
20%
15%
10%
5%
%
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.0441
N = 35

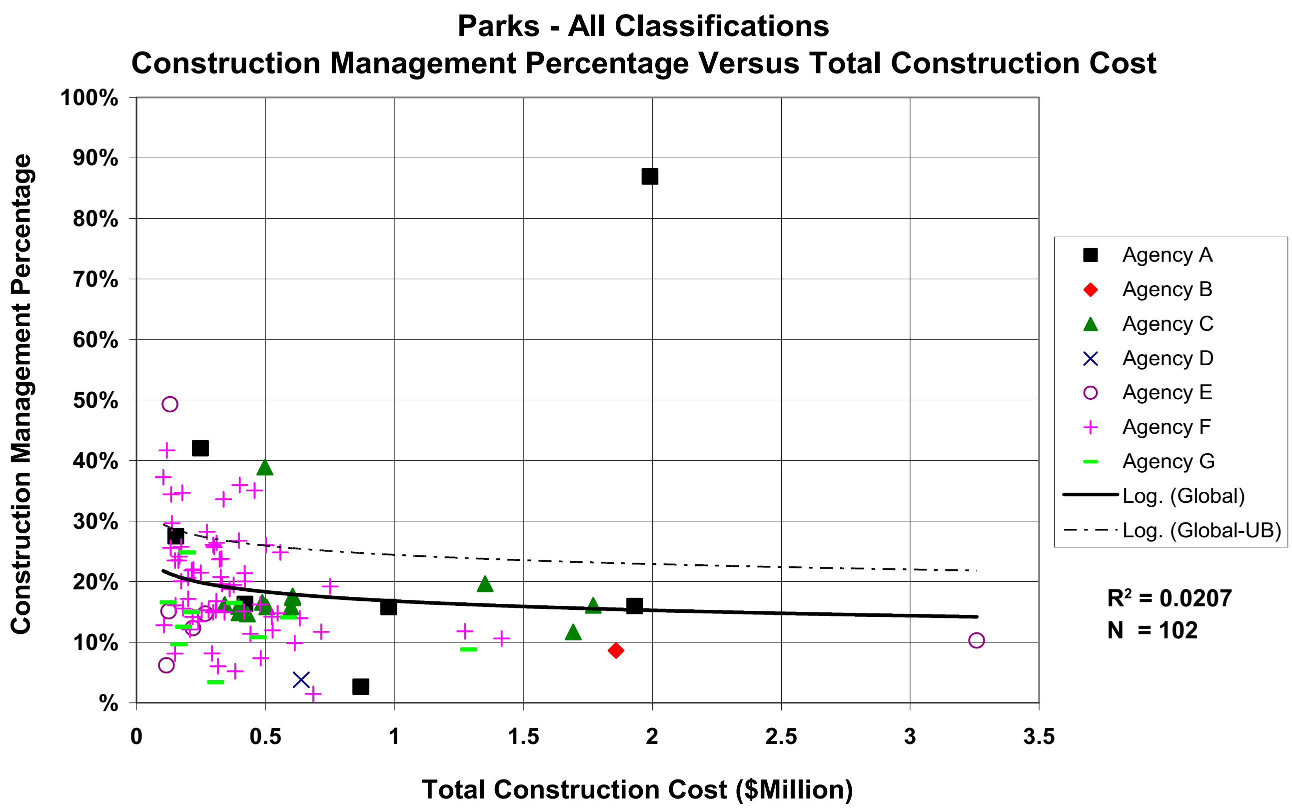

Streets - Signals
Construction Management Percentage Versus Total Construction Cost
Construction Management Percentage
90%
80%
70%
60%
50%
40%
30%
20%
10%
%
0
0.5
1
1.5
2
2.5
3
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.0569
N = 78

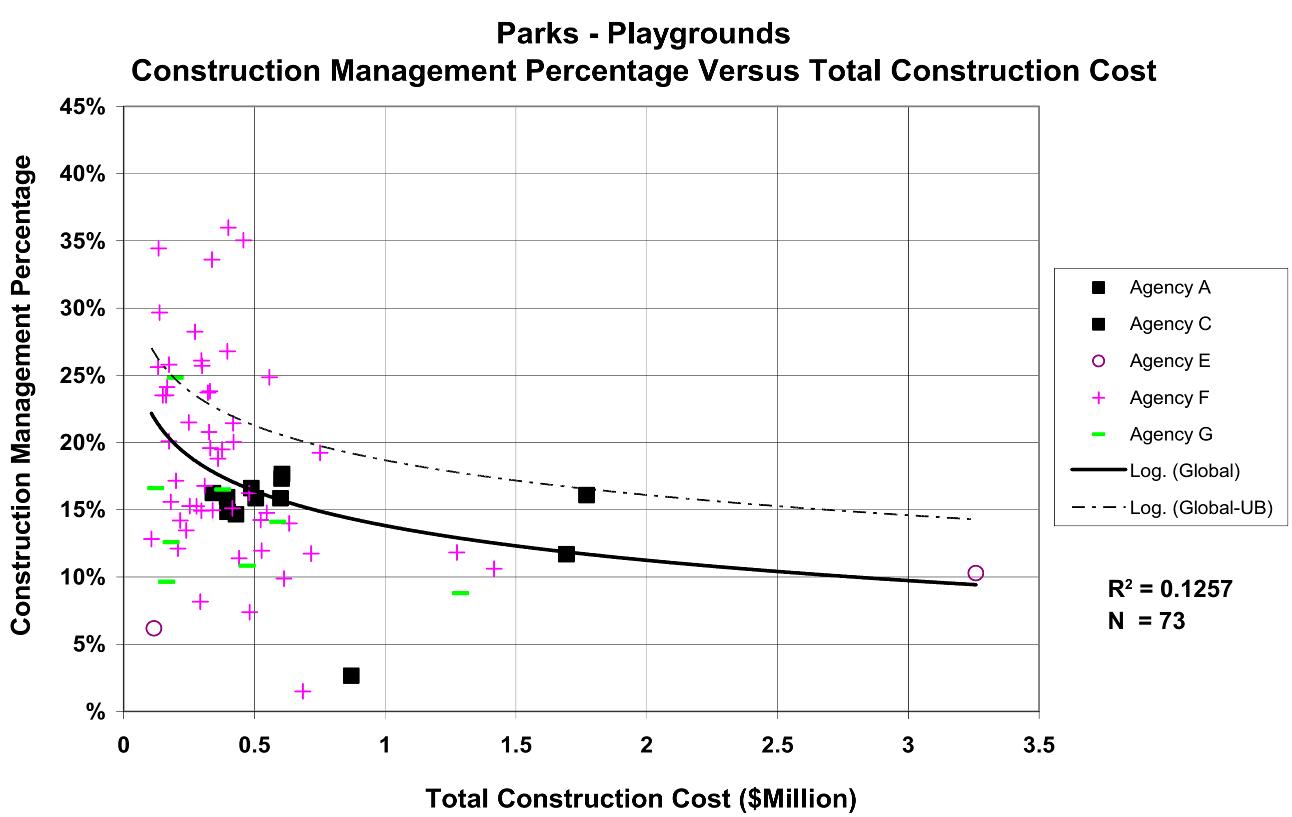

Pipe Systems - All Classifications
Construction Management Percentage Versus Total Construction Cost
Construction Management Percentage
70%
60%
50%
40%
30%
20%
10%
%
0
5
10
15
20
25
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.0334
N = 222

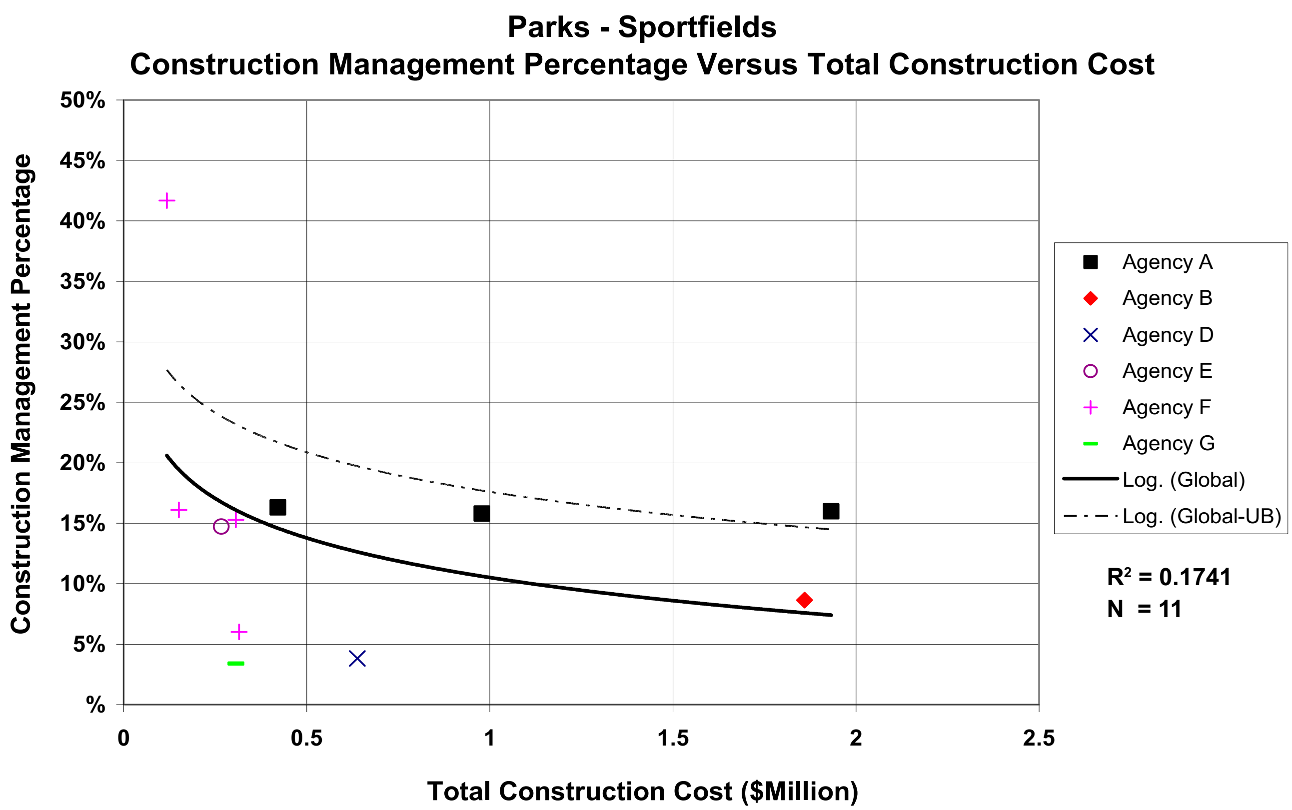

Pipe Systems - Gravity System (Storm Drains/Sewers)
Construction Management Percentage Versus Total Construction Cost
Construction Management Percentage
60%
50%
40%
30%
20%
10%
%
0
5
10
15
20
25
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.0606
N = 170

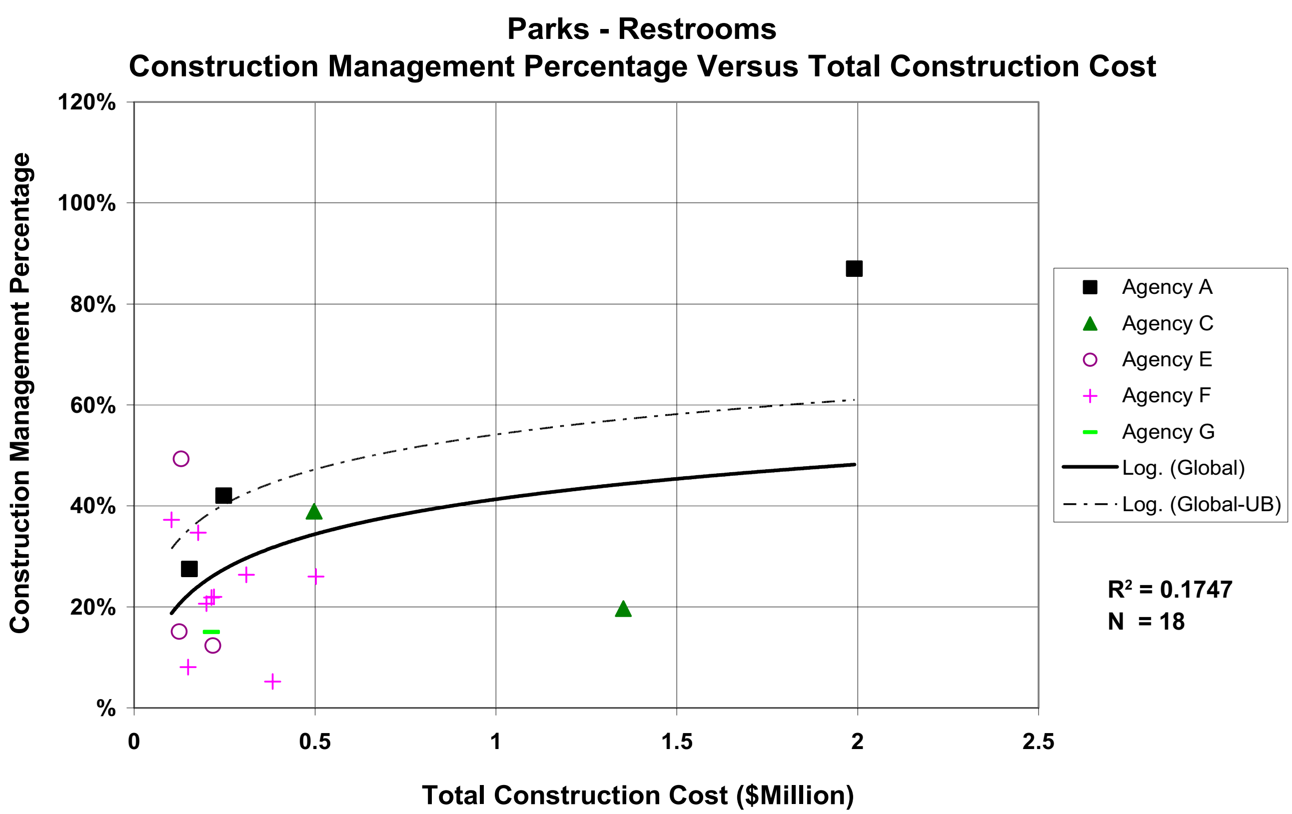

Pipe Systems - Pressure Systems
Construction Management Percentage Versus Total Construction Cost
Construction Management Percentage
35%
30%
25%
20%
15%
10%
5%
%
0
0.5
1
1.5
2
2.5
Total Construction Cost ($Million)
Agency A
Agency C
Log. (Global)
Log. (Global-UB)
R² = 0.0361
N = 28


Pipe Systems - Pump Stations
Construction Management Percentage Versus Total Construction Cost
Construction Management Percentage
80%
70%
60%
50%
40%
30%
20%
10%
%
0
1
2
3
4
5
6
7
8
9
10
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Log. (Global)
Log. (Global-UB)
R² = 0.1109
N = 24


Parks - All Classifications
Construction Management Percentage Versus Total Construction Cost
Construction Management Percentage
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
%
0
0.5
1
1.5
2
2.5
3
3.5
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.0207
N = 102


Parks - Playgrounds
Construction Management Percentage Versus Total Construction Cost
Construction Management Percentage
45%
40%
35%
30%
25%
20%
15%
10%
5%
%
0
0.5
1
1.5
2
2.5
3
3.5
Total Construction Cost ($Million)
Agency A
Agency C
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.1257
N = 73


Parks - Sportfields
Construction Management Percentage Versus Total Construction Cost
Construction Management Percentage
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
%
0
0.5
1
1.5
2
2.5
Total Construction Cost ($Million)
Agency A
Agency B
Agency D
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.1741
N = 11

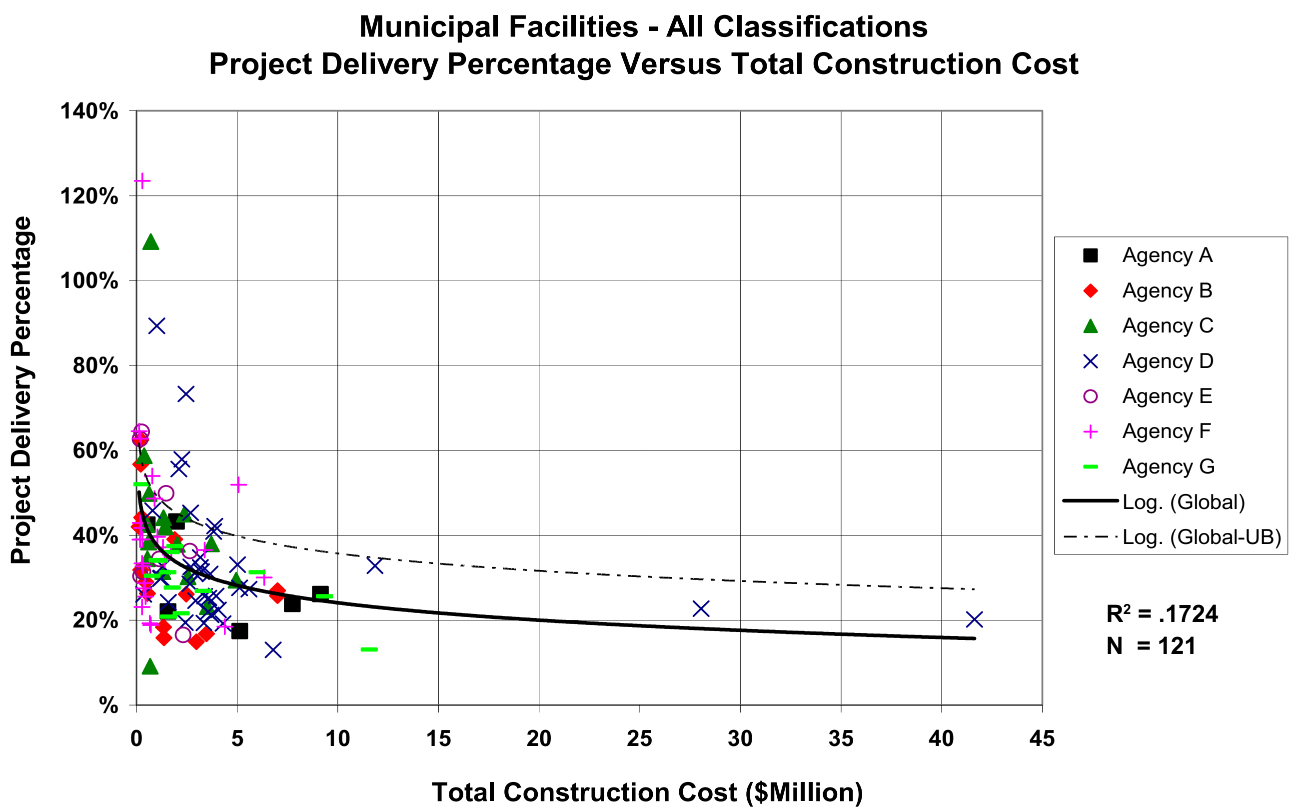

Parks - Restrooms
Construction Management Percentage Versus Total Construction Cost
Construction Management Percentage
120%
100%
80%
60%
40%
20%
%
0
0.5
1
1.5
2
2.5
Total Construction Cost ($Million)
Agency A
Agency C
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.1747
N = 18

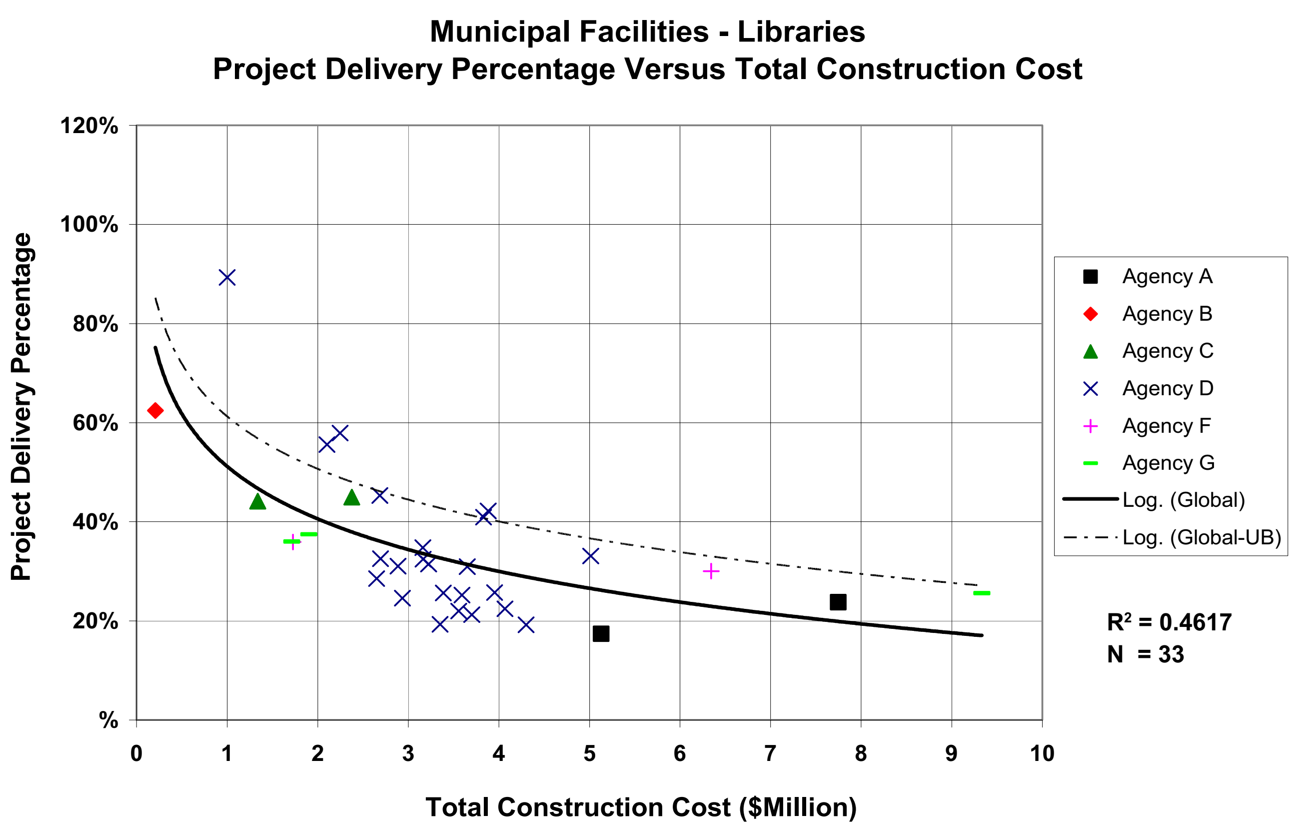
CURVES GROUP 3

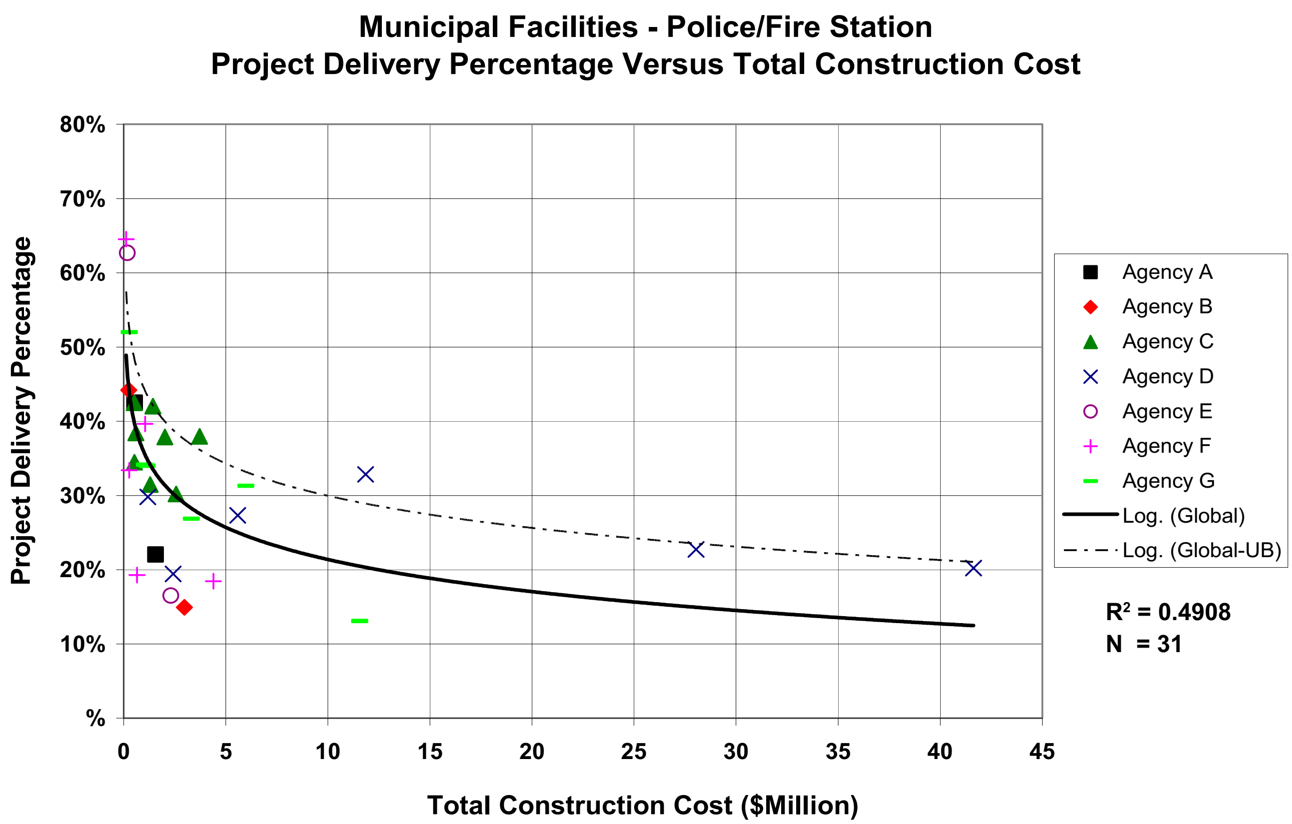
Project Delivery as Percentage of Total Construction Cost

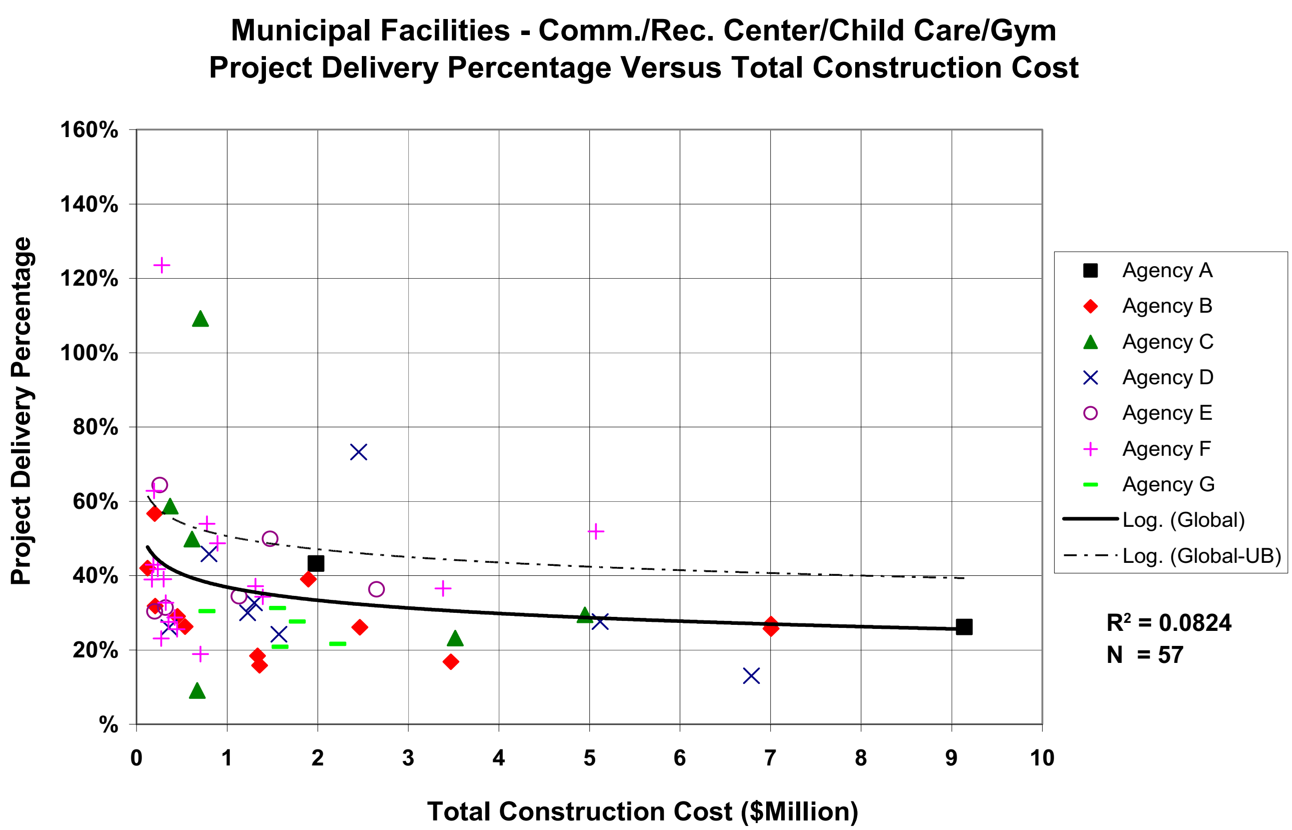
Versus

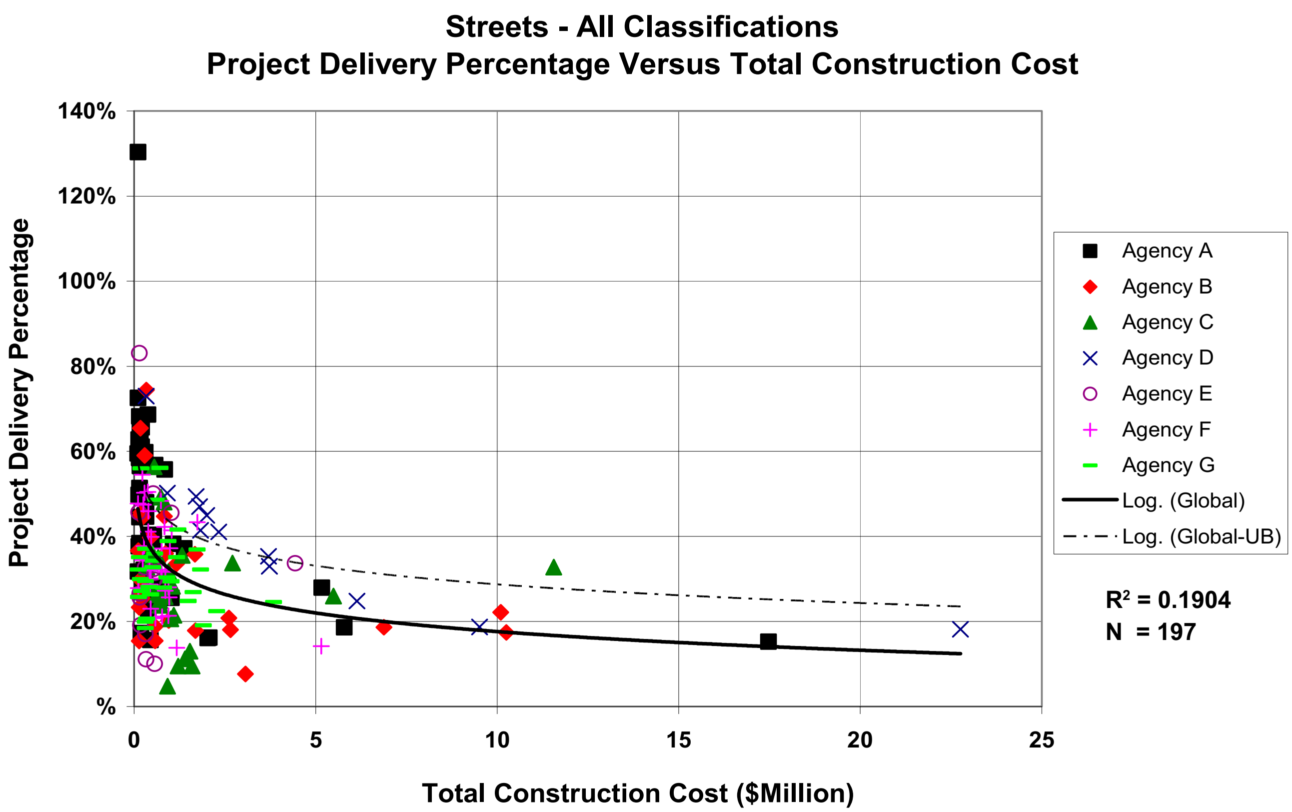
Total Construction Cost


Municipal Facilities - All Classifications
Project Delivery Percentage Versus Total Construction Cost
Project Delivery Percentage
140%
120%
100%
80%
60%
40%
20%
%
0
5
10
15
20
25
30
35
40
45
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = .1724
N = 121

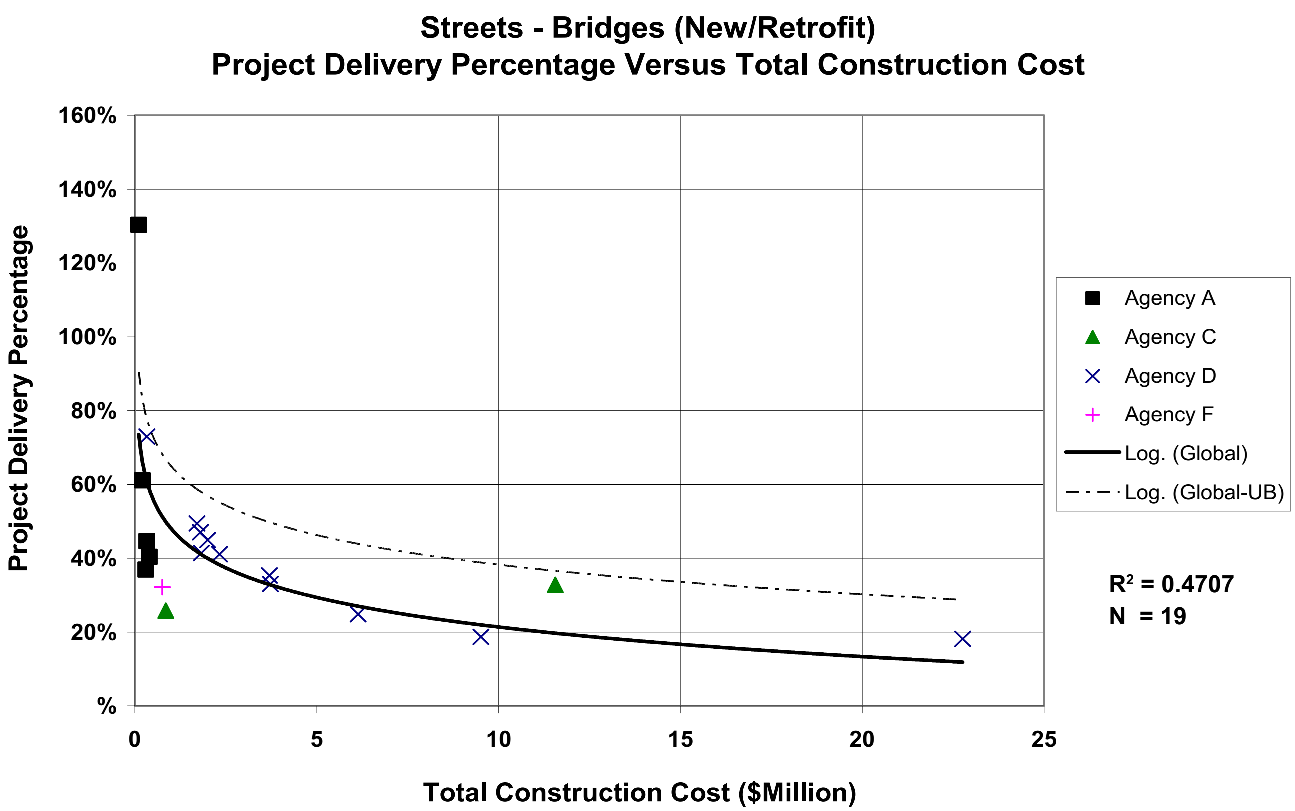

Municipal Facilities - Libraries
Project Delivery Percentage Versus Total Construction Cost
Project Delivery Percentage
120%
100%
80%
60%
40%
20%
%
0
1
2
3
4
5
6
7
8
9
10
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.4617
N = 33

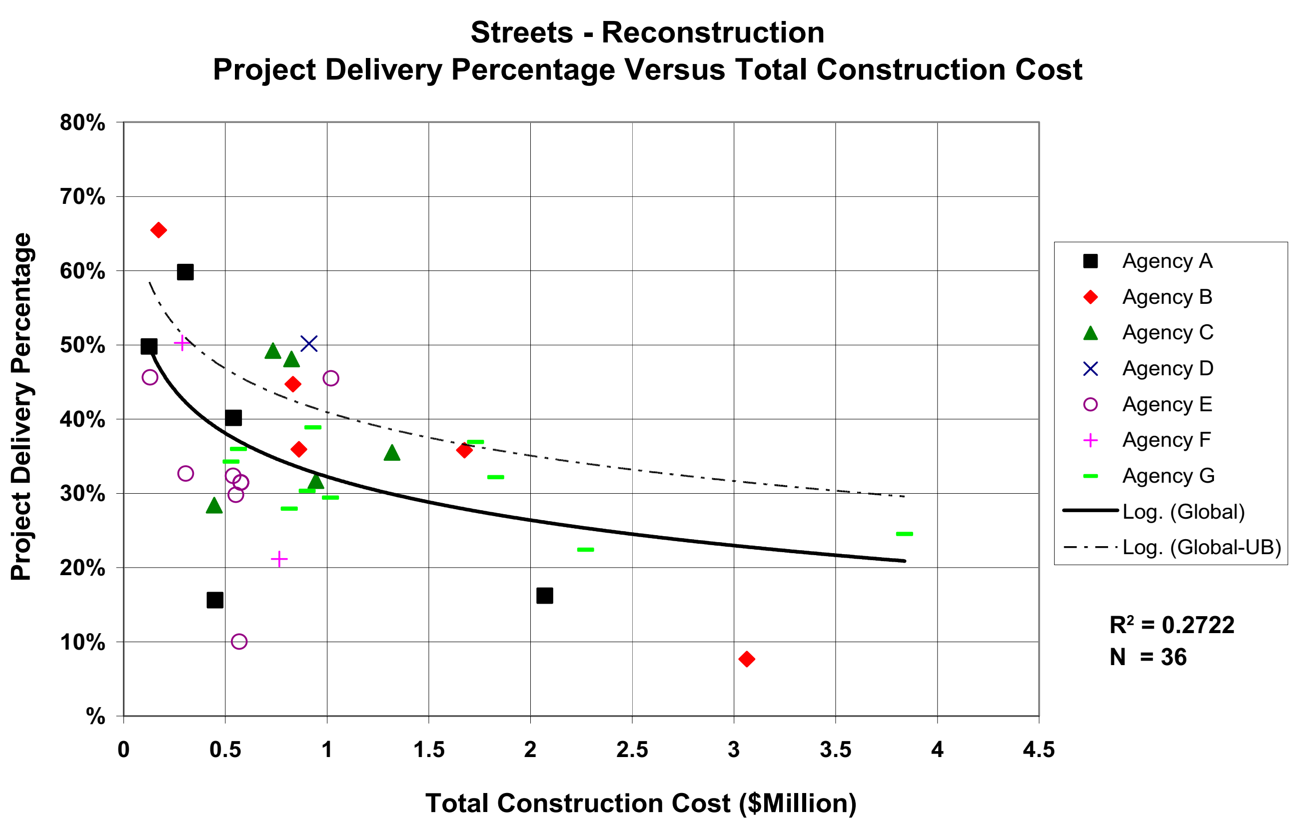

Municipal Facilities - Police/Fire Station
Project Delivery Percentage Versus Total Construction Cost
Project Delivery Percentage
80%
70%
60%
50%
40%
30%
20%
10%
%
0
5
10
15
20
25
30
35
40
45
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.4908
N = 31


Municipal Facilities - Comm./Rec. Center/Child Care/Gym
Project Delivery Percentage Versus Total Construction Cost
Project Delivery Percentage
160%
140%
120%
100%
80%
60%
40%
20%
%
0
1
2
3
4
5
6
7
8
9
10
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.0824
N = 57

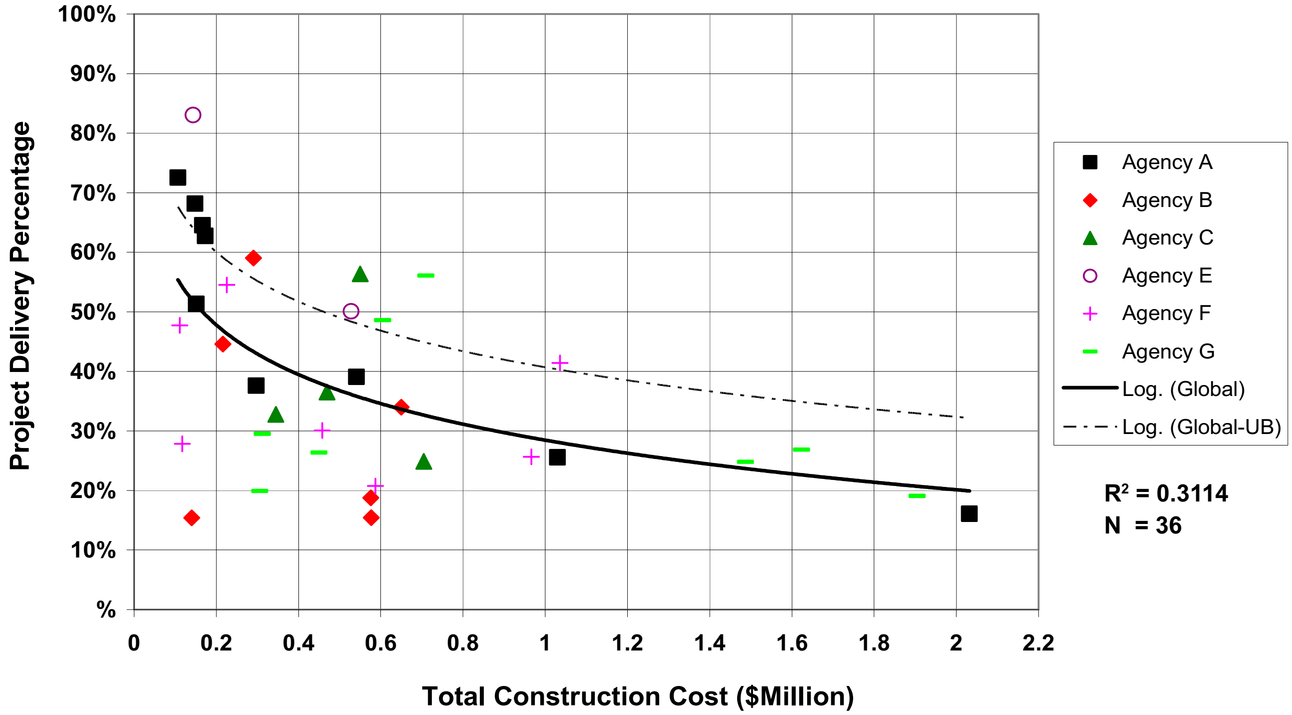

Streets - All Classifications
Project Delivery Percentage Versus Total Construction Cost
140%
120%
100%
80%
60%
40%
20%
%
0
5
10
15
20
25
Project Delivery Percentage
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.1904
N = 197


Streets - Widening/New/Grade Separation
Project Delivery Percentage Versus Total Construction Cost
70%
60%
50%
40%
30%
20%
10%
%
0
2
4
6
8
10
12
14
16
18
20
Project Delivery Percentage
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.4743
N = 28

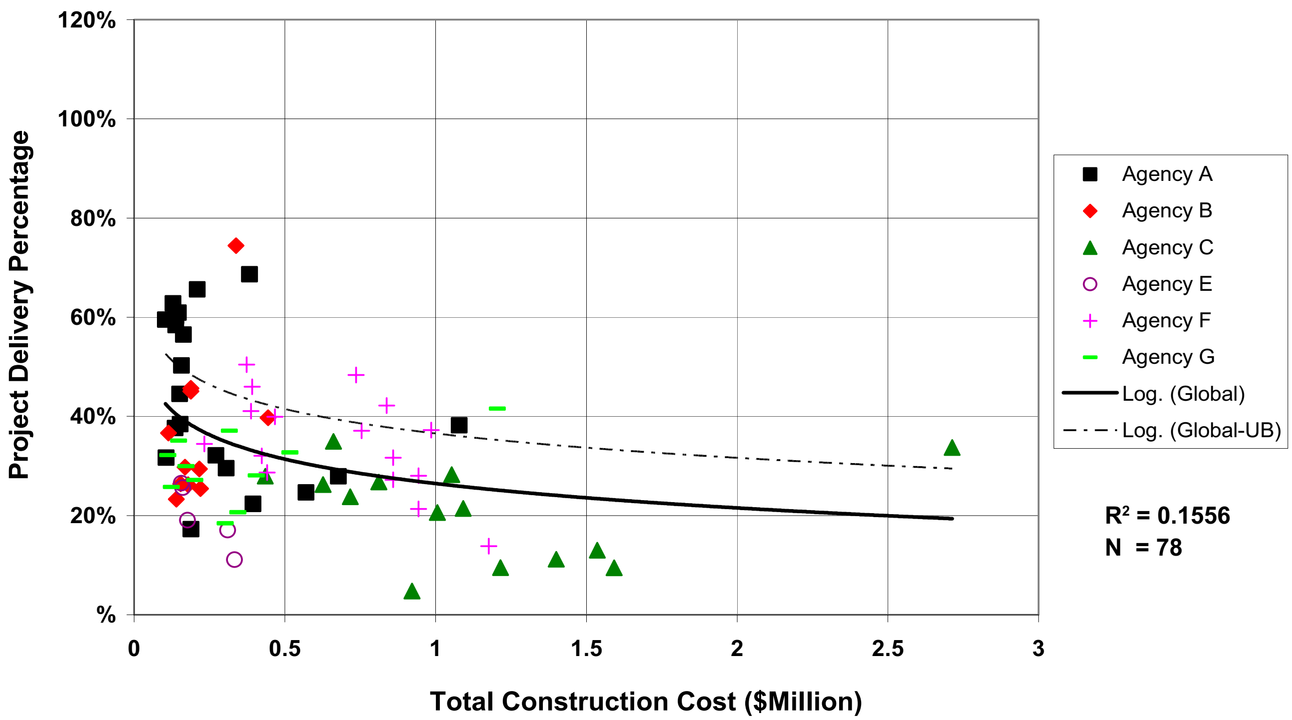

Streets - Bridges (New/Retrofit)
Project Delivery Percentage Versus Total Construction Cost
Project Delivery Percentage
160%
140%
120%
100%
80%
60%
40%
20%
%
0
5
10
15
20
25
Total Construction Cost ($Million)
Agency A
Agency C
Agency D
Agency F
Log. (Global)
Log. (Global-UB)
R² = 0.4707
N = 19

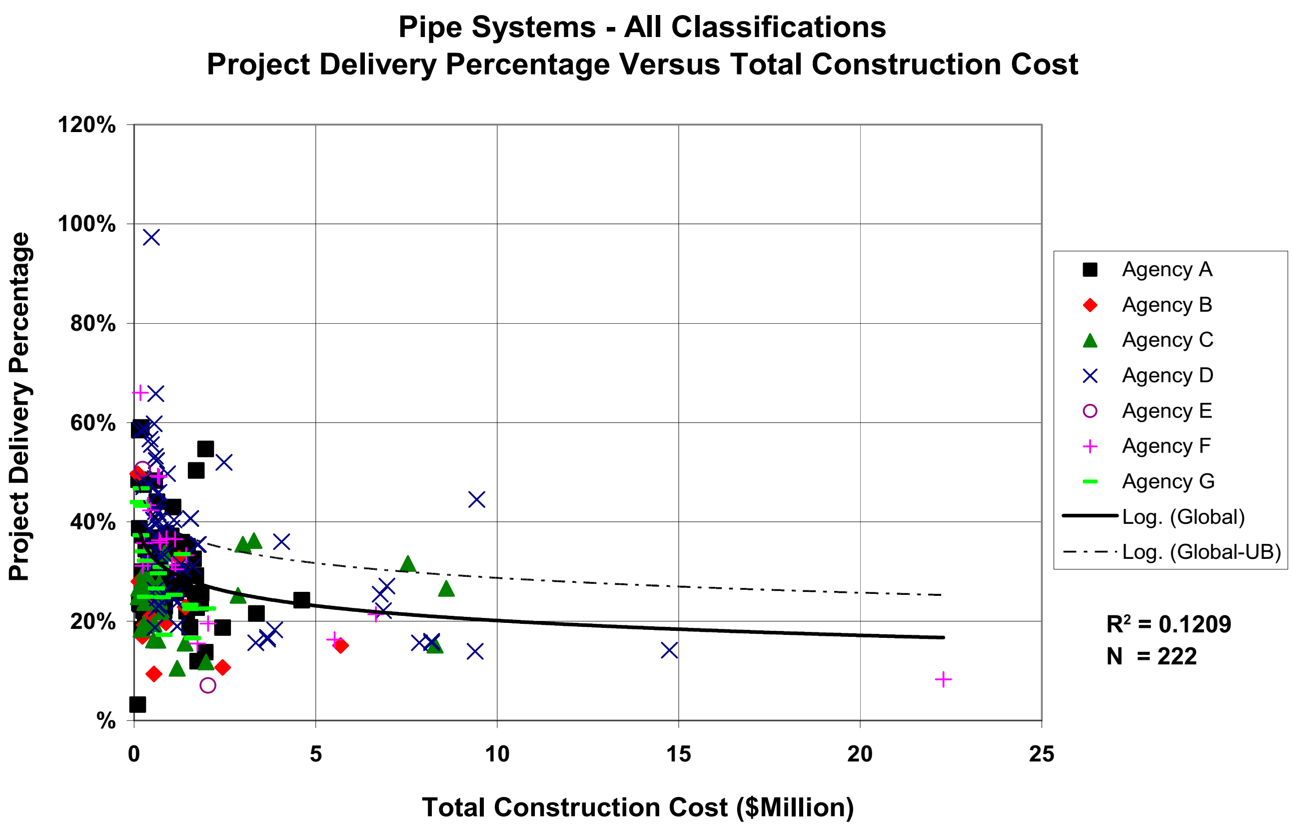

Streets - Reconstruction
Project Delivery Percentage Versus Total Construction Cost
Project Delivery Percentage
80%
70%
60%
50%
40%
30%
20%
10%
%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.2722
N = 36

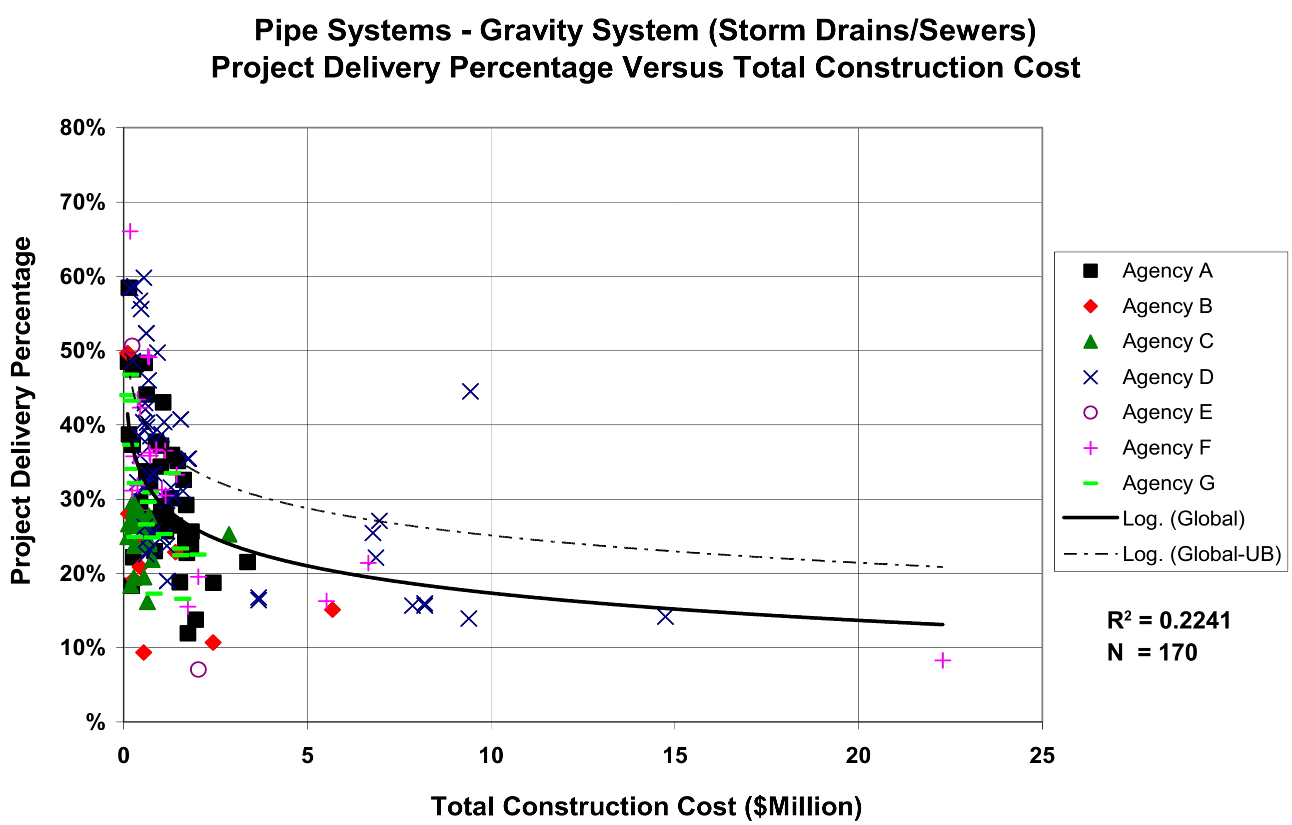
Streets - Bike/Pedestrian
Project Delivery Percentage Versus Total Construction Cost



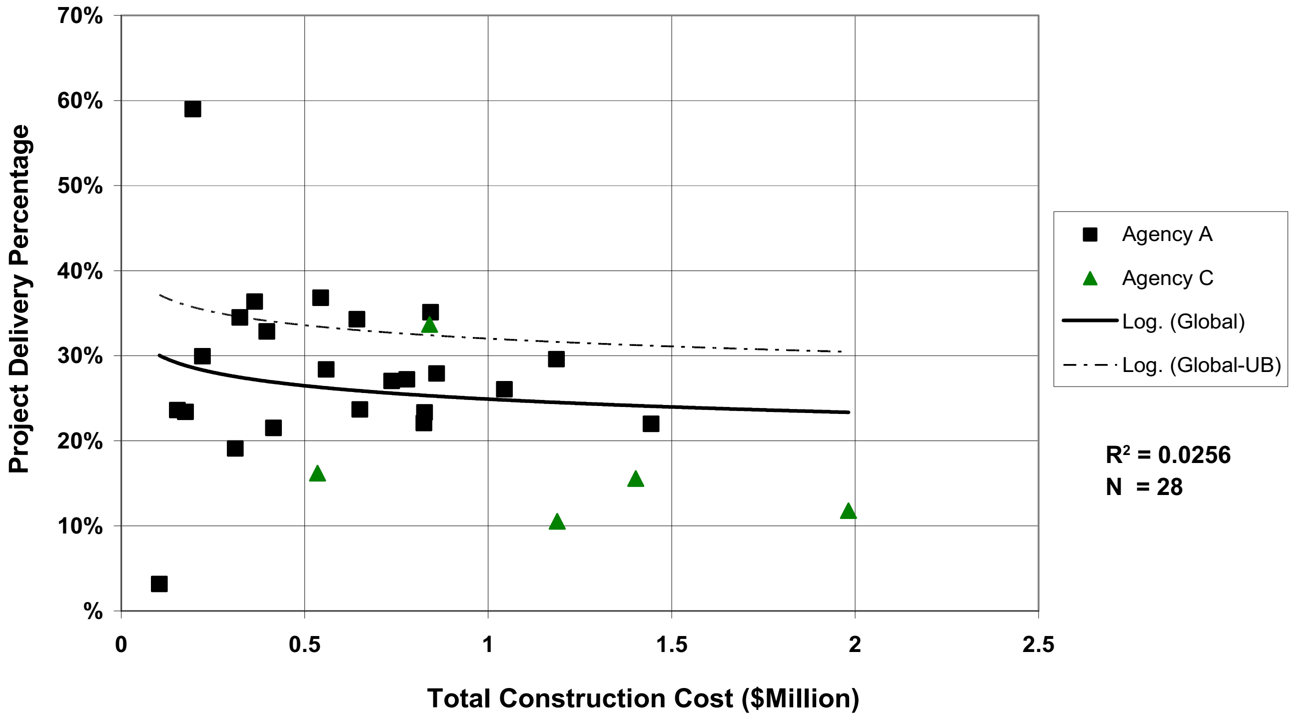
Streets - Signals
Project Delivery Percentage Versus Total Construction Cost



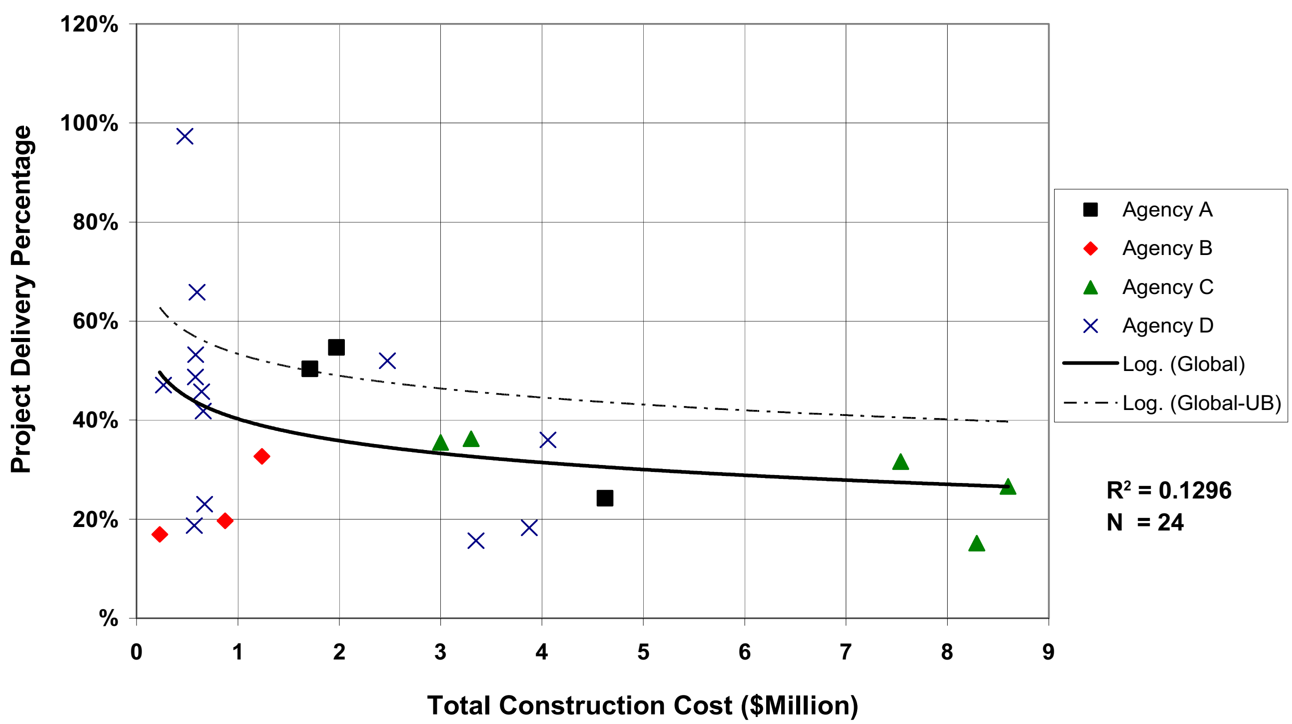

Pipe Systems - All Classifications
Project Delivery Percentage Versus Total Construction Cost
Project Delivery Percentage
120%
100%
80%
60%
40%
20%
%
0
5
10
15
20
25
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.1209
N = 222


Pipe Systems - Gravity System (Storm Drains/Sewers)
Project Delivery Percentage Versus Total Construction Cost
Project Delivery Percentage
80%
70%
60%
50%
40%
30%
20%
10%
%
0
5
10
15
20
25
Total Construction Cost ($Million)
Agency A
Agency B
Agency C
Agency D
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.2241
N = 170

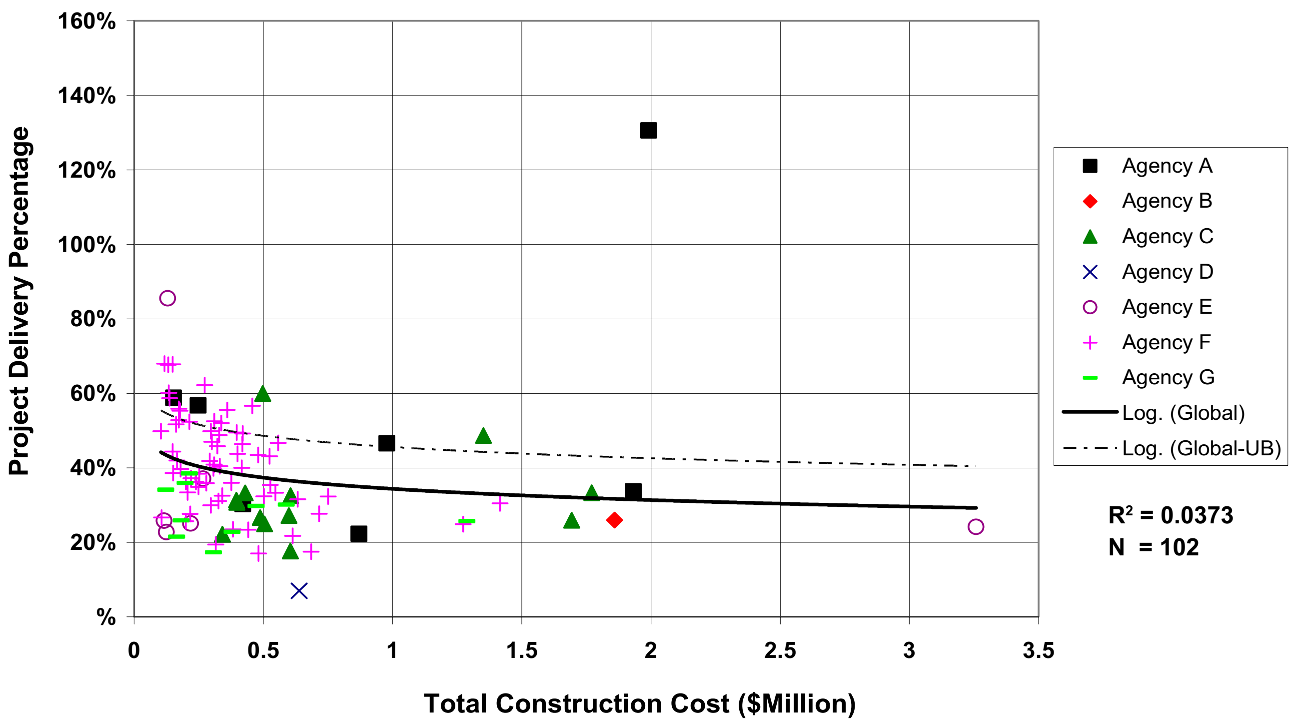
Pipe Systems - Pressure Systems
Project Delivery Percentage Versus Total Construction Cost



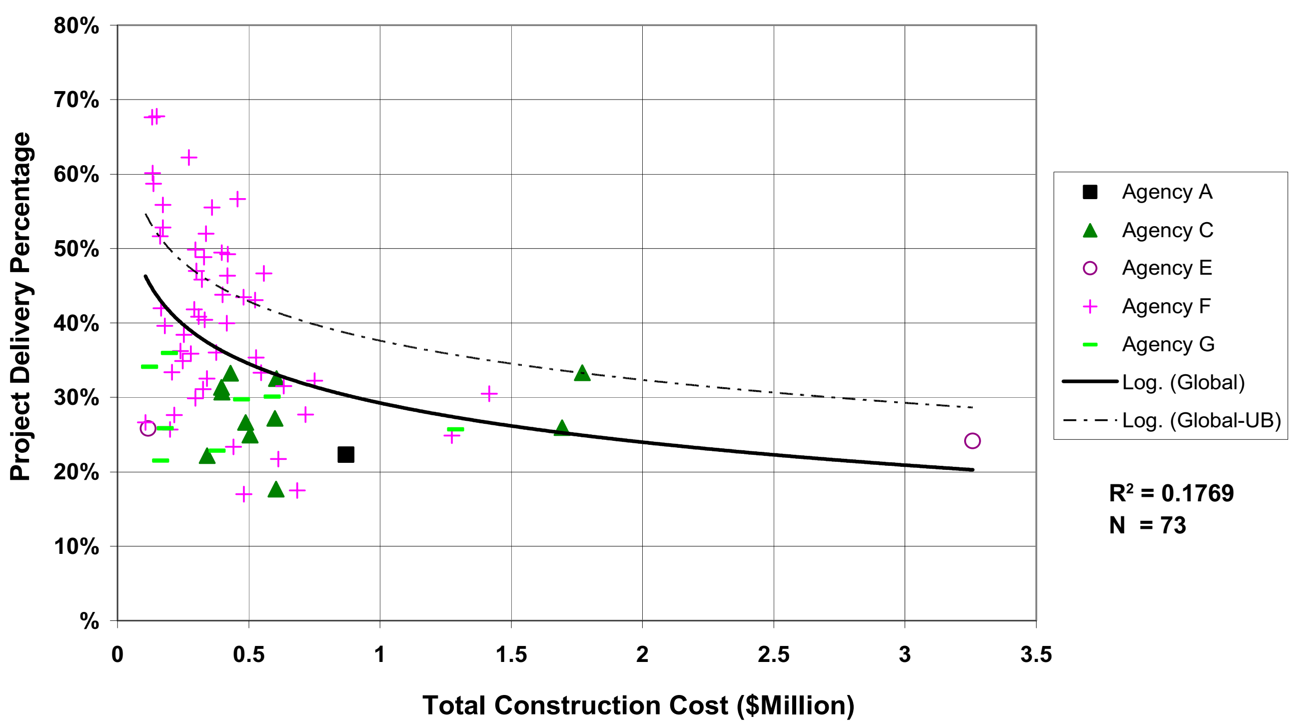
Pipe Systems - Pump Stations
Project Delivery Percentage Versus Total Construction Cost

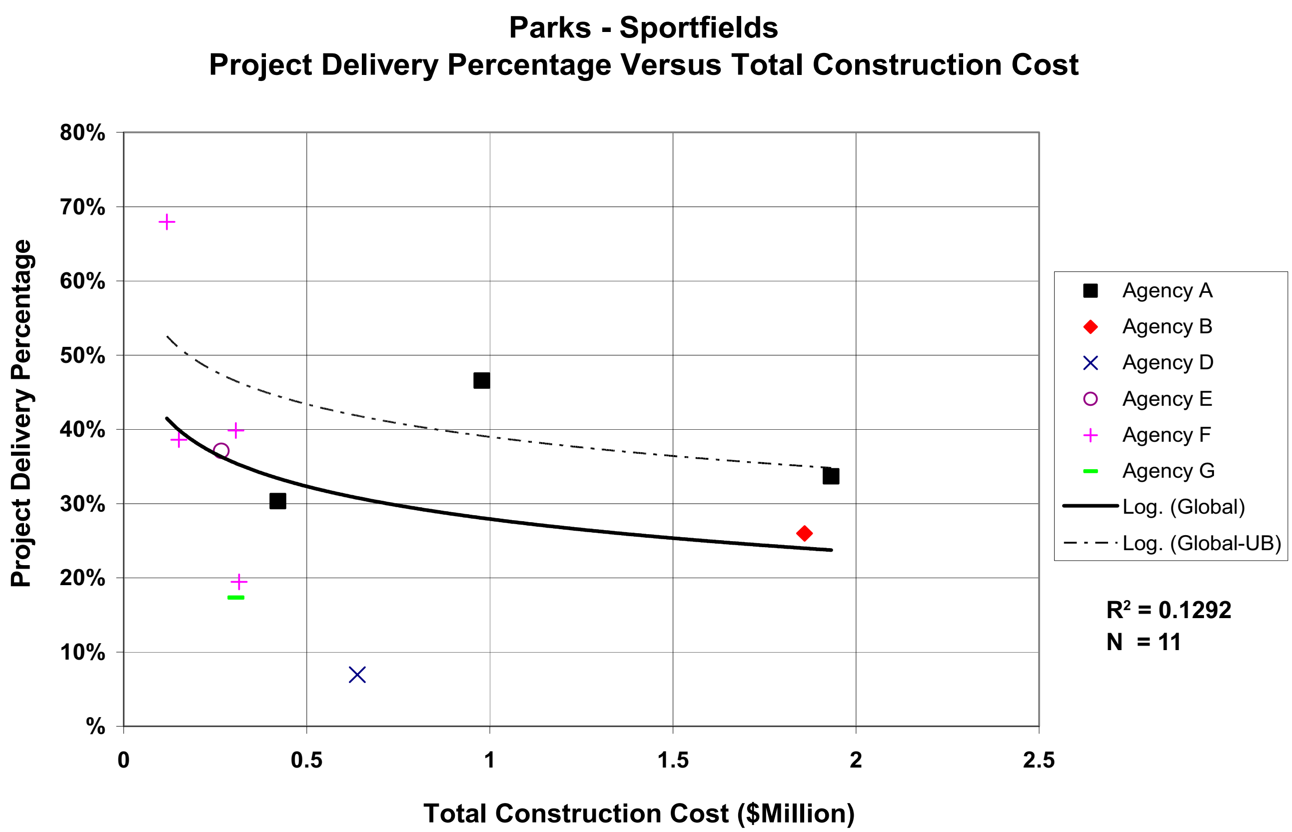


Parks - All Classifications
Project Delivery Percentage Versus Total Construction Cost



Parks - Playgrounds
Project Delivery Percentage Versus Total Construction Cost




Parks - Sportfields
Project Delivery Percentage Versus Total Construction Cost
80%
70%
60%
50%
40%
30%
20%
10%
%
Project Delivery Percentage
0
0.5
1
1.5
2
2.5
Total Construction Cost ($Million)
Agency A
Agency B
Agency D
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.1292
N = 11

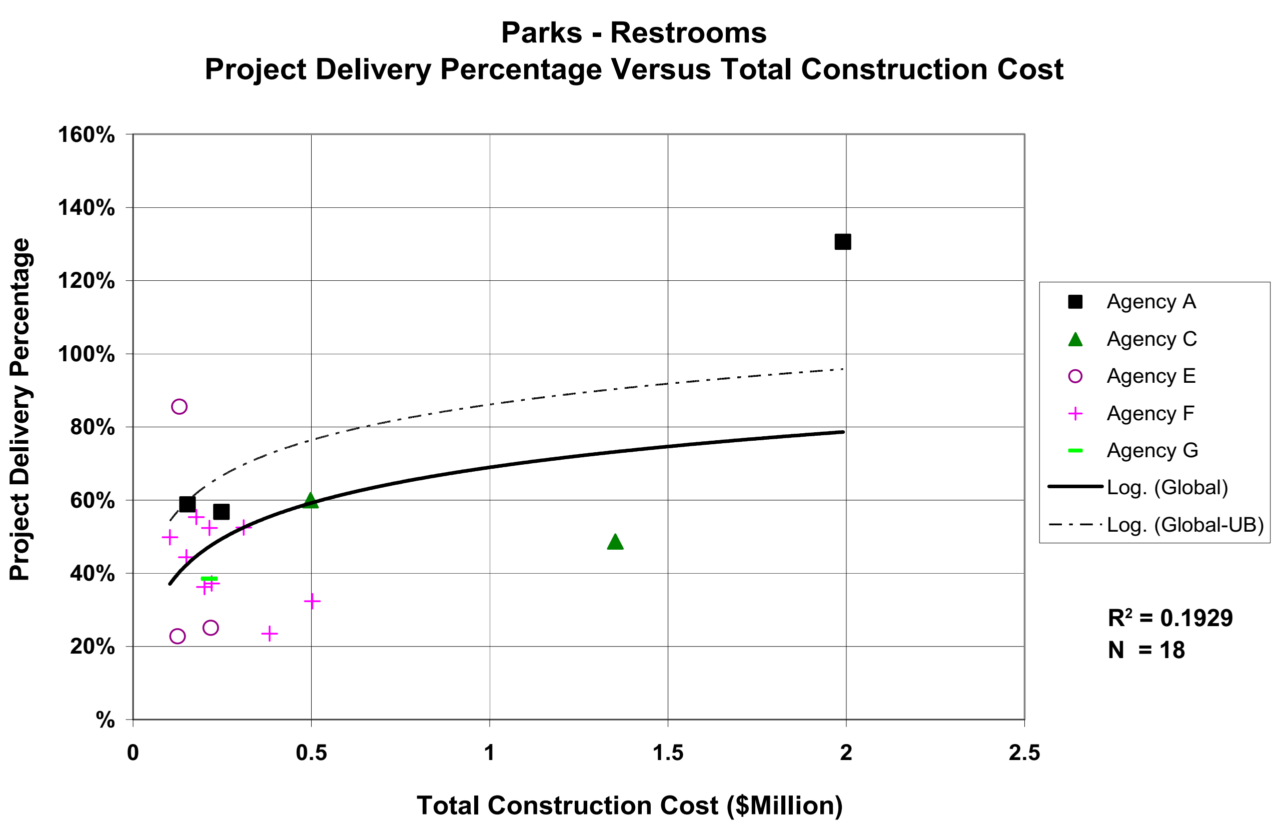

Parks - Restrooms
Project Delivery Percentage Versus Total Construction Cost
160%
140%
120%
100%
80%
60%
40%
20%
%
Project Delivery Percentage
0
0.5
1
1.5
2
2.5
Total Construction Cost ($Million)
Agency A
Agency C
Agency E
Agency F
Agency G
Log. (Global)
Log. (Global-UB)
R² = 0.1929
N = 18

Table A-1 — Performance Graphs R^2 Results

PROJECT TYPE AND CLASSIFICATION	DESIGN % VS TCC	CONSTRUCTION MANAGEMENT % VS TCC	PROJECT DELIVERY % VS TCC
Municipal Facilities	0.13	0.07	0.17
Libraries	0.45	0.23	0.46
Police/Fire Station	0.41	0.33	0.49
Community Building / Recreation Center / Child Care Center / Gymnasium	0.02	0.06	0.08
Streets	0.08	0.11	0.19
Widening / New / Grade Separation	0.36	0.13	0.47
Bridge (New / Retrofit)	0.42	0.14	0.47
Reconstruction	0.03	0.36	0.27
Bike / Pedestrian	0.32	0.04	0.31
Signals	0.07	0.06	0.16
Pipe Systems	0.13	0.03	0.12
Gravity System (Storm Drains / Sewers)	0.20	0.06	0.22
Pressure Systems	0.004	0.04	0.02
Pump Station	0.08	0.11	0.13
Parks	0.03	0.02	0.04
Playgrounds	0.09	0.13	0.18
Sportfields	0.04	0.17	0.13
Restrooms	0.09	0.17	0.19

Note: TCC=Total Construction Cost (Including all Change Orders)

Appendix B

Indirect Rates

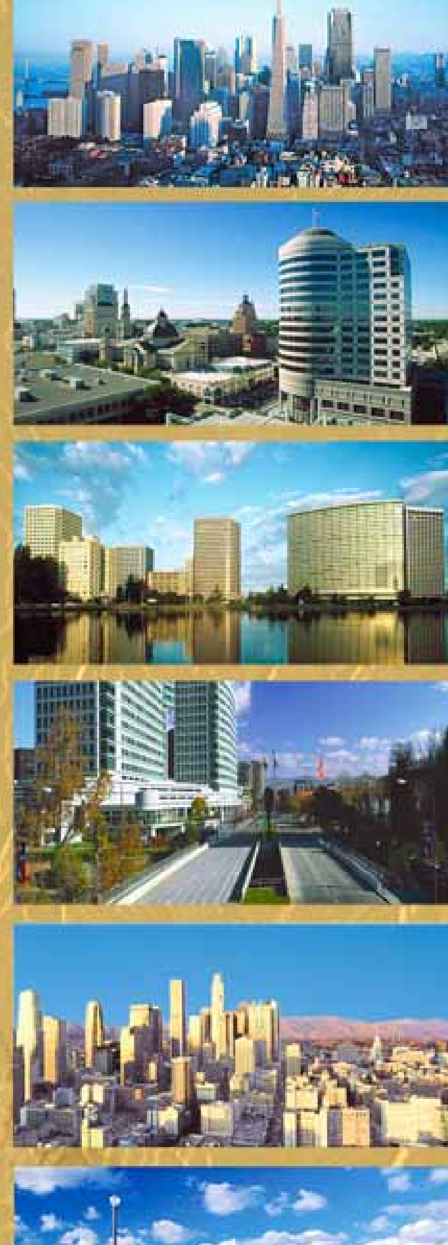


Table B-1 — Indirect Rates Applied to Capital Projects

Agency	Fringe Benefits	Compensated Time Off	City Overhead	Department Overhead	Agency Overhead	Indirect Rate Factor[1]	Receive General Fund Support For CIP
City of Long Beach Department of Public Works	38.60%	19.40%	4.4%	11.9%	72.7%	147%	YES
City of Los Angeles Department of Public Works Bureau of Engineering	19.41%	18.38%	29.94%	26.31%	52.79%	146.83%	YES
City of Oakland Public Works Agency	45.54%	21.53%	22.05%	5.78%	11.01%	114.27%	NO
City of Sacramento							NO
Department of General Services	30.00%	18.70%	40.95%	6.67%	75.15%	194.44%	
Department of Transportation	30.00%	18.70%	40.95%	6.67%	75.15%	194.44%	
Department of Utilities	36.9%	18.70%	N/A	N/A	N/A	90.35%	
City of San Diego Public Buildings & Parks	27.70%	15.50%	12.00%	60.80%	4.00%	120.10%	NO
Transportation & Drainage Design	27.70%	14.70%	47.90%	31.80%	4.60%	126.60%	
Water/Wastewater Facilities	27.50%	13.50%	11.90%	51.50%	4.30%	108.70%	
City and County of San Francisco Department of Public Works Bureau of Engineering Bureau of Construction Management Bureau of Architecture	19.88%	26.28%	17.47%[2]	40.95%	80.89%	168.00%	NO
City of San Jose Department of Public Works	27.85%	25.00%	27.77%	1.58%	Included	120%	NO

Notes: [1] This value may be different from the sum of overhead values. The compounding formula may vary by agency.
[2] Not included in the Indirect Rate.

Participating Agencies

- City of Long Beach, Department of Public Works
- City of Los Angeles, Department of Public Works/ Bureau of Engineering
- City of Oakland, Public Works Agency
- City of Sacramento, Department of General Services, Department of Transportation, Department of Utilities
- City of San Diego, Engineering & Capital Projects
- City & County of San Francisco, Department of Public Works/ Bureau of Engineering/ Bureau of Construction Management/ Bureau of Architecture
- City of San Jose, Department of Public Works

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