CIP Benchmarking Study

California Multi-Agency CIP Benchmarking Study

Annual Report - Update 2017








Department of PUBLICWORKS
CITY OF SACRAMENTO

OAKLAND
PUBLIC WORKS AGENCY

CITY OF SAN JOSE
CAPITAL OF SILICON VALLEY

CITY OF LOS ANGELES
FOUNDED 1781

CITY OF LONG BEACH

THE CITY OF SAN DIEGO • STATE OF CALIFORNIA
SEMPER VIGILANS

December 2017

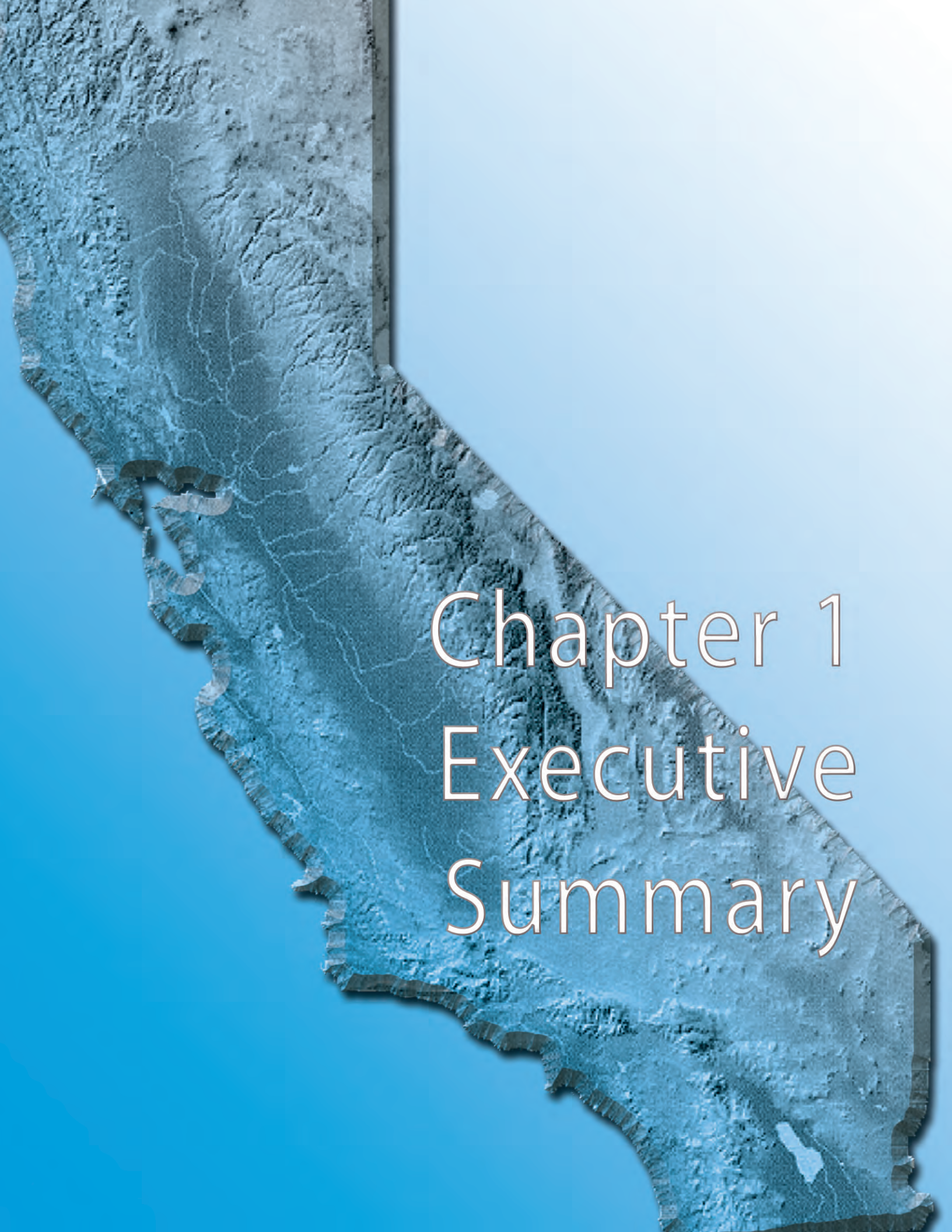
TOC

Table of Contents

APPENDICES

TABLES

Page Intentionally Left Blank



Chapter 1 Executive Summary

CHAPTER 1 Executive Summary

A. INTRODUCTION

The California Multi-Agency CIP Benchmarking Study (Study) is a collaborative effort that involves the sharing of ideas and data between several of the largest cities in California. This report presents the findings of several key components of the study including performance benchmarking and best management practices (BMPs).

Performance benchmarking is conducted to establish relationships between project delivery costs and total construction cost (TCC). The *Study* examines how these relationships change over a five-year trailing period. This is a core concept of the *Study* that provides a meaningful benchmark by which participating agencies can assess their project delivery performance and identify potential reasons for differences between them and peers.

Best management practices are discussed between agencies and tracked to provide participating agencies a living archive of practices being implemented by peers, lessons learned through their implementation, and potential benefits to be derived if implemented.

A brief overview of these *Study* components is presented in this executive summary.

B. PERFORMANCE BENCHMARKING

The project data submitted by the agencies are compiled in a customized Microsoft Access® database. This database serves as a repository for the data collected since the inception of the *Study*. Each year, the project database is updated with the inclusion of project data submitted for that *Study* year and updated project data submitted for previous years. The Update 2017 database includes a total of 547 projects, 437 of which belong in the 80th percentile subset by TCC.

Project Delivery Costs by Project Type

Table 1-1 summarizes project delivery cost as a percentage of TCC by each of the four project types in the Study for the full range of TCC. **Table 1-2** similarly summarizes project delivery cost as a percentage of TCC for the smaller 80th percentile projects based on TCC. The project delivery percentage for a category is the arithmetic average of the project delivery percentages of the individual projects grouped under that category.

Table 1-1
Average Project Delivery Costs by Project Type (% of TCC)
(Full Range of TCC)

Type	Design [1,2]	Construction Management [1,2]	Total Project Delivery [1,2]	Median Total Construction Cost ($MM)	Number of Projects [3]
Municipal Facilities	26%	24%	50%	2.27	56
Parks	26%	20%	46%	1.00	41
Pipe Systems	25%	22%	46%	1.17	266
Streets	31%	19%	49%	0.80	184
All Types	**27%**	**21%**	**48%**	**1.04**	**547**

Notes:
1. Project Delivery percentages represent arithmetic averages of the individual projects and do not represent the results from the regression analyses.
2. Project Delivery percentages vary from year to year based on the selection and the composition of the projects in the database.
3. Total excludes projects delivered by alternative delivery mechanisms such a design-build, JOC, and CM@Risk. Projects delivered by alternative techniques are retained in the database but not analyzed. These projects are not included in the projects selected for analysis in the *Study*.

Table 1-2
Average Project Delivery Costs by Project Type (% of TCC)
(80th Percentile Range of TCC)

Type	Design [1,2]	Construction Management [1,2]	Total Project Delivery [1,2]	Median Total Construction Cost ($MM)	Number of Projects [3]
Municipal Facilities	29%	25%	54%	1.22	44
Parks	28%	23%	51%	0.66	32
Pipe Systems	26%	23%	49%	0.86	212
Streets	33%	19%	52%	0.55	147
All Types	**29%**	**22%**	**51%**	**0.80**	**437**

Notes:
1. Project Delivery percentages represent arithmetic averages of the individual projects and do not represent the results from the regression analyses.
2. Project Delivery percentages vary from year to year based on the selection and the composition of the projects in the database.
3. Total excludes projects delivered by alternative delivery mechanisms such a design-build, JOC, and CM@Risk. Projects delivered by alternative techniques are retained in the database but not analyzed. These projects are not included in the projects selected for analysis in the *Study*.

Regression Analysis

A regression analysis was performed to understand the relationship between project delivery as a percent of TCC. This analysis is important to establish statistical significance related to the performance benchmarking. The results reflect the agencies' experience with the delivery of capital projects; on a percentage basis projects with lower TCCs are more expensive to deliver than projects with higher TCCs. Results from the regression analysis methodology are discussed in **Appendix B**. **Appendix B** calculates the project delivery percentages differently than observed in **Table 1-1** and **Table 1-2**, as described in detail in **Appendix B**.

Project Delivery Percentages as Ranges of TCC

In addition to evaluating a subset of projects defined by the lower 80th percentile subset, the project team evaluated the project delivery percentages on further subsets. An analysis was performed on how the project delivery percentage would change if the projects were categorized by TCC cost ranges.

The results show how the project delivery percentage changes for different ranges of TCC of projects. Projects with higher TCC typically have lower project delivery percentages of TCC and projects with lower TCC typically have a higher project delivery percentage of TCC. The results are further discussed in **Chapter 3**.

C. BEST MANAGEMENT PRACTICES

At the start of this *Study* in 2002, the agencies examined over 100 practices used in project delivery. Many practices included those the participants did not commonly use at the time, but believed could add value if ultimately implemented as Best Management Practices (BMPs). Each year the agencies look at industry changes in order to identify new BMPs. Each Agency's implementation of these selected practices will continue to be tracked. No new BMPs have been developed in Update 2017, although the agencies are continuing to track their performance on the already developed BMPs.

While a BMP may be developed to address a specific issue, its implementation may affect other elements of project delivery. The participating agencies judged that each of the BMPs favorably impact one of the following categories:

- Cost
- Schedule
- Quality
- Communication
- Environment
- Customer Service

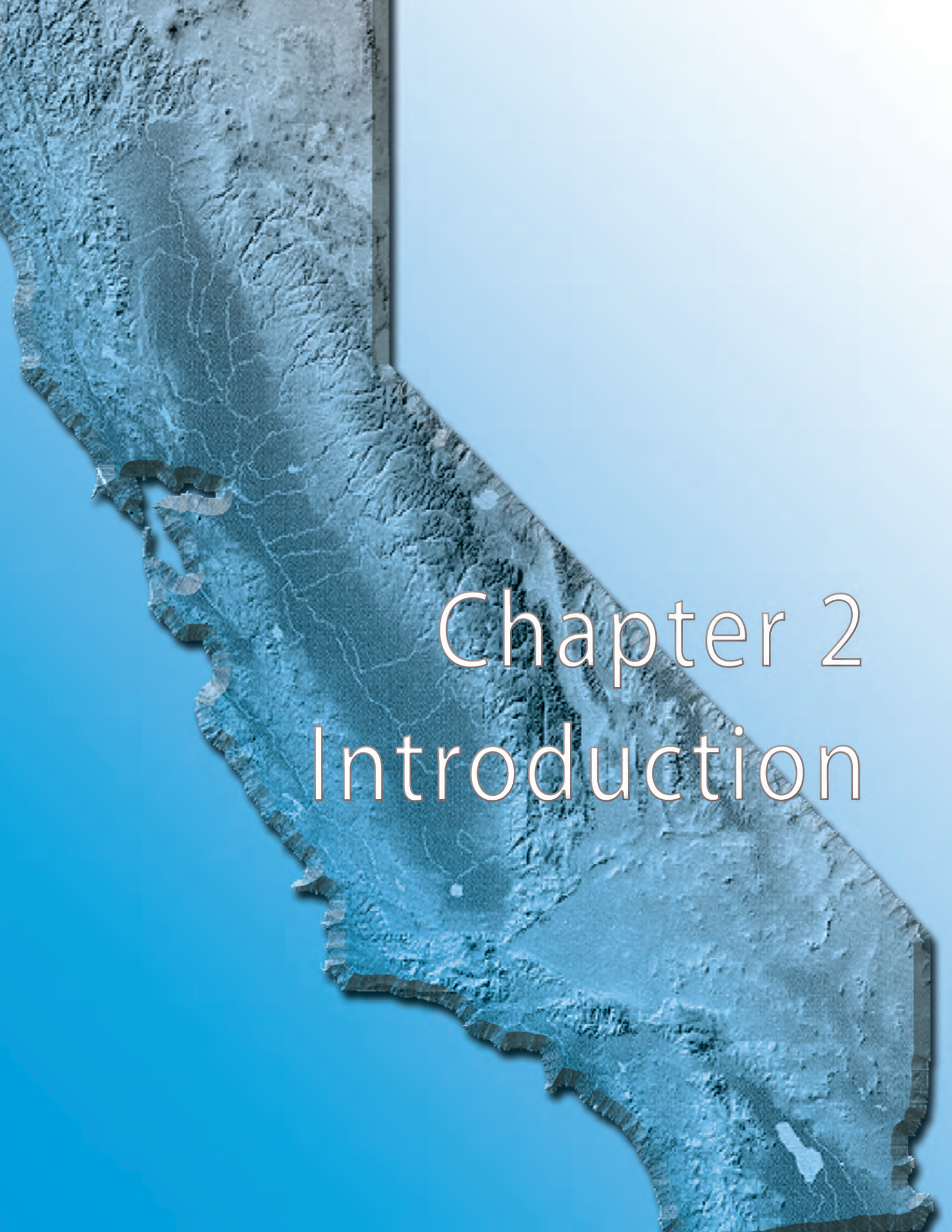
These BMPs continue to be an important element of the *Study* by providing a reference for participating agencies to identify additional BMPs that may be beneficial to implement or to understand challenges associated with their implementation. The discussion on BMPs is found in **Chapter 4** of this report.

D. ACKNOWLEDGEMENTS

This *Study* is made possible through the generous contributions of each participating agency, city staff, and consultants. Contributors include:

- City of Long Beach/ Port of Long Beach
- City of Los Angeles
- City of Sacramento
- City of San Diego
- City of San Francisco
- City of San José
- City of Oakland
- Stantec, Inc.
- Roebbelen Contracting, Inc.

A full list of acknowledgements is presented in **Chapter 5**. The City of Oakland took a temporary break from participating in the *Study*. However, previously submitted projects from the City of Oakland are still maintained in the *Study*.



Chapter 2
Introduction

CHAPTER 2

Introduction

The California Multi-Agency CIP Benchmarking Study (Study) is a collaborative effort that involves the sharing of ideas and data between several of the largest cities in California. Each participating member contributes to the discussion of lessons learned out of their capital improvement program (CIP) implementation. Through this framework, members of the *Study* wish to: increase efficiency in delivering services, employ best management practices (BMPs), implement continuous training programs, and develop best-in-class capabilities.

The *Study* provides a forum for the agencies to share information among themselves via meetings that focus on current issues and a database that serves as both a repository of the agencies' projects and a tool for data analysis. The purpose of this collaboration is to share the best ideas of the group for the benefit of all and to gather insight on how to address challenges that might appear to be new, but which others have already faced and addressed successfully.

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*. The Project Team acknowledges that there have been significant benefits derived from collaborating and pooling their project delivery knowledge and experience since the inception of the *Study*.

The participating agencies currently include:

- City of Long Beach, Department of Public Works and Harbor Department Port of Long Beach
- City of Los Angeles, Department of Public Works, Bureau of Engineering
- City of Oakland, Public Works Department, Bureau of Engineering and Construction. City of Oakland took a temporary leave from the *Study* in 2017.
- City of Sacramento, Department of Public Works and Department of Utilities
- City of San Diego, Public Works Department, Engineering and Capital Projects Department
- City and County of San Francisco, Department of Public Works, Building Design and Construction, Infrastructure Design and Construction
- City of San José, Department of Public Works and City Manager's Office

While the participating agencies have many similarities in terms of function and capital program delivery, it is important to note that a number of factors create differences. Some of these include organization and cost

structure. This is reflected in the "Indirect Rates Applied to Capital Projects" table shown in **Appendix C**. Variances amongst the agency indirect rates can create measureable delivery cost differences between the agencies for similar projects. However, the large magnitude of projects in the *Study* database has normalized these differences when data is compiled for major project categories and/or across all project types.

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.

General information on each participating agency is summarized on **Table 2-1**.

B. BENEFITS OF PARTICIPATION

The participating 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 agencies have expressed many benefits of the *Study*. Ready access to performance data and BMPs of the largest cities in California helps member agencies in their decision-making process regarding policy and procedural improvements while providing training initiatives for new project

Table 2-1
Participating Agency General Information

Information	Population[1]	Area (sq. mi.)	Website	Government Form
Long Beach	480,173	50	http://www.longbeach.gov http://www.polb.com	Council-Manager-Charter[2] Commission-Mayor-Council
Los Angeles	4,041,707	469	http://eng.lacity.org	Mayor-Council
Oakland	426,074	66	http://www2.oaklandnet.com/	Mayor-Council-Administrator
Sacramento	493,025	98	http://www.cityofsacramento.org	Council-Manager
San Diego	1,406,318	342	http://www.sandiego.gov	Mayor-Council
San Francisco	874,228	49	http://www.sfdpw.org	Mayor-Board of Supervisors (11 members)
San José	1,046,079	178	http://www.sanjoseca.gov	Mayor-Council-Manager

Notes:
Source: California Department of Finance, E-1 Population Estimates for Cities, Counties, and the State — January 1, 2016 and 2017.
1. Provisional population estimate for the city as of January 1, 2017.
2. Mayor has veto power.

managers. Sharing project delivery costs provides agencies a higher level of design and construction estimate certainty and a benchmark to assess their individual CIP implementation performance. The tracking and reporting of the *Study* provides a structured framework for agencies to more seamlessly correlate performance with that of the collective.

The *Study*, through regular meetings, facilitates the discussion of how executives from each agency are managing and meeting similar challenges. Meetings involve the discussion of timely subjects that prepare agencies in addressing coming issues. The *Study* helps agency staff better communicate typical CIP challenges, e.g., needed resources, with elected officials and community stakeholders.

C. STUDY FOCUS

This year, the participating agencies devoted in-person meeting time to collaborating with each other on pressing issues facing all the agencies. Agency implementation of selected BMPs has been and will continue to be tracked during the *Study*. A description of the BMP along with their "Perceived Value" is presented in **Chapter 4, Best Management Practices**.

D. STUDY GOALS

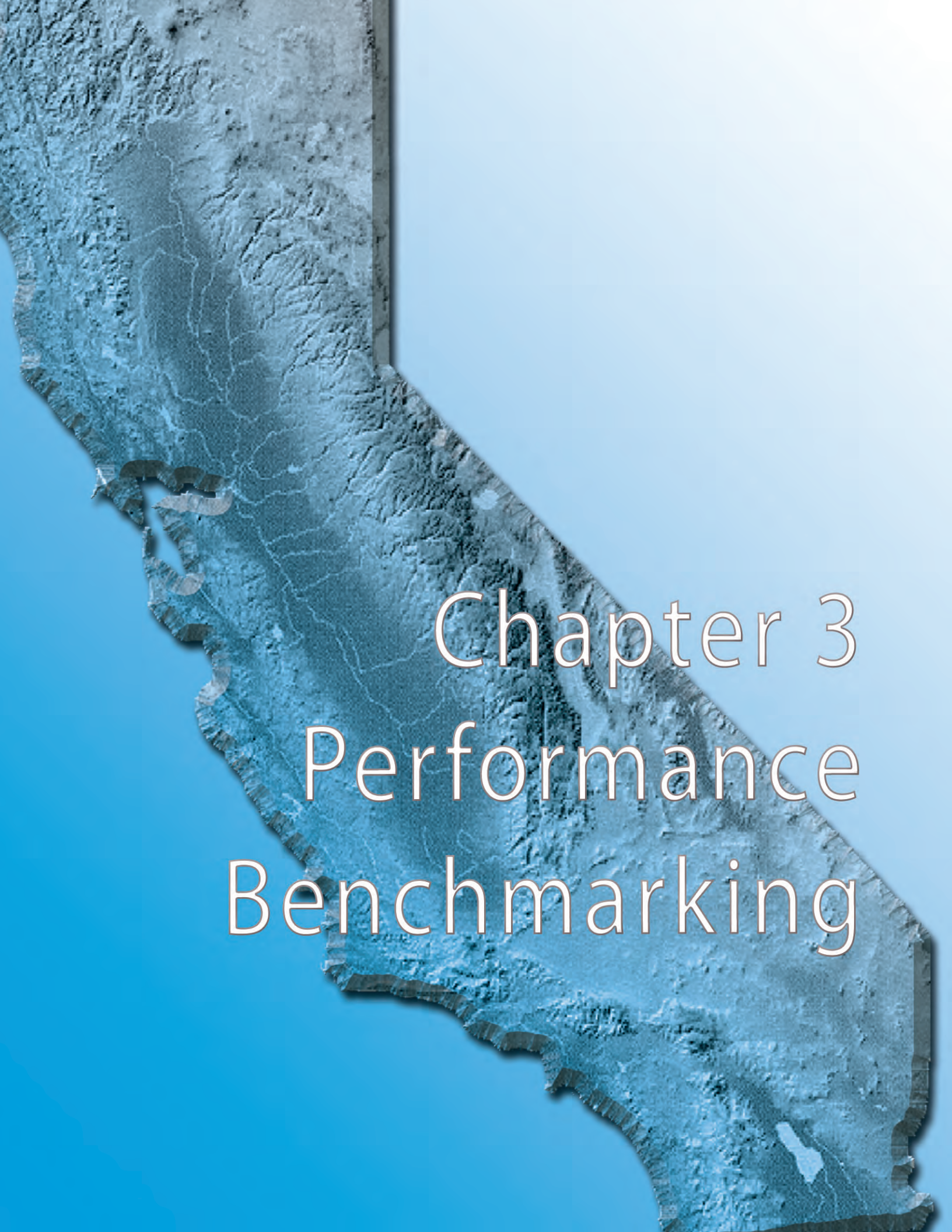
The *Study* method is described in detail in the first *Study* report (published in 2002) and modifications to it have been documented in subsequent *Study* reports. In Update 2017, the agencies made progress on several goals:

1. **Collect projects delivered by alternative delivery techniques in the performance database.**

   Over the years, the participating agencies have executed several projects using alternative delivery methods such as design-build and job-order-contracting yielding benefits in areas such as cost, schedule, and overall project delivery. In order to capture such projects as part of the *Study*, the agencies have decided to collect cost data for projects delivered via alternative methods. This practice was initiated in Update 2011 and continued in Update 2017. However, the agencies decided that these projects would not be analyzed until a sufficient number of projects are collected to facilitate meaningful analyses. In addition, criteria for analysis for projects delivered by alternative delivery techniques needs to be defined. The performance questionnaire was updated in Update 2017 to better categorize alternative delivery projects.

2. **Track the adoption of BMPs.** The Project Team continued to track the implementation of BMPs in order to link these practices to project delivery performance improvement over time in order to encourage their implementation. The Project Team continued to discuss common challenges and share ideas for addressing those challenges during the quarterly meetings. Although no new BMPs were adopted for Update 2017, agencies focused on specific challenges implementing BMPs already identified.

Page Intentionally Left Blank



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 (TCC). The objective of this exercise is to develop relationships between these variables by performing regression analyses. Since Update 2009, the results of the regression analyses have yielded significantly better correlation compared to prior years of the *Study*. This is primarily due to the adoption of statistical techniques for model selection and significant improvements in the modeling methodology.

The project costs data are collected from the agencies using a Performance Questionnaire created in Microsoft Excel®. Data are then compiled from the questionnaires in Excel® using a Visual Basic for Applications (VBA) code where the data is reviewed and vetted, and then transferred into the database. A copy of the current Performance Questionnaire can be found in **Appendix A**. The Performance Questionnaire was updated in Update 2017 to better differentiate between alternative delivery projects and to gather more information to determine construction duration.

Note that the values presented in tables for previous years in this Update 2017 Benchmarking Report may have changed from prior reports due to the addition or update of past projects in Update 2017.

A. STUDY CRITERIA

The following criteria applied to Update 2017 performance benchmarking analyses:

- **Total Construction Cost** – TCC is the sum of costs associated with the awarded construction contract, net change orders, utility relocation, and construction by agency forces. TCC does not include the cost of land acquisition, environmental monitoring and mitigation, design, or construction management. All projects included in the analyses have a TCC exceeding $100,000. The participating agencies use fully-loaded (direct and indirect) costs for project delivery tasks. (See **Appendix C**).

- **Completion Date –** Projects included in the *Study* analyses were completed on or after January 1, 2012 and before December 31, 2016. Projects with earlier or later completion dates were kept in the database, but excluded from the analyses.

- **Outlier Elimination –** Statistical elimination was used to identify outliers in the performance model. The total project delivery percentage of each project in the database was evaluated against all other projects in the same classification. An outlier was identified as a project whose total project delivery percentage was

outside the range expressed by the following inequality:

$$m - 3\sigma \leq x \leq m + 3\sigma$$

where m is the mean of the project delivery percentages, σ is the standard deviation of the project delivery percentages for all projects in the same classification, and x is the project delivery percentage of a particular project.

It should be noted that this approach, which was first adopted in Update 2008, allows for the inclusion of more data than in previous years. Previously, other methods including visual inspection were used for the elimination of outlier data points. This change was in part allowed by the improved modeling techniques that have been documented in prior *Study* reports.

Projects confirmed as outliers by this statistical technique were kept in the database, but excluded from the analyses.

- **Project Delivery Method –** All projects analyzed in this *Study* were delivered through the traditional design-bid-build method. In prior *Study* years, project costs data were only collected and analyzed for projects delivered using the traditional design-bid-build method. Over the years, the participating agencies have executed several projects using alternative delivery methods such as design-build, construction management at risk, on-call engineering services, and job-order-contracting yielding benefits in areas such as cost, schedule, and overall project delivery. In order to capture such projects as part of the *Study*, the agencies have decided to collect cost data for projects delivered via alternative methods. However, the agencies decided that these projects will not be analyzed until a sufficient number of projects are collected to facilitate meaningful analyses.

- **Change Order Classification –** To support meaningful change order analyses, the Project Team reported change orders in accordance with the following classifications:

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

- **Project Classifications –** Sixteen project classifications grouped into four project types are used in this *Study*. The project types and classifications are shown in **Table 3-1**.

Table 3-1
Project Types and Classifications

Project Types	Classifications
Municipal Facilities	• Libraries • Police and Fire Stations • Community Centers, Recreation Centers, Child Care Facilities, Gymnasiums • Other Municipal Facilities[1]
Streets	• Widening, New, and Grade Separation • Bridges • Reconstruction • Bike Ways, Pedestrian Ways, and Streetscapes • Signals
Pipe Systems	• Gravity Systems • Pressure Systems • Pump Stations • Other Pipes
Parks	• Playgrounds • Sport fields • Restrooms

Notes:
1. Projects include design and/or construction activities for parking structures, yards, soil anchors, docks, animal shelters, reservoirs, water treatment plants, piers, and animal services centers.

B. DATA COLLECTION AND CONFIRMATION

To obtain meaningful results from the performance model, it is essential that the data collected from the agencies are accurate and conform to the *Study* criteria. The agencies recognize the importance of quality input data and are committed to providing accurate, complete project delivery cost data to support the development of performance models. Project delivery costs are defined as the sum of all agency and consultant costs associated with project planning, design, bid, award, construction management, and closeout activities. Examples of specific activities included in each phase of project delivery are presented in **Table 3-2**.

For the Update 2017 *Study*, the agencies completed the questionnaires with comparable, complete, and accurate values. The agencies also review and compare their data collection and confirmation techniques on a regular basis. For example, in the second quarterly meeting during Update 2016, each agency completed questionnaires on three previously submitted projects to compare with original submittals. The values obtained were nearly identical, with differences resulting typically from close-out costs that happen years after the project is completed. In addition, discussion among the Project Team helps clarify and resolve inconsistencies in the data collection methodologies. It also ensures that input data is vetted before projects are submitted for analysis.

Table 3-2
Project Cost Categories

Category and Phase	Description
1) Design Costs:	The design phase (and associated costs) begins with the initial concept development, includes planning as well as design, and ends with the issuance of a construction Notice to Proceed. Design costs consist of direct labor costs, other direct agency costs such as art fees and permits, and consultant services cost associated with planning and design. Design may include the following:
Planning	• Complete schematic design documents • Review and develop scope • Evaluate schedule and budget • Review alternative approaches to design and construction • Obtain owner approval to proceed • Attend hearings and proceedings in connection with the project • Prepare feasibility studies • Prepare comparative studies of sites, buildings, or locations • Provide submissions for governmental approvals • Provide services related to future facilities, systems, or equipment • Provide services as related to the investigation of existing conditions of site or buildings or to prepare as-built drawings • Develop life cycle costs • Complete environmental documentation and clearances • Monitor and control project costs
Design	• Complete design development documents including outline specifications • Evaluate budget and schedule against updated construction cost estimate • Complete design and specifications • Develop bid documents and forms including contracts • Complete permit applications • Manage right-of-way procurement process • Coordinate agency reviews of documents • Review substitutions of materials and equipment • Prepare additive or deductive alternate documentation • Coordinate geotechnical, hazardous material, acoustic or other specialty design requirements • Provide interior design services • Monitor and control project costs
Bid and Award	• Prepare advertisement for bids • Qualify bidders • Manage the pre-bid conference • Evaluate bids • Prepare the recommendation for award • Obtain approval of contract award from Board/Council • Prepare the Notice to Proceed • Monitor and control project costs

Table 3-2
Project Cost Categories (cont'd)

Category and Phase	Description
2) Construction Management Costs:	All costs associated with construction management, including closeout costs, are included in this category. Construction management costs consist of direct labor, other agency costs, and consultant usage. Construction management may include the following:
Construction	• Hold pre-construction conference • Review and approve schedule and schedule updates • Perform on-site management • Review shop drawings, samples, and submittals • Perform lab work, testing, and inspection • Process payment requests • Review and negotiate Change Orders • Prepare monthly reports to owner and agencies • Respond to Requests for Information • Develop and implement a project communications plan • Perform document control • Manage claims • Perform final inspections and develop and track punch list
Closeout Phase	• Commission facilities and equipment • Train maintenance and operation personnel • Document and track warranty and guarantee information • Plan move-in • File notices (occupancy, completion, etc.) • Check and file as-built documents • Monitor and control project costs
3) Total Project Delivery Costs:	This is the total cost of delivering a capital improvement project, equal to the sum of the design cost and construction management costs indicated above.
4) Change Order Cost:	Please see the Update 2005 Report for descriptions of the following types of change orders: • Changed/unforeseen 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. • 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. • Client-Initiated Changes - This type of change results from additions, deletions or revisions to the physical work.

Table 3-2
Project Cost Categories (cont'd)

Category and Phase	Description
5)Total Construction Cost (TCC):	This is the direct construction cost, including all change orders during the construction phase (from the issuance of Notice to Proceed to Notice of Completion). The following costs are associated with construction and are included in the TCC: • Direct actual construction • Total amount of change orders throughout construction • Fixtures, furnishing, and equipment (FFE) • Utilities relocation • Construction work performed by the agency's staff and other agencies' staff

C. PERFORMANCE DATABASE

The projects data submitted by the agencies are compiled in a customized Microsoft Access® database. This database serves as a repository for the data collected since the inception of the *Study*. Each year, the projects database is updated with the inclusion of projects data submitted for that *Study* year.

Table 3-3 summarizes the number of projects included in the database and in the analyses. The 5-year database used for the current analysis contains 547 projects. This total excludes project data completed outside of January 1, 2012 to December 31, 2016, or projects identified as outliers. Projects identified as outliers are not included in the performance data analysis but are retained in the performance database. In addition, projects delivered by alternative delivery are excluded from the analysis but included in the database. The 547 projects selected for analysis do not include projects delivered by alternative delivery. As explained under subsection A *Study* Criteria of this chapter, outlier analysis was performed using statistical techniques to ensure consistency in the selection of outlier data points.

Table 3-3 shows that as the rules for project selection were refined, the number of non-representative and projects with TCC less than $100K have decreased. In addition, only 14 projects have been excluded as outliers in the Update 2017 *Study*.

In the *Study* 2002 report, it was recommended that at least 10 projects per classification and a minimum data set of 2,000 projects distributed evenly among classifications, ranges of TCC, and agencies are necessary to achieve statistically-significant results. While over 2,000 projects have been collected in the database, the number of projects analyzed in any *Study* phase is significantly lower due to the criteria selected for the inclusion of projects in the database. Although the requirement for the minimum number of projects per classification has been met for all project categories, more data needs to be collected to ensure an even distribution of projects amongst all classifications.

The agencies acknowledged that it is vital to the success of the *Study* to continue increasing the size of the data set, thereby increasing the confidence, consistency, and reliability of results. As previously indicated, there are 4 project types (Municipal Facilities, Streets, Pipe Systems, and Parks) and 16 project classifications included in this *Study*. **Table 3-4** summarizes the distribution of projects included in the analyses.

Table 3-3
Growth of Database

Study Phase[1]	Submitted			Deleted[2]		Count After Deletions[3]	Excluded		Net
	Traditional Projects Submitted	(a) Alternative Delivery Projects Submitted[4]	(b) Total	(c) TCC <$100K	(d) Non-Repre-sentative	(e)=(b)-(a)-(c)-(d)	(f) Project Completion Date before 2012 or in 2017	(g) Outliers[5]	Projects in Analyses (h)= (e)-(f)-(g)
I	239	0	239	27	44	168	168	0	0
II	285	0	285	0	35	250	250	0	0
III	262	0	262	0	29	233	233	0	0
IV	173	0	173	18	24	131	131	0	0
V	182	0	182	0	4	178	178	0	0
VI	191	0	191	0	4	187	187	0	0
VII	158	0	158	2	0	156	156	0	0
VIII	151	0	151	2	0	149	149	0	0
IX	173	10	183	2	0	171	171	0	0
X	121	15	136	1	0	120	120	0	0
XI	160	15	175	0	4	160	157	0	3
XII	142	8	150	2	0	141	72	1	68
XIII	145	27	172	0	0	145	22	3	120
XIV	162	19	181	4	0	158	5	4	149
XV	124	20	144	4	0	120	3	5	112
XVI	98	35	133	1	0	97	1	1	95
Total	**2,764**	**151**	**2,915**	**63**	**144**	**2,565**	**2,004**	**14**	**547**

Notes:

1. *Study* Phase indicates action taken on the count of projects corresponding to *Study* Years I = 2002, II = 2003, …, XV = 2016, and XVI = 2017.
2. Projects that do not fit *Study* criteria for project classifications and minimum TCC of $100K were omitted from the database.
3. Projects delivered by alternative techniques are retained in the database but not analyzed. These projects are not included in the projects selected for analysis in the *Study*.
4. These represent projects delivered by alternative project delivery techniques. These projects are kept in the database, but not analyzed. These projects will be analyzed when a sufficient number of such projects are available to facilitate meaningful analyses.
5. Outliers are identified based on statistical analysis.

Table 3-4
Projects Distribution Matrix (2012-2016)

Agency	Long Beach	Los Angeles	Oakland	Sacramento	San Diego	San Francisco	San José	Total[1]
Municipal Facilities	**3**	**19**	**7**	**5**	**10**	**10**	**2**	**56**
Comm./Rec. Center/ Child Care/Gyms	0	11	6	0	3	3	0	23
Libraries	0	0	0	0	0	0	1	1
Police/Fire Stations	1	3	0	0	2	2	0	8
Other Municipal Facilities [2]	2	5	1	5	5	5	1	24
Parks	**2**	**7**	**8**	**0**	**5**	**3**	**16**	**41**
Playgrounds	2	5	5	0	3	2	14	31
Restrooms	0	0	1	0	0	1	0	2
Sport Fields	0	2	2	0	2	0	2	8
Pipe Systems	**2**	**57**	**22**	**27**	**100**	**2**	**56**	**266**
Gravity Systems (Storm Drains/Sewers)	1	55	21	18	53	2	51	201
Pressure Systems	0	0	0	6	37	0	1	44
Pump Stations	0	0	1	2	2	0	3	8
Other Pipes	1	2	0	1	8	0	1	13
Streets	**25**	**19**	**21**	**45**	**30**	**31**	**13**	**184**
Bike/Pedestrian/ Streetscapes	0	0	12	21	13	2	6	54
Bridges (New/Retrofit)	3	8	5	3	1	0	0	20
Reconstructions	21	8	1	5	9	27	3	74
Signals	1	0	3	11	4	2	4	25
Widening/New/ Grade Separations	0	3	0	5	3	0	0	11
Total[1]	**32**	**102**	**58**	**77**	**145**	**46**	**87**	**547**

Notes:

1. Total refers to the projects included in the Update 2017 analyses only. Total excludes projects delivered by alternative delivery methods such a design-build, JOC, on-call engineering services, and CM@Risk. Projects delivered by alternative methods are retained in the database but not analyzed. These projects are not included in the projects selected for analysis in the *Study*.
2. Projects include design and/or construction activities for parking structures, yards, soil anchors, docks, animal shelters, reservoirs, water treatment plants, piers, and animal services centers.

D. REGRESSION ANALYSIS RESULTS

During Update 2008, several changes were made to improve the modeling methodology. These included developing a statistically-sound method for outlier analysis, using a linear trendline regression for modeling project costs relationships, and using the upper and lower bounds of a 95 percent confidence interval to estimate the range of the project delivery percentages. Results from the regression analysis methodology are discussed in **Appendix B**.

It is important to note that the project delivery percentages developed in **Appendix B** are calculated differently than the average project delivery percentages in **Section 3**, as described in more detail in **Appendix B**. **Section 3** evaluates the arithmetic average project delivery of all projects, while **Appendix B** calculates the average slope using the least squares fit method.

This is better explained by the following example. Consider 5 projects in the pipe category having the a1, a2, a3, a4, and a5 as their individual project delivery costs and b1, b2, b3, b4, and b5 as their individual TCC. The project delivery percentages in **Section 3** are the arithmetic average of the project delivery percentages represented as:

$$\textbf{Project Delivery Percentage} = \left(\frac{a1}{b1} + \frac{a2}{b2} + \frac{a3}{b3} + \frac{a4}{b4} + \frac{a5}{b5} \right) \Big/ 5$$

The project delivery percentage in **Appendix B** is calculated using the below formula which utilizes the least squares fit method:

$$\textbf{Project Delivery Percentage} = \left(\frac{a1 + a2 + a3 + a4 + a5}{b1 + b2 + b3 + b4 + b5} \right)$$

E. CHARACTERISTICS OF DATA ANALYZED

Project performance data were analyzed using the custom database application at both the Project Type level and the Project Classification level (see **Table 3-1**).

Project Count and Project Delivery by Completion Year

Table 3-5 summarizes characteristics of the projects included in the analyses 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 median value is the value at which 50 percent of the values are above and 50 percent of the values are below.

Table 3-5
Project Count and Project Delivery by Completion Year

Project Completion Year	Count by Project Type					Project Delivery Data [1,2]				
	Municipal Facilities	Streets	Pipes	Parks	Total[3]	Average TCC ($MM)	Median TCC ($MM)	Design Cost (% of TCC)	Construction Management Cost (% of TCC)	Project Delivery Cost (% of TCC)
2012	19	45	52	11	127	$2.48	$0.96	27%	24%	51%
2013	14	35	63	7	119	$2.69	$1.24	29%	20%	49%
2014	5	50	79	10	144	$2.02	$0.92	26%	20%	46%
2015	12	29	47	7	95	$2.32	$1.29	27%	20%	47%
2016	6	25	25	6	62	$3.31	$1.12	24%	20%	44%
Total	**56**	**184**	**266**	**41**	**547**	**$2.47**	**$1.04**	**27%**	**21%**	**48%**

Notes:
1. Project Delivery percentages represent arithmetic averages of the individual projects and do not represent the results from the regression analyses.
2. Project Delivery percentages vary from year to year based on the selection and the composition of the projects in the database.
3. Total excludes projects delivered by alternative delivery mechanisms such a design-build, on-call engineering support, JOC, and CM@Risk. Projects delivered by alternative techniques are retained in the database but not analyzed. These projects are not included in the projects selected for analysis in the *Study*.

The relatively higher project delivery percentages from projects completed in 2012 to 2013 can be attributed to the "below market rate" bids that were being widely observed in California's construction sector from 2007 to 2009 due to the recession. Projects that were started during the recession would have been completed in the 2009 to 2013 time period. In addition, factors such as personnel turnover in the agencies have also affected productivity, leading to inefficiencies due to the loss of project specific knowledge. For each project completion year since 2012, project delivery costs as a percentage of the TCC have steadily decreased by 1 to 3 percent annually (except from 2014 to 2015).

Project Delivery Costs by Project Type

Table 3-6 shows project delivery costs by each of the four project types in the *Study* for the full range of TCC. The project delivery percentage for a category is the arithmetic average of the project delivery percentages of the individual projects grouped under that category.

Table 3-6
Average Project Delivery Costs by Project Type (% of TCC)
(Full Range of TCC)

Type	Design[1,2]	Construction Management[1,2]	Total Project Delivery[1,2]	Median Total Construction Cost ($MM)	Number of Projects[3]
Municipal Facilities	26%	24%	50%	2.27	56
Parks	26%	20%	46%	1.00	41
Pipe Systems	25%	22%	46%	1.17	266
Streets	31%	19%	49%	0.80	184
All Types	**27%**	**21%**	**48%**	**1.04**	**547**

Notes:
1. Project Delivery percentages represent arithmetic averages of the individual projects and do not represent the results from the regression analyses.
2. Project Delivery percentages vary from year to year based on the selection and the composition of the projects in the database.
3. Total excludes projects delivered by alternative delivery mechanisms such a design-build, on-call engineering support, JOC, and CM@Risk. Projects delivered by alternative techniques are retained in the database but not analyzed. These projects are not included in the projects selected for analysis in the *Study*.

Projects belonging to the Parks and Pipes categories have the lowest average project delivery percentage, although all project categories have a similar project delivery percentage. The Pipes category has the highest number of projects (266) in the Update 2017 database. The Pipe and Streets category projects combined total 82 percent of the projects in the database. The Municipal Facilities category exhibits the highest average project delivery cost, and also has the highest median TCC whereas the Streets category also has a high average project delivery cost but the lowest median TCC. The average project delivery percentage for the overall dataset is 48 percent. These percentages have remained relatively stable for the four project types over previous years.

Over the course of the *Study*, the agencies have observed that the relatively high average project delivery cost of Streets projects is likely due to increasing cost influences of right-of-way acquisition, community outreach requirements, environmental mitigation requirements, and the smaller median total construction cost of these projects.

Table 3-7 shows project delivery costs by each of the four project types in the *Study* for the 80th percentile subset of TCC (Note: In Update 2009, the concept of looking at a subset of projects was introduced. This subset generally characterizes the projects in the type or classification being examined. This step was taken as it was generally believed that project delivery for the very large projects did not characterize the overall projects in the type of classification being examined.). The trends in the project delivery costs for the projects in the 80th percentile subset of TCC follow that of the projects in the full range of TCC. As expected based upon the agencies' practical experience, project delivery costs are higher for projects that fall in the 80th percentile subset of TCC.

Consultant Usage Analysis

Project delivery performance and consultant usage by agency are presented in **Table 3-8**. The table indicates that on average, 62 percent of the design work and 78 percent of the construction management efforts are completed in-house by the participating agencies. Consultants account for approximately 31 percent of the total project delivery costs while in-house efforts by the participating agencies accounts for the remaining 69 percent of the project delivery costs. From the available data, a clear relationship between the level of in-house effort and project delivery costs cannot be established.

Table 3-7
Average Project Delivery Costs by Project Type (% of TCC)
(80th Percentile Subset of TCC)

Type	Design[1,2]	Construction Management[1,2]	Total Project Delivery[1,2]	Median Total Construction Cost ($MM)	Number of Projects[3]
Municipal Facilities	29%	25%	54%	1.22	44
Parks	28%	23%	51%	0.66	32
Pipe Systems	26%	23%	49%	0.86	212
Streets	33%	19%	52%	0.55	147
All Types	**29%**	**22%**	**51%**	**0.80**	**437**

Notes:
1. Project Delivery percentages represent arithmetic averages of the individual projects and do not represent the results from the regression analyses.
2. Project Delivery percentages vary from year to year based on the selection and the composition of the projects in the database.
3. Total excludes projects delivered by alternative delivery mechanisms such a design-build, on-call engineering support, JOC, and CM@Risk. Projects delivered by alternative techniques are retained in the database but not analyzed. These projects are not included in the projects selected for analysis in the *Study*.

F. OTHER CONSIDERATIONS

Size of the Database

The size of the project database remains relatively the same for each *Study* update due to the 5-year rolling window criterion for project completion dates; as new projects are added, old projects are excluded from analyses based on age. The participating agencies are challenged to identify as many completed projects as possible that meet the *Study* criteria. The benefits of projects delivered via alternative delivery techniques can be quantified by including them for analysis in the project database. However, due to the significant difference in delivery mechanisms, those projects will have to be analyzed separately from the rest of the projects in the database.

BMP Implementation and Project Delivery Costs

Although it is desirable for project delivery costs to decrease as agency efficiencies increase and BMPs are implemented, this can be confounded by other factors that change annually such as project size and construction cost fluctuations.

Table 3-8
Project Delivery Performance and Consultant Usage by Agency (2012-2016)

AGENCY	DESIGN					CONSTRUCTION MANAGEMENT					PROJECT DELIVERY					TCC	
	In-House		Consultants			In-House		Consultants			In-House		Consultants				
	($M)	% of Design [1]	($M)	% of Design	Total % of TCC [2,3]	($M)	% of CM	($M)	% of CM	Total % of TCC	($M)	% of PD	($M)	% of PD	Total % of TCC	Average ($MM)	Median ($MM)
Agency A	42.3	78%	11.9	22%	31%	39.2	96%	1.5	4%	20%	81.5	86%	13.5	14%	51%	1.7	1.1
Agency B	15.2	39%	23.3	61%	25%	15.9	50%	15.9	50%	17%	31.1	44%	39.2	56%	42%	2.8	0.5
Agency C	18.0	91%	1.7	9%	18%	16.5	93%	1.3	7%	16%	34.5	92%	3.0	8%	34%	2.6	1.3
Agency D	56.5	57%	42.0	43%	27%	84.9	84%	16.5	16%	31%	141.4	71%	58.5	29%	58%	4.5	2.1
Agency E	4.7	36%	8.4	64%	28%	5.3	23%	18.2	77%	22%	10.0	27%	26.5	73%	50%	2.7	0.8
Agency F	18.1	86%	3.0	14%	25%	19.1	97%	0.6	3%	23%	37.2	91%	3.5	9%	49%	1.1	0.8
Agency G	20.2	55%	16.2	45%	27%	9.2	99%	0.1	1%	12%	29.4	64%	16.3	36%	39%	2.3	0.8
OVERALL	**175.0**	**62%**	**106.6**	**38%**	**27%**	**190.1**	**78%**	**54.0**	**22%**	**21%**	**365.1**	**69%**	**160.5**	**31%**	**48%**	**2.5**	**1.0**

Notes:
1. In-House and Consultant costs are expressed as percentages of total agency Design, CM (Construction Management), and PD (Project Delivery) costs.
2. TCC = Total Construction Cost
3. Design, CM, and PD costs are expressed as percentages of TCC and are unweighted, arithmetic averages of projects by agency.

G. SMALLER PROJECT ANALYSIS

In 2009, the project team decided to differentiate the projects based on the full set of projects and a subset of "smaller cost projects". It was hypothesized that projects with smaller total construction cost (TCC) will have a higher project delivery percentage due to costs associated with project delivery which are independent of the size of project. These project delivery costs include:

- regulatory requirements (such as CEQA)
- public involvement and outreach
- right of way acquisition
- project alternatives and scope development
- utility agreements and relocations
- bidding costs and procurement of public contracts

In Update 2009, it was decided that the "smaller projects" cutoff limit would be the smallest 80 percent of projects ranked by the TCC for each category of projects. For example, if there were 100 street projects, the 80 least expensive TCC street projects would be included in the smaller projects cutoff. The hypothesis was confirmed, and it was found that the smaller projects typically have about a 3 to 5 percent higher project delivery percentage of TCC than the full set of projects.

In Update 2014, the project team reconsidered the smaller project cutoff limit, especially since the actual project delivery cost for "small projects" was felt to be much greater than that of the 80th percentile subset of projects. Therefore, an analysis was performed to evaluate the project delivery percentage for the projects in the database based on various TCC cost ranges.

Table 3-9 through **Table 3-12** show the project delivery percentages for a range of construction costs by project type. In each project type category, the projects were arranged within four to five cost ranges. More than five cost ranges were not developed because more cost ranges lead to a fewer number of projects in each category, allowing the project delivery percentage to be more easily influenced by projects with extreme (either high or low) project delivery percentages. The cost ranges for each project type were developed in Update 2014 to distribute the projects evenly amongst the cost ranges. The cost ranges in subsequent updates have been the same as the cost ranges in Update 2014 to allow for comparison between *Study* update years.

In discussing the results presented in the tables below, the project team felt that the project delivery percentages shown are more reflective of the actual project delivery costs for small projects and are a useful tool for determining the expected project delivery costs of smaller projects.

Table 3-9
Municipal Facilities (2011-2016) Project Delivery Percentage based on Cost Ranges of TCC

Dollar Ranges of Projects based on TCC		Number of Projects	AVERAGE of projects between Cost X and Cost Y, % TCC		
$X	$Y		Design %	Const Mang %	Project Delivery %
100,000	800,000	13	28%	28%	55%
800,000	3,000,000	21	30%	26%	57%
3,000,000	10,000,000	13	26%	19%	46%
10,000,000	70,000,000	9	15%	18%	33%

Table 3-10
Streets (2011-2016) Project Delivery Percentage based on Cost Ranges of TCC

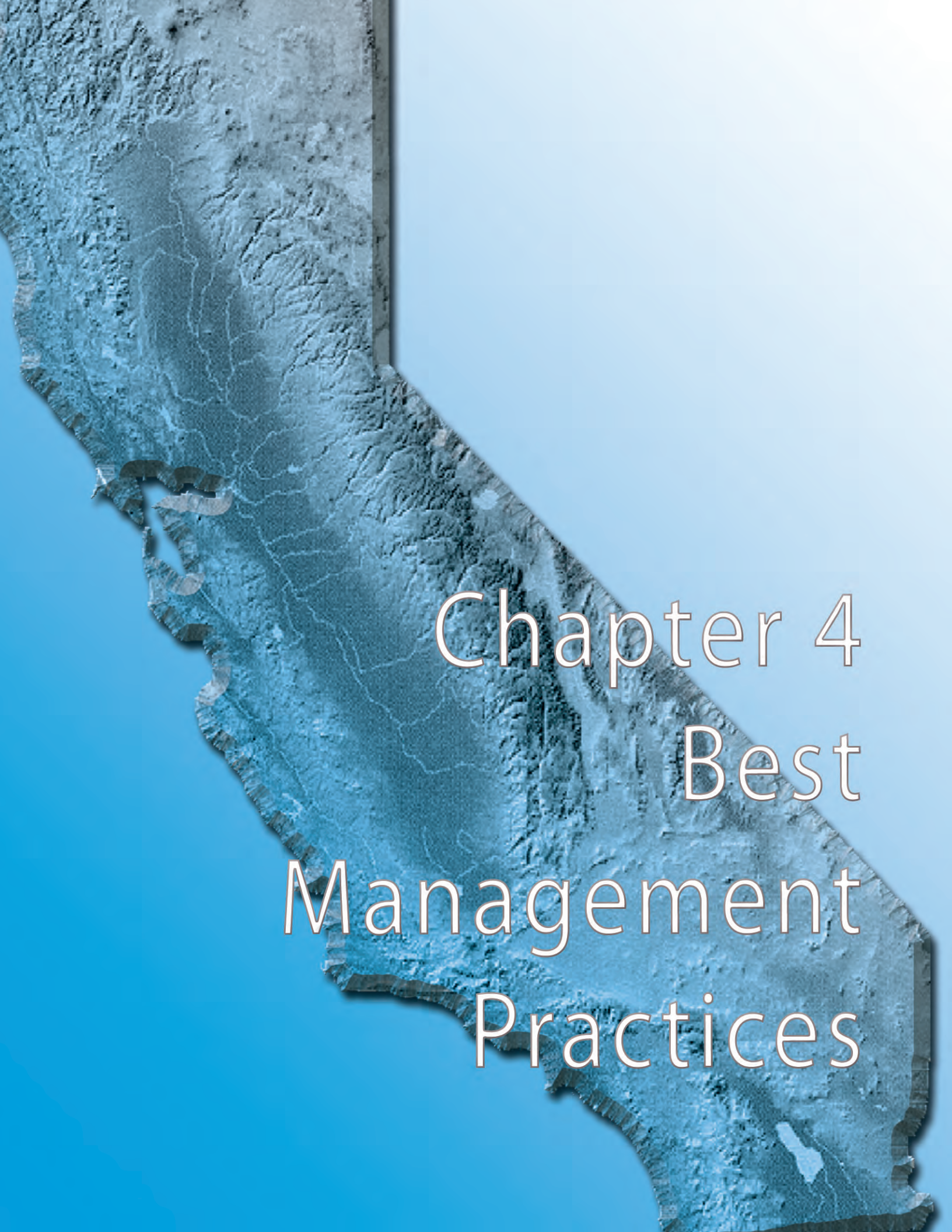
Dollar Ranges of Projects based on TCC		Number of Projects	AVERAGE of projects between Cost X and Cost Y, % TCC		
$X	$Y		Design %	Const Mang %	Project Delivery %
100,000	300,000	41	43%	22%	65%
300,000	600,000	38	33%	19%	53%
600,000	1,300,000	42	26%	17%	44%
1,300,000	2,400,000	26	27%	18%	45%
2,400,000	70,000,000	37	22%	17%	39%

Table 3-11
Pipes (2011-2016) Project Delivery Percentage based on Cost Ranges of TCC

Dollar Ranges of Projects based on TCC		Number of Projects	AVERAGE of projects between Cost X and Cost Y, % TCC		
$X	$Y		Design %	Const Mang %	Project Delivery %
100,000	300,000	29	33%	26%	59%
300,000	600,000	40	25%	22%	47%
600,000	1,300,000	73	26%	22%	48%
1,300,000	2,400,000	69	24%	24%	48%
2,400,000	17,000,000	55	18%	17%	35%

Table 3-12
Parks (2011-2016) Project Delivery Percentage based on Cost Ranges of TCC

Dollar Ranges of Projects based on TCC		Number of Projects	AVERAGE of projects between Cost X and Cost Y, % TCC		
$X	$Y		Design %	Const Mang %	Project Delivery %
100,000	350,000	6	38%	29%	67%
350,000	500,000	5	40%	36%	76%
500,000	1,000,000	9	27%	18%	45%
1,000,000	27,000,000	21	19%	15%	34%



Chapter 4
Best Management Practices

CHAPTER 4 Best Management Practices

At the onset of this *Study* in 2002, the agencies examined over 100 practices used in project delivery. Included in this *Study* were a number of practices that the participants did not commonly use at the time, but believed could add value if ultimately implemented as Best Management Practices (BMPs). Each year the agencies look at changes in the industry and reflect on relevant experiences in order to identify new BMPs. Existing BMPs, in some cases, are reworked by the agencies to address specific challenges encountered during implementation. As in the past, agency implementation of these selected practices continues to be tracked during the *Study*.

A BMP is usually developed to address a specific issue, however, its implementation may affect other elements of project delivery. A BMP that reduces project schedule, for example, may also favorably impact both communication and project costs. While it is not possible to discreetly quantify all the benefits of a given BMP, the participating agencies developed an approach to identify the major benefits associated with each BMP. This was accomplished in Update 2010 *Study* by assigning a Perceived Value to each BMP. The Agencies continue to identify the perceived value on all new BMPs.

The participating agencies judge that each of the BMPs favorably impact one of the following categories:

- Cost

- Schedule

- Quality

- Communication

- Environment

- Customer Service

To identify the predominant Perceived Values associated with each new BMP, the participating agencies vote on which Perceived Values are most applicable for their Agency. The responses are then tabulated. A Perceived Value receiving three or more votes relative to a BMP is considered to be of significance. If a BMP is not shown to have Perceived Value in a certain category, it indicates that the Perceived Value received two or less votes relative to a BMP; it does not mean that a BMP has no benefit to that Perceived Value category. The majority of the BMPs are assigned a Perceived Value of either "cost" or "schedule", followed by "quality". This indicates that majority of the agencies found these "Perceived Values" as most applicable to the adopted BMPs.

A. PROGRESS ON BEST MANAGEMENT PRACTICE IMPLEMENTATION

BMPs have been included since the *Study* 2002 report. For Update 2017, the agencies continued to exchange ideas regarding strategies for implementing various BMPs by using networking opportunities during the face-to-face meetings. Many Agencies are pursuing the full implementation of the BMPs but have competing priorities such as hiring challenges as a result of prior years' staffing reductions, furloughs, and the management's increased involvement in resolving budgetary issues. Constraints continue to limit the full implementation of BMPs for some agencies. In those instances, a partially implemented BMP is considered complete by that agency and is noted in **Table 4-1**. Agencies continue to focus their efforts on adherence to BMPs that have been implemented and judged to provide efficiencies in project delivery processes for participating departments. The key for the following **Table 4-1** is as follows:

Cities:

- LA: Los Angeles;
- LB: Long Beach (Port: Port of Long Beach);
- OK: Oakland;
- SC: Sacramento (DT: Dept. of Transportation, DU: Dept. of Utilities),
- SD: San Diego,
- SF: San Francisco,
- SJ: San José

Level of Implementation:

- ✓ :Implemented,
- PI: Partially implemented,
- NI: No plans to implement at this time,
- TBD: To be determined

The "Ref" column includes a reference number for the item and also includes the year the BMP was added to the *Study*. If no year is referenced, the item was included in the original 2002 Report.

Table 4-1
Implementation of BMPs

Cat.	Ref.*	BMP, Description, and Perceived Value	Implementation and Notes	
Planning	1.a.	**BMP:** Define capital projects well with respect to scope and budget including community and client approval at the end of the planning phase. **Description:** Changes in project scope or budget increase both total construction cost and the cost of project delivery. The later these changes occur in the life of the project, the greater the increase. Reaching and documenting consensus with the community and the client will reduce changes after the project delivery process begins. **Perceived Value:** 	✓	LA, LB, OK, SC DT, SD, SJ SC DU: Community involved after project is better-defined, typically at 30% design. SF: Define the scope and budget at the end of planning phase per the BMP, but often engage the community early in the project, i.e. in the planning phase.
	1.b.	**BMP:** Complete Feasibility Studies on projects prior to defining budget and scope. **Description:** Feasibility studies should be completed early in the process so that issues are identified and either resolved or accommodated within the final definition of scope, budget, and project delivery schedule. This will also reduce overall project delivery costs. Early feasibility studies are particularly important on complex projects and projects with a construction budget greater than $5 million. **Perceived Value:** 	✓	LA, OK, SC DT LB, SD, SJ: When applicable. SC DU: Only on complex projects that require a Feasibility *Study*. SF: Provide pre-planning feasibility studies on larger, more complex or politically sensitive projects. Developed a 1-Page "Project Development MOU" that allows the Client to fund "seed money" while the project is being scoped.

Cat.	Ref.*	BMP, Description, and Perceived Value	Implementation and Notes	
Planning	1.d.	**BMP:** Utilize a Board/Council project prioritization system. **Description:** Departments responsible for project delivery have limited resources. A system will ensure that resources are directed to meet the community's most critical needs. **Perceived Value:** 	✓	OK, SC DT, SD SF: 10-Year Capital plan developed City-wide and priorities set by City-wide committee of major department heads. Individual departments also prioritize projects per their department when they are Bond funded projects.
			PI	LA: Council establishes oversight committees which develop and manage a priority system and/or process. LB: Only on our Major and Secondary Street Program, Utility Undergrounding Program, and projects funded by Tidelands Funding. New project controls system makes provisions for project prioritization.
			NI	SJ
			TBD	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.	**BMP:** Resource load all CIP projects for design and construction. **Description:** The resources required to deliver projects according to the master CIP schedule mandated by the Board/Council should become part of the CIP. This will facilitate defining performance measures and ensure that there is a common understanding of the resources required to deliver the CIP. **Perceived Value:** 	✓	LA, OK, SC DT, SJ SC DU: Estimate drafting only. SD: Doesn't include human resource loading.
			NI	LB
			TBD	SF: BDC in the process of resource loading projects for long term projections, i.e. 1-3 years; already have short term forecasting in place.
	1.f.	**BMP:** Include a Master Schedule in the CIP that identifies start and finish dates for projects. **Description:** A master schedule can be used to define resource needs and performance measures. **Perceived Value:** 	✓	LA, OK, SC DT, SD, SF, SJ LB: City uses project tracking software. Master Schedule published monthly. SC DU: Completion date only estimated, not determined by scheduling analysis.

Cat.	Ref.*	BMP, Description, and Perceived Value	Implementation and Notes	
Planning	1.g 2007	**BMP:** Make an early determination on which environmental document is required and incorporate into the schedule. **Description:** Completing the environmental assessment and permitting process influences project schedules and costs. Establish a checklist of potential environmental and permit requirements and examine each project scope against the list early in the planning process. **Perceived Value:** 	✓	LA, LB, OK, SC DU, SC DT, SD, SJ SF: House regulatory affairs staff of 2-3 work full time and interface with the planning department on projects and whether or not CEQA approvals are required. Document to be submitted to Planning is EEA (Early Evaluation Application) if necessary. Standard for "When a project is not a CEQA project" in place.
Design	1.i.	**BMP:** Show projects on a Geographical Information System. **Description:** Entering and tracking planned projects into a GIS which is available to all private and public sector project planners will reduce the potential for conflicts and re-work. **Perceived Value:** 	✓	LA, OK, SC DU, SC DT, SD, SF, SJ LB: Infrastructure only.
	2.b.	**BMP:** Provide a detailed clear, precise scope, schedule, and budget to designers prior to design start. **Description:** Design professionals will work more efficiently if given a clear scope when contracted to provide the design services. Clear scope and budget should be defined in advance and made a part of the design professional's contract if/when a consultant is used. **Perceived Value:** 	✓	LA, LB, OK, SC DT, SD, SJ SC DU: General scope only for simple projects. SF: Scope provided for simpler straightforward projects, and in some cases the pre-planning phase used to develop the scope more accurately for the client. Some clients provide a PMP (Project Management Plan) before the start of the project.
	2.f.	**BMP:** Define requirements for reliability, maintenance, and operation prior to design initiation. **Description:** Reliability, maintenance, operational requirements, and standard materials and equipment should be clearly defined in advance, approved by the user/client, and included in the design professional's contract when a consultant is used. **Perceived Value:** 	✓	LA, LB, OK, SC DT, SD, SF, SJ SD: Some Asset types only.
			NI	SC DU

Cat.	Ref.*	BMP, Description, and Perceived Value	Implementation and Notes	
Design	2.i.	**BMP:** Adapt successful designs to project sites, whenever possible (e.g. fire stations, gymnasiums, etc). **Description:** Successful designs of fire stations, police facilities, maintenance facilities, pump stations, and many other projects should be re-used when possible. Site adaptations of successful designs may reduce design costs by half. **Perceived Value:** 	✓	LA, LB, OK, SC DU, SC DT, SD, SJ SF: Accomplished through our detail library, specifications, etc. Provide Lessons Learned sessions on projects with the goal of learning from the project and refining the project delivery approach.
			NI	SD: Due to public input.
	2.k. 2003	**BMP:** Train in-house staff to use Green Building Standards. **Descriptions:** Communities have a stake in the environment as well as in the cost of operating and maintaining public facilities. Utilizing "Green Building Standards" allows facilities to be built and operated with renewable resources and other environmentally sound practices. **Perceived Value:** 	✓	LA, LB, OK, SD, SJ, SF
			NI	SC DT, SC DU SF: All projects are required to be LEED Gold. Have an internal "Green Building Committee" and also work very closely with the Department of the Environment.
	2.l. 2004	**BMP:** Limit Scope Changes to early stages of design. **Description:** It is well known within the industry that the later a change occurs in the construction process, the more costly the change is. **Perceived Value:** 	✓	LA, LB, OK, SC DT, SF, SJ SD, SC DU: Control and minimize, but difficult to eliminate, since clients and engineers come up with new/better solutions in addition to the community and politicians influence.
	2.m. 2004	**BMP:** Require scope changes during design to be accompanied by budget and schedule approvals. **Description:** All scope changes after the initial definition within the design agreement will affect project delivery cost and therefore should be documented. Documentation should include an understanding and acceptance/approval by all stakeholders of the cost and time implications of any changes. **Perceived Value:** 	✓	LA, LB, OK, SC DT, SD, SJ SF: Always the goal, however, not always manageable with some clients. In depth due diligence and good project planning helps this to be more successful.
			NI	SC DU

Cat.	Ref.*	BMP, Description, and Perceived Value	Implementation and Notes	
Design	2.n. 2006	**BMP:** Implement a rotating Request for Quote process for contracting small projects to streamline the bidding and award process during construction. (Include criteria for exemptions from formal Council approval). **Description:** Smaller projects cost more (as a percentage of construction cost) to deliver. One way of reducing the cost of project delivery on small projects is to shorten the bid and award process by setting a threshold amount under which the delivery team may solicit and receive quotes from qualified contractors and award contracts without getting Board/Council prior approval. **Perceived Value:** 	✓	LB, OK, SD SF: As-needed job order contracting (JOC) for projects under $600K; Utilization of Bureau of Building & Repair (BBR) for projects under $600K and are developing an in-house Design-Build process between A/E team and BBR.
			PI	SJ: Regularly procures a number of on-call contractors for various small projects. Minor contracts (under $100,000), may be awarded without Council approval. LA: In progress for Sidewalk Repair Program
			NI	SC DT, SC DU: Maintains on-call consultant list for various engineering, traffic, landscape, architecture, and geotechnical services.
	2.o 2007	**BMP:** Establish criteria for obtaining independent cost estimates which take in consideration both project characteristics and volatility of the market. **Description:** Having to re-design and re-bid a project on which bids come in over budget can significantly impact project delivery cost. Accurate estimates at the end of each design phase, performed by unbiased, independent, qualified professionals with an understanding of local market conditions will reduce the potential for receiving unexpected bids. **Perceived Value:** 	✓	SF: Establishing estimating database
			PI	LA, SD LB: On-call contracts established for check estimating services as needed. SJ: No criteria established – done on a case-by-case basis.
			NI	SC DU
			TBD	OK, SC DT
	2.p 2008	**BMP:** Establish criteria for responsible charge design approval such that it occurs at the lowest appropriate organizational level in order to expedite design completion. **Description:** Many times responsible charge design approval is set at a very high level. This can sometimes result in only one person with limited time who can approve all sheets in a design package. This leads to a bottleneck situation. **Perceived Value:** 	✓	LA, SC DT, SC DU, SD, SJ SF: Project cost estimate at every phase. Goal is also to conduct all Value Engineering no later than the Design Development Phase.
			TBD	LB, OK

Cat.	Ref.*	BMP, Description, and Perceived Value	Implementation and Notes	
Design	2.q 2010	**BMP:** Receive bids electronically. **Description:** Electronic bidding programs have increased over the last several years. Receiving bids electronically provides a centralized location to store all bid related documents for public access along with ability to increase bidder participation. **Perceived Value:** 	✓	SD
			PI	OK LB: Currently receive bids for projects less than $100,000; Port: All bids being received electronically.
			NI	SC DT, SF: In process and soon to be launched with new F$P financial system.
			TBD	SC DU, LA, SJ
	2.r. 2011	**BMP:** Use of electronic signatures to do direct conversion from CAD to PDF. **Description:** Currently wet signatures on all pages is standard practice. This causes scanned files to be very large electronic files. Use of electronic signatures in all but the cover page will reduce file size and allow for easier distribution. **Perceived Value:** 	✓	SC DT, SC DU, SD
			PI	LA
			NI	OK SF: In process and already being used by some divisions.
			TBD	LB, SJ
	2.s. 2011	**BMP:** Have awarding authority to approve plans, advertisement and award of contract in one board/ council action. **Description:** Combine approval of plans, advertisement and award of contract by the awarding authority into a single action. **Perceived Value:** 	✓	LB, OK, SC DU SC DT: City Council approval is not required to advertise. SD: Part of the CIP streamlining, city council approval is obtained once a year on a list of projects to be awarded as a part of the annual budget hearing. SF: Depends on the city agency. Most agencies have commissions, SF Public Works has sole award authority without a council or board. SJ: The Director of Public Works approves all plans and advertisements; also generally awards contracts $1M or less.
			NI	LA

Cat.	Ref.*	BMP, Description, and Perceived Value	Implementation and Notes	
Design	2.t. 2011	**BMP:** Lessen time period between design completion and issuance of notice to proceed. Examples include items such as: - Pre-qualification of contractors - Good Faith Effort submitted on-line - Submittal incentives (i.e., award and material submittals allowed 30 day period; every day early is added to construction contract duration) - Have ability to issue contracts within your department - Electronic proposal documents provided 48 hours after bid opening; hard copy provided at bid time - Contractor's self-certification **Description:** Implementation of new practices such as using an electronic process or pre-qualification in an effort to reduce the overall timeframe from design completion to notice to proceed. **Perceived Value:** 	✓	LA, SJ SD: Has an established contractor pre-qualification program
			PI	OK, SC DT
			TBD	SC DU LB: Contractor pre-qualification program SF: For some CMGC contracts, contractors prequalified and given incentives for early construction. Also adopted some "best value" language in Chapter 6 so it's not all based on lowest bid.
Quality Assurance / Quality Control	3.I.a.	**BMP:** Develop and use a standardized Project Delivery Manual. **Description:** Standardized procedures streamline project design, bidding, and construction processes. Standardized design management procedures will reduce scope creep and delays in construction document preparation. During construction, standard procedures will reduce response times on RFIs, and add overall clarity and efficiency to the construction management process. Having a standard manual will also reduce the time necessary for project documentation training. **Perceived Value:** 	✓	LA, SC DT, SD SC DU, OK: Needs updating. SF: Yes, and continually reviewing and updated. Hired a "Technical Manager" who oversees QC/QA processes along with the "Technical Committee"
			PI	SJ LB: Staffing cuts have delayed completion. PM manual is 4 years old; will be updated to include CM & Design standards.
	3.II.b.	**BMP:** Perform a formal Value Engineering *Study* for projects larger than $1 million. **Description:** Value Engineering identifies life cycle costs of design elements included in a project and certain alternatives. While the cost of the value engineering process may initially add costs to project delivery, overall project costs will be reduced. **Perceived Value:** 	✓	LA, LB, SC DT, SC DU, SD SF: As needed.
			NI	OK, SJ

Cat.	Ref.*	BMP, Description, and Perceived Value	Implementation and Notes	
Quality Assurance / Quality Control	3.III.a.	**BMP:** Use a formal Quality Management System. **Description:** Quality management should include all activities from the preparation of design documents through the closeout of construction. (Constructability reviews, independent cost estimates, classification and auditing of change orders, etc.) The implementation and tracking of quality control should be formalized on a checklist to ensure application. **Perceived Value:** 	✓	OK, SC DT, SF LB: Staffing cuts have delayed completion. SD: Some asset types only.
			PI	LA, SJ: When applicable
			NI	SC DU
	3.III.b	**BMP:** Perform and use post-project reviews to identify lessons learned. **Description:** Project Managers should develop formal post project reviews and identify lessons learned. These documents should be made available to PM's on projects of a similar scope and nature. This BMP will make future project management and delivery more efficient and cost effective. **Perceived Value:** 	✓	LA, OK, SC DT, SD, SJ 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. SF: Have a robust Lessons Learned process and are tracking all projects that have Lessons Learned.
			PI	LB: Is being done only on projects that exceed 10% contingency or go into liquidated damages; Port: Instituting as part of QA/QC process.
	3.III.k 2007	**BMP:** Establish a Utility Coordinating Committee with members from public and private entities. **Description:** Regular meetings of a committee will establish a forum for ideas to improve the utility relocation process and thus improve project progress. Meetings will also be an opportunity for problem projects (relocations) to be discussed. **Perceived Value:** 	✓	LA, LB, OK, SC DT, SC DU, SD, SF, SJ
	3.III.l 2007	**BMP:** Designate a responsible person for and establish a process of notifications and milestones for utility relocations. **Description:** Identifying a utility relocation specialist within the project delivery team who is familiar with the procedures and contacts within the public and private utility entities will improve communication and problem solving during design and construction. **Perceived Value:** 	✓	LA, SC DT, SC DU, SD, SF SJ: Various Divisions/Sections have a utility coordinator and processes as needed.
			PI	OK
			NI	LB: PM remains responsible for all utility work on their projects.

Cat.	Ref.*	BMP, Description, and Perceived Value	Implementation and Notes	
Construction Management	3.III.m 2008	**BMP:** Maintain and regularly update electronic standard contract specifications and related documents as well as technical/special provision. **Description:** Standard contract specifications and technical special provisions need to be regularly maintained and updated in order to reduce the amount of time required to create contract bid documents. If a City implements new requirements, the standards should be modified for every project one time instead of each manager having to modify these documents of every project. **Perceived Value:** 	✓	LA, LB, OK, SC DT, SC DU, SF, SD
			PI	SJ
	4.I.a.	**BMP:** Delegate authority to the City Engineer/Public Works Director or other departments to approve change orders to the contingency amount. **Description:** Change order work should be authorized as soon as is practically possible in order to avoid potential delays to critical work. Scheduling a significant change order for review and authorization by the Board may delay project progress, even though it may be within the contingency amount allowed in the project budget. Authorization of the City Engineer/ Public Works Director to approve changes within the contingency budgeted for changes will ensure that critical changes are acted on promptly and that delays are minimized. **Perceived Value:** 	✓	LB, OK, SC DU LA, SJ: Individual CO < $100,000. SD: Individual CO < $500,000. SF: Reviews start at Bureau level but also need to be approved by Deputy Director & Director of Public Works.
			NI	SC DT
	4.I.m.	**BMP:** Classify types of change orders. **Description:** Classification of change orders into categories such as changed conditions, unforeseen conditions, owner requests, or design changes for owner use improves understanding of the project and lessons learned from the data may improve project delivery on similar projects. **Perceived Value:** 	✓	LB, OK, SC DT, SC DU, SD, SF, SJ, LA

Cat.	Ref.*	BMP, Description, and Perceived Value	Implementation and Notes	
Construction Management	4.II.a.	**BMP:** Include a formal Dispute Resolution Procedure in all contract agreements. **Description:** Construction is acknowledged as a dispute prone industry. As such, it makes sense to provide options in the contract documents to avoid litigation and to expedite disputes resolution using alternatives to litigation. **Perceived Value:** 	✓	LA, OK, SC DT, SC DU, SD, SF SJ: For projects > $10 M
			NI	LB: City Attorney will not allow this language in project specifications.
	4.III.a.	**BMP:** Use a team building process for projects greater than $5 million. **Description:** Partnering is a team-building process that has a proven record of improving working relationships and production, and reducing claims and disputes on construction projects. It is one of several team-building processes that should be used in the interest of reducing conflict and facilitating project delivery. **Perceived Value:** 	✓	OK, SC DT SF: The Mayor requires all city projects over $100K to undergo partnering, although threshold being reviewed. Also tracking partnering through EPM. LA, LB, SC DU, SD: As-needed. SJ: For projects > $10M.
	4.IV.a.	**BMP:** Involve the Construction Management Team prior to completion of design. **Description:** Experienced contractors and construction managers should be included in the design process to make designs more constructible and lower cost. Construction managers and contractors are frequently more experienced about the products and/or equipment as well as construction methods that are readily available. Their contributions to selections and decisions during the design process will facilitate construction procurement, means and methods. **Perceived Value:** 	✓	LA, LB, OK, SC DT, SC DU, SJ SD: Always request a constructability review service from the CM team on all projects. SF: Request the internal CM team review all projects for constructability no later than 50% CD. All projects over $5M required to have outside constructability reviews in addition.

Cat.	Ref.*	BMP, Description, and Perceived Value	Implementation and Notes	
Construction Management	4.IV.b 2010	**BMP:** Implement Electronic Contract Payment Process. **Description:** Many approvals are required to process contract payments. Using electronic procedures provides an avenue to expedite the necessary approvals. **Perceived Value:** 	✓	SF: We are doing payments electronically via our first generation system which was demonstrated back in San Diego around 2008. We pay within the Mayor's directive of 10 to 15 days. And direct deposit is already available to the contractors through BofA. SJ: Upon request, City will pay by wire transfer. SD: City will pay by wire transfer.
			PI	LA LB: Currently done for some street related projects.
			NI	SC DT
			TBD	OK, SC DU
	4.IV.c 2010	**BMP:** Agency should file As-built drawings within 6 months of project completion. **Description:** One of the last tasks for a project is the updating and filing of As-built drawings. Many times, this task is put off for other pressing matters. This BMP establishes a 6 month deadline. **Perceived Value:** 	✓	OK, SC DT, SC DU, SF: Process currently under review LA: Procedures are established in the Bureau of Engineering Project Delivery Manual.
			PI	LB: Being done on a go forward basis. Past projects still backlogged. SD: Has been implemented on sewer and water pipeline projects. SJ: Generally yes, however, it depends on post-construction circumstances.
	4.V.a. 2003	**BMP:** Delegate authority below Council to make contract awards under $1 million. **Description:** The time and costs of scheduling and presenting a Council or Board item can be saved and project starts can be expedited if awards on projects with budgets under $1 million can be awarded administratively. **Perceived Value:** 	✓	LA, SF, SJ LB: Board must approve all contracts over $200,000. SD: Up to $30M.
			NI	OK, SC DT, SC DU

Cat.	Ref.*	BMP, Description, and Perceived Value	Implementation and Notes	
Construction Management	4.V.b 2003	**BMP:** Establish a pre-qualification process for contractors on large, complex projects. **Description:** Prequalification helps screen contractors for prior performance on similar projects, safety and financial capability thus reducing risk and, ultimately, project delivery cost. **Perceived Value:** 	✓	LA, LB, OK, SC DU, SD, SF, SJ
			NI	SC DT
	4.V.c 2003	**BMP:** Make bid documents available online. **Description:** Making bid documents available on line will reduce Agency printing costs. It may also increase bidder participation by making documents easily available to a larger pool of potential bidders and subcontractors. **Perceived Value:** 	✓	LA, LB, OK, SC DT, SJ, SD SF: Documents available on line and on CD.
			PI	SC DU
Project Management	5.I.f.	**BMP:** Assign a client representative to every project. **Description:** Client (end user) representation during the life of the project will expedite decisions on submittals, substitutions, and changes. Their involvement will also help determine intent and streamline the commissioning and occupancy process. **Perceived Value:** 	✓	LA, LB, OK, SC DT, SC DU, SD, SF, SJ
	5.I.j 2003	**BMP:** Create in-house project management team for small projects. **Description:** It has been documented that the cost of project delivery of small projects is a higher percentage of the construction cost. Establishing a project management team that specializes in smaller projects may lead to economies such as grouping similar projects during permitting and bidding thus reducing project delivery cost. **Perceived Value:** 	✓	LB, OK, SF, SJ
			NI	LA, SC DT, SD SC DU: Not enough PMs to justify this. Don't want to restrict staff to small, less-rewarding projects.

Cat.	Ref.*	BMP, Description, and Perceived Value	Implementation and Notes	
Project Management	5.I.k 2004	**BMP:** Institutionalize Project Manager performance and accountability. **Description:** Recognize that professional project management requires specific education, training, and experience. Provide for PMI, CCM, or other formal training and certification and establish performance measures for project delivery personnel. **Perceived Value:** 	✓	LA, LB, OK, SC DT, SD, SF, SJ
			PI	SC DU: There is interest but no definite plan. Implementation, although partially complete, is taken as far as it can go with our Agency.
	5.II.a	**BMP:** Provide formal training for Project Managers on a regular basis. **Description:** Project Managers come to projects with varying degrees of skill and familiarity with Agency procedures. Orientation and training will improve their ability to deliver the project on the intended schedule. It is also important that updated training is available at least on an annual basis. **Perceived Value:** 	✓	LA, SC DT, SF, OK, SD LB: Implementing a Project Development Manual. Additional training done at Division level. SF: In place but needs review.
			NI	SC DU
			TBD	SJ: As a formal program is being revised/updated, ad-hoc trainings are being provided as necessary.
	5.II.d 2006	**BMP:** Implement verification procedures to ensure that PM training includes Agency policies, procedures, forms, and standards of practice (scheduling, budgeting, claims avoidance, risk analysis, etc). **Description:** The success of a project is influenced significantly by the education and skills of the project manager. Agencies should verify that PM's know and use the tools available within an Agency and that they are current with industry practices. **Perceived Value:** 	✓	LA, OK, SC DT, SD
			PI	SF: Have training courses for claims avoidance. Needs review and more robust training.
			NI	SC DU
			TBD	LB, SJ
	5.III.a.	**BMP:** Adopt and use a Project Control System on all projects. **Description:** A web-based project control system will improve collaboration and documentation during the design and construction process. Questions, answers, proposals, and decisions can be expedited using a collaborative system. **Perceived Value:** 	✓	LA, LB, OK, SC DT, SD, SF, SJ
			NI	SC DU

Cat.	Ref.*	BMP, Description, and Perceived Value	Implementation and Notes	
Project Management	5.III.e 2006	**BMP:** Implement a financial system that tracks expenditures by category to monitor project hard and soft costs during project delivery. **Description:** It is recommended that a system that identifies actual expenditures against planned budgets be made available to project managers to be used as a performance measurement tool. **Perceived Value:** 	✓	LA, LB, OK, SC DT, SD, SJ SC DU: Intend to utilize SC DT's software if it proves to function well with our PM Database. SF: New financial system in place but still working out the kinks.
	5.III.f 2006	**BMP:** Implement a Work Breakdown Structure (WBS) to measure progress on project deliverables. **Description:** Getting accurate data on the cost of project delivery depends upon being able to capture and classify expenses to the phases of construction on each project. Ideally, costs would be identified by each of five project delivery phases and coded to particular milestones or deliverables. **Perceived Value:** 	✓	LB, OK, SC DT, SD, SF: Recently updated
			PI	LA
			NI	SC DU
			TBD	SJ
	5.III.g 2006	**BMP:** Monitor "earned value" versus budgeted and actual expenditures during project delivery. **Description:** Soft costs "burn rate" should be proportionate to percent complete during the design and construction phases. Using a program which measures and relates soft cost expenses to earned values permits better tracking and control during project delivery. **Perceived Value:** 	✓	LA, OK, SC DT, SF
			PI	SD
			NI	LB, SC DU, SJ
	5.III.h 2007	**BMP:** Include a fixed ROW acquisition milestone schedule and obtain commitments from participating City departments. **Description:** Prolonged ROW acquisition can be avoided if all stakeholders agree on milestones to complete the acquisitions. **Perceived Value:** 	✓	SC DT, SJ
			PI	LA, LB SD: It is difficult to get the commitments side.
			NI	OK, SC DU SF: No additional ROW required outside military base closure.
	5.III.i 2008	**BMP:** Implement an electronic progress payment/ schedule of values system to improve efficiency. **Description:** Reduction in the length of time and inefficiencies in processing of progress payments through the use of electronic means. **Perceived Value:** 	✓	SC DT, SF
			NI	LA, SC DU, SJ, SD LB: Current accounting system cannot accommodate a fully electronic approval process; Port: Implementing software to this end.
			TBD	OK

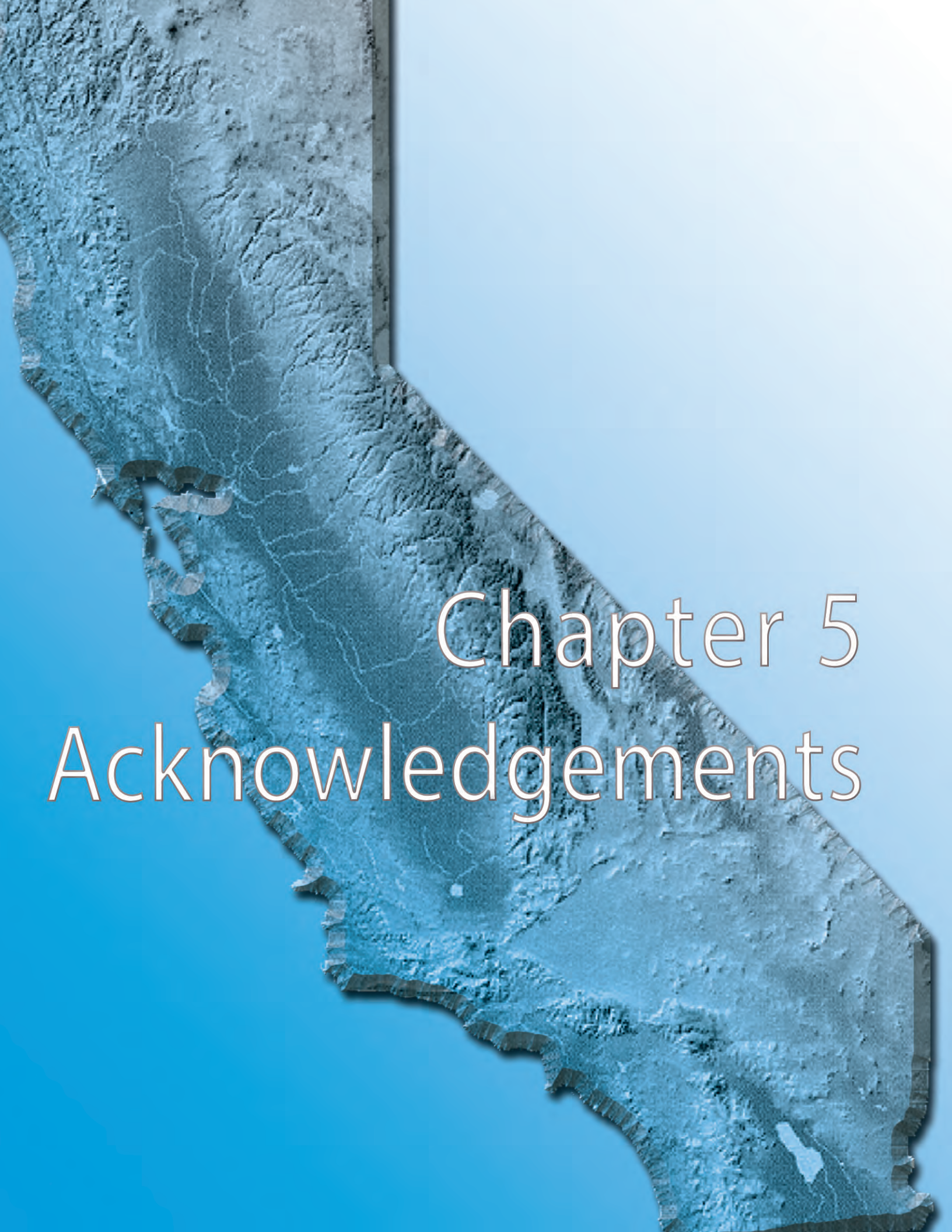
Cat.	Ref.*	BMP, Description, and Perceived Value	Implementation and Notes	
Project Management	5.III.j	**BMP:** Implement a schedule tracking system that monitors the actual percent complete against the percent of time elapsed for each identified phase of the approved project schedule. **Description:** Establishing a system where a project's schedule is broken into its phases. Actual percent complete is then measured against time elapsed in each phase throughout the development of the project. This system becomes a tool for management by project managers and supervisors. **Perceived Value:** 	✓	LA, OK, SC DT LB: City uses project tracking software.
			PI	SC DU, SD SF: Developed the Enterprise Project Management (EPM) which is used for project updates, financial and schedule tracking, and as a reporting tool. Project Leads are responsible for creating the schedules per client department MOUs, and tracking actual schedules to baselines.
			TBD	SJ
	5.III.k. 2014	**BMP:** Establish the use of dashboards as a quick way to check project delivery performance for both internal and external reporting and that is easy to use, has appropriate level of transparency and is efficient. **Description:** The dashboard concept is based on the ability to drill down to multiple levels of data so the user can get the level of detail desired. The level of detail to be provided in each dashboard is at the discretion of each Agency. The external dashboard increases public awareness of the project delivery performance and increases agency accountability. The internal dashboard provides a platform to measure, monitor, evaluate, and report performance to assist in establishing clear business rules and improve internal communication. **Perceived Value:** 	✓	LA, SD, SF
			PI	LB, OK, SC DT, SJ
			TBD	SC DU
	5.IV.a 2006	**BMP:** Bundle small projects whenever possible. **Description:** Bundling small projects so that they are designed, bid, and constructed together will reduce project delivery cost proportionately. **Perceived Value:** 	✓	LA, LB, OK, SC DT, SC DU, SD, SF, SJ
	5.IV.b 2007	**BMP:** Have a coordinator with expertise in the environmental process within the department delivering the engineering/capital project. **Description:** Identifying an environmental specialist within the project delivery team who is familiar with procedures and contacts within the approving entities will reduce permit procurement time and costs. **Perceived Value:** 	✓	LA, SD, SF SJ: Various Divisions/Sections have an environmental coordinator as needed.
			NI	LB, OK, SC DT, SC DU

Cat.	Ref.*	BMP, Description, and Perceived Value	Implementation and Notes	
Consultant Selection and Use	6.c.	**BMP:** Include a standard consultant contract in the RFQ/RFP with an indemnification clause. **Description:** The negotiation of the design contract can be expedited if the consultant understands and agrees to the conditions of the contract at the time a proposal is submitted. **Perceived Value:** 	✓	LA, LB, OK, SC DT, SC DU, SF, SJ SD: Some asset types only.
	6.e.	**BMP:** Delegate authority to the Public Works Director/ City Engineer to approve consultant contracts under $250,000 when a formal RFP selection process is used. **Description:** Authorization for the Public Works Director/City Engineer to award consulting contracts ensures earlier start of design and construction management activities and will reduce consultant selection process costs. **Perceived Value:** 	✓	SD, SF
			NI	LA, OK, SC DT LB: City Manager retains authority up to $100,000; Port: Authority up to $200,000. SC DU: Threshold is $100,000. SJ: City Manager has authority described.
	6.g.	**BMP:** Implement and use a consultant rating system that identifies quality of consultant performance. **Description:** The performance of consultants should be tracked so that those who deliver quality services at reasonable costs can be adequately considered for future awards. **Perceived Value:** 	✓	LA, OK, SD, SF, SJ SF: Have a contractor rating system but need to review and update the consultant rating system.
			PI	LB: Used for on-call consulting services contracts; Port: Implementing process as a compliment to contractor rating system.
			NI	SC DT SC DU: Track performance for those selected for "support services."
	6.m 2006	**BMP:** Implement as-needed, rotating, or on-call contracts for design and construction management work that allow work to be authorized on a task order basis to expedite the delivery of smaller projects. **Description:** Establishing an on-call list of qualified consultants with expertise in a variety of design disciplines will expedite the start of the design process. **Perceived Value:** 	✓	LA, LB, OK, SC DT, SC DU, SD, SF, SJ

Cat.	Ref.*	BMP, Description, and Perceived Value	Implementation and Notes	
Consultant Selection and Use	6.n 2013	**BMP:** Determine appropriate consultant costs for professional services agreements. **Description:** Establish a documented agency methodology for analyzing acceptable consultant costs and billing rates for use in contract negotiations. **Perceived Value:** 	PI	LA, OK, SF, SJ
			TBD	LB, SC DT, SC DU, SD
Sustainable Development	7.a. 2009	**BMP:** Identify the environmental benefits of the project at the time of award. **Description:** Provide written, environmental benefits to the awarding authority on projects that use sustainable practices or aim to achieve LEED certification. **Perceived Value:** 	✓	LA, LB, OK, SC DT, SJ
			PI	SD
			TBD	SC DU SF: For building projects, this is done at the start of planning for the application of LEED. All projects over 10,000 SF required to be LEED Gold.

Notes:
LA: Los Angeles; LB: Long Beach (Port: Port of Long Beach); OK: Oakland; SC: Sacramento (DT: Dept. of Transportation, DU: Dept. of Utilities), SD: San Diego, SF: San Francisco, SJ: San José
✓: Implemented, PI: Partially implemented, NI: No plans to implement at this time, TBD: To be determined
* See Process Questionnaire in Appendix C of 2002 Report; year noted indicates this BMP was added later.

Page Intentionally Left Blank



Chapter 5
Acknowledgements

CHAPTER 5

Acknowledgements

The participation and contribution of the following individuals to the Study is gratefully appreciated. This work would not have been possible without their contributions.

Update 2017 Project Team

Study Team:

Alex Garcia, P.E.,
Assistant Deputy Director
City of San Diego, Public Works Department, Construction Management and Field Division
9573 Chesapeake Dr.
San Diego, CA 92101
(858) 627-3268
AGarcia@sandiego.gov

Mohsen Maali, P.E.,
Senior Civil Engineer
City of San Diego, Public Works Department, Project & Operations Support Division
525 B Street, Suite 750
San Diego, CA 92101
(619) 533-6671
MMaali@sandiego.gov

Sheila Bose, P.E.,
Senior Civil Engineer
City of San Diego, Public Works Department, Right-of-Way Division
525 B Street, Suite 750
San Diego, CA 92101
(619) 533-4698
SBose@sandiego.gov

Debbie Van Martin, P.E.,
Senior Civil Engineer
City of San Diego, Public Works Department, Architectural Engineering and Parks Division
525 B Street, Suite 750
San Diego, CA 92101
(619) 533-6651
DVanMartin@sandiego.gov

Kyleen Marcella,
Consultant
MWH, now part of Stantec
300 N. Lake Avenue, Suite 400
Pasadena, CA 91101
(626) 568-6047
kyleen.marcella@stantec.com

Adnan Anabtawi,
Consultant
MWH, now part of Stantec
2353 130th Ave NE, Suite 200
Bellevue, WA 98005
(425) 602-3539
adnan.anabtawi@stantec.com

Robert Flory,
Consultant
Roebbelen Contracting Inc.
1241 Hawks Flight Court
El Dorado Hills, CA 95762
(916) 939-8305
(510) 305-5788 (cell)
robertf@roebbelen.com

Project Team:

Alvin Papa, P.E.,
Assistant City Engineer
City of Long Beach,
Department of Public Works
333 W. Ocean Blvd., 9th Floor
Long Beach, CA 90802
(562) 570-6386
(562) 570-6012 (fax)
Alvin.Papa@longbeach.gov

Sean Crumby, P.E.,
Deputy Director of Public Works / City Engineer
City of Long Beach,
Department of Public Works
333 W. Ocean Blvd., 9th Floor
Long Beach, CA 90802
(562) 570-6695
(562) 570-6012 (fax)
Sean.Crumby@longbeach.gov

Sean Gamette, P.E.,
Managing Director
Port of Long Beach, Engineering Bureau
Airport Plaza, 4th floor
Long Beach, CA 90815
(562) 283-7277
Sean.gamette@polb.com

Suzanne Plezia, P.E.,
Senior Director of Program Delivery
Port of Long Beach, Engineering Bureau
Airport Plaza, 4th floor
Long Beach, CA 90815
(562) 283-7277
Suzanne.plezia@polb.com

Marlene Dupras, P.E.,
Deputy Chief Harbor Engineer,
Program Management
Port of Long Beach, Engineering Bureau
Airport Plaza, 4th floor
Long Beach, CA 90815
(562) 283-7277
Marlene.dupras@polb.com

Gary Lee Moore, P.E.,
City Engineer
City of Los Angeles, Department of
Public Works, Bureau of Engineering
1149 S. Broadway, Suite 700
Los Angeles, CA 90015
(213) 485-4935
(213) 485-4923 (fax)
gary.lee.moore@lacity.or**g**

Ted Allen, P.E.,
Deputy City Engineer
City of Los Angeles, Department of
Public Works, Bureau of Engineering
1149 S. Broadway, Suite 700
Los Angeles, CA 90015
(213) 485-4915
(213) 485-4923 (fax)
ted.allen@lacity.org

Edick Ohanian, P.E.
Principal Civil Engineer
City of Los Angeles, Department of
Public Works, Bureau of Engineering
1149 S. Broadway, Suite 140
Los Angeles, CA 90015
(213) 847-0577
(213) 847-0703 (fax)
edick.ohanian@lacity.org

Nicholas Theocharides,
Engineering Services
Division Manager
City of Sacramento, Department
of Transportation
915 I Street, Room 2000
Sacramento, CA 95814
(916) 808-5065
(916) 808-8281 (fax)
nicolas@cityofsacramento.org

Jesse Gothan, P.E.,
Supervising Engineer
City of Sacramento, Department
of Public Works
915 I Street, Room 2000
Sacramento CA 95814
(916) 808-6897
(916) 808-8281 (fax)
jgothan@cityofsacramento.org

Nicole Henderson,
Supervising Financial Analyst
City of Sacramento, Department
of Public Works
915 I Street, Room 2000
Sacramento CA 95814
(916) 808-8242
(916) 808-8281 (fax)
nhenderson@cityofsacramento.org

Dan Sherry,
Engineering and Water
Resources Division Manager
City of Sacramento,
Department of Utilities
1395 35th Avenue
Sacramento, CA 95822
(916) 808-1419
dsherry@cityofsacramento.org

Brett Grant,
Supervising Engineer
City of Sacramento,
Department of Utilities
1395 35th Avenue
Sacramento, CA 95822
(916) 808-141**3**
bgrant@cityofsacramento.org

Michelle Carrey,
Supervising Engineer
City of Sacramento,
Department of Utilities
1395 35th Avenue
Sacramento, CA 95822
(916) 808-1438
mcarrey@cityofsacramento.org

Mark Dorian, A.I.A.,
Operations Manager
City and County of San Francisco,
Dept. of Public Works, Building
Design and Construction
30 Van Ness Avenue, 4th Floor
San Francisco, CA 94102
(415) 557-4719
(415) 522-7777 (fax)
Mark.Dorian@sfdpw.org

Patrick Rivera, P.E.,
Division Manager
City and County of San Francisco,
Dept. of Public Works, Infrastructure
Design & Construction
30 Van Ness Avenue, 5th Floor
San Francisco, CA 94102
(415) 558-4001
Patrick.Rivera@sfdpw.org

Julia Laue, A.I.A.,
Division Manager
City and County of San Francisco,
Dept. of Public Works, Building
Design and Construction
30 Van Ness Avenue, 4th Floor
San Francisco, CA 94102
(415) 557-4704
(415) 522-7777 (fax)
Julia.Laue@sfdpw.org

David D. Sykes, P.E.,
Assistant City Manager
City of San José, Office
of the City Manager
200 E. Santa Clara St.
San José, CA 95113
(408) 535-8185
dave.sykes@sanjoseca.gov

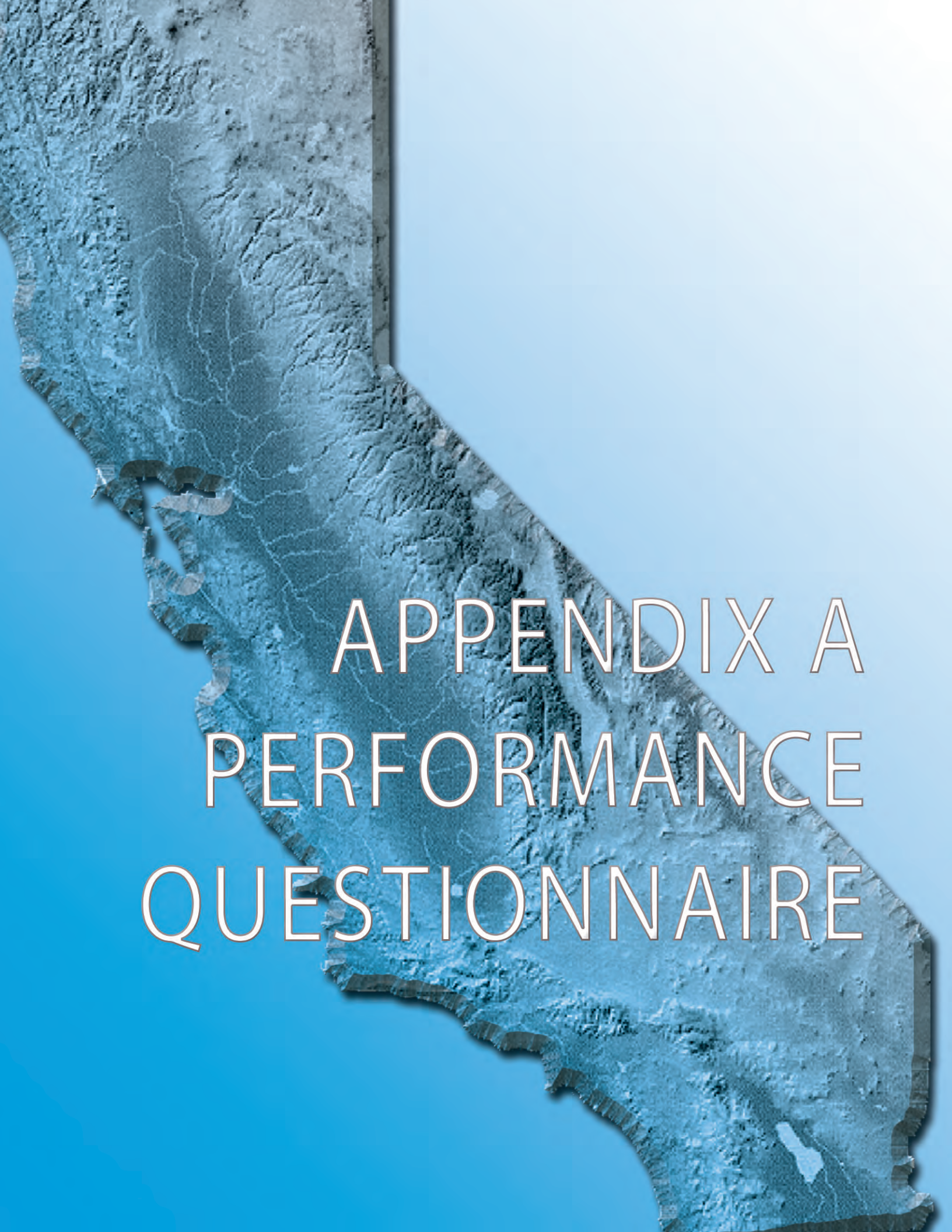
Barry Ng, P.E., L.S.,
Director
City of San José, Department
of Public Works
200 E. Santa Clara St.
5th Floor Tower
San José, CA 95113
(408) 535-8477
barry.ng@sanjoseca.gov

Michael O'Connell, P.E.,
Deputy Director
City of San José, Department
of Public Works
200 E. Santa Clara St.
5th Floor Tower
San José, CA 95113
(408) 975-7333
michael.oconnell@sanjoseca.gov

Patricia A. Cannon, P.E., L.S.,
Division Manager
City of San José, Department
of Public Works
1661 Senter Road, Building A, 1st Floor
San José, CA 95112
(408) 975-7380
patty.cannon@sanjoseca.gov

Page Intentionally Left Blank

APPENDICES



APPENDIX A
PERFORMANCE QUESTIONNAIRE

APPENDIX A

Performance Questionnaire

California Multi-Agency Benchmarking Study Update 2017 Performance Questionnaire

Agency:

Project Name:

Project Type:

New/Rehab Index:

Alternative Project Delivery:

☐ LEED Green Building

☐ Project Financial Elements Closed and Complete

Description:

Comments:

	Planning		Design		Construction		Total	
	DOLLAR	% of TCC*	DOLLAR	% of TCC*	DOLLAR	% of TCC*	DOLLAR	% of TCC*
AGENCY LABOR								
AGENCY COSTS(1)								
Art Fees								
SUB-TOTAL AGENCY								
CONSULTANT								
TOTALS								
PHASE DURATION		Months		Months		Months		

AMOUNT OF CONSTRUCTION CONTRACT ENGINEER'S ESTIMATE							
COST OF CHANGE ORDERS	Changed Conditions		Changed Bid Documents		Client-Initiated Changes:	Total Change Orders	$-
UTILITY RELOCATION COST							
CITY FORCES CONSTRUCTION							
TOTAL CONSTRUCTION COST (TCC)							
LAND ACQUISITION							
PROJECT COMPLETION DATE							
TOTAL PROJECT COST							$-
NUMBER OF BIDS RECEIVED							

(1) Agency costs include other direct costs and can be listed underneath.
This value is locked and it is calculated from its items (Rows 15 - 19).

Page Intentionally Left Blank

APPENDIX B
PERFORMANCE CURVES

APPENDIX B Performance Curves

REGRESSION ANALYSIS RESULTS

The results of the regression analysis performed using the performance model are presented in the following paragraphs.

REGRESSION DEFINITIONS

A brief overview of the relevant statistical terminology and their definitions is provided in the following paragraphs:

Performance curves produced for this *Study* are regressions of data, demonstrating how close of a relationship exists between the dependent variable (on the y-axis) and the independent variable (on the x-axis). For instance, a regression curve of design cost versus total construction cost (TCC) would be prepared to evaluate how much of the variability in design cost is due to the TCC value.

The regression trendline can be used as a starting point for evaluating the budget for a suite of projects. Caution and use of professional judgment is required if using the regression trendline to budget an individual project.

Confidence Interval

The upper and lower bounds of 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.

Coefficient of Determination

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 coefficient of determination, is a value between 1 and 0, with a value approaching 0 indicating a poor model and a value approaching 1 indicating a high dependence of the y-value statistic on the x-value statistic.

Statistical Significance

To evaluate the statistical significance of the result obtained, the regression analyses included a calculation of p-values. Whereas the R^2 value is a descriptive statistic (i.e., describes the current set of data), the p-value is a predictive statistic. It indicates whether there are enough data points to arrive at statistically-significant results and whether the data set could be used to forecast new values. The selection of a desirable p-value is subjective, though 0.10 or 0.05 is typically used as the maximum desirable value.

For the purposes of this *Study*, a critical p-value of 0.10 was selected. Thus, any result where $p \leq 0.10$ is considered statistically significant. There is no difference between a p-value slightly below 0.10 as one that is far below 0.10. Both results are considered to have equal statistical significance.

For regressions resulting in a p-value above 0.10, additional projects should be added to the database to improve the result. Please see the *Study* 2002 report for additional detail on the connection between the number of projects and p-values. Pump stations and restroom projects had p-values less than 0.1, and therefore the values obtained are not statistically significant.

For each of the regressions, the R^2 value and p-value should be considered separately. A high R^2 value does not mean the result is statistically-significant, and vice-versa.

The results of the regression analyses are discussed in the remainder of this section. The results of the regression analyses are summarized in **Table B-1** and **Table B-2**. **Table B-1** summarizes the performance model results for the full range of TCC while **Table B-2** summarizes the results for the 80th percentile subset of TCC. These tables also summarize the design, construction management, and project delivery costs expressed as a percentage of the TCC and the R^2 and the p-values for the different project types.

It is important to note that while the slopes of the linear regression models are an expression of the project delivery cost as a percentage of construction, the slopes are not equal to the average and median project delivery percentages shown in **Table 3-5, Table 3-6** and **Table 3-7**. This is due to the fact that the linear trendline is fit by the least squares method.

This is better explained by the following example. Consider 5 projects in the municipal category having the a1, a2, a3, a4, and a5 as their individual project delivery costs and b1, b2, b3, b4, and b5 as their individual TCC. The arithmetic average of the project delivery percentages would be represented as:

Project Delivery Percentage =

$$\left(\frac{a1}{b1} + \frac{a2}{b2} + \frac{a3}{b3} + \frac{a4}{b4} + \frac{a5}{b5} \right) \Big/ 5$$

The project delivery percentages presented in **Table 3-5** through **Table 3-12** are computed using the above formula which is the average of the individual project delivery percentages

In the regression analysis, the project delivery percentage is computed in fashion that is more similar to the following formula which represents the average slope of the least squares fit.

Project Delivery Percentage =

$$\left(\frac{a1 + a2 + a3 + a4 + a5}{b1 + b2 + b3 + b4 + b5} \right)$$

The project delivery percentages presented in **Table B-1** and **Table B-2** are computed using the above formula.

The plots depicting the regression relationships are shown in this section. It should also be noted that while majority of projects are clustered near the origin of the graph, the slope of the trendline is predominantly governed by the data points scattered at relatively high TCC values.

Since the slope of the trendline provides the design, construction management, or the project delivery costs as a percentage of the TCC for a group of projects, the results better reflect the properties of a program of projects rather than that of an individual project. Therefore, the reader must avoid budgeting individual projects based solely on these analyses.

In most cases, the results reflect the agencies' experience with the delivery of capital projects that on a percentage basis projects with lower TCCs are more expensive to deliver than projects with higher TCCs. Only 3 out of the 16 categories have lower project delivery percentages for the 80th percentile subset of projects than the full range of projects. It is concluded that the model results are reasonable from a statistical perspective.

For projects belonging to the Parks category, there is no increase in the project delivery percentages for projects evaluated in the 80th percentile subset of TCC. Project delivery percentages for projects belonging to the Pipes, Streets and Municipal category exhibit a 13, 16, and 16 percent increase, respectively, than the 80th percentile subset. Comparing the results summarized in **Table B-1** and **Table B-2** shows that an economy of scale exists in delivering projects with a higher TCC versus those with a lower TCC.

The elimination of auto-correlation in Update 2008 and the use of the linear trendline to describe the relationship between project delivery costs and the TCC have significantly improved the R^2 values as compared to the *Study* years prior to 2008. The linear regression trendline equations are shown in **Table B-3**.

The reader is cautioned that these tables should only be used as a reference and not for prediction of performance. Readers are urged to review the curves in this section in conjunction with using this table.

Table B-1
Summary of Performance Models (Full Range of TCC)

Project Type or Classification	Number of Projects [1]	Design Cost				Construction Management Cost				Project Delivery Cost			
		(% of TCC)	95% CI (% of TCC)	R^2	p-value	(% of TCC)	95% CI (% of TCC)	R^2	p-value	(% of TCC)	95% CI (% of TCC)	R^2	p-value
Municipal Facilities	**56**	**15%**	**12%-17%**	**0.75**	**2.5E-18**	**23%**	**21%-26%**	**0.85**	**2.8E-24**	**38%**	**35%-40%**	**0.94**	**1.3E-35**
Libraries	1	21%	N/A	N/A	N/A	23%	N/A	N/A	N/A	44%	N/A	N/A	N/A
Police/Fire Stations	8	13%	11%-15%	0.97	8.7E-07	19%	14%-23%	0.92	3.6E-05	31%	26%-37%	0.96	3.9E-06
Comm./Rec.Center/ Child Care/Gyms	23	26%	21%-31%	0.85	1.5E-10	14%	8%-20%	0.56	2.9E-05	40%	32%-48%	0.84	2.7E-10
Other Municipal	24	11%	9%-13%	0.86	2.1E-11	27%	24%-30%	0.94	9.2E-16	39%	37%-41%	0.98	2.0E-22
Streets	**184**	**17%**	**16%-18%**	**0.87**	**1.3E-82**	**13%**	**12%-14%**	**0.84**	**1.6E-73**	**30%**	**28%-31%**	**0.92**	**2.1E-103**
Widening/New/ Grade Separations	11	14%	13%-16%	0.98	1.2E-09	14%	12%-16%	0.96	1.5E-08	28%	26%-31%	0.99	8.1E-11
Bridges	20	17%	14%-21%	0.86	1.6E-09	9%	5%-13%	0.50	3.3E-04	26%	19%-33%	0.74	5.6E-07
Reconstructions	74	27%	25%-29%	0.93	1.4E-44	11%	9%-13%	0.66	5.9E-19	38%	36%-40%	0.96	1.6E-52
Bike/Pedestrian/ Streetscapes	54	25%	22%-28%	0.84	8.9E-23	17%	15%-20%	0.80	2.6E-20	42%	38%-47%	0.88	7.4E-26
Signals	25	28%	21%-35%	0.74	2.1E-08	15%	12%-17%	0.85	1.8E-11	43%	35%-50%	0.86	9.2E-12
Pipes	**266**	**17%**	**16%-19%**	**0.75**	**5.7E-81**	**17%**	**16%-19%**	**0.66**	**1.9E-63**	**34%**	**32%-37%**	**0.77**	**2.3E-87**
Gravity Mains	201	17%	16%-18%	0.75	1.4E-61	17%	15%-19%	0.64	1.8E-46	34%	31%-37%	0.77	7.0E-65
Pressure Systems	44	18%	15%-21%	0.74	5.6E-14	14%	12%-17%	0.79	5.9E-16	32%	27%-37%	0.80	1.9E-16
Pump Stations	8	30%	24%-36%	0.95	8.3E-06	22%	17%-27%	0.94	1.3E-05	52%	43%-60%	0.96	2.4E-06
Other Pipes	13	19%	13%-25%	0.79	2.1E-05	35%	29%-41%	0.93	2.3E-08	54%	48%-60%	0.97	3.0E-10
Parks	**41**	**23%**	**21%-25%**	**0.92**	**7.4E-24**	**14%**	**13%-15%**	**0.95**	**9.5E-28**	**36%**	**34%-39%**	**0.95**	**4.0E-28**
Playgrounds	31	26%	25%-27%	0.98	2.3E-28	14%	13%-15%	0.97	9.5E-24	40%	38%-42%	0.99	2.0E-30
Sportfields	8	9%	4%-14%	0.70	4.8E-03	10%	6%-15%	0.84	4.9E-04	20%	11%-28%	0.81	9.2E-04
Restrooms	2	19%	-4%-43%	0.99	6.1E-02	14%	-20%-48%	0.97	1.2E-01	34%	23%-44%	1.00	1.5E-02

Notes:

TCC = Total Construction Cost; CI = Confidence Interval. The project delivery percentages indicated are the ranges corresponding to the 95 percent confidence intervals on the mean slope of the linear regression trendline. Caution and review of the report text are urged in using this information. Refer to Appendix B for the corresponding regression curves, R^2 values, and N values for more details.

1. Total excludes projects delivered by alternative delivery mechanisms such a design-build, JOC, and CM@Risk. Projects delivered by alternative techniques are retained in the database but not analyzed. These projects are not included in the projects selected for analysis in the *Study*.

Table B-2
Summary of Performance Models (80th Percentile Subset of TCC)

Project Type or Classification	Number of Projects [1]	Design Cost				Construction Management Cost				Project Delivery Cost			
		(% of TCC)	95% CI (% of TCC)	R^2	p-value	(% of TCC)	95% CI (% of TCC)	R^2	p-value	(% of TCC)	95% CI (% of TCC)	R^2	p-value
Municipal Facilities	**44**	**32%**	**28%-37%**	**0.82**	**1.7E-17**	**21%**	**17%-26%**	**0.72**	**1.7E-13**	**54%**	**48%-60%**	**0.89**	**2.9E-22**
Libraries	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Police/Fire Stations	6	12%	5%-18%	0.81	5.5E-03	17%	5%-29%	0.73	1.4E-02	29%	10%-47%	0.77	9.8E-03
Comm./Rec.Center/ Child Care/Gyms	18	26%	22%-30%	0.91	2.1E-10	27%	21%-33%	0.82	8.3E-08	53%	45%-62%	0.91	2.2E-10
Other Municipal	19	23%	19%-28%	0.85	6.0E-09	15%	11%-18%	0.84	1.3E-08	38%	31%-45%	0.88	1.2E-09
Streets	**147**	**28%**	**25%-30%**	**0.74**	**1.2E-44**	**19%**	**17%-21%**	**0.70**	**1.6E-39**	**46%**	**42%-50%**	**0.80**	**1.6E-53**
Widening/New/ Grade Separations	8	20%	2%-37%	0.51	3.2E-02	21%	11%-32%	0.77	1.9E-03	41%	15%-68%	0.66	7.7E-03
Bridges	15	33%	28%-39%	0.93	1.2E-09	23%	18%-29%	0.85	4.1E-07	57%	48%-66%	0.93	2.4E-09
Reconstructions	59	23%	19%-27%	0.70	7.3E-17	16%	13%-19%	0.63	3.0E-14	39%	33%-45%	0.75	2.5E-19
Bike/Pedestrian/ Streetscapes	43	32%	26%-38%	0.73	1.3E-13	22%	18%-27%	0.70	1.1E-12	54%	47%-61%	0.85	1.3E-18
Signals	**19**	48%	35%-60%	0.78	2.2E-07	17%	11%-23%	0.68	8.3E-06	64%	55%-74%	0.92	3.2E-11
Pipes	212	**24%**	**23%-26%**	**0.78**	**1.5E-71**	**23%**	**21%-24%**	**0.83**	**3.9E-83**	**47%**	**44%-49%**	**0.87**	**8.0E-95**
Gravity Mains	160	25%	23%-27%	0.80	7.6E-58	24%	22%-25%	0.85	1.1E-66	49%	46%-51%	0.89	7.1E-77
Pressure Systems	35	22%	16%-27%	0.66	1.9E-09	18%	15%-21%	0.83	1.6E-14	40%	33%-48%	0.78	8.4E-13
Pump Stations	**6**	19%	6%-31%	0.74	1.4E-02	23%	14%-31%	0.91	9.6E-04	41%	27%-56%	0.91	8.4E-04
Other Pipes	**10**	40%	26%-55%	0.81	1.5E-04	33%	26%-41%	0.92	2.6E-06	74%	54%-94%	0.89	1.5E-05
Parks	32	**19%**	**15%-23%**	**0.77**	**1.7E-11**	**17%**	**13%-20%**	**0.78**	**1.0E-11**	**36%**	**31%-41%**	**0.86**	**5.0E-15**
Playgrounds	24	24%	20%-28%	0.85	7.0E-11	21%	17%-26%	0.81	6.9E-10	45%	39%-51%	0.92	8.3E-14
Sportfields	6	18%	8%-27%	0.81	5.6E-03	19%	12%-26%	0.91	9.5E-04	37%	25%-49%	0.92	5.5E-04
Restrooms [2]	1	28%	N/A	N/A	N/A	2%	N/A	N/A	N/A	30%	N/A	N/A	N/A

Notes:

TCC = Total Construction Cost; CI = Confidence Interval. The project delivery percentages indicated are the ranges corresponding to the 95 percent confidence intervals on the mean slope of the linear regression trendline. Caution and review of the report text are urged in using this information. Refer to Appendix B for the corresponding regression curves, R^2 values, and N values for more details.

1. Total excludes projects delivered by alternative delivery mechanisms such a design-build, JOC, and CM@Risk. Projects delivered by alternative techniques are retained in the database but not analyzed. These projects are not included in the projects selected for analysis in the *Study*.
2. Municipal Facilities – Libraries and Parks - Restrooms have too few projects to calculate statistics.

Table B-3
Summary of Regression Equations

Project Type or Classification	Design Cost (x) vs. TCC Full Range of TCC	Design Cost (x) vs. TCC Smaller Project Subset of TCC	CM Cost (x) vs. TCC Full Range of TCC	CM Cost (x) vs. TCC Smaller Project Subset of TCC	Project Delivery Cost (x) vs. TCC Full Range of TCC	Project Delivery Cost (x) vs. TCC Smaller Project Subset of TCC
Municipal Facilities	**0.1472x**	**0.3245x**	**0.2321x**	**0.2143x**	**0.3792x**	**0.5388x**
Libraries	0.2077x	N/A	0.2310x	N/A	0.4388x	N/A
Police/Fire Stations	0.1290x	0.1187x	0.1857x	0.1689x	0.3147x	0.2876x
Comm./Rec. Center/Child Care/Gyms	0.2593x	0.2615x	0.1400x	0.2699x	0.3994x	0.5315x
Other Municipal	0.1146x	0.2336x	0.2723x	0.1458x	0.3870x	0.3794x
Streets	**0.1668x**	**0.2761x**	**0.1295x**	**0.1856x**	**0.2963x**	**0.4617x**
Widening/New/ Grade Separations	0.1404x	0.1990x	0.1432x	0.2141x	0.2837x	0.4130x
Bridges	0.1727x	0.3349x	0.0882x	0.2326x	0.2609x	0.5674x
Reconstructions	0.2694x	0.2321x	0.1119x	0.1567x	0.3813x	0.3888x
Bike/Pedestrian/ Streetscapes	0.2500x	0.3176x	0.1749x	0.2229x	0.4249x	0.5405x
Signals	**0.2775x**	0.4753x	0.1475x	0.1689x	0. 4250x	0.6442x
Pipes	0.1728x	**0.2425x**	**0.1709x**	**0.2266x**	**0.3437x**	**0.4690x**
Gravity Mains	0.1702x	0.2500x	0.1700x	0.2359x	0.3401x	0.4859x
Pressure Systems	0.1790x	0.2192x	0.1439x	0.1824x	0.3228x	0.4016x
Pump Stations	**0.2973x**	0.1859x	0.2182x	0.2288x	0.5156x	0.4147x
Other Pipes	**0.1871x**	0.4040x	0.3507x	0.3342x	0.5379x	0.7382x
Parks	0.2263x	**0.1933x**	**0.1367x**	**0.1657x**	**0.3631x**	**0.3590x**
Playgrounds	0.2593x	0.2391x	0.1398x	0.2131x	0. 3991x	0.4522x
Sportfields	0.0907x	0.1762x	0.1049x	0.1913x	0.1956x	0.3675x
Restrooms [1]	0.1920x	N/A	0.1440x	N/A	0.3360x	N/A

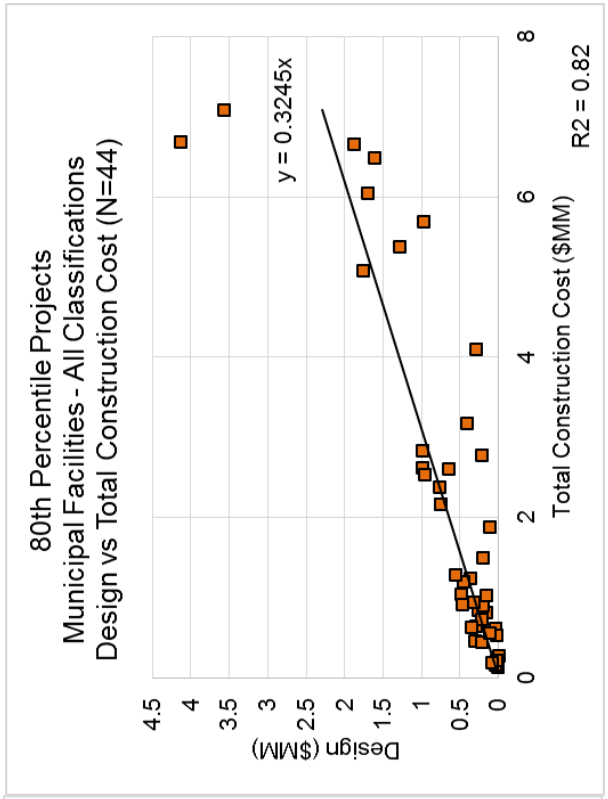
Note:
TCC = Total Construction Cost; CM = Construction Management.
1. Municipal Facilities – Libraries and Parks - Restrooms have too few projects to calculate statistics for smaller project subset.

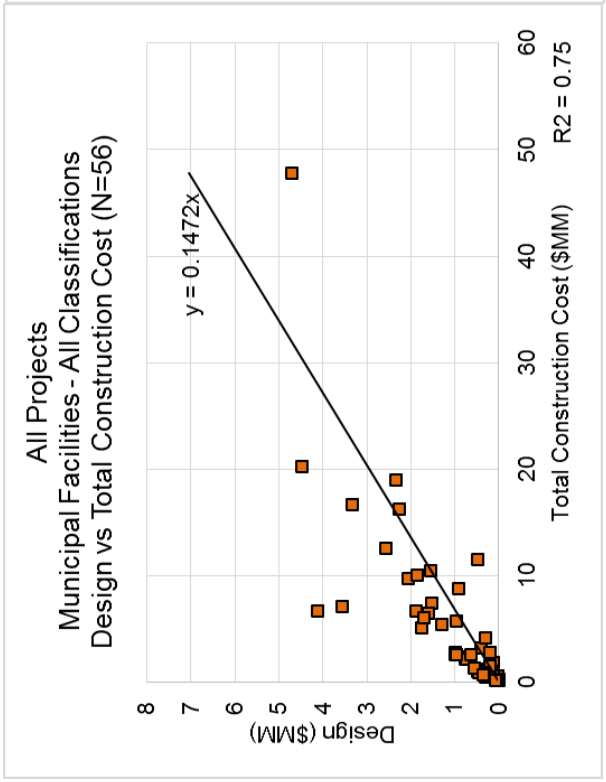
APPENDIX B

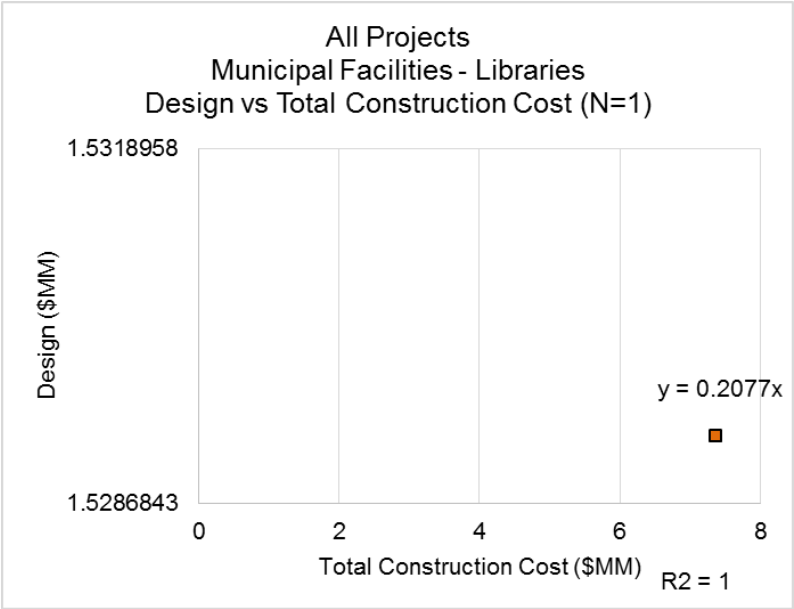
Performance Curves

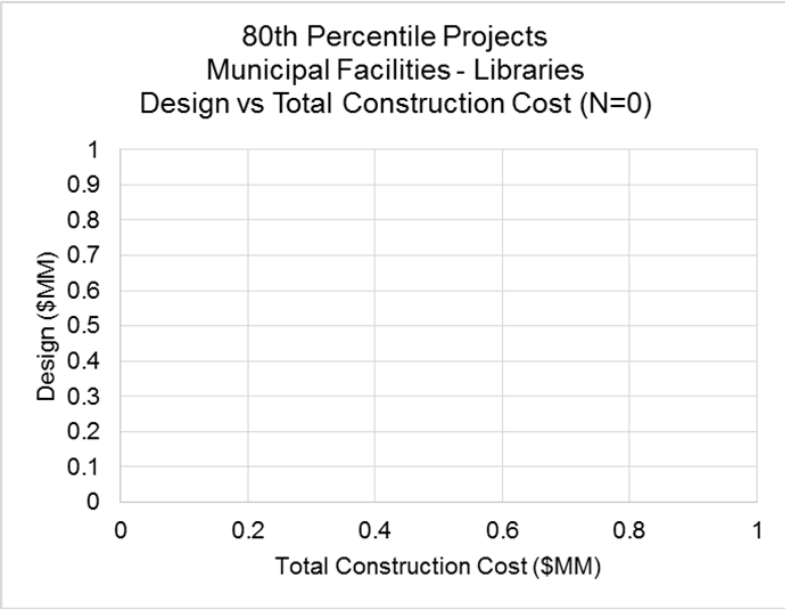
CURVES GROUP 1

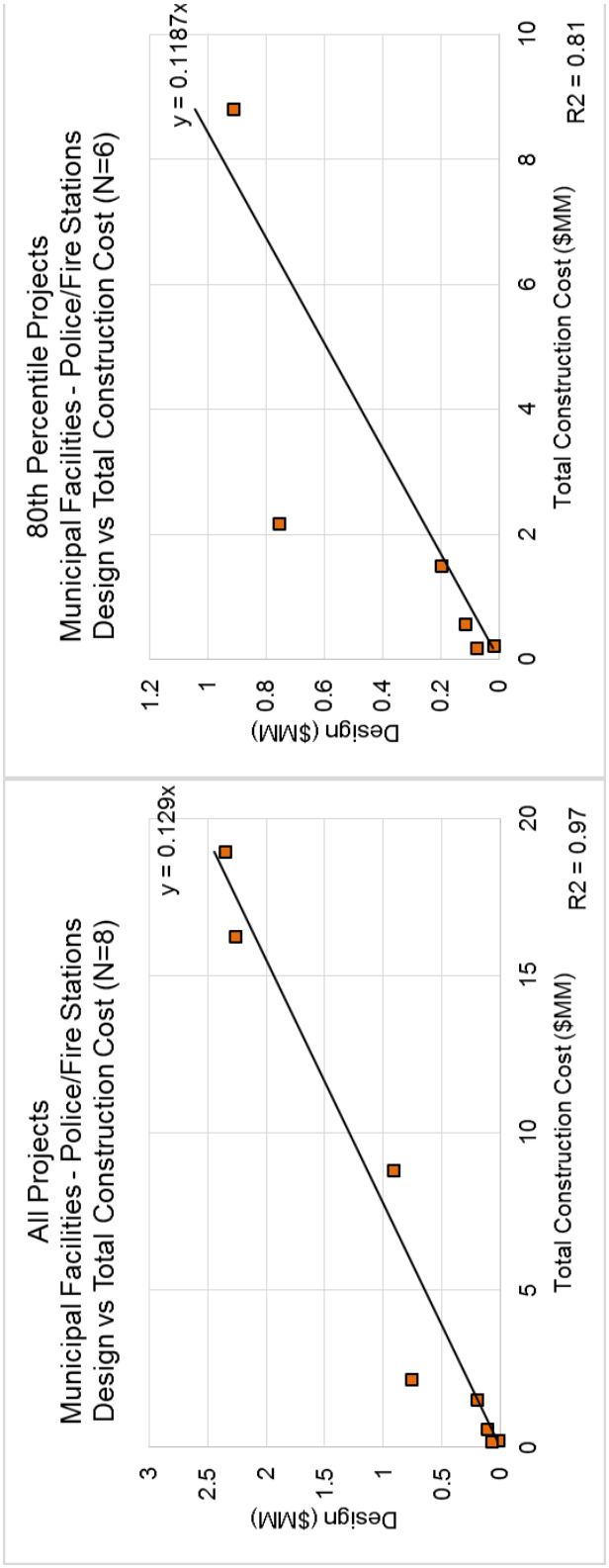
Design Cost vs Total Construction Cost

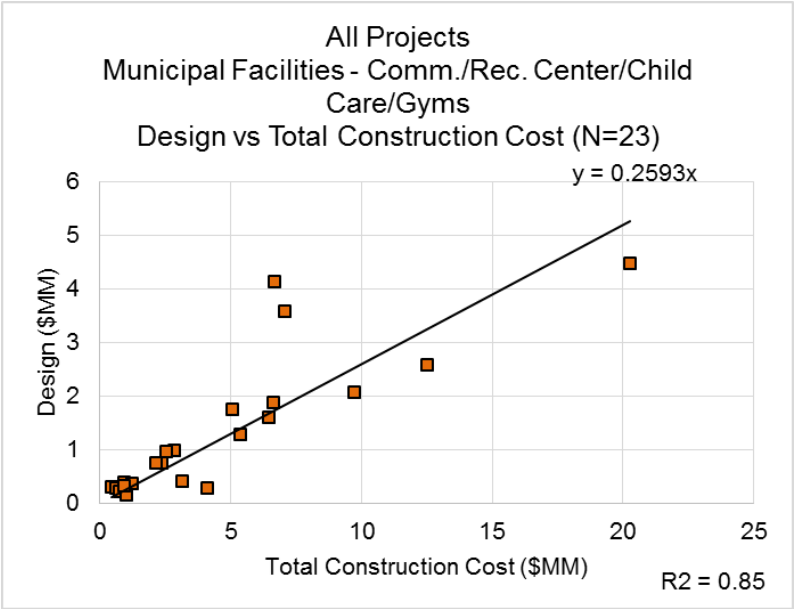

80th Percentile Projects
Municipal Facilities - All Classifications
Design vs Total Construction Cost (N=44)
y = 0.3245x
R2 = 0.82
Design ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
0
2
4
6
8

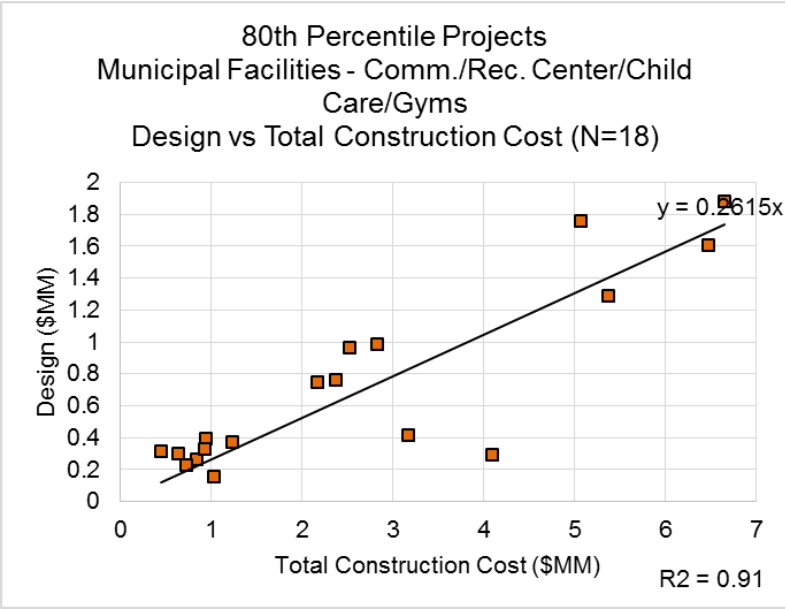

All Projects
Municipal Facilities - All Classifications
Design vs Total Construction Cost (N=56)
y = 0.1472x
R2 = 0.75
Design ($MM)
Total Construction Cost ($MM)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60

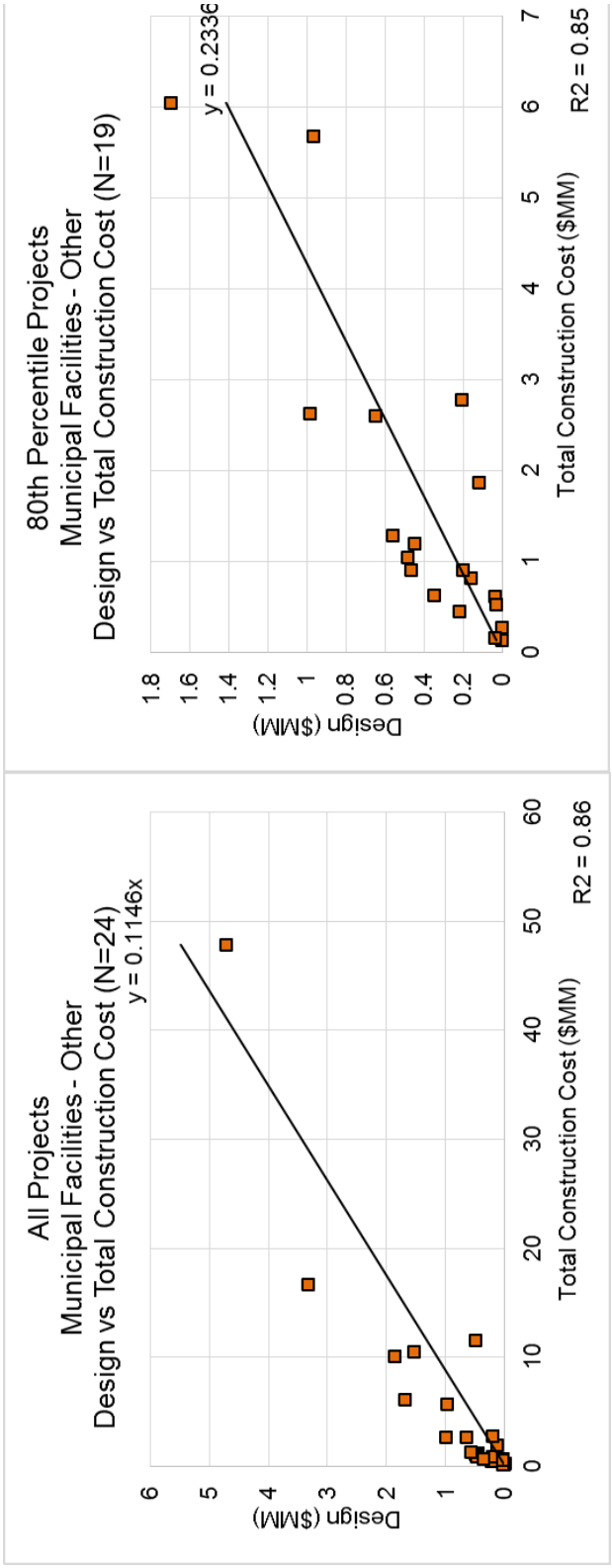

All Projects
Municipal Facilities - Libraries
Design vs Total Construction Cost (N=1)
1.5318958
1.5286843
Design ($MM)
y = 0.2077x
0
2
4
6
8
Total Construction Cost ($MM)
R2 = 1

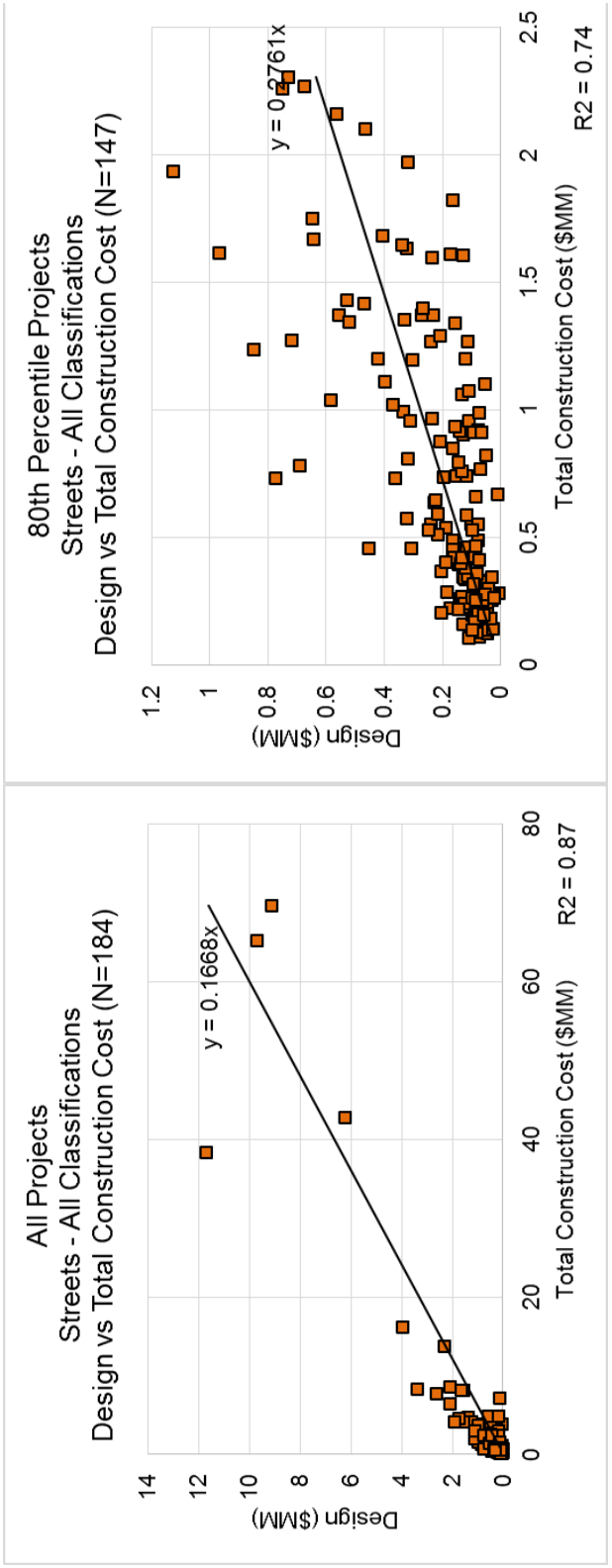

80th Percentile Projects
Municipal Facilities - Libraries
Design vs Total Construction Cost (N=0)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Design ($MM)
0
0.2
0.4
0.6
0.8
1
Total Construction Cost ($MM)

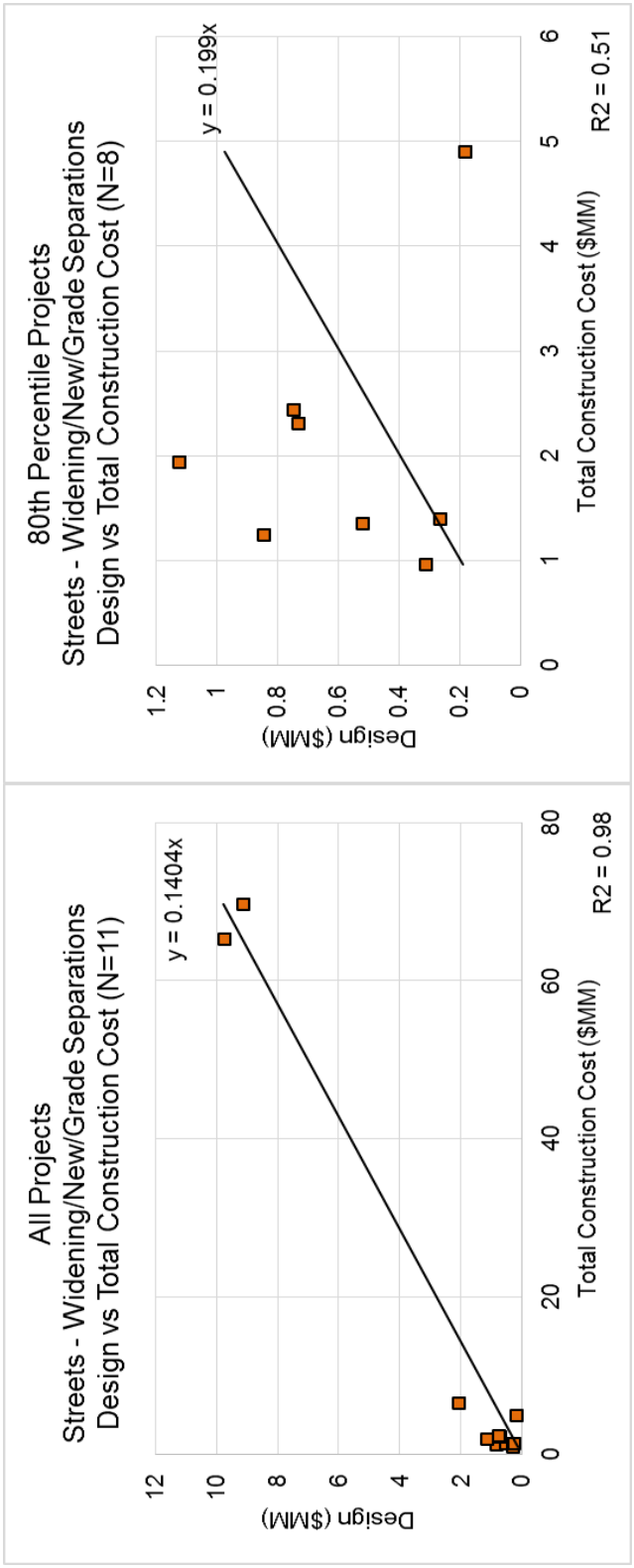

80th Percentile Projects
Municipal Facilities - Police/Fire Stations
Design vs Total Construction Cost (N=6)
y = 0.1187x
R2 = 0.81
Design ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
0
2
4
6
8
10
All Projects
Municipal Facilities - Police/Fire Stations
Design vs Total Construction Cost (N=8)
y = 0.129x
R2 = 0.97
Design ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
3
0
5
10
15
20

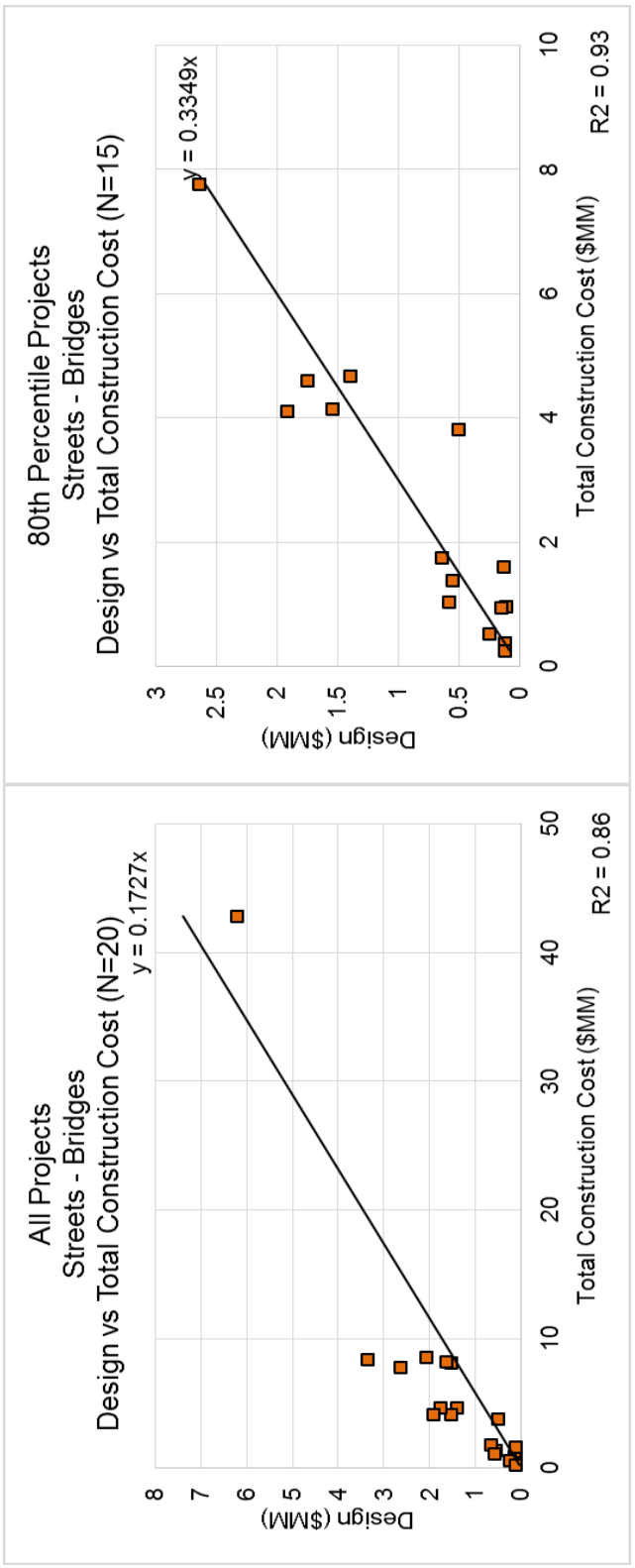

All Projects
Municipal Facilities - Comm./Rec. Center/Child Care/Gyms
Design vs Total Construction Cost (N=23)
y = 0.2593x
Design ($MM)
Total Construction Cost ($MM)
R2 = 0.85
0
1
2
3
4
5
6
0
5
10
15
20
25

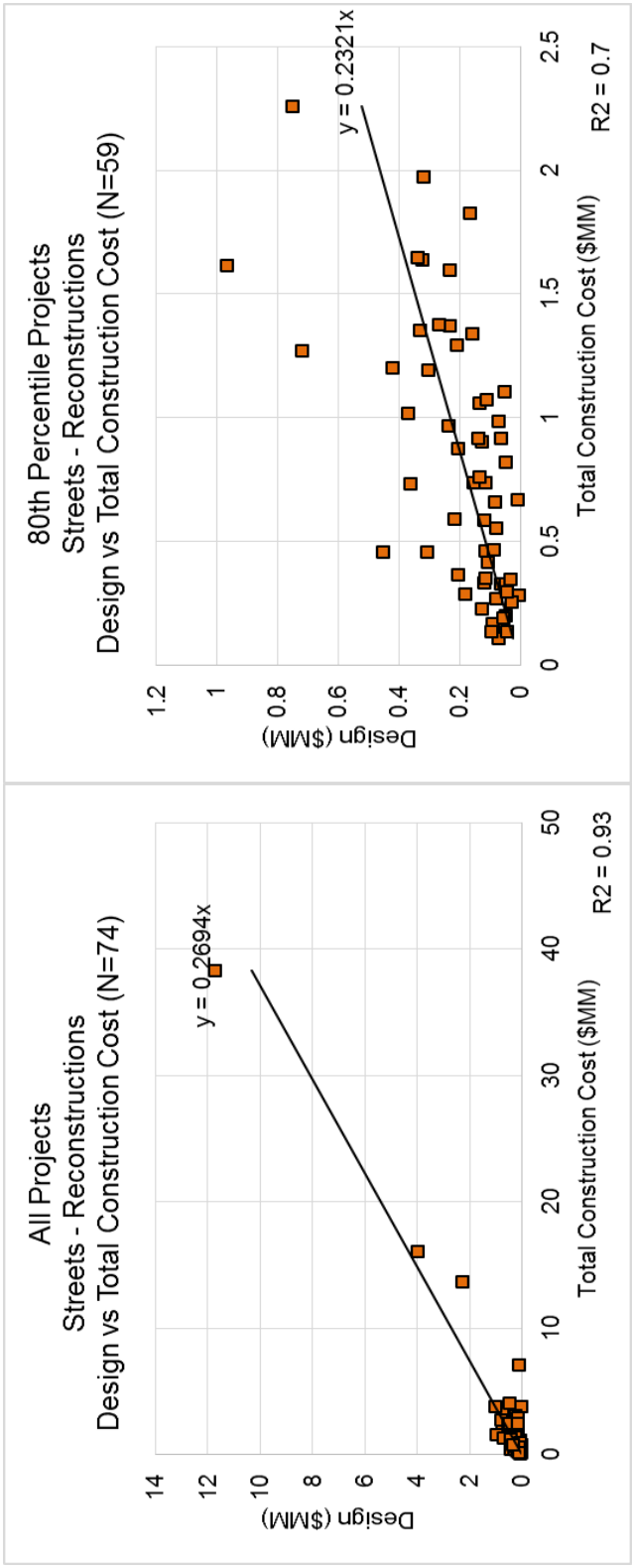

80th Percentile Projects
Municipal Facilities - Comm./Rec. Center/Child Care/Gyms
Design vs Total Construction Cost (N=18)
y = 0.2615x
Design ($MM)
Total Construction Cost ($MM)
R2 = 0.91
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
1
2
3
4
5
6
7

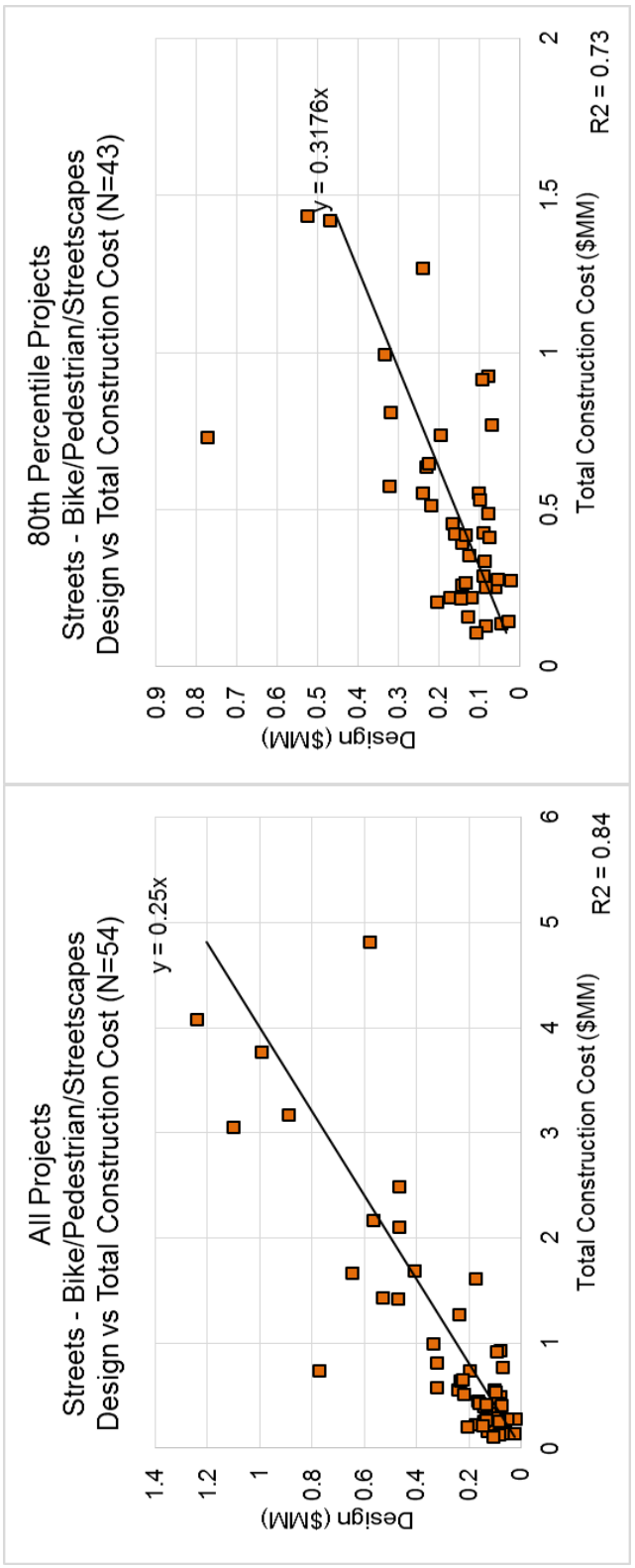

80th Percentile Projects
Municipal Facilities - Other
Design vs Total Construction Cost (N=19)
y = 0.2336
R2 = 0.85
Design ($MM)
Total Construction Cost ($MM)
All Projects
Municipal Facilities - Other
Design vs Total Construction Cost (N=24)
y = 0.1146x
R2 = 0.86
Design ($MM)
Total Construction Cost ($MM)

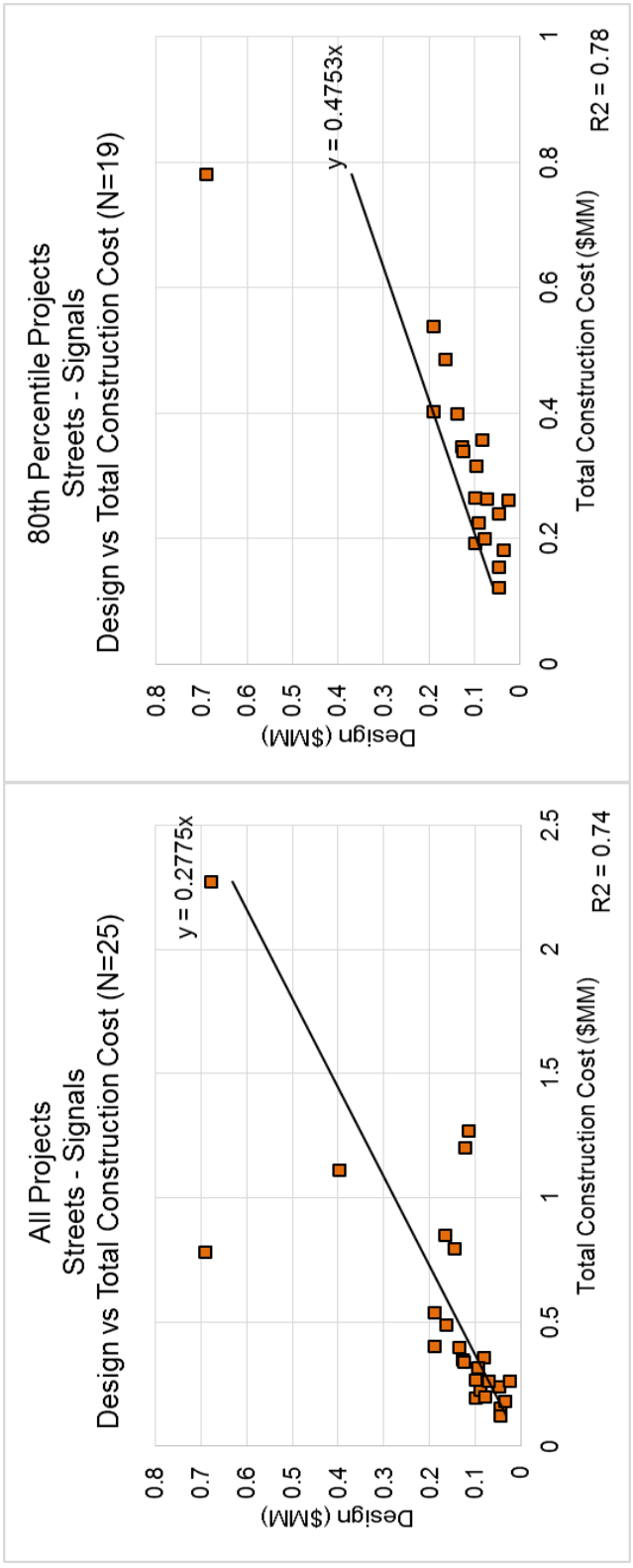

80th Percentile Projects
Streets - All Classifications
Design vs Total Construction Cost (N=147)
y = 0.2761x
R2 = 0.74
Design ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
0
0.5
1
1.5
2
2.5
All Projects
Streets - All Classifications
Design vs Total Construction Cost (N=184)
y = 0.1668x
R2 = 0.87
Design ($MM)
Total Construction Cost ($MM)
0
2
4
6
8
10
12
14
0
20
40
60
80

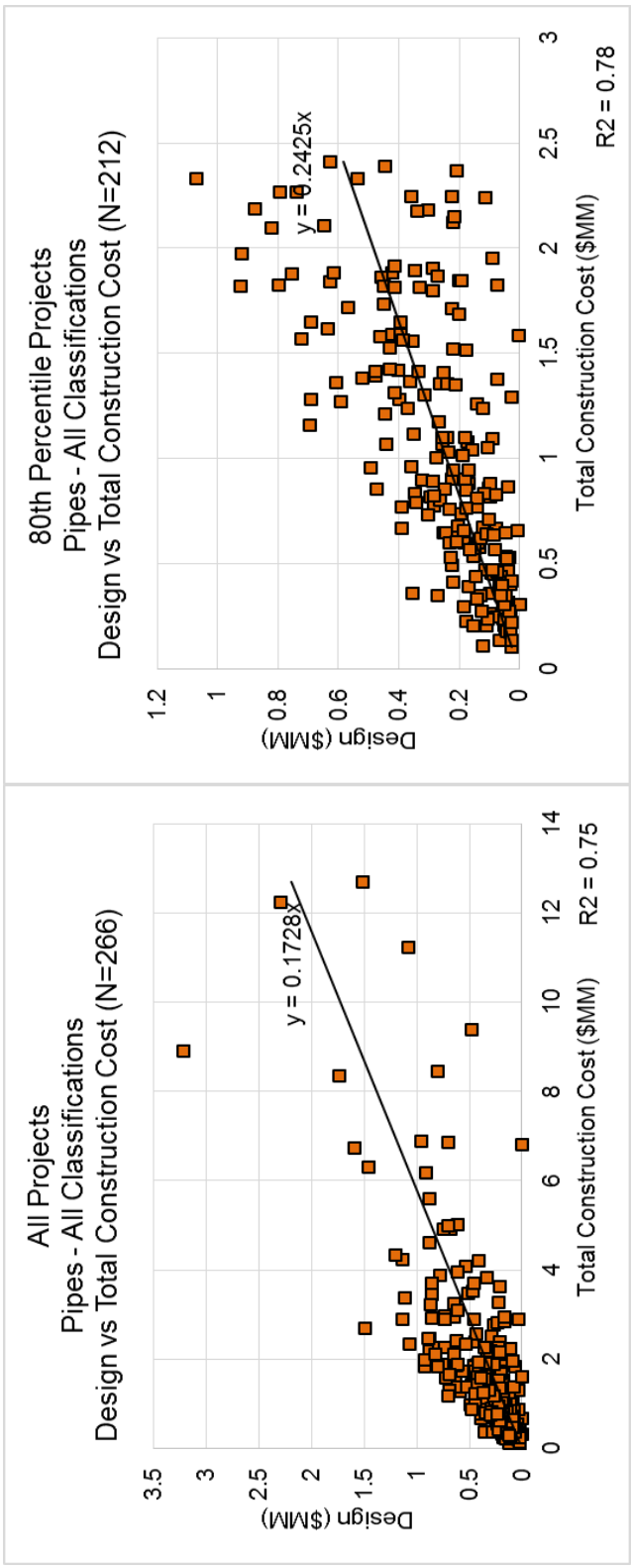

80th Percentile Projects
Streets - Widening/New/Grade Separations
Design vs Total Construction Cost (N=8)
y = 0.199x
R2 = 0.51
Design ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
0
1
2
3
4
5
6
All Projects
Streets - Widening/New/Grade Separations
Design vs Total Construction Cost (N=11)
y = 0.1404x
R2 = 0.98
Design ($MM)
Total Construction Cost ($MM)
0
2
4
6
8
10
12
0
20
40
60
80

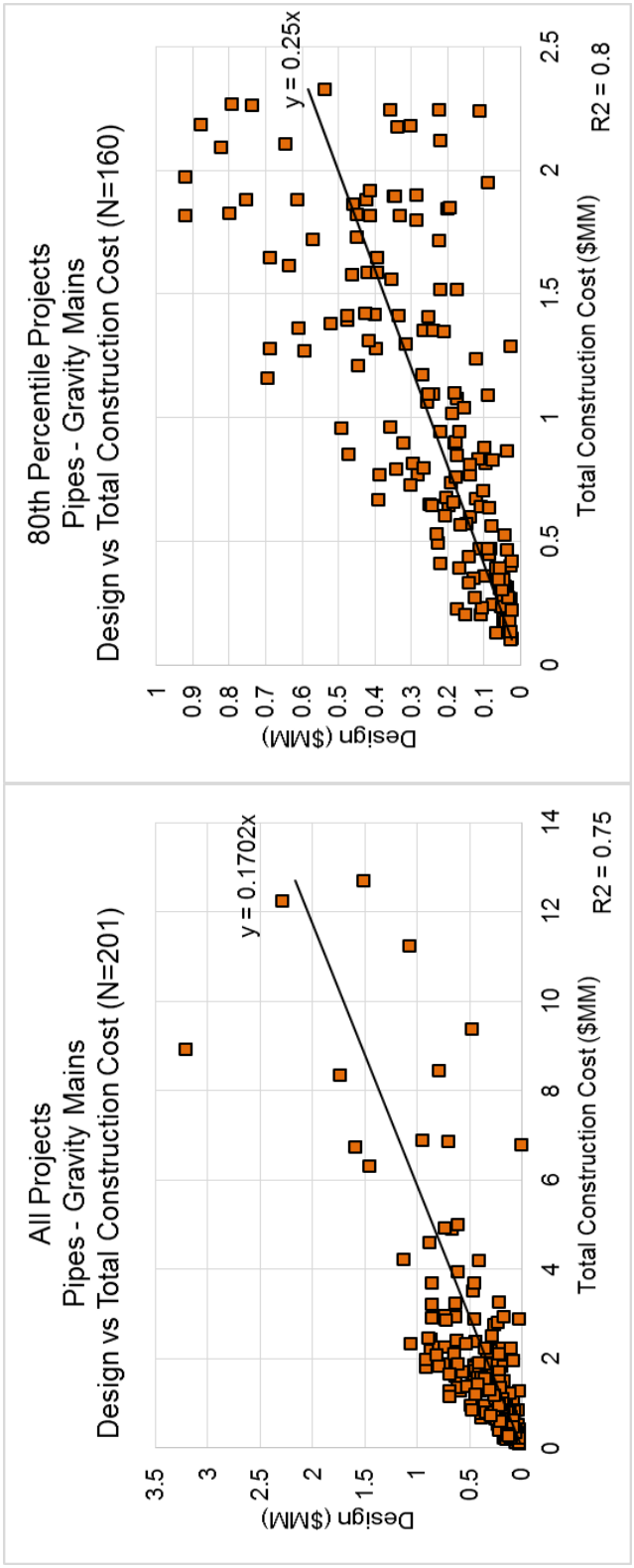

80th Percentile Projects
Streets - Bridges
Design vs Total Construction Cost (N=15)
y = 0.3349x
R2 = 0.93
Design ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
3
0
2
4
6
8
10
All Projects
Streets - Bridges
Design vs Total Construction Cost (N=20)
y = 0.1727x
R2 = 0.86
Design ($MM)
Total Construction Cost ($MM)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50

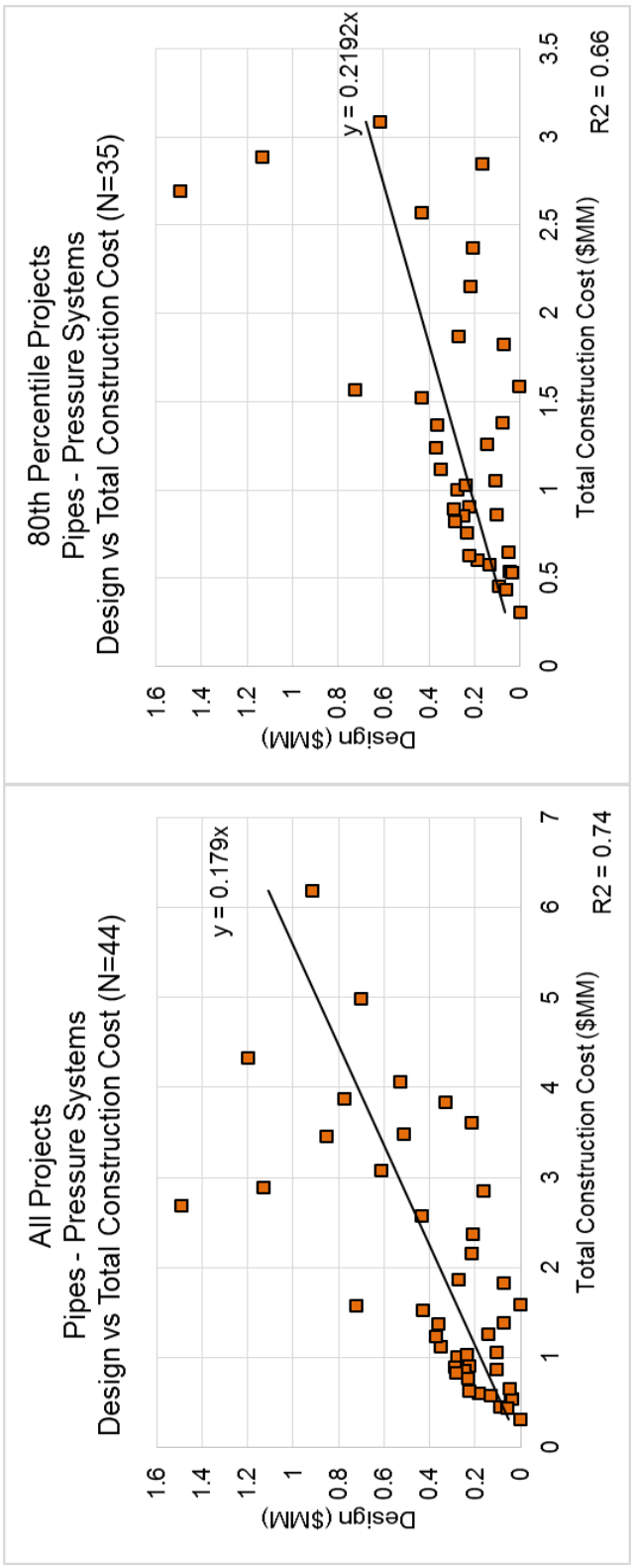

80th Percentile Projects
Streets - Reconstructions
Design vs Total Construction Cost (N=59)
y = 0.2321x
R2 = 0.7
Design ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
0
0.5
1
1.5
2
2.5
All Projects
Streets - Reconstructions
Design vs Total Construction Cost (N=74)
y = 0.2694x
R2 = 0.93
Design ($MM)
Total Construction Cost ($MM)
0
2
4
6
8
10
12
14
0
10
20
30
40
50

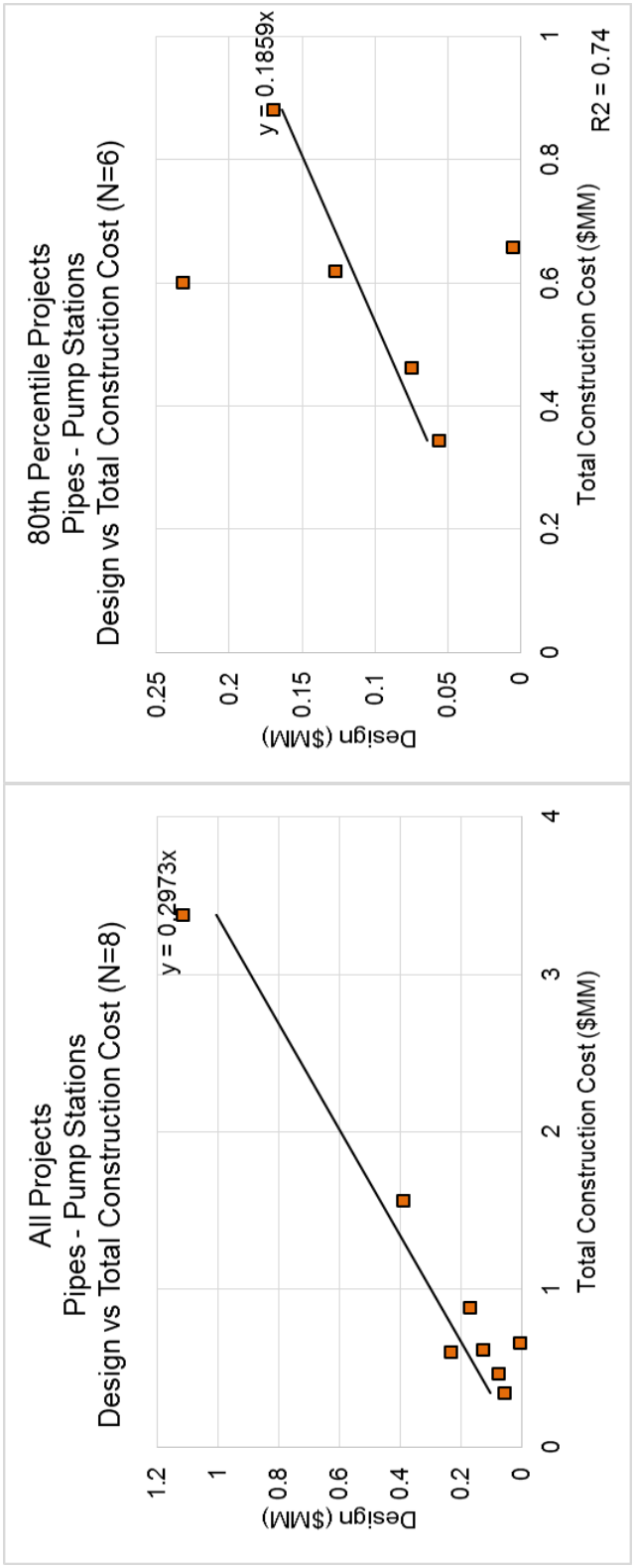

80th Percentile Projects
Streets - Bike/Pedestrian/Streetscapes
Design vs Total Construction Cost (N=43)
y = 0.3176x
R2 = 0.73
Design ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0
0.5
1
1.5
2
All Projects
Streets - Bike/Pedestrian/Streetscapes
Design vs Total Construction Cost (N=54)
y = 0.25x
R2 = 0.84
Design ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0
1
2
3
4
5
6

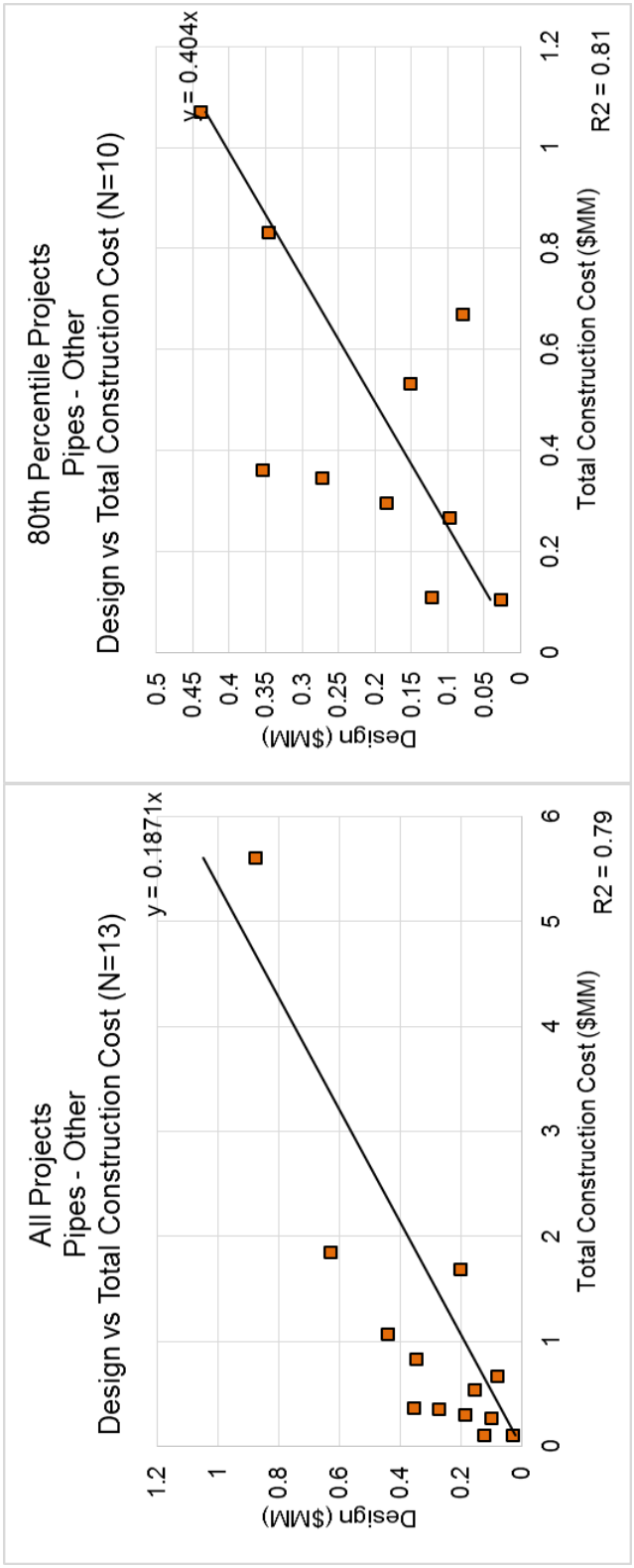

80th Percentile Projects
Streets - Signals
Design vs Total Construction Cost (N=19)
y = 0.4753x
R2 = 0.78
Design ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.2
0.4
0.6
1
All Projects
Streets - Signals
Design vs Total Construction Cost (N=25)
y = 0.2775x
R2 = 0.74
0.5
1.5
2
2.5

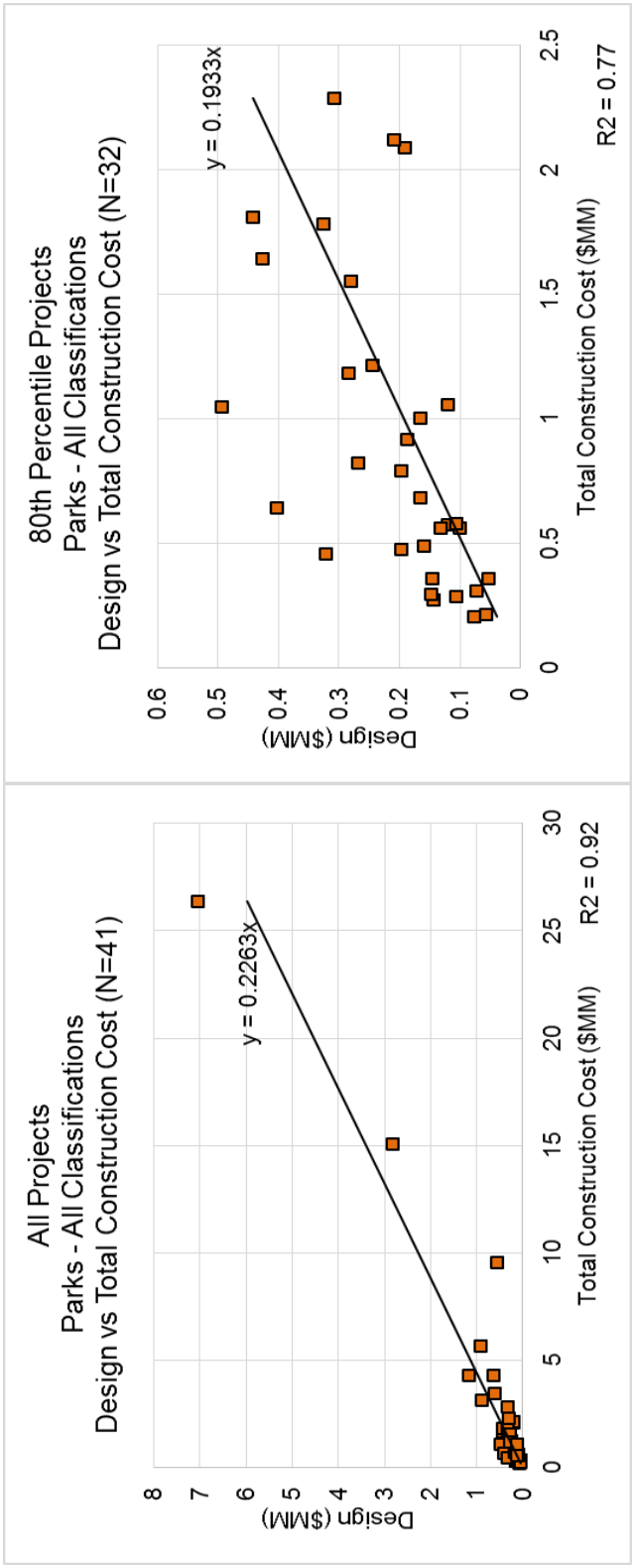

80th Percentile Projects
Pipes - All Classifications
Design vs Total Construction Cost (N=212)
y = 0.2425x
R2 = 0.78
Design ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
0
0.5
1
1.5
2
2.5
3
All Projects
Pipes - All Classifications
Design vs Total Construction Cost (N=266)
y = 0.1728x
R2 = 0.75
Design ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
3
3.5
0
2
4
6
8
10
12
14

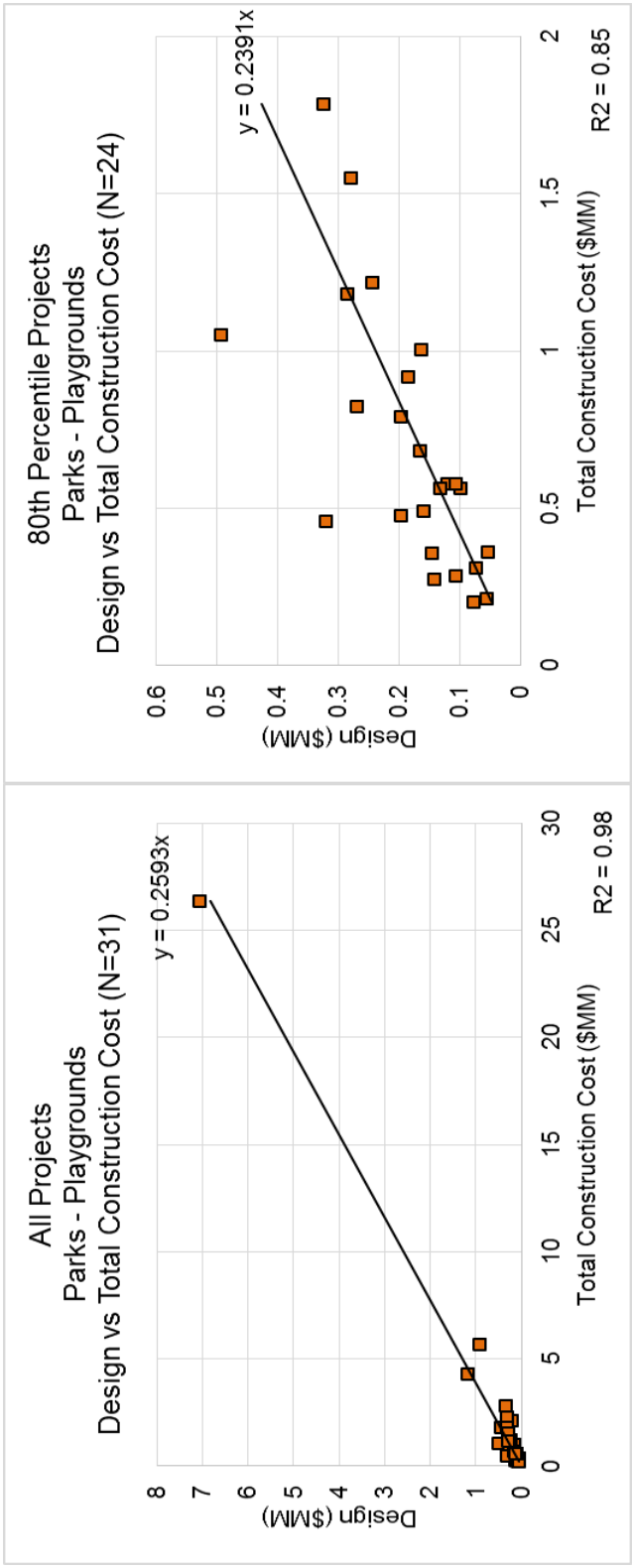

80th Percentile Projects
Pipes - Gravity Mains
Design vs Total Construction Cost (N=160)
y = 0.25x
R2 = 0.8
Design ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
0.5
1
1.5
2
2.5
All Projects
Pipes - Gravity Mains
Design vs Total Construction Cost (N=201)
y = 0.1702x
R2 = 0.75
Design ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
3
3.5
0
2
4
6
8
10
12
14

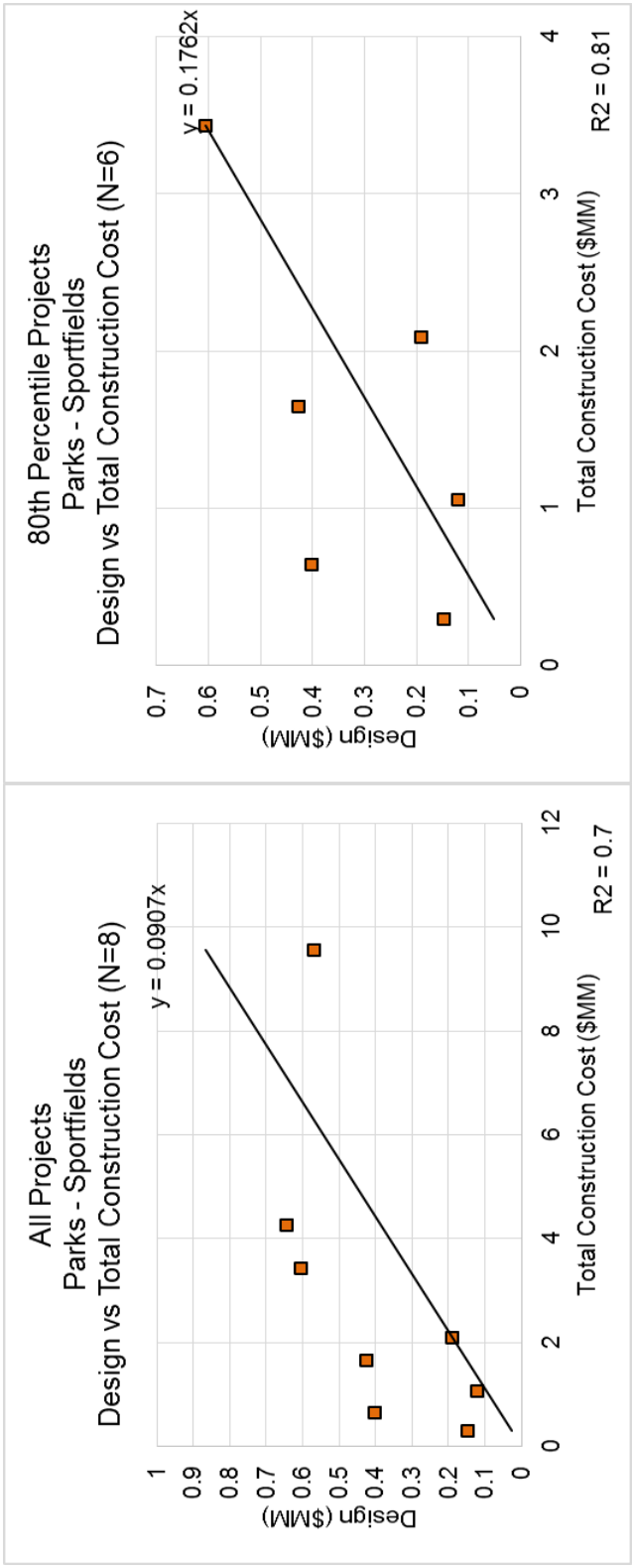

80th Percentile Projects
Pipes - Pressure Systems
Design vs Total Construction Cost (N=35)
y = 0.2192x
R2 = 0.66
Design ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
0
0.5
1
1.5
2
2.5
3
3.5
All Projects
Pipes - Pressure Systems
Design vs Total Construction Cost (N=44)
y = 0.179x
R2 = 0.74
Design ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
0
1
2
3
4
5
6
7

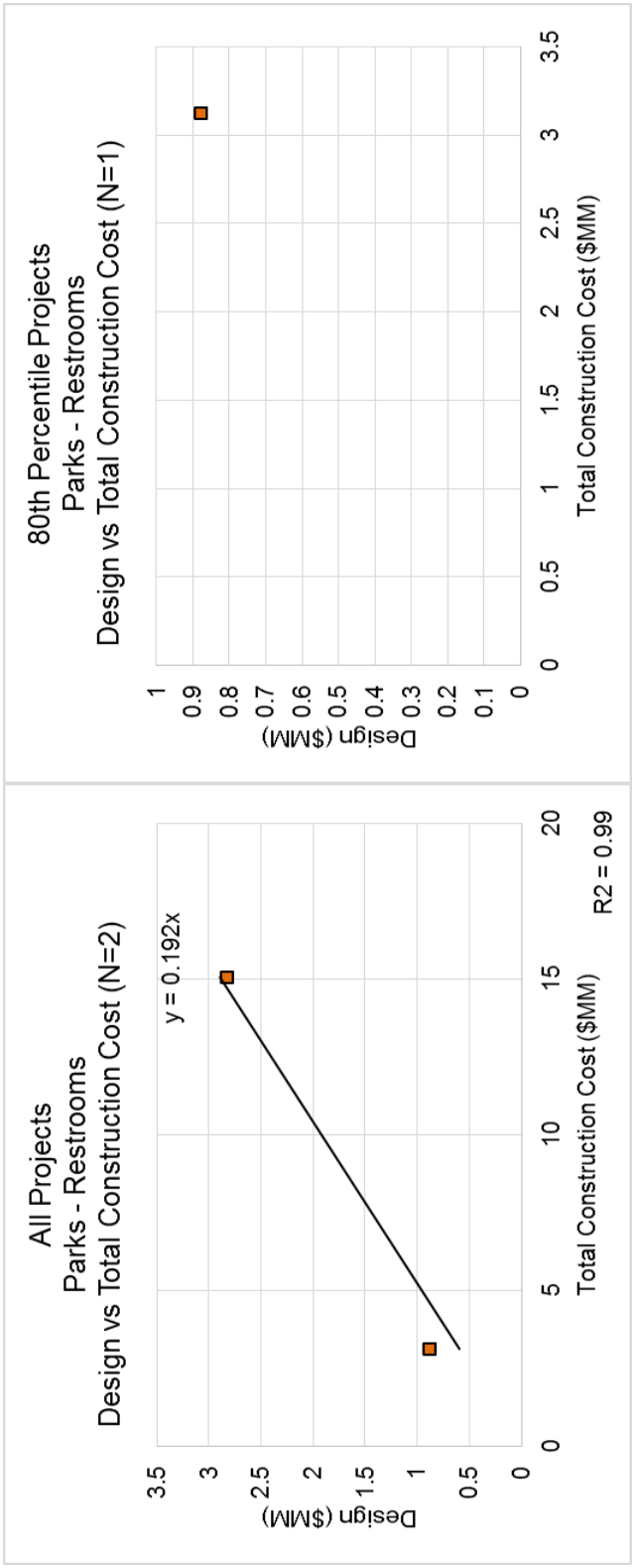

80th Percentile Projects
Pipes - Pump Stations
Design vs Total Construction Cost (N=6)
y = 0.1859x
R2 = 0.74
Design ($MM)
Total Construction Cost ($MM)
0
0.05
0.1
0.15
0.2
0.25
0.2
0.4
0.6
0.8
1
All Projects
Pipes - Pump Stations
Design vs Total Construction Cost (N=8)
y = 0.2973x
Design ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
1
2
3
4


80th Percentile Projects
Pipes - Other
Design vs Total Construction Cost (N=10)
y = 0.404x
R2 = 0.81
Design ($MM)
Total Construction Cost ($MM)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0
0.2
0.4
0.6
0.8
1
1.2
All Projects
Pipes - Other
Design vs Total Construction Cost (N=13)
y = 0.1871x
R2 = 0.79
Design ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
0
1
2
3
4
5
6


80th Percentile Projects
Parks - All Classifications
Design vs Total Construction Cost (N=32)
y = 0.1933x
R2 = 0.77
Design ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0
0.5
1
1.5
2
2.5
All Projects
Parks - All Classifications
Design vs Total Construction Cost (N=41)
y = 0.2263x
R2 = 0.92
Design ($MM)
Total Construction Cost ($MM)
0
1
2
3
4
5
6
7
8
0
5
10
15
20
25
30


80th Percentile Projects
Parks - Playgrounds
Design vs Total Construction Cost (N=24)
y = 0.2391x
R2 = 0.85
Design ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0
0.5
1
1.5
2
All Projects
Parks - Playgrounds
Design vs Total Construction Cost (N=31)
y = 0.2593x
R2 = 0.98
Design ($MM)
Total Construction Cost ($MM)
0
1
2
3
4
5
6
7
8
0
5
10
15
20
25
30

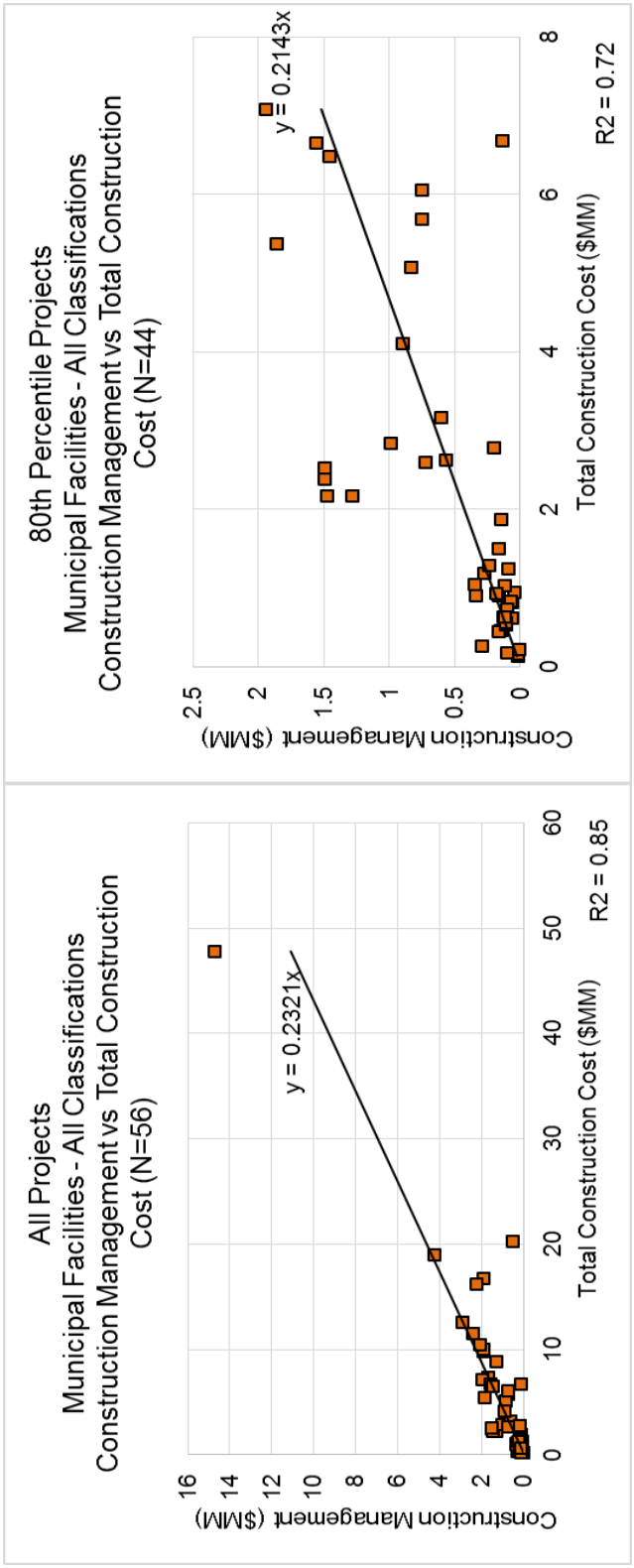

80th Percentile Projects
Parks - Sportfields
Design vs Total Construction Cost (N=6)
y = 0.1762x
R2 = 0.81
Design ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0
1
2
3
4
All Projects
Parks - Sportfields
Design vs Total Construction Cost (N=8)
y = 0.0907x
R2 = 0.7
Design ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
2
4
6
8
10
12

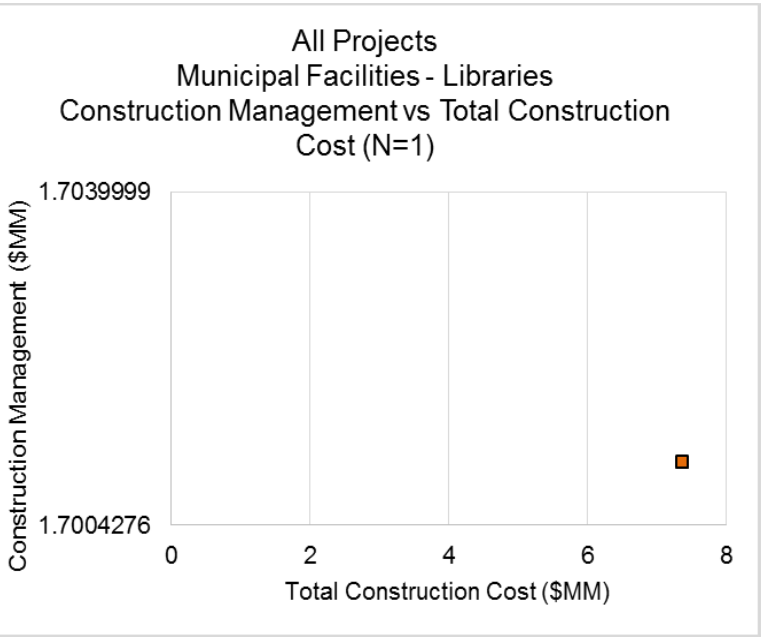

80th Percentile Projects
Parks - Restrooms
Design vs Total Construction Cost (N=1)
Design ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
0.5
1
1.5
2
2.5
3
3.5
All Projects
Parks - Restrooms
Design vs Total Construction Cost (N=2)
y = 0.192x
R2 = 0.99
Design ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
3
3.5
0
5
10
15
20

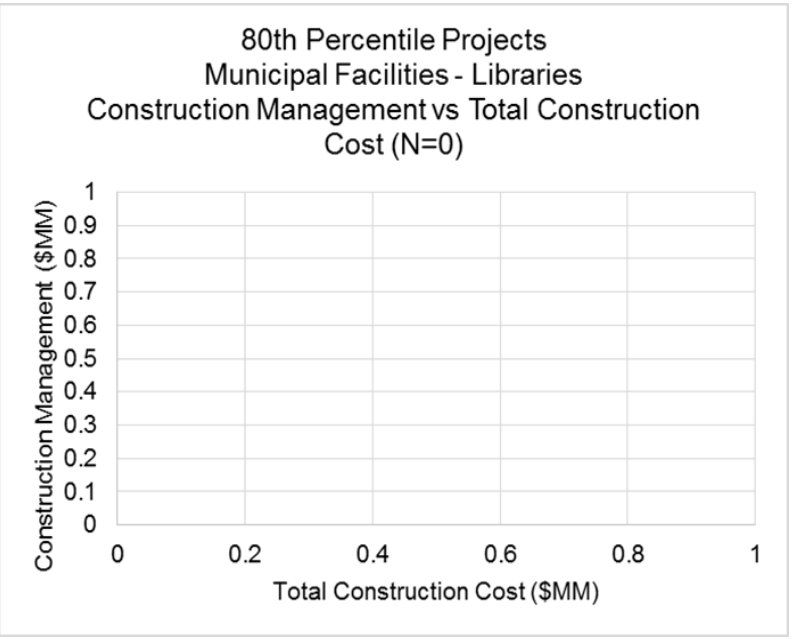
Page Intentionally Left Blank

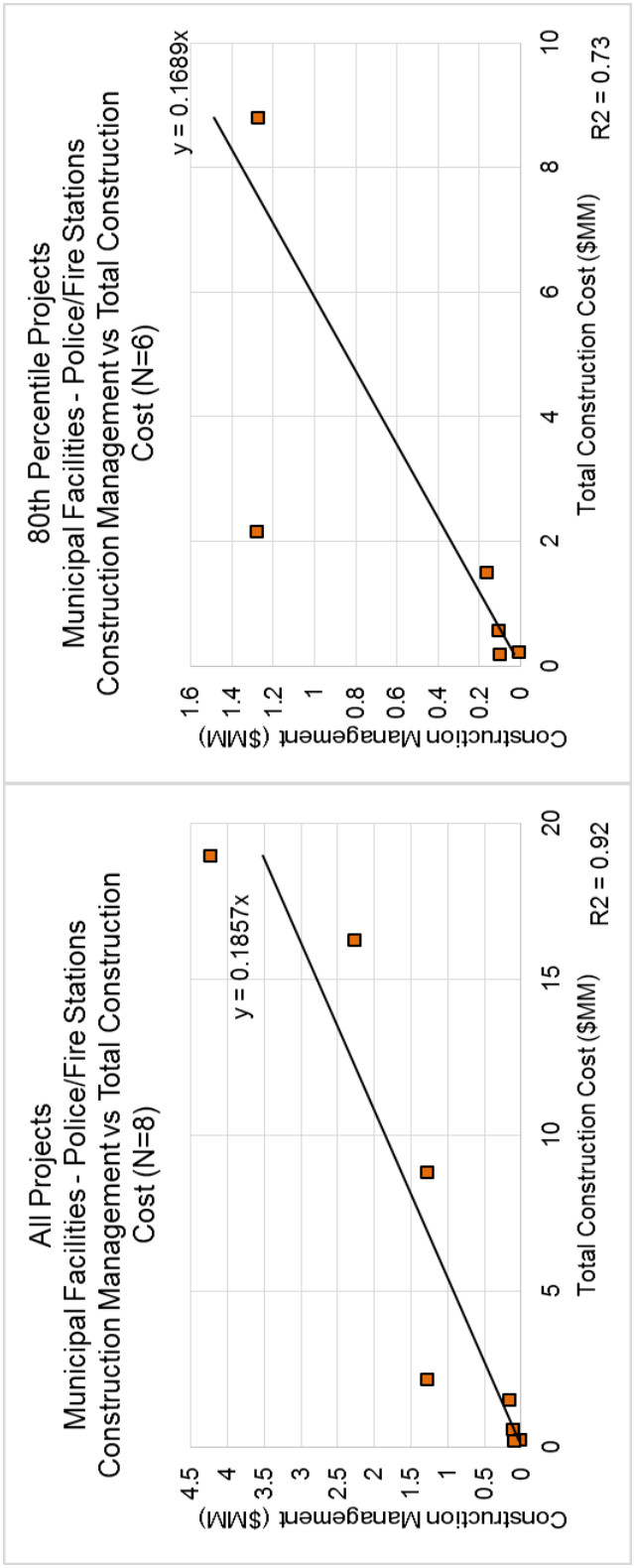
CURVES GROUP 2

Construction Management Cost
vs
Total Construction Cost

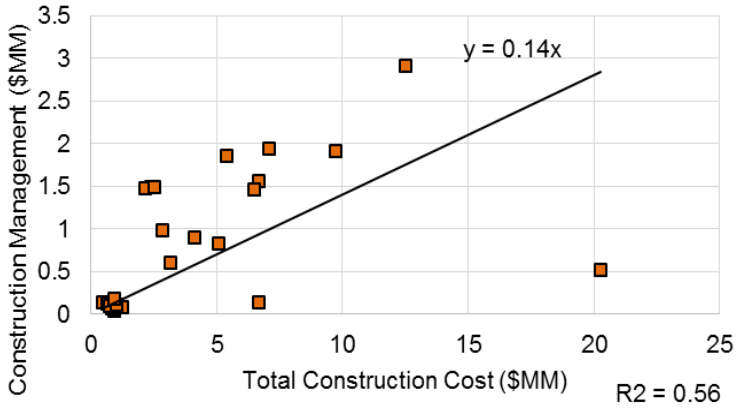

80th Percentile Projects
Municipal Facilities - All Classifications
Construction Management vs Total Construction Cost (N=44)
y = 0.2143x
R2 = 0.72
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
0
2
4
6
8
All Projects
Municipal Facilities - All Classifications
Construction Management vs Total Construction Cost (N=56)
y = 0.2321x
R2 = 0.85
Construction Management ($MM)
Total Construction Cost ($MM)
0
2
4
6
8
10
12
14
16
0
10
20
30
40
50
60


All Projects
Municipal Facilities - Libraries
Construction Management vs Total Construction Cost (N=1)
Construction Management ($MM)
1.7039999
1.7004276
0
2
4
6
8
Total Construction Cost ($MM)

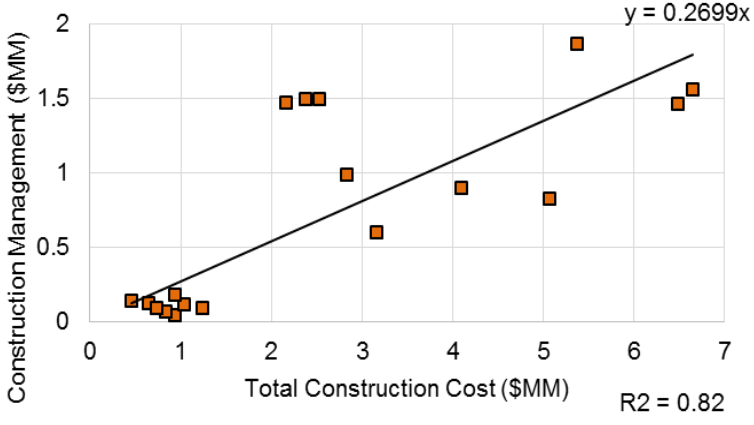

80th Percentile Projects
Municipal Facilities - Libraries
Construction Management vs Total Construction Cost (N=0)
Construction Management ($MM)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.2
0.4
0.6
0.8
1
Total Construction Cost ($MM)

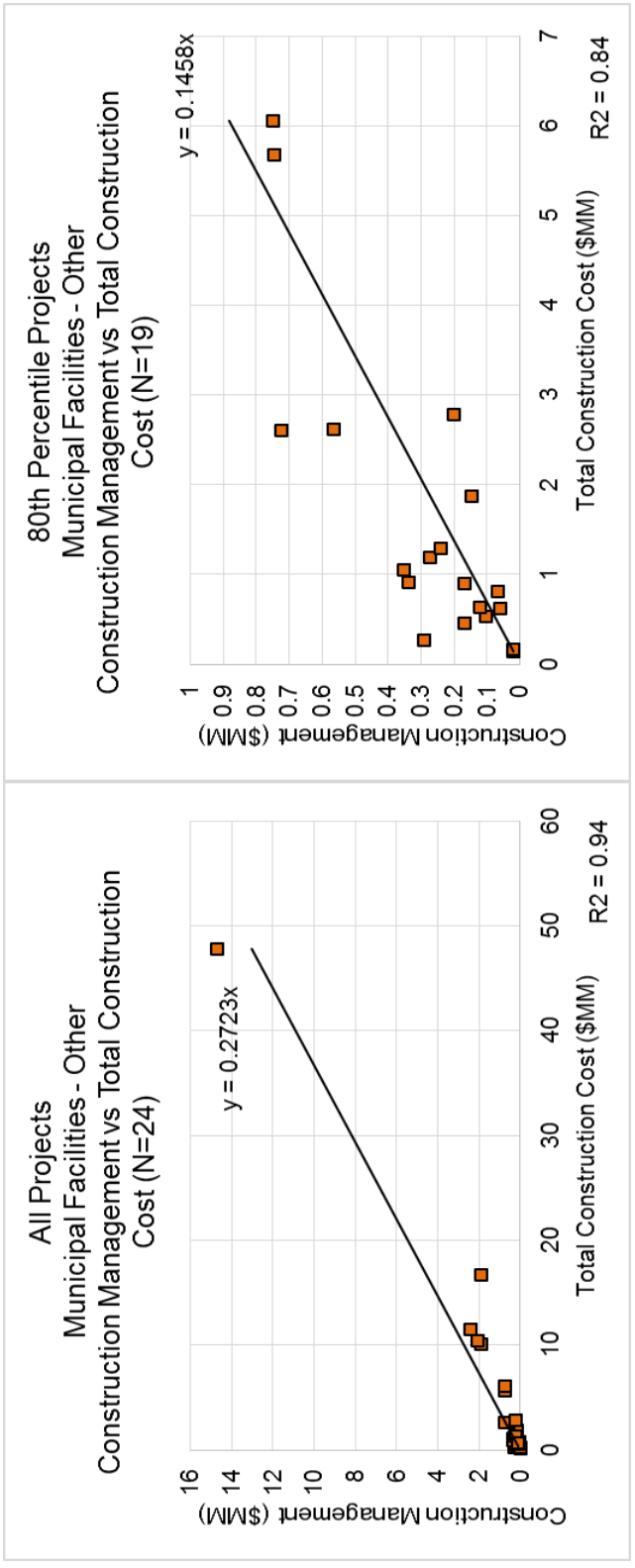

80th Percentile Projects
Municipal Facilities - Police/Fire Stations
Construction Management vs Total Construction Cost (N=6)
y = 0.1689x
R2 = 0.73
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
0
2
4
6
8
10
All Projects
Municipal Facilities - Police/Fire Stations
Construction Management vs Total Construction Cost (N=8)
y = 0.1857x
R2 = 0.92
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
0
5
10
15
20

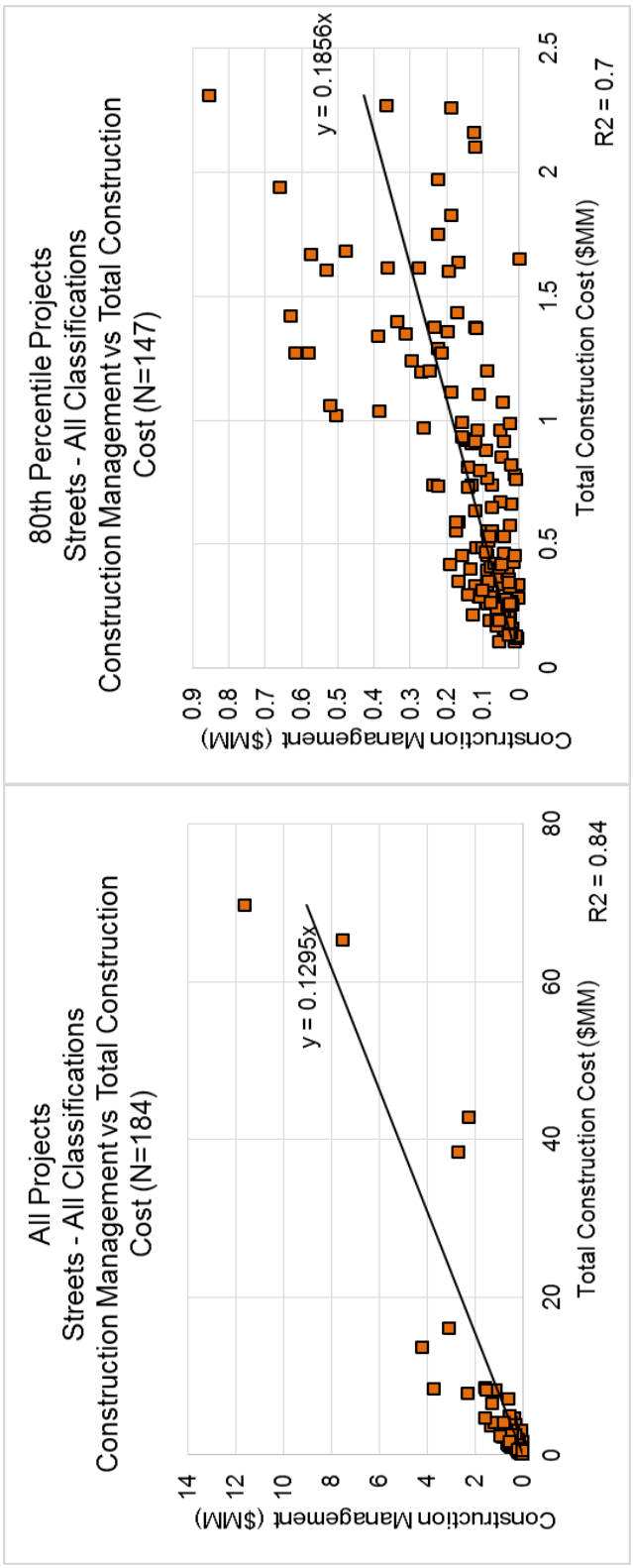
All Projects
Municipal Facilities - Comm./Rec. Center/Child Care/Gyms
Construction Management vs Total Construction Cost (N=23)

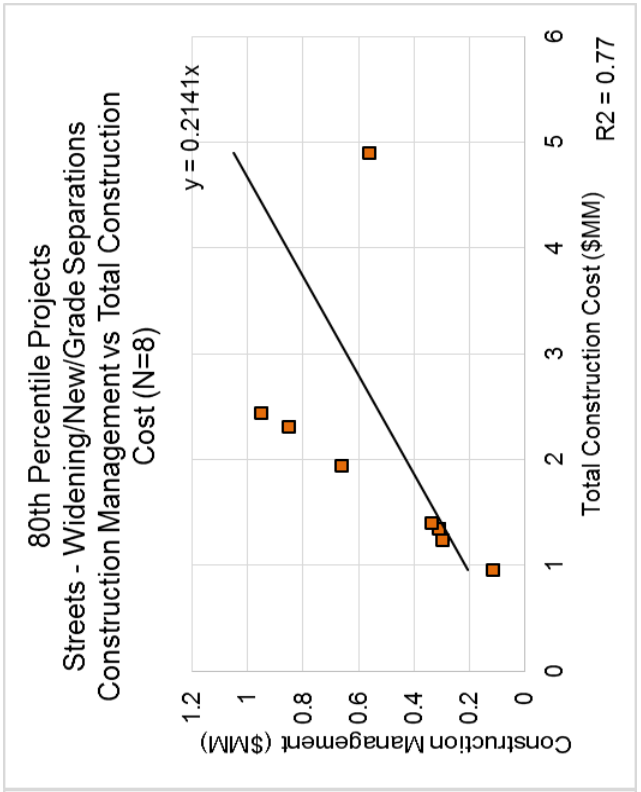


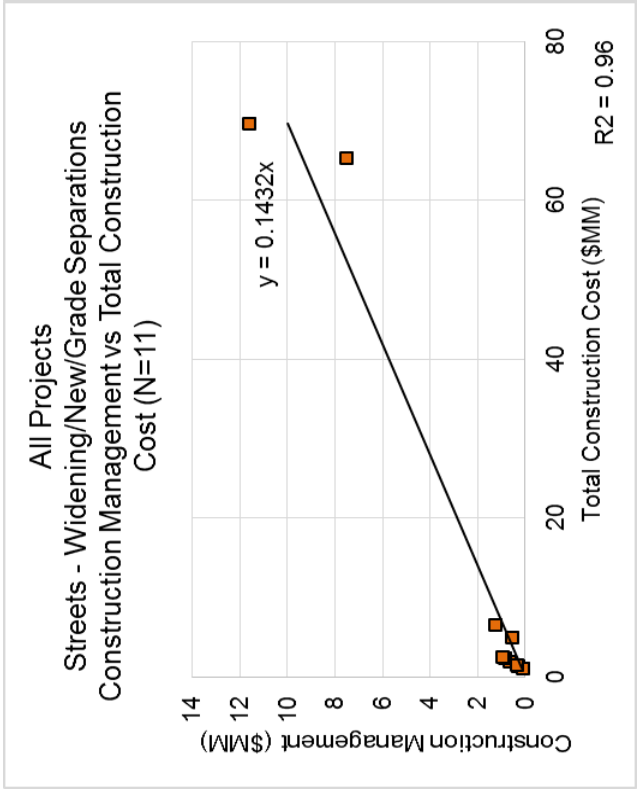
80th Percentile Projects
Municipal Facilities - Comm./Rec. Center/Child Care/Gyms
Construction Management vs Total Construction Cost (N=18)

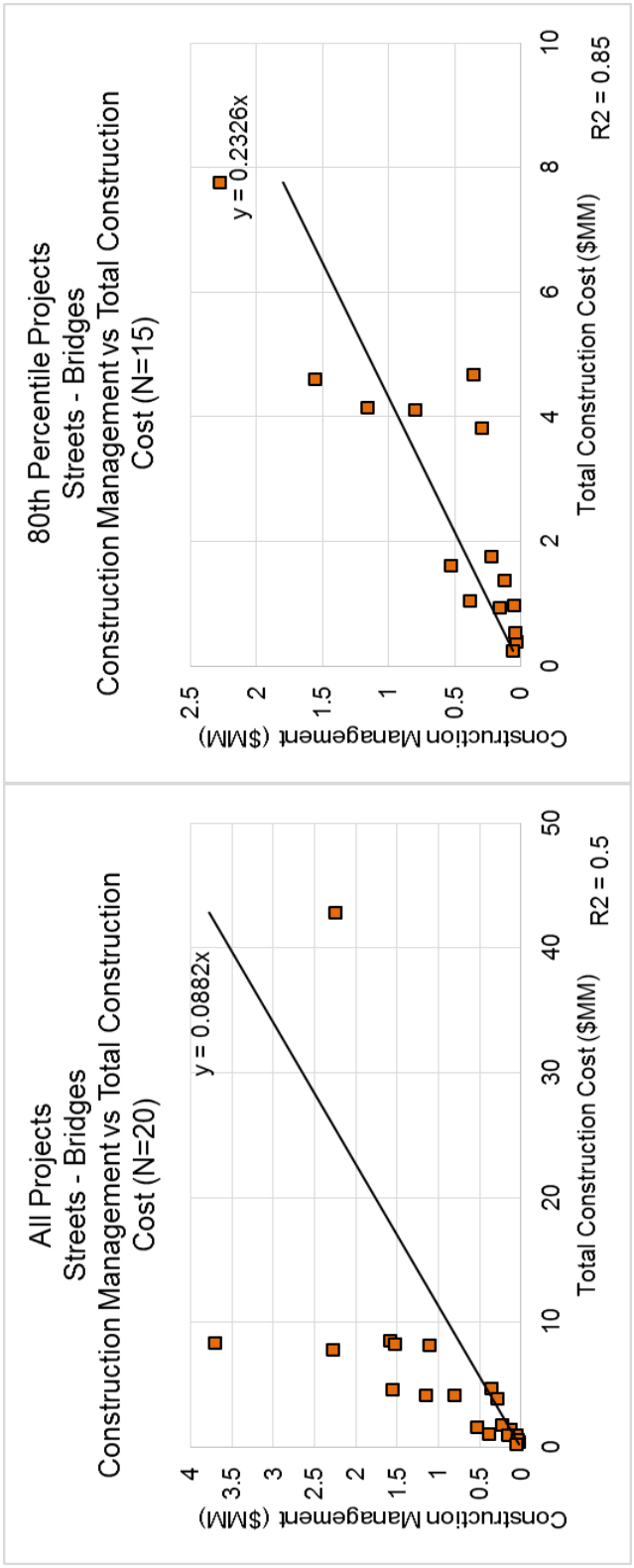


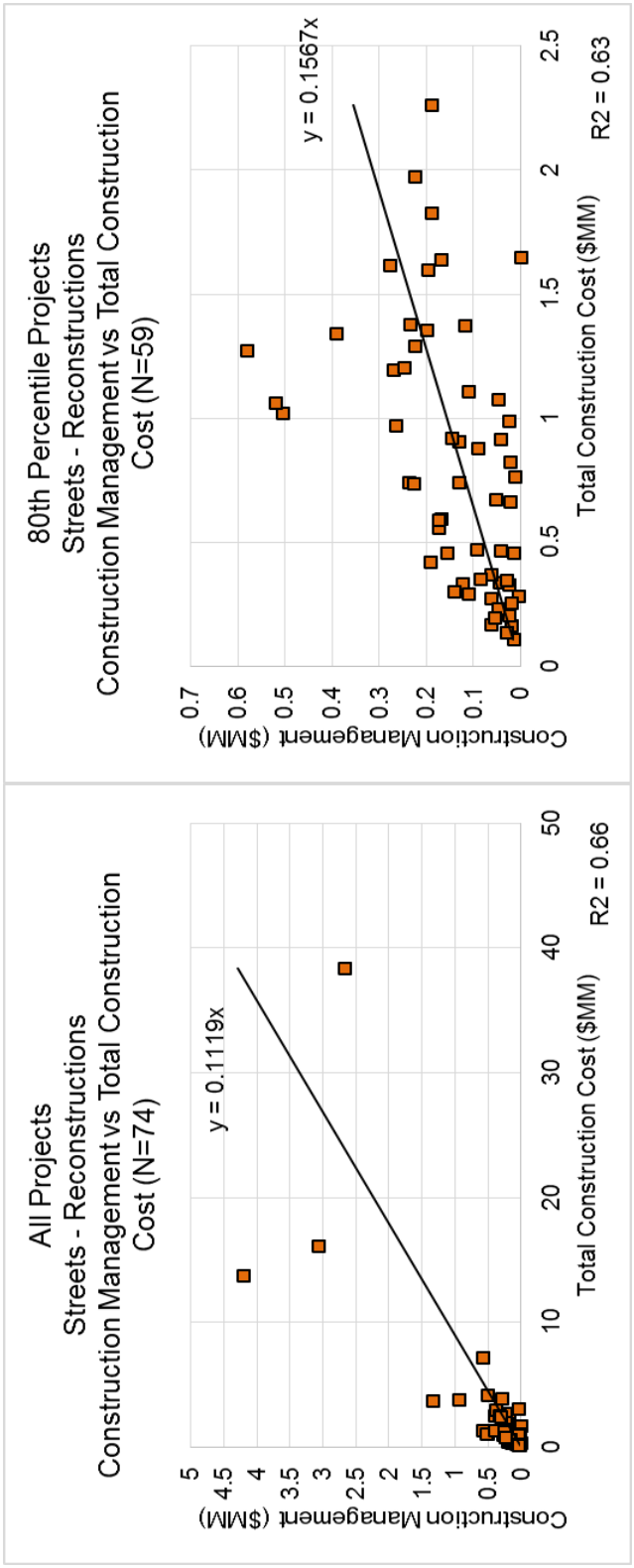

80th Percentile Projects
Municipal Facilities - Other
Construction Management vs Total Construction Cost (N=19)
y = 0.1458x
R2 = 0.84
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
1
2
3
4
5
6
7
All Projects
Municipal Facilities - Other
Construction Management vs Total Construction Cost (N=24)
y = 0.2723x
R2 = 0.94
Construction Management ($MM)
Total Construction Cost ($MM)
0
2
4
6
8
10
12
14
16
0
10
20
30
40
50
60

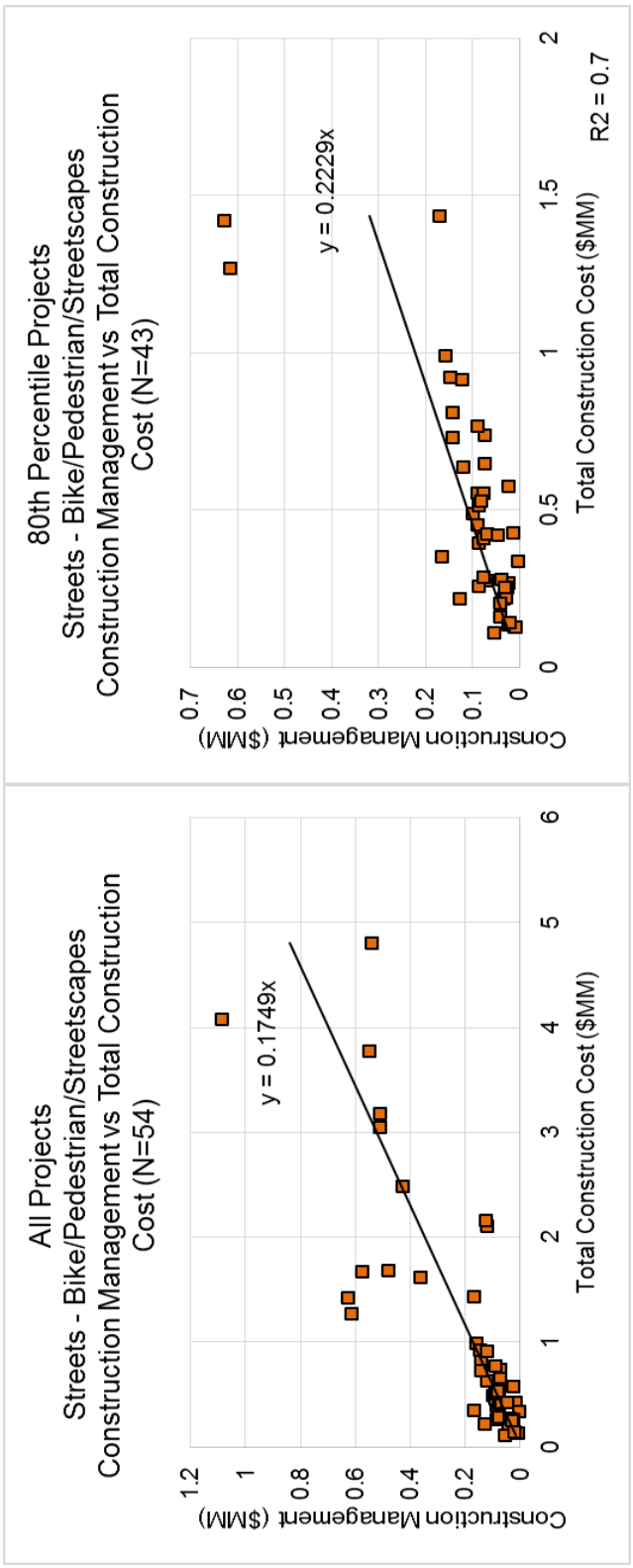

80th Percentile Projects
Streets - All Classifications
Construction Management vs Total Construction Cost (N=147)
Construction Management ($MM)
Total Construction Cost ($MM)
y = 0.1856x
R2 = 0.7
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0
0.5
1
1.5
2
2.5
All Projects
Streets - All Classifications
Construction Management vs Total Construction Cost (N=184)
Construction Management ($MM)
Total Construction Cost ($MM)
y = 0.1295x
R2 = 0.84
0
2
4
6
8
10
12
14
0
20
40
60
80

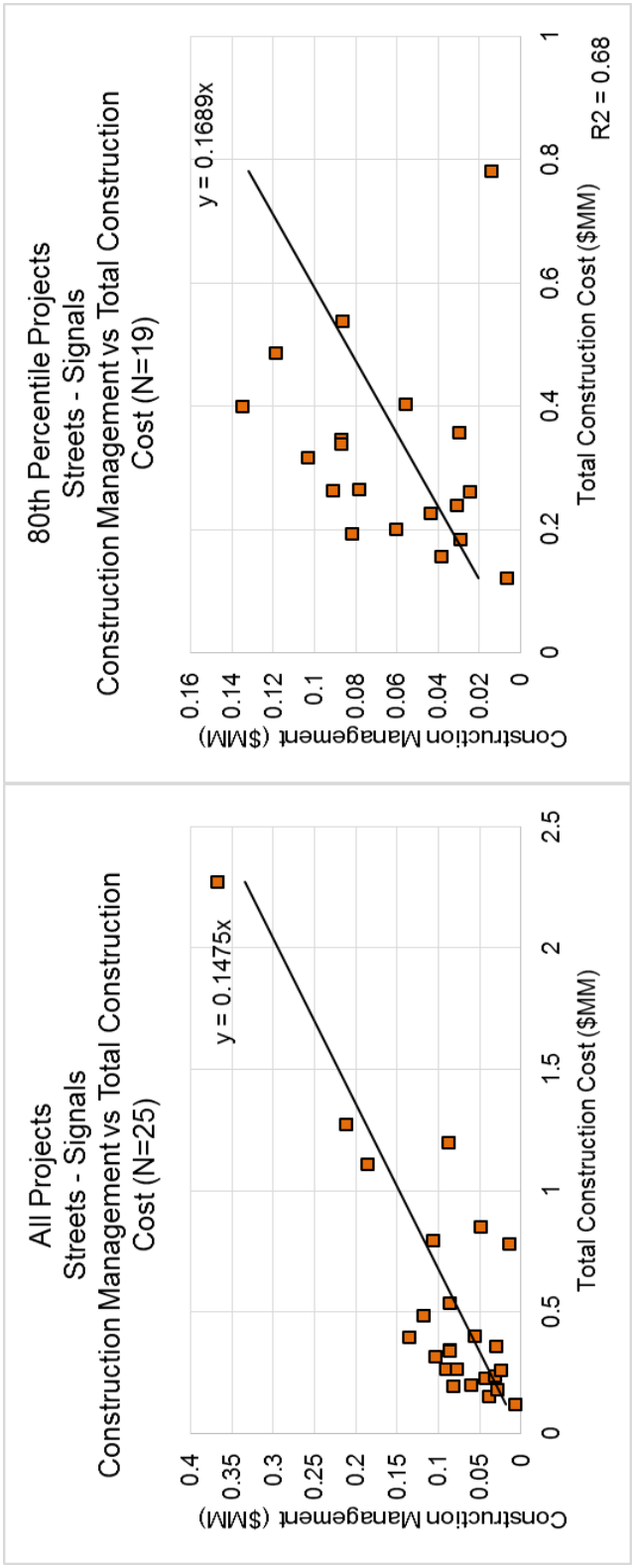

80th Percentile Projects
Streets - Widening/New/Grade Separations
Construction Management vs Total Construction Cost (N=8)
y = 0.2141x
R2 = 0.77
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
0
1
2
3
4
5
6

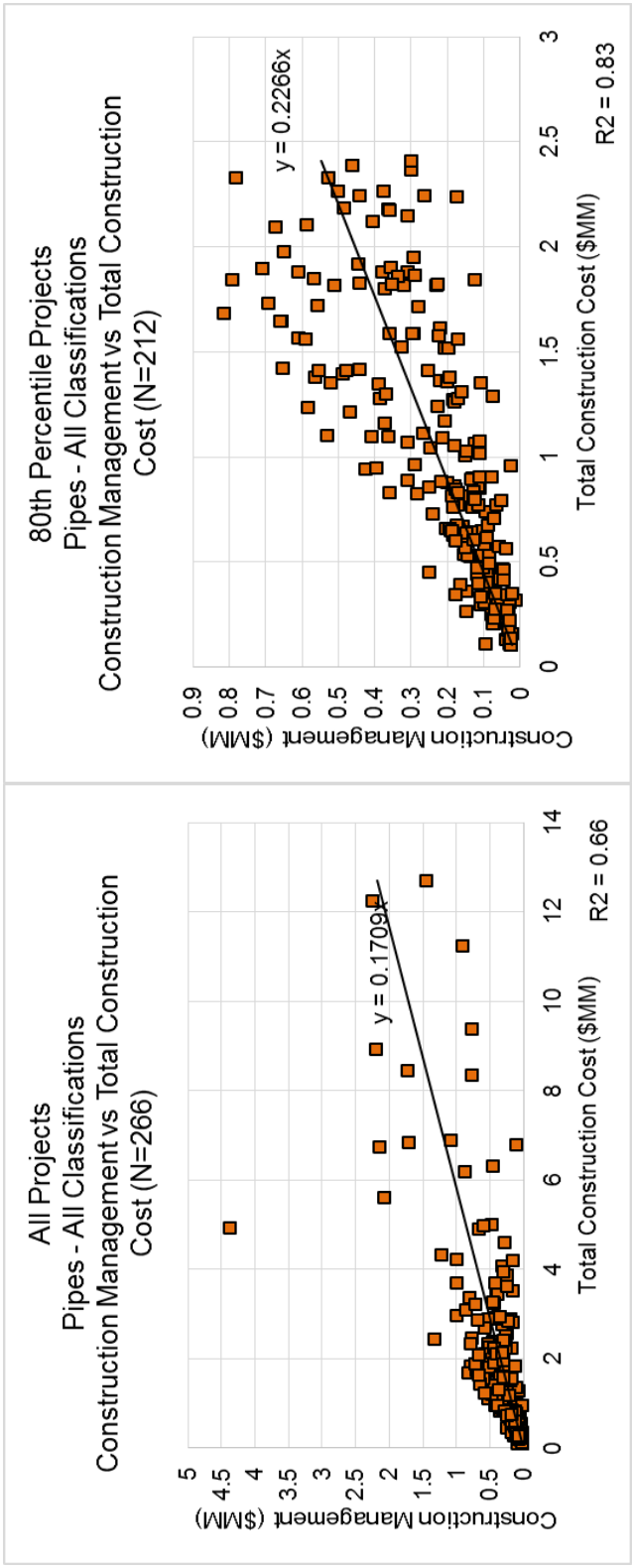

All Projects
Streets - Widening/New/Grade Separations
Construction Management vs Total Construction Cost (N=11)
y = 0.1432x
R2 = 0.96
Construction Management ($MM)
Total Construction Cost ($MM)
0
2
4
6
8
10
12
14
0
20
40
60
80

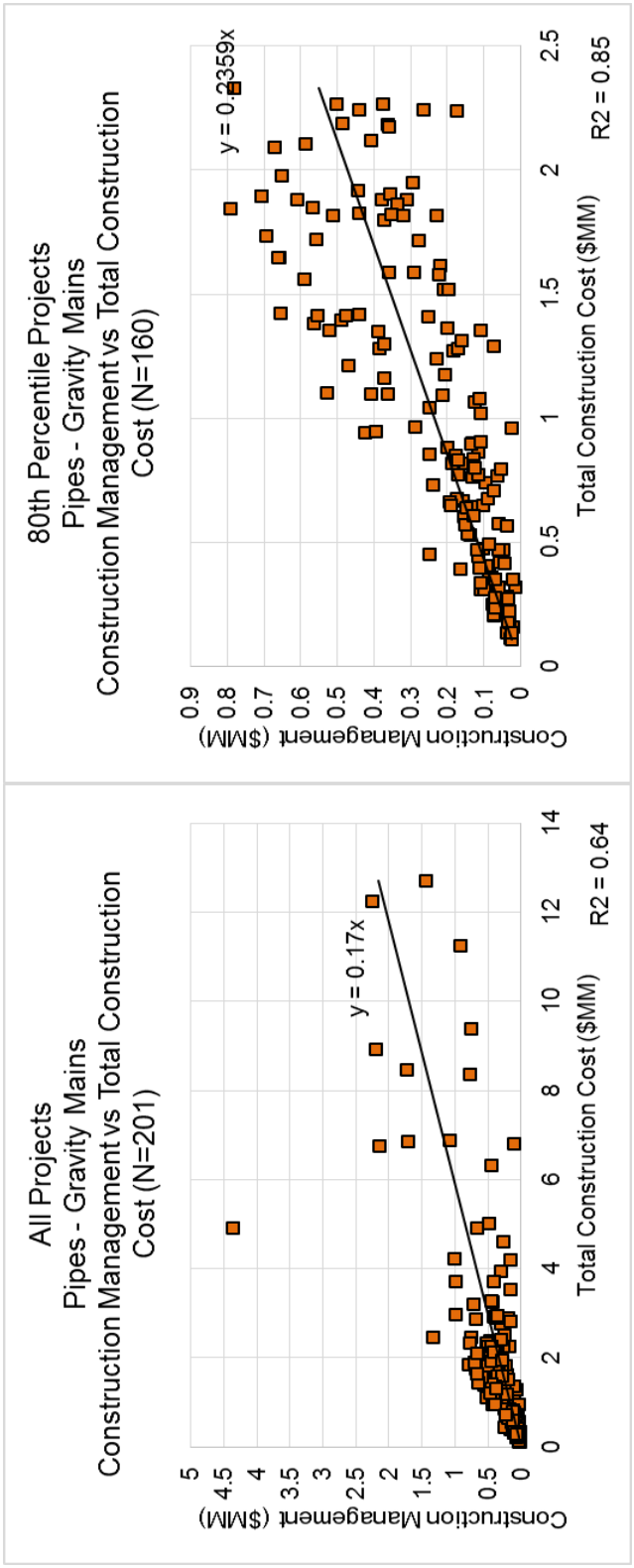

80th Percentile Projects
Streets - Bridges
Construction Management vs Total Construction Cost (N=15)
y = 0.2326x
R2 = 0.85
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
0
2
4
6
8
10
All Projects
Streets - Bridges
Construction Management vs Total Construction Cost (N=20)
y = 0.0882x
R2 = 0.5
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
3
3.5
4
0
10
20
30
40
50

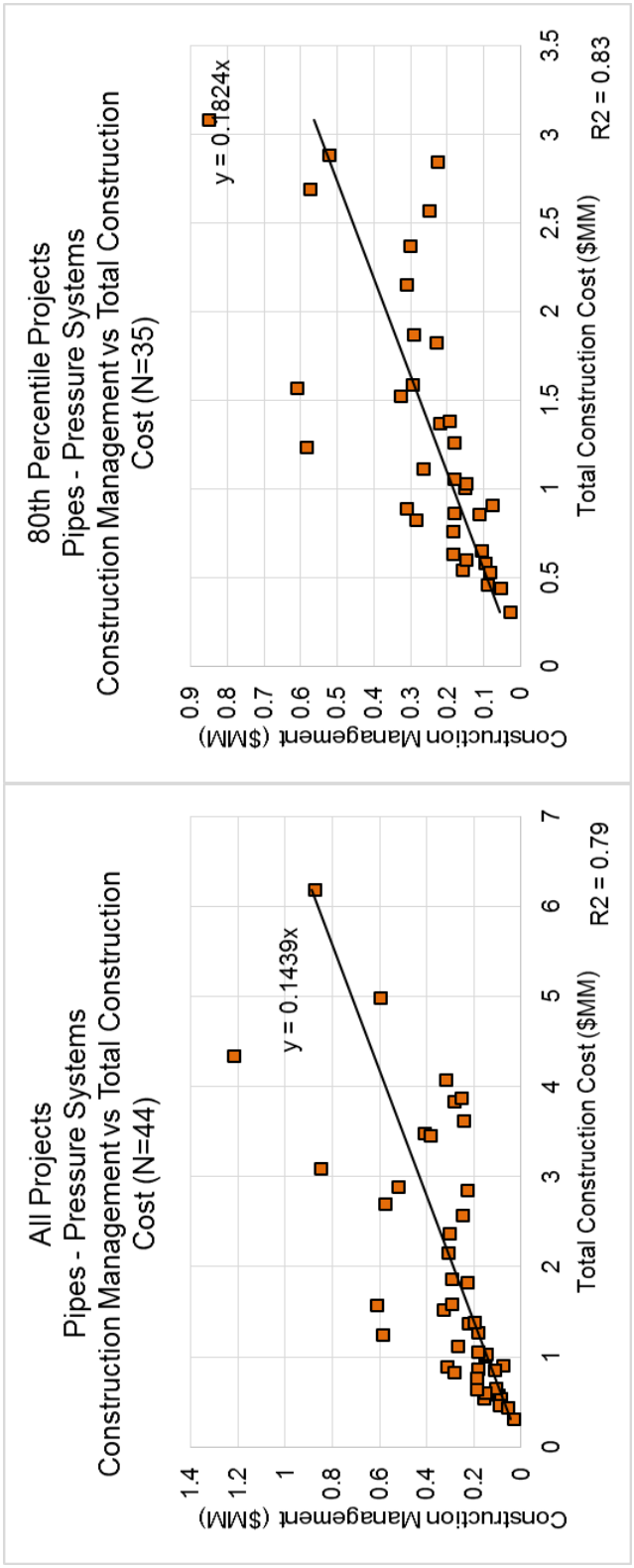

80th Percentile Projects
Streets - Reconstructions
Construction Management vs Total Construction Cost (N=59)
y = 0.1567x
R2 = 0.63
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0
0.5
1
1.5
2
2.5
All Projects
Streets - Reconstructions
Construction Management vs Total Construction Cost (N=74)
y = 0.1119x
R2 = 0.66
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50

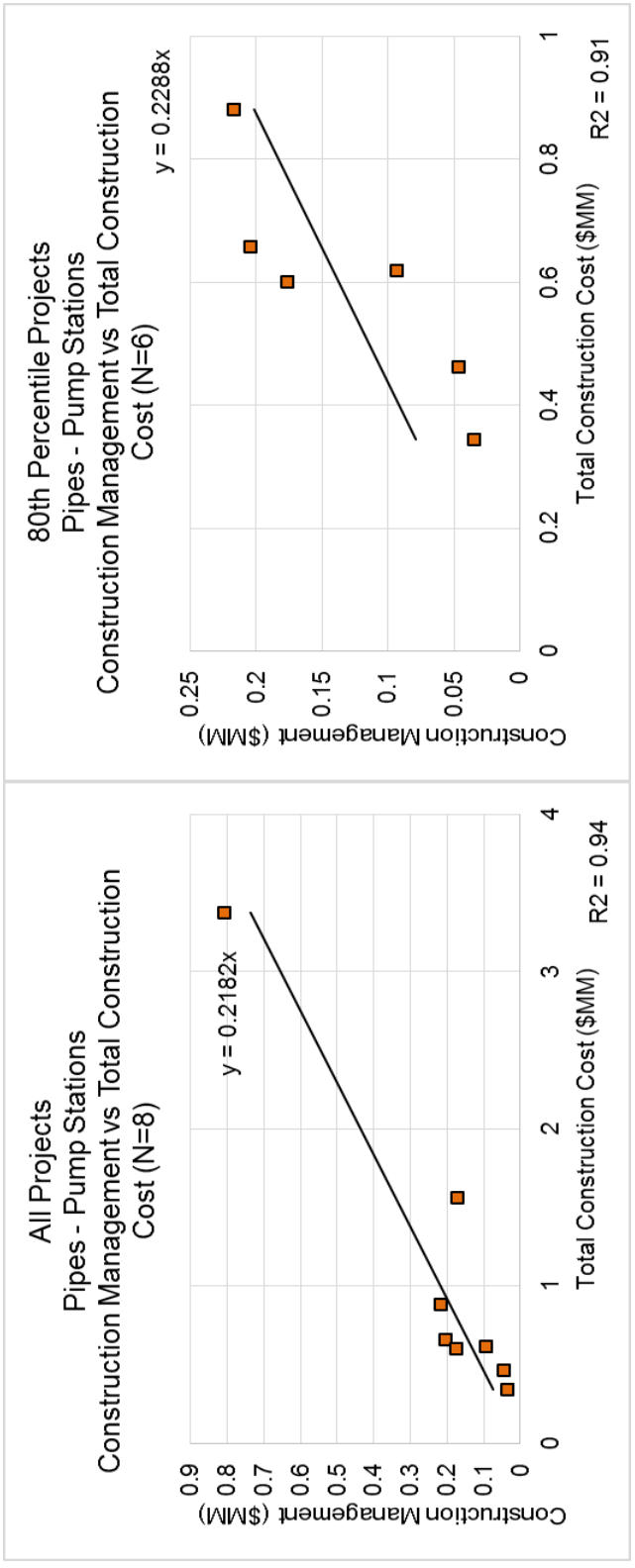

80th Percentile Projects
Streets - Bike/Pedestrian/Streetscapes
Construction Management vs Total Construction Cost (N=43)
y = 0.2229x
R2 = 0.7
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0
0.5
1
1.5
2
All Projects
Streets - Bike/Pedestrian/Streetscapes
Construction Management vs Total Construction Cost (N=54)
y = 0.1749x
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
0
1
2
3
4
5
6

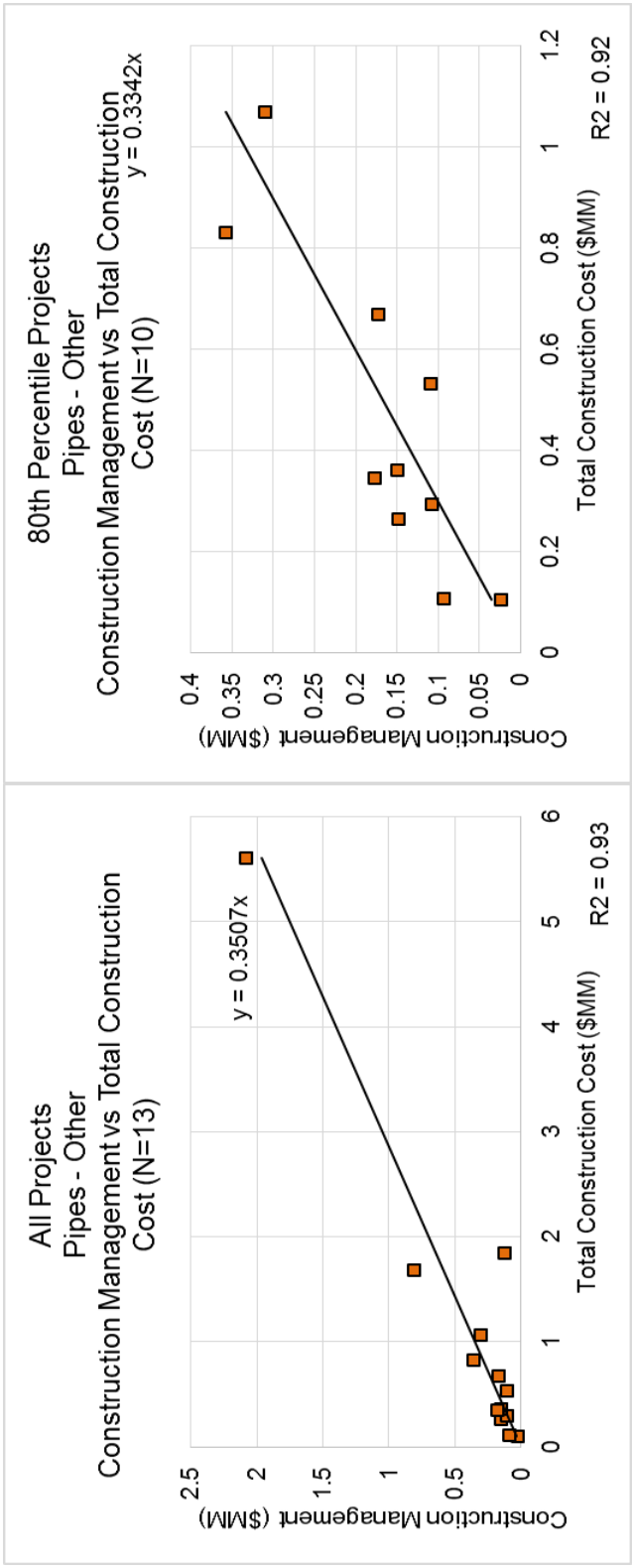

80th Percentile Projects
Streets - Signals
Construction Management vs Total Construction Cost (N=19)
y = 0.1689x
R2 = 0.68
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0
0.2
0.4
0.6
0.8
1
All Projects
Streets - Signals
Construction Management vs Total Construction Cost (N=25)
y = 0.1475x
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0
0.5
1
1.5
2
2.5

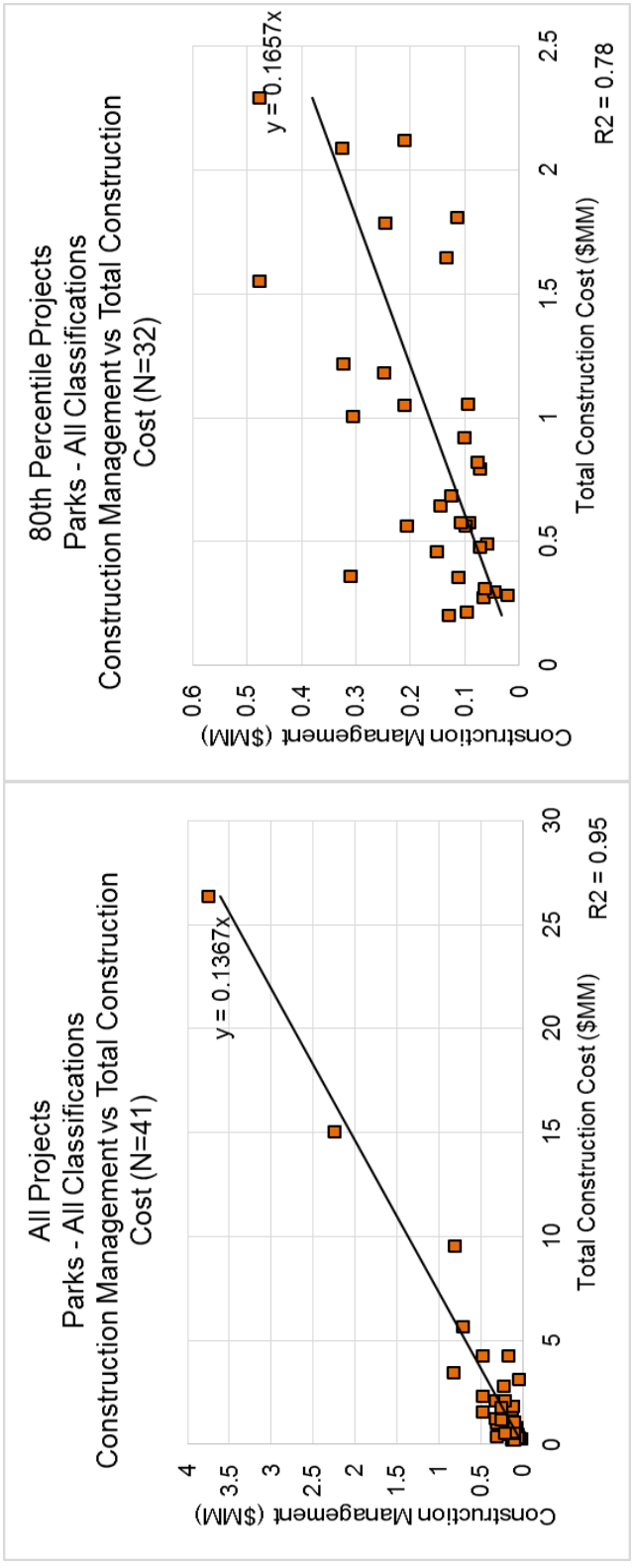

80th Percentile Projects
Pipes - All Classifications
Construction Management vs Total Construction Cost (N=212)
y = 0.2266x
R2 = 0.83
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0
0.5
1
1.5
2
2.5
3
All Projects
Pipes - All Classifications
Construction Management vs Total Construction Cost (N=266)
y = 0.1709x
R2 = 0.66
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
2
4
6
8
10
12
14

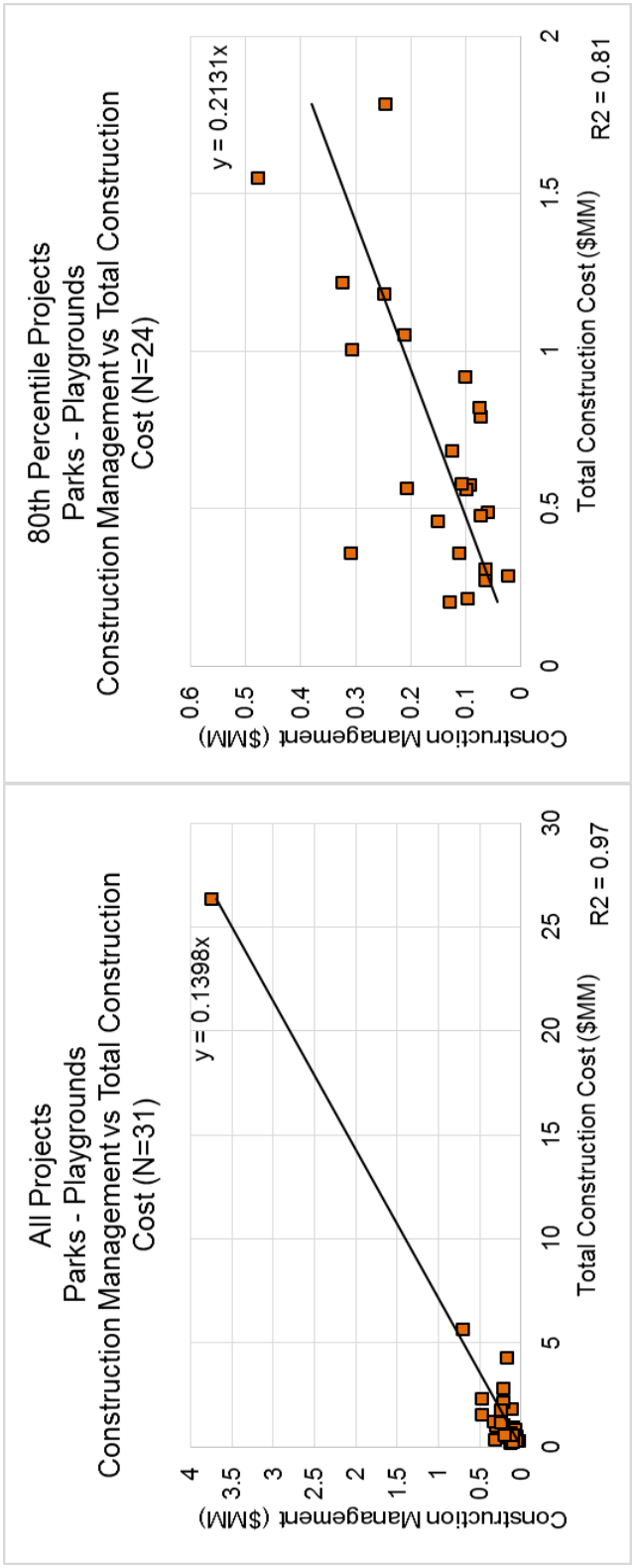

80th Percentile Projects
Pipes - Gravity Mains
Construction Management vs Total Construction Cost (N=160)
y = 0.2359x
R2 = 0.85
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0
0.5
1
1.5
2
2.5
All Projects
Pipes - Gravity Mains
Construction Management vs Total Construction Cost (N=201)
y = 0.17x
R2 = 0.64
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
2
4
6
8
10
12
14

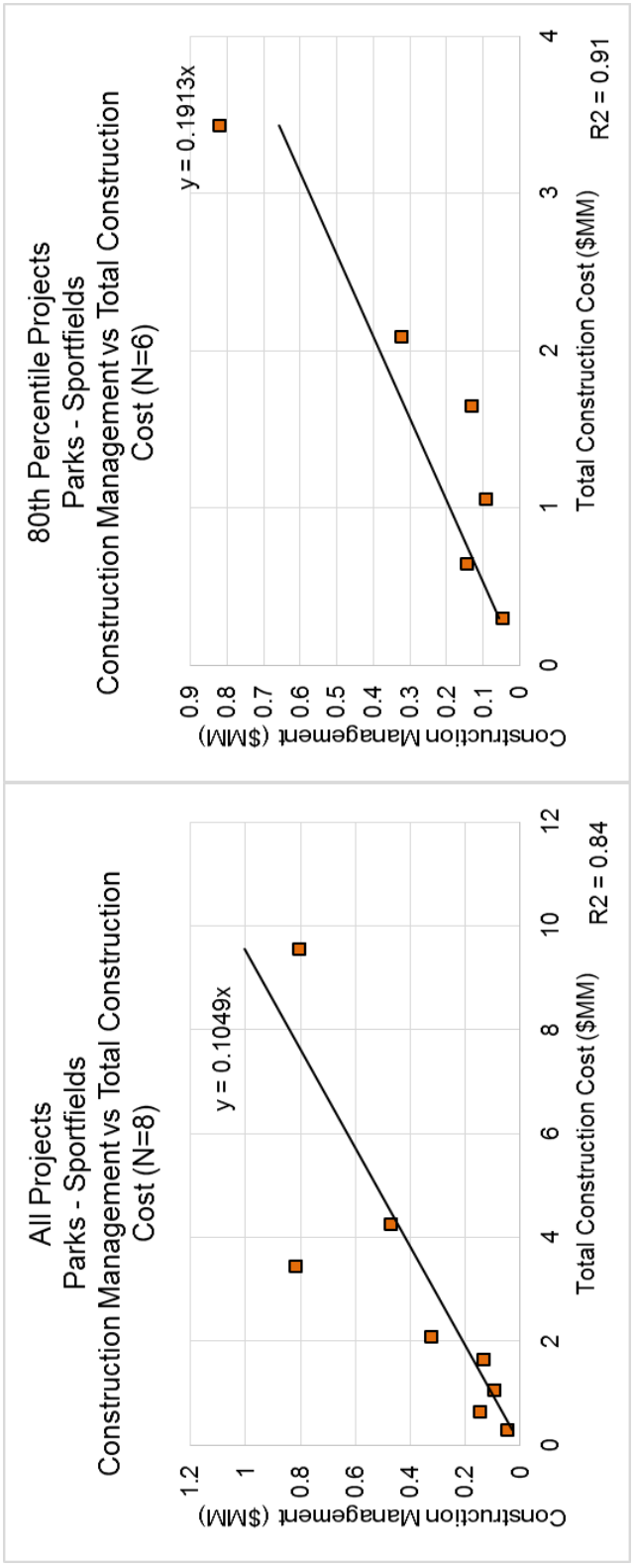

80th Percentile Projects
Pipes - Pressure Systems
Construction Management vs Total Construction Cost (N=35)
y = 0.1824x
R2 = 0.83
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0
0.5
1
1.5
2
2.5
3
3.5
All Projects
Pipes - Pressure Systems
Construction Management vs Total Construction Cost (N=44)
y = 0.1439x
R2 = 0.79
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0
1
2
3
4
5
6
7

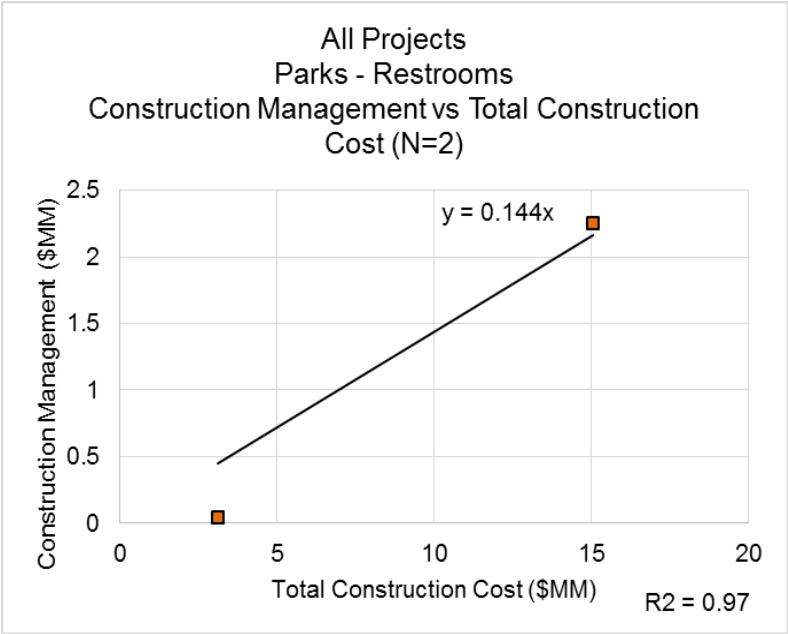

All Projects
Pipes - Pump Stations
Construction Management vs Total Construction Cost (N=8)
y = 0.2182x
R2 = 0.94
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
2
3
4
80th Percentile Projects
Pipes - Pump Stations
Construction Management vs Total Construction Cost (N=6)
y = 0.2288x
R2 = 0.91
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.05
0.1
0.15
0.2
0.25
0.2
0.4
0.6
0.8
1

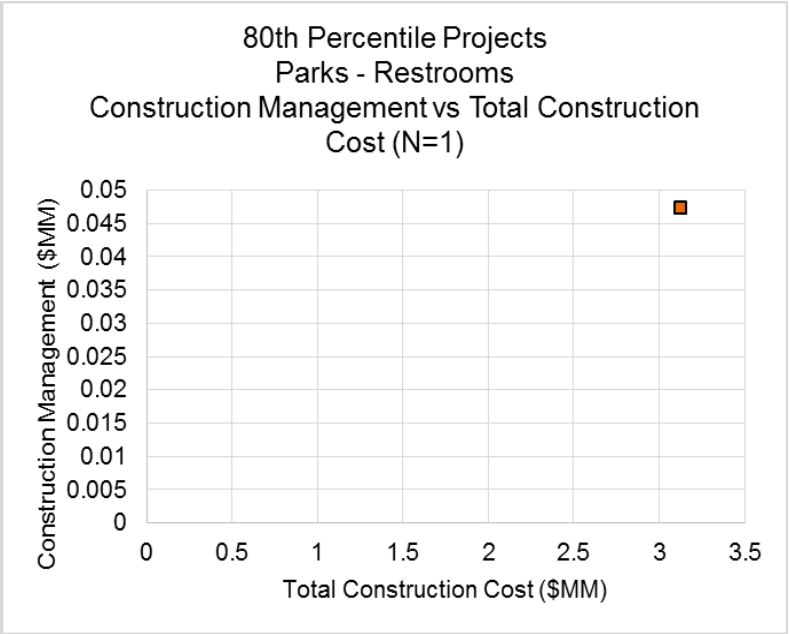

80th Percentile Projects
Pipes - Other
Construction Management vs Total Construction Cost (N=10)
y = 0.3342x
R2 = 0.92
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0
0.2
0.4
0.6
0.8
1
1.2
All Projects
Pipes - Other
Construction Management vs Total Construction Cost (N=13)
y = 0.3507x
R2 = 0.93
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
0
1
2
3
4
5
6


80th Percentile Projects
Parks - All Classifications
Construction Management vs Total Construction Cost (N=32)
y = 0.1657x
R2 = 0.78
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0
0.5
1
1.5
2
2.5
All Projects
Parks - All Classifications
Construction Management vs Total Construction Cost (N=41)
y = 0.1367x
R2 = 0.95
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
3
3.5
4
0
5
10
15
20
25
30


80th Percentile Projects
Parks - Playgrounds
Construction Management vs Total Construction Cost (N=24)
y = 0.2131x
R2 = 0.81
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0
0.5
1
1.5
2
All Projects
Parks - Playgrounds
Construction Management vs Total Construction Cost (N=31)
y = 0.1398x
R2 = 0.97
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
3
3.5
4
0
5
10
15
20
25
30


80th Percentile Projects
Parks - Sportfields
Construction Management vs Total Construction Cost (N=6)
y = 0.1913x
R2 = 0.91
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0
1
2
3
4
All Projects
Parks - Sportfields
Construction Management vs Total Construction Cost (N=8)
y = 0.1049x
R2 = 0.84
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
0
2
4
6
8
10
12

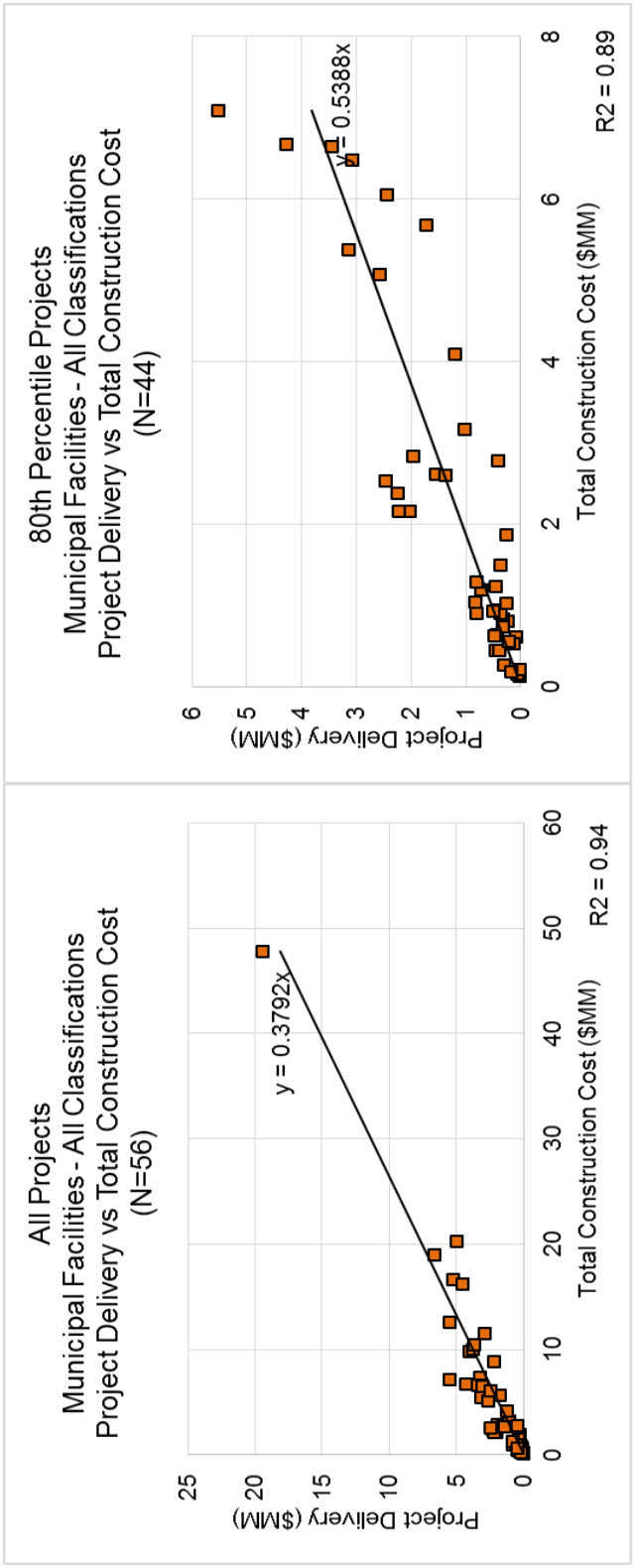

All Projects
Parks - Restrooms
Construction Management vs Total Construction Cost (N=2)
y = 0.144x
Construction Management ($MM)
Total Construction Cost ($MM)
R2 = 0.97
0
0.5
1
1.5
2
2.5
0
5
10
15
20

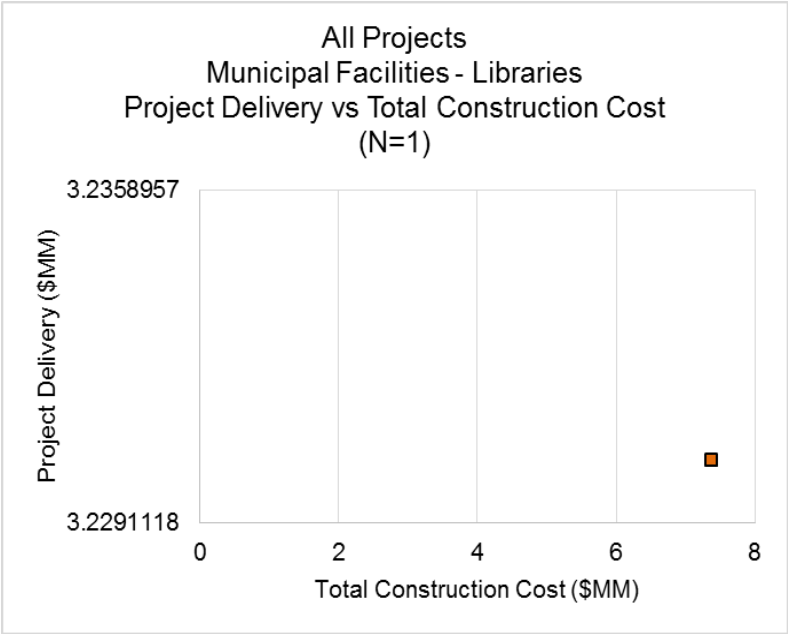

80th Percentile Projects
Parks - Restrooms
Construction Management vs Total Construction Cost (N=1)
Construction Management ($MM)
Total Construction Cost ($MM)
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
0.04
0.045
0.05
0
0.5
1
1.5
2
2.5
3
3.5

Page Intentionally Left Blank

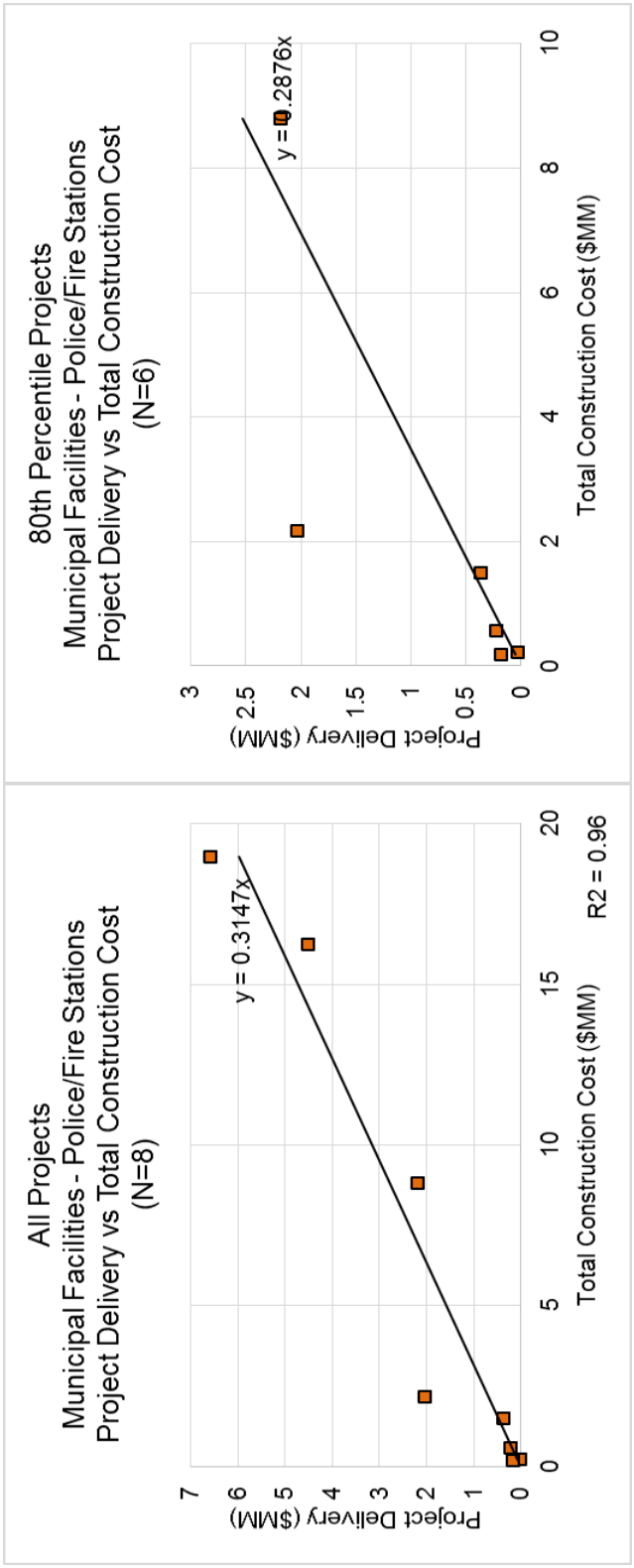
CURVES GROUP 3

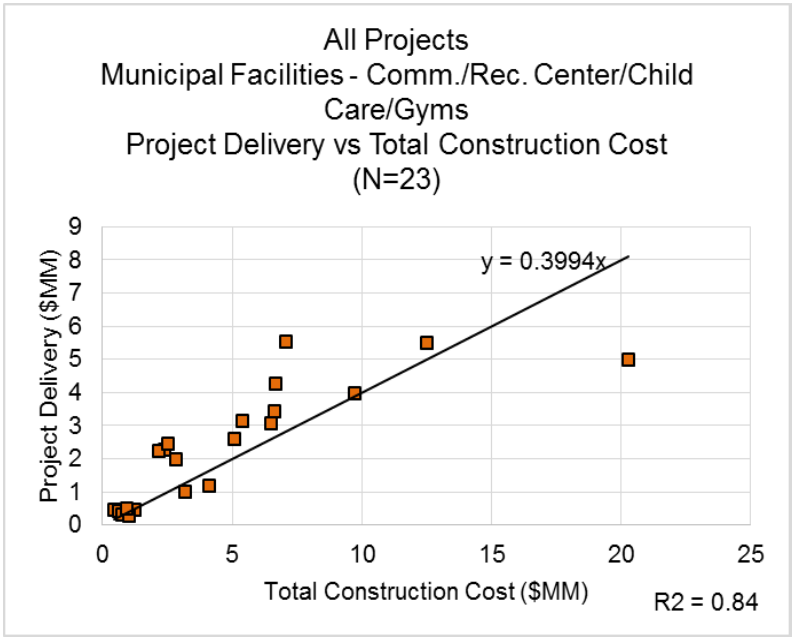
Project Delivery Cost
vs
Total Construction Cost

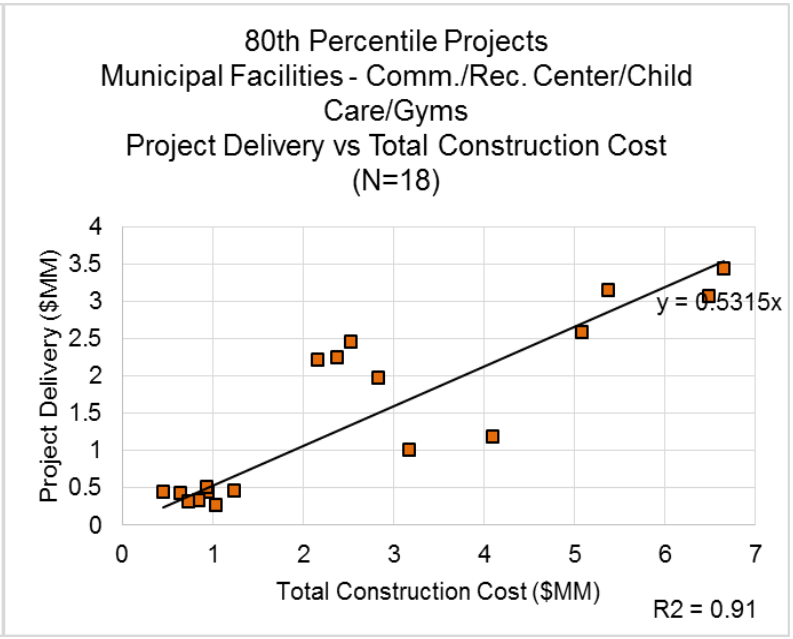

80th Percentile Projects
Municipal Facilities - All Classifications
Project Delivery vs Total Construction Cost
(N=44)
y = 0.5388x
R2 = 0.89
Project Delivery ($MM)
Total Construction Cost ($MM)
0
1
2
3
4
5
6
0
2
4
6
8
All Projects
Municipal Facilities - All Classifications
Project Delivery vs Total Construction Cost
(N=56)
y = 0.3792x
R2 = 0.94
Project Delivery ($MM)
Total Construction Cost ($MM)
0
5
10
15
20
25
0
10
20
30
40
50
60

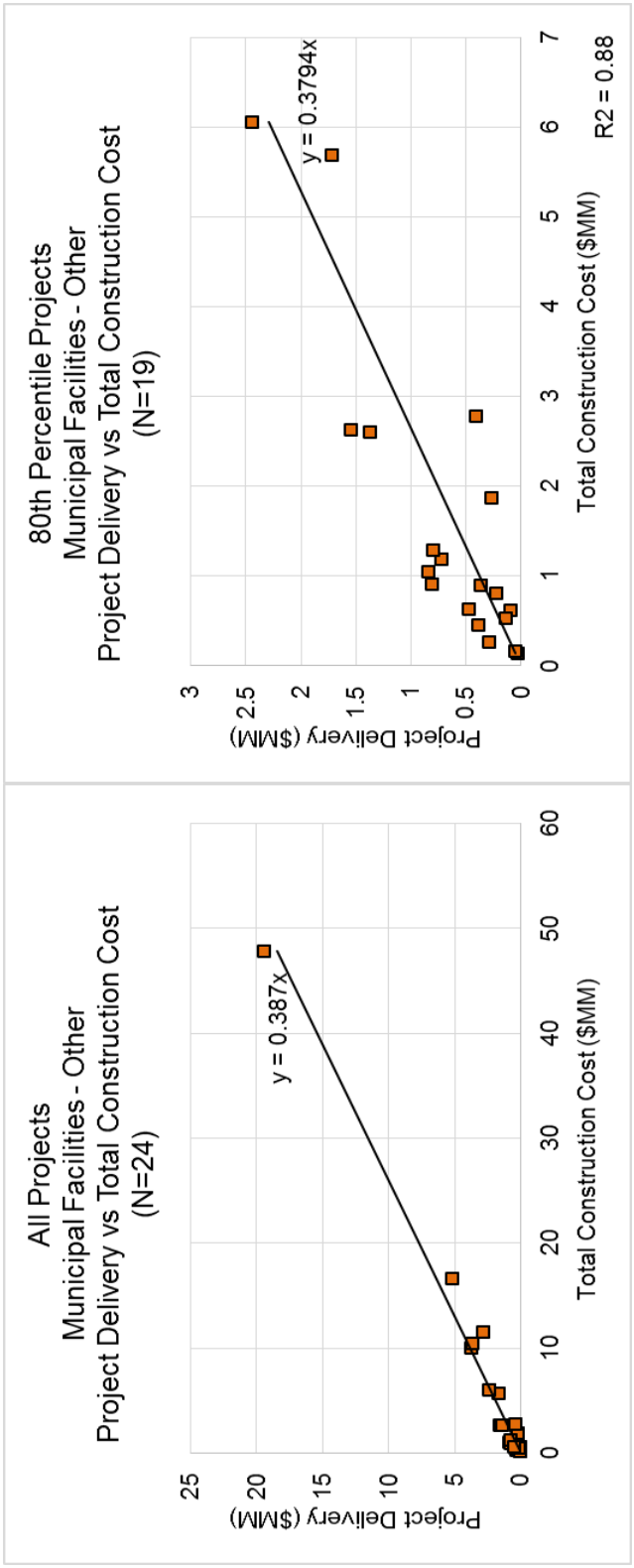

All Projects
Municipal Facilities - Libraries
Project Delivery vs Total Construction Cost
(N=1)
3.2358957
3.2291118
Project Delivery ($MM)
0
2
4
6
8
Total Construction Cost ($MM)

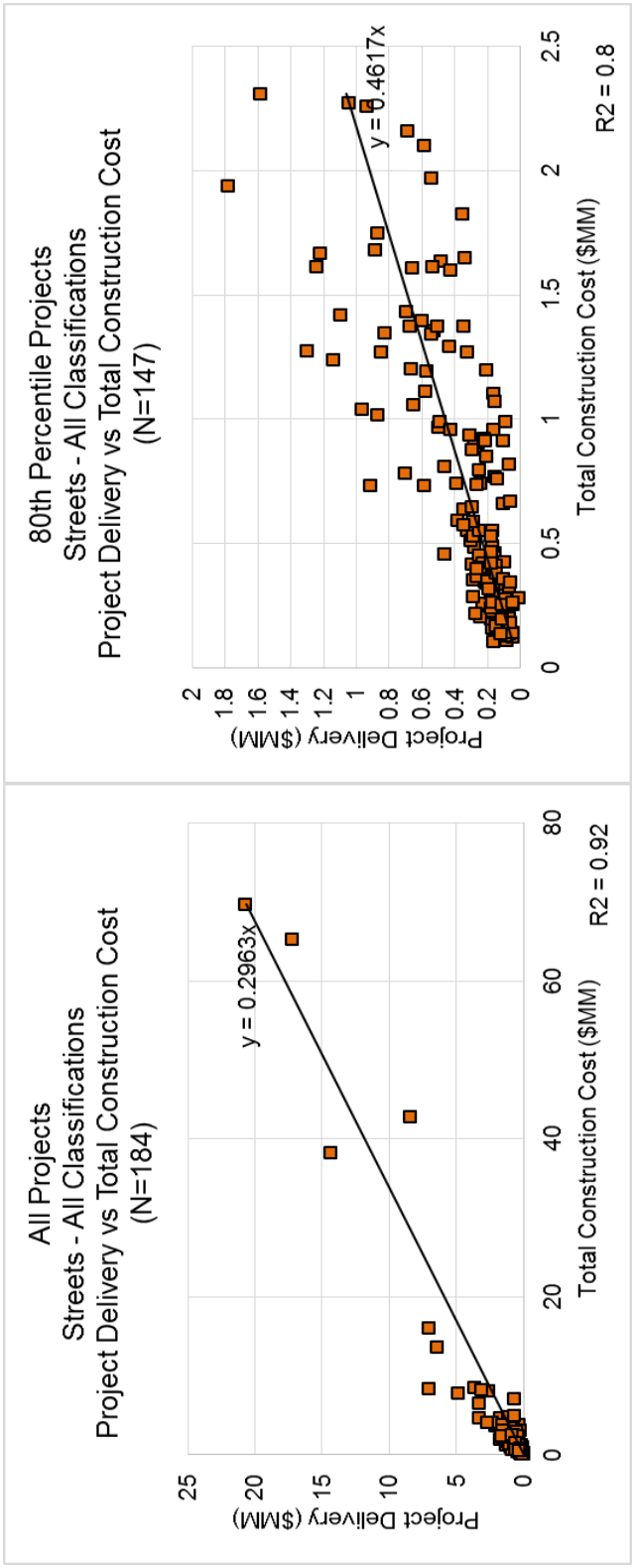

80th Percentile Projects
Municipal Facilities - Libraries
Project Delivery vs Total Construction Cost
(N=0)
Project Delivery ($MM)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.2
0.4
0.6
0.8
1
Total Construction Cost ($MM)

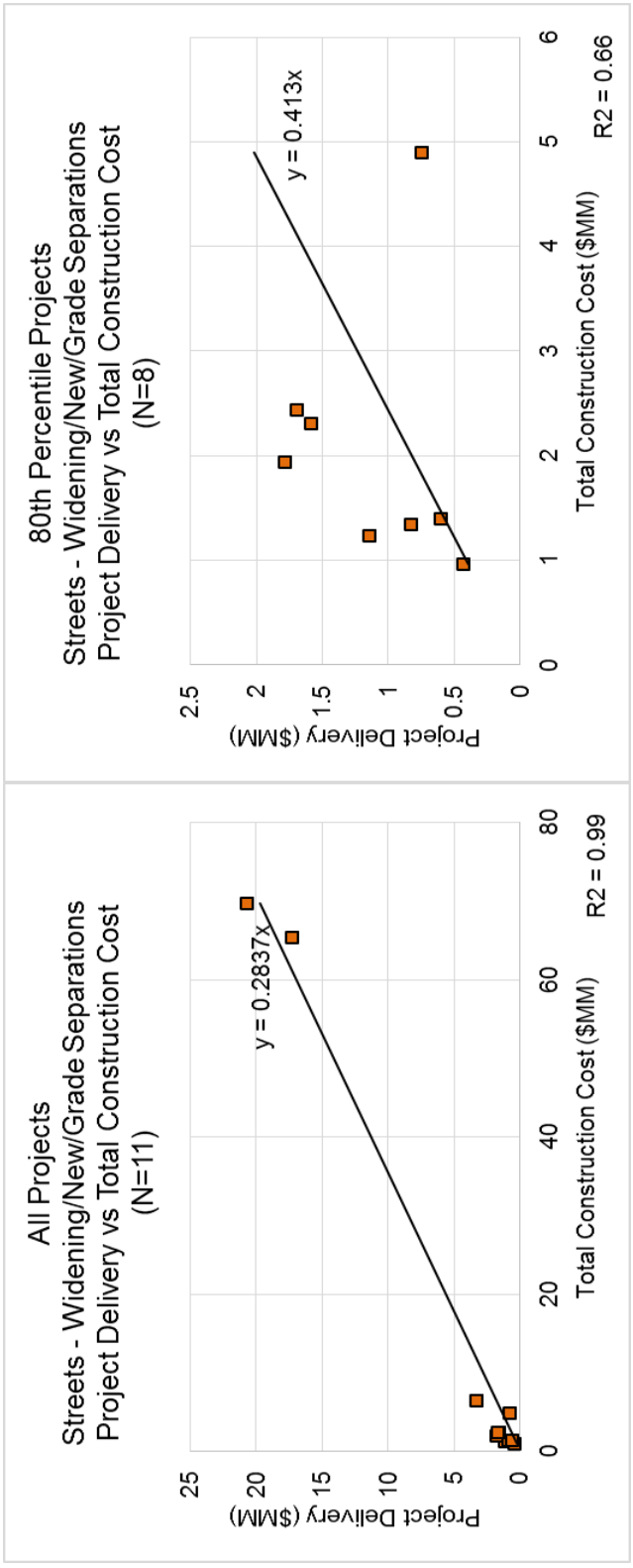

80th Percentile Projects
Municipal Facilities - Police/Fire Stations
Project Delivery vs Total Construction Cost
(N=6)
y = 0.2876x
Project Delivery ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
3
0
2
4
6
8
10
All Projects
Municipal Facilities - Police/Fire Stations
Project Delivery vs Total Construction Cost
(N=8)
y = 0.3147x
R2 = 0.96
Project Delivery ($MM)
Total Construction Cost ($MM)
0
1
2
3
4
5
6
7
0
5
10
15
20

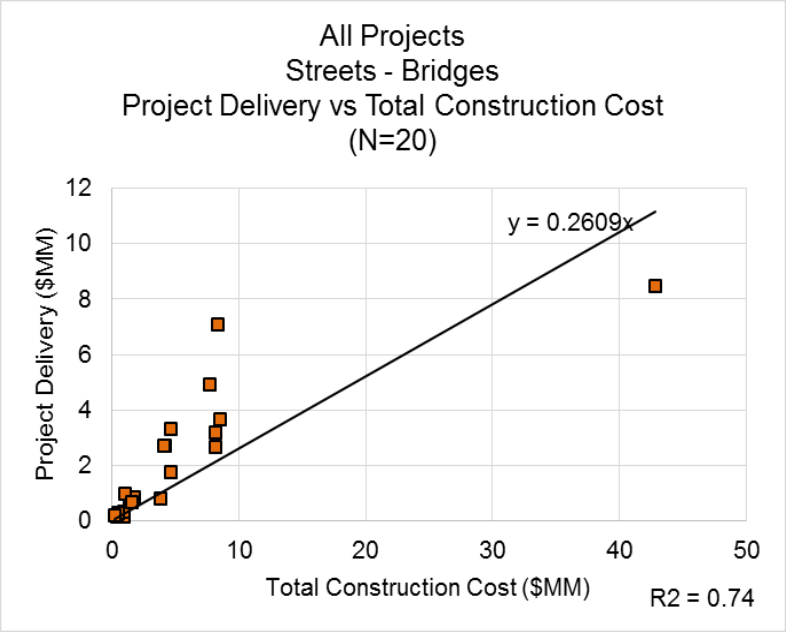

All Projects
Municipal Facilities - Comm./Rec. Center/Child Care/Gyms
Project Delivery vs Total Construction Cost
(N=23)
y = 0.3994x
Project Delivery ($MM)
Total Construction Cost ($MM)
R2 = 0.84
0
1
2
3
4
5
6
7
8
9
0
5
10
15
20
25

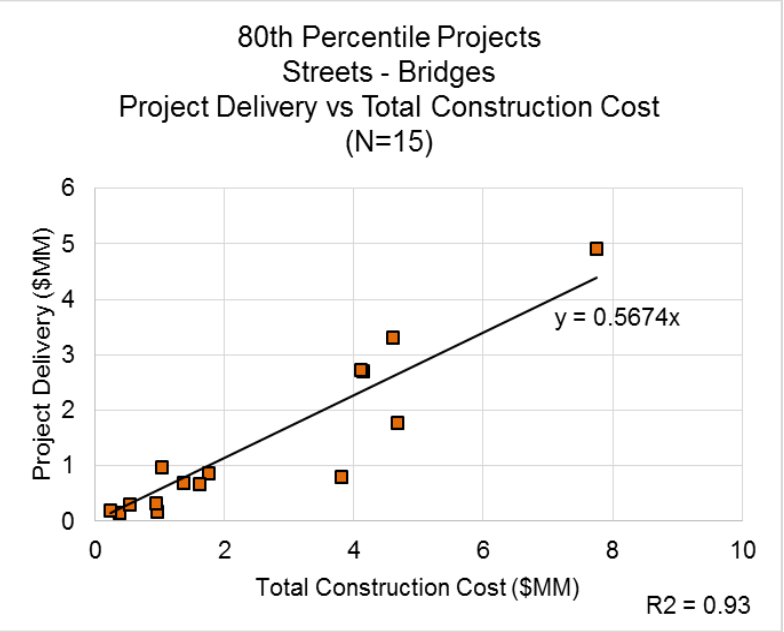

80th Percentile Projects
Municipal Facilities - Comm./Rec. Center/Child Care/Gyms
Project Delivery vs Total Construction Cost
(N=18)
y = 0.5315x
Project Delivery ($MM)
Total Construction Cost ($MM)
R2 = 0.91
0
0.5
1
1.5
2
2.5
3
3.5
4
0
1
2
3
4
5
6
7

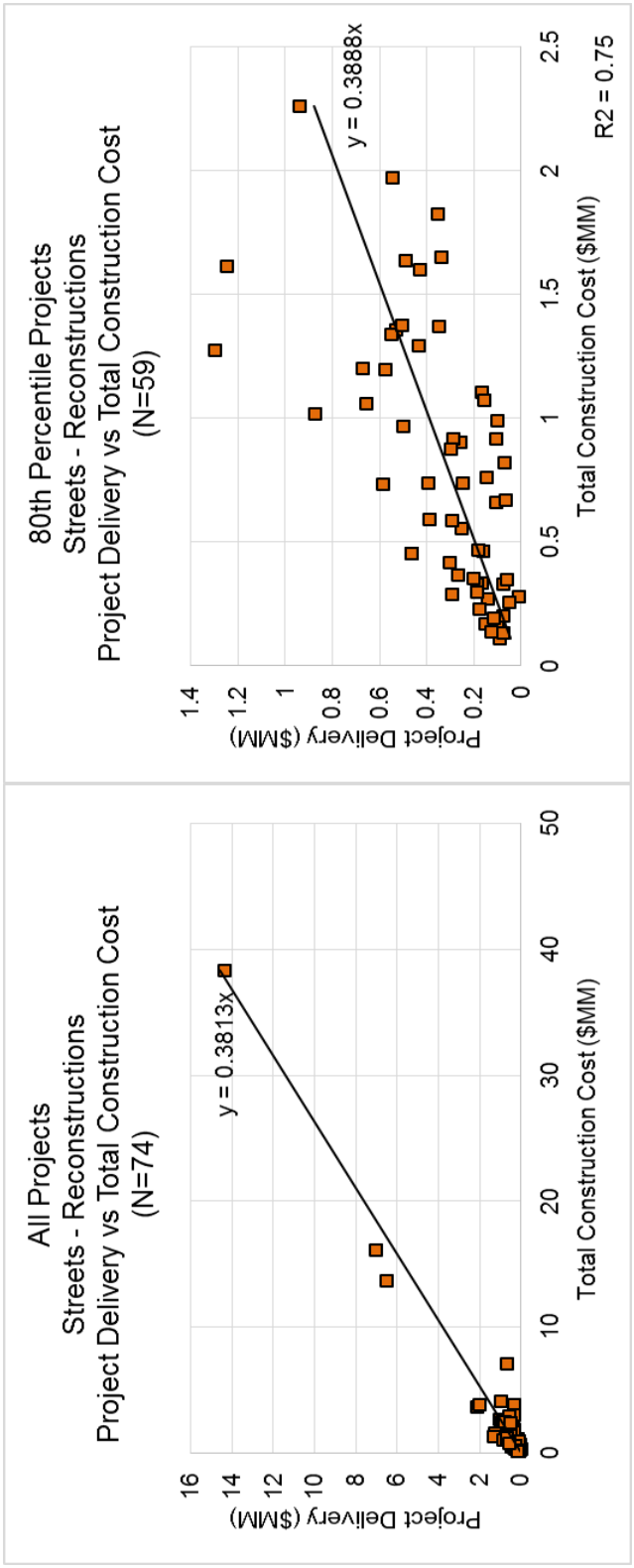

80th Percentile Projects
Municipal Facilities - Other
Project Delivery vs Total Construction Cost
(N=19)
y = 0.3794x
R2 = 0.88
Project Delivery ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
3
0
1
2
3
4
5
6
7
All Projects
Municipal Facilities - Other
Project Delivery vs Total Construction Cost
(N=24)
y = 0.387x
Project Delivery ($MM)
Total Construction Cost ($MM)
0
5
10
15
20
25
0
10
20
30
40
50
60

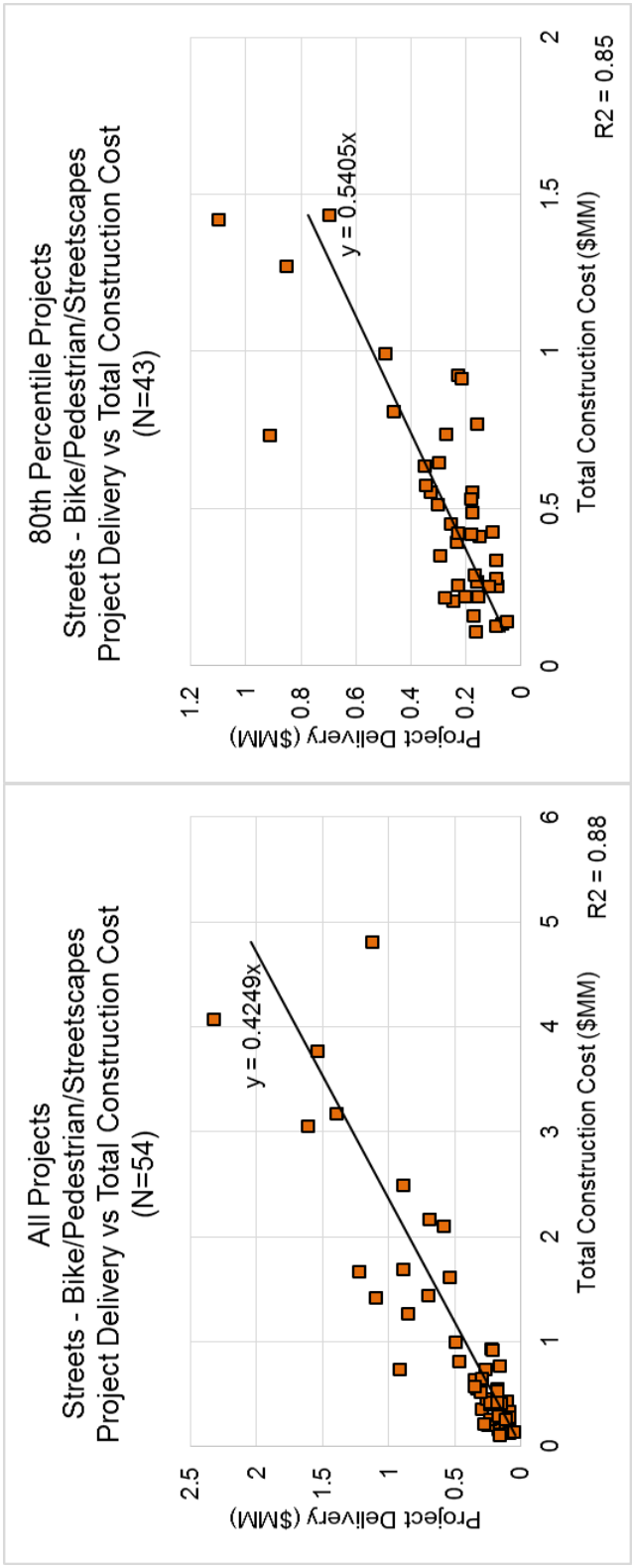

80th Percentile Projects
Streets - All Classifications
Project Delivery vs Total Construction Cost
(N=147)
y = 0.4617x
R2 = 0.8
Project Delivery ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
0.5
1
1.5
2
2.5
All Projects
Streets - All Classifications
Project Delivery vs Total Construction Cost
(N=184)
y = 0.2963x
R2 = 0.92
Project Delivery ($MM)
Total Construction Cost ($MM)
0
5
10
15
20
25
0
20
40
60
80

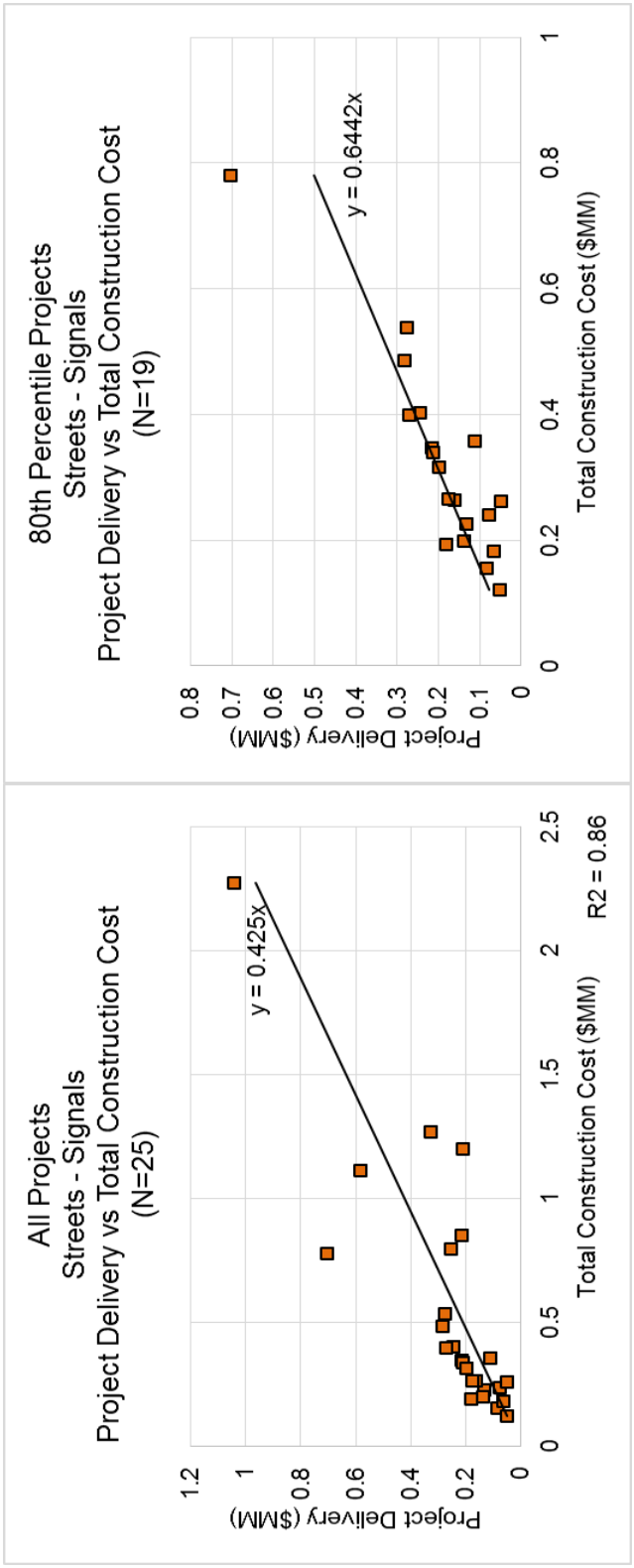

All Projects
Streets - Widening/New/Grade Separations
Project Delivery vs Total Construction Cost
(N=11)
y = 0.2837x
R2 = 0.99
Project Delivery ($MM)
Total Construction Cost ($MM)
0
5
10
15
20
25
0
20
40
60
80
80th Percentile Projects
Streets - Widening/New/Grade Separations
Project Delivery vs Total Construction Cost
(N=8)
y = 0.413x
R2 = 0.66
Project Delivery ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
0
1
2
3
4
5
6

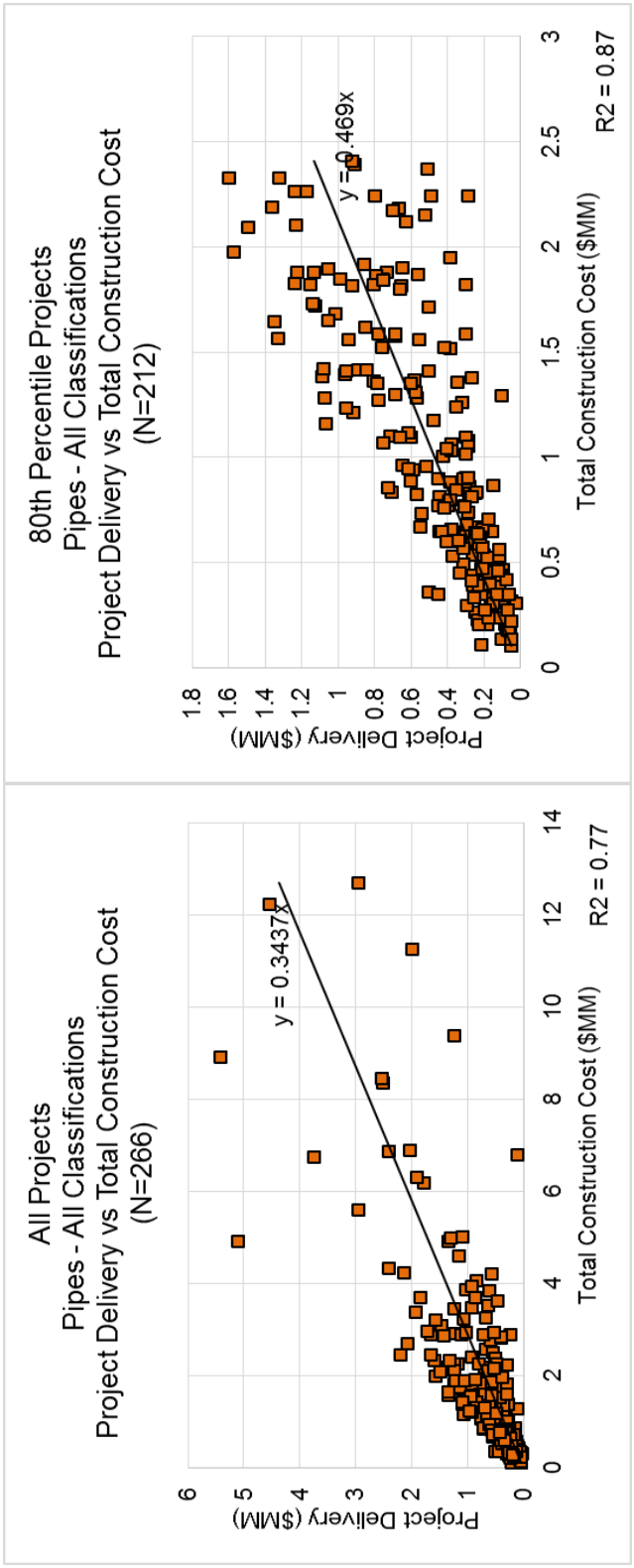

All Projects
Streets - Bridges
Project Delivery vs Total Construction Cost
(N=20)
y = 0.2609x
Project Delivery ($MM)
Total Construction Cost ($MM)
R2 = 0.74
0
2
4
6
8
10
12
0
10
20
30
40
50

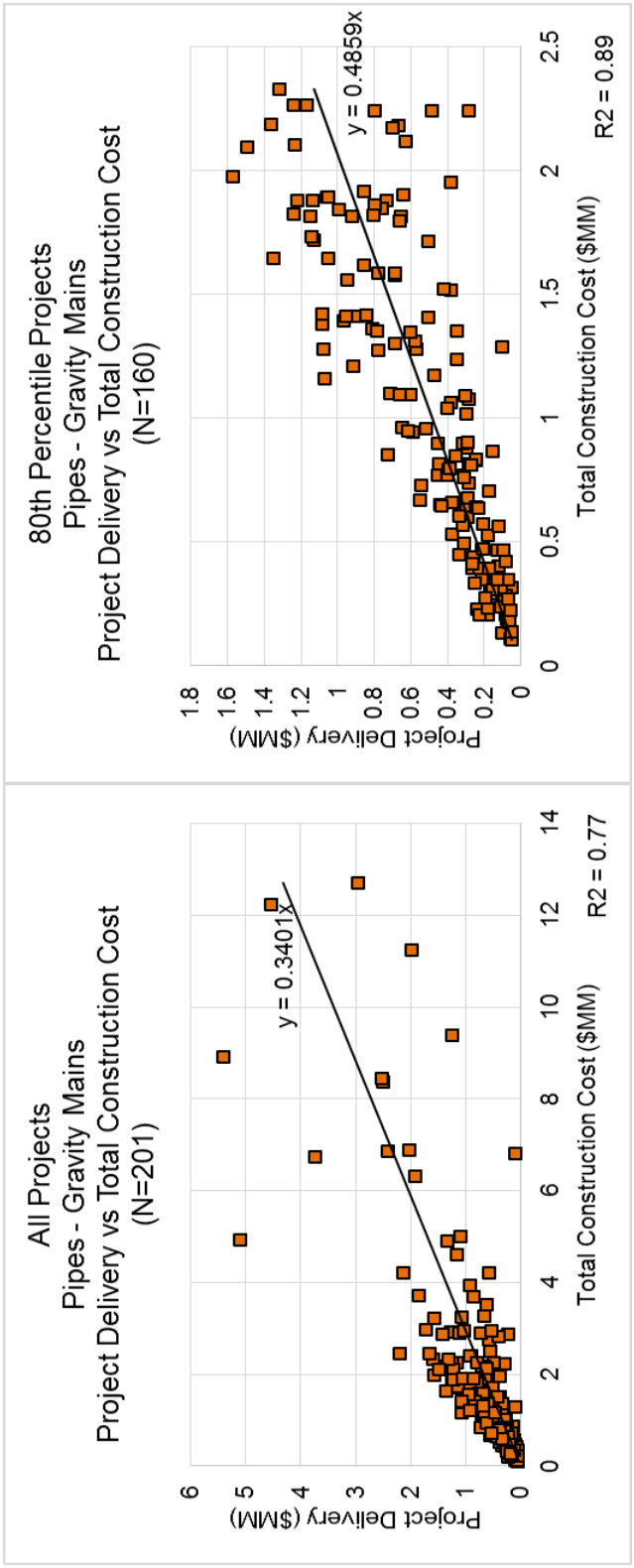

80th Percentile Projects
Streets - Bridges
Project Delivery vs Total Construction Cost
(N=15)
y = 0.5674x
Project Delivery ($MM)
Total Construction Cost ($MM)
R2 = 0.93
0
1
2
3
4
5
6
0
2
4
6
8
10

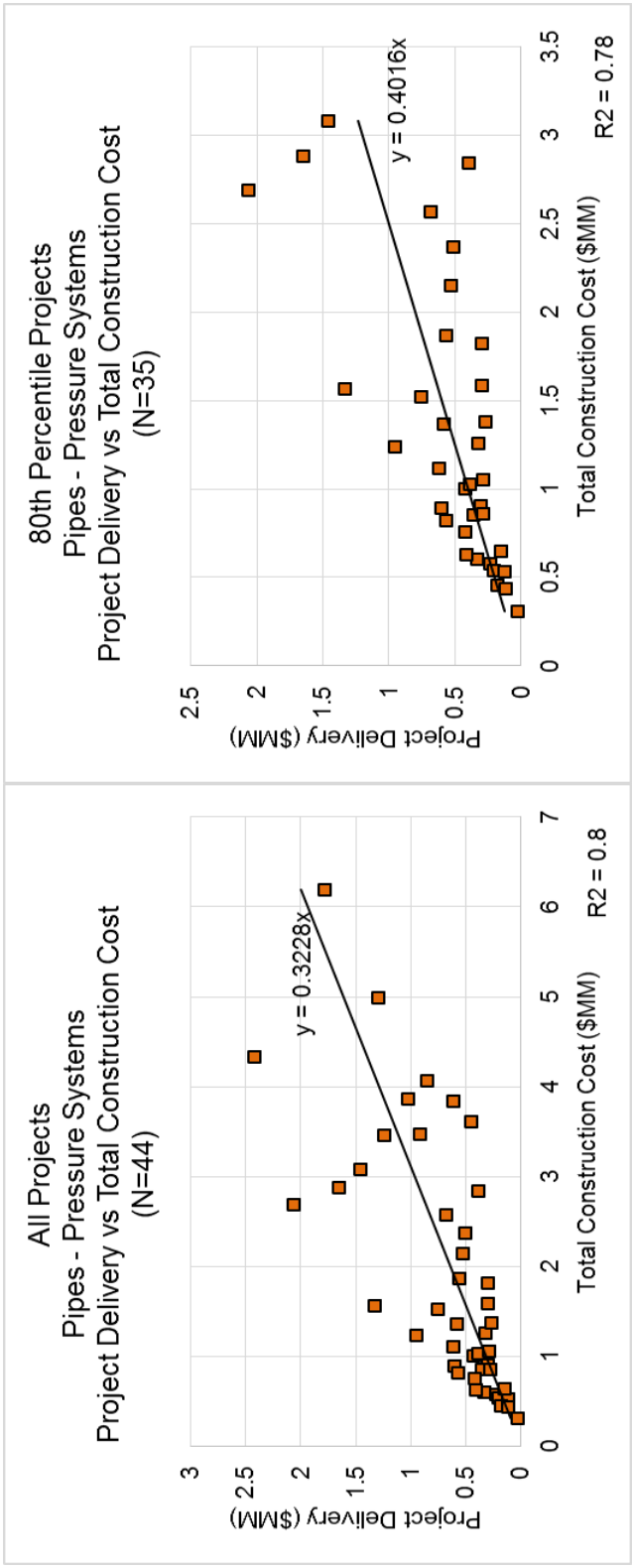

80th Percentile Projects
Streets - Reconstructions
Project Delivery vs Total Construction Cost
(N=59)
y = 0.3888x
R2 = 0.75
Project Delivery ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0
0.5
1
1.5
2
2.5
All Projects
Streets - Reconstructions
Project Delivery vs Total Construction Cost
(N=74)
y = 0.3813x
Project Delivery ($MM)
Total Construction Cost ($MM)
0
2
4
6
8
10
12
14
16
0
10
20
30
40
50

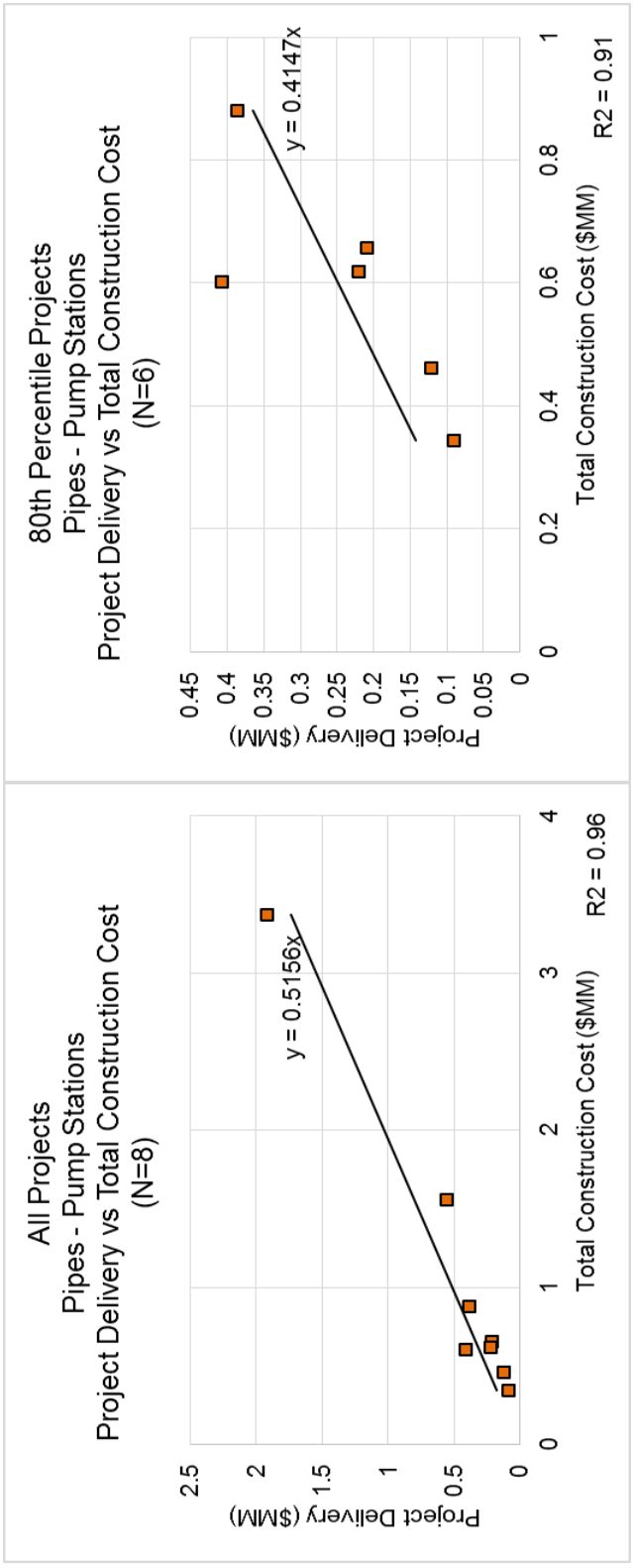

80th Percentile Projects
Streets - Bike/Pedestrian/Streetscapes
Project Delivery vs Total Construction Cost
(N=43)
y = 0.5405x
R2 = 0.85
Project Delivery ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
0
0.5
1
1.5
2
All Projects
Streets - Bike/Pedestrian/Streetscapes
Project Delivery vs Total Construction Cost
(N=54)
y = 0.4249x
R2 = 0.88
Project Delivery ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
0
1
2
3
4
5
6

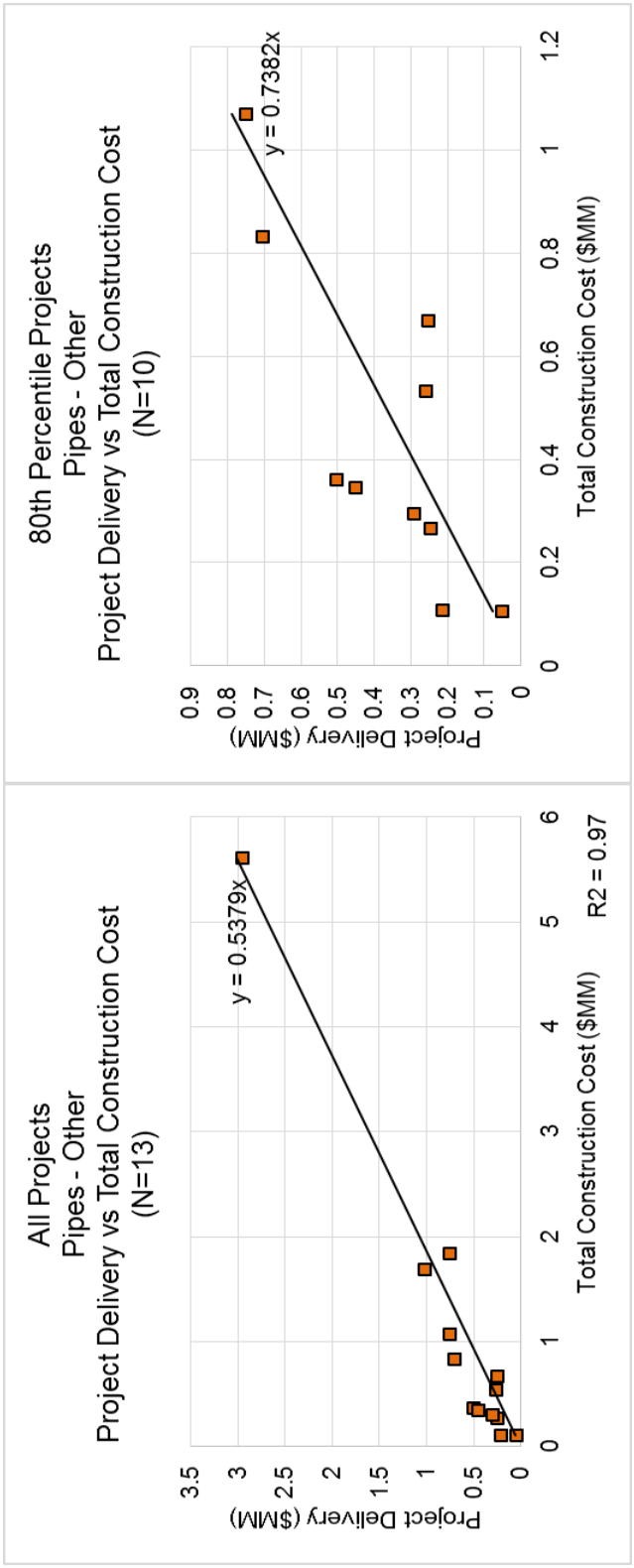

80th Percentile Projects
Streets - Signals
Project Delivery vs Total Construction Cost
(N=19)
y = 0.6442x
Project Delivery ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.2
0.4
0.6
0.8
1
All Projects
Streets - Signals
Project Delivery vs Total Construction Cost
(N=25)
y = 0.425x
R2 = 0.86
Project Delivery ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
0.5
1
1.5
2
2.5

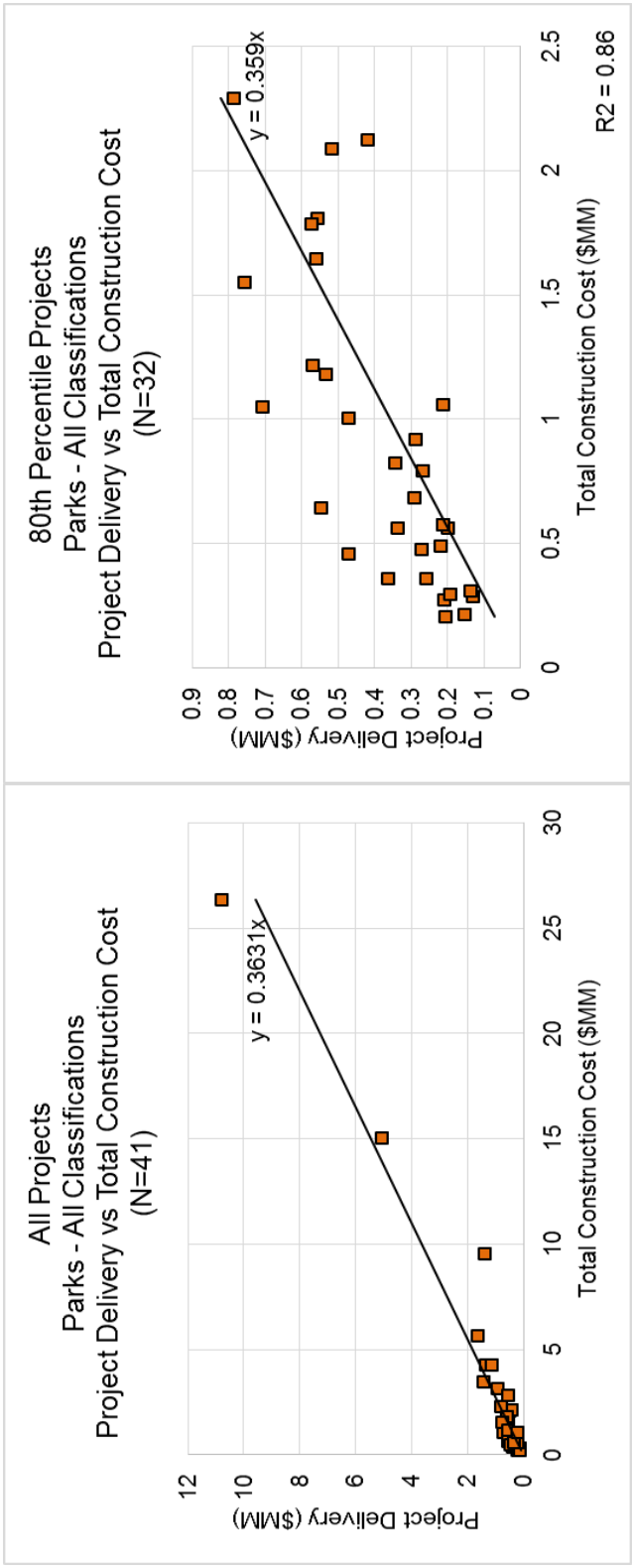

80th Percentile Projects
Pipes - All Classifications
Project Delivery vs Total Construction Cost
(N=212)
y = 0.469x
R2 = 0.87
Project Delivery ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
0
0.5
1
1.5
2
2.5
3
All Projects
Pipes - All Classifications
Project Delivery vs Total Construction Cost
(N=266)
y = 0.3437x
R2 = 0.77
Project Delivery ($MM)
Total Construction Cost ($MM)
0
1
2
3
4
5
6
0
2
4
6
8
10
12
14

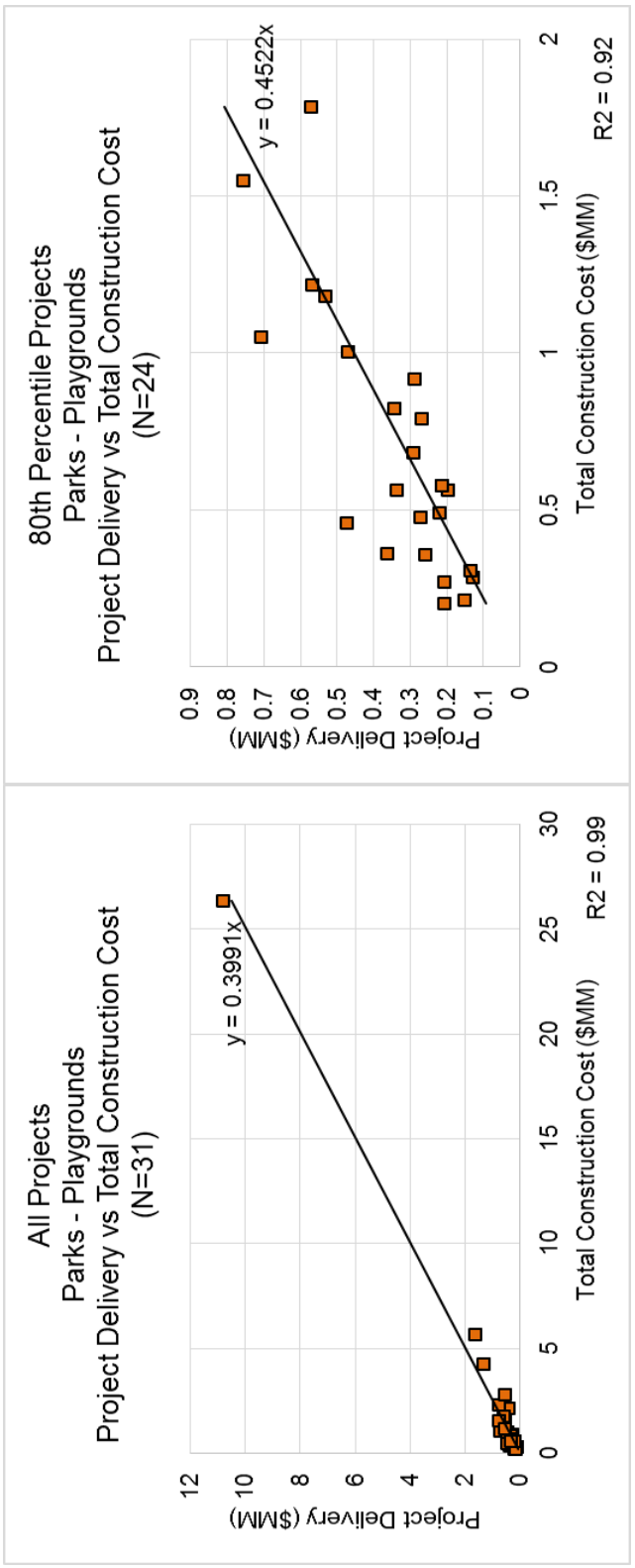

80th Percentile Projects
Pipes - Gravity Mains
Project Delivery vs Total Construction Cost
(N=160)
y = 0.4859x
R2 = 0.89
Project Delivery ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
0
0.5
1
1.5
2
2.5
All Projects
Pipes - Gravity Mains
Project Delivery vs Total Construction Cost
(N=201)
y = 0.3401x
R2 = 0.77
Project Delivery ($MM)
Total Construction Cost ($MM)
0
1
2
3
4
5
6
0
2
4
6
8
10
12
14

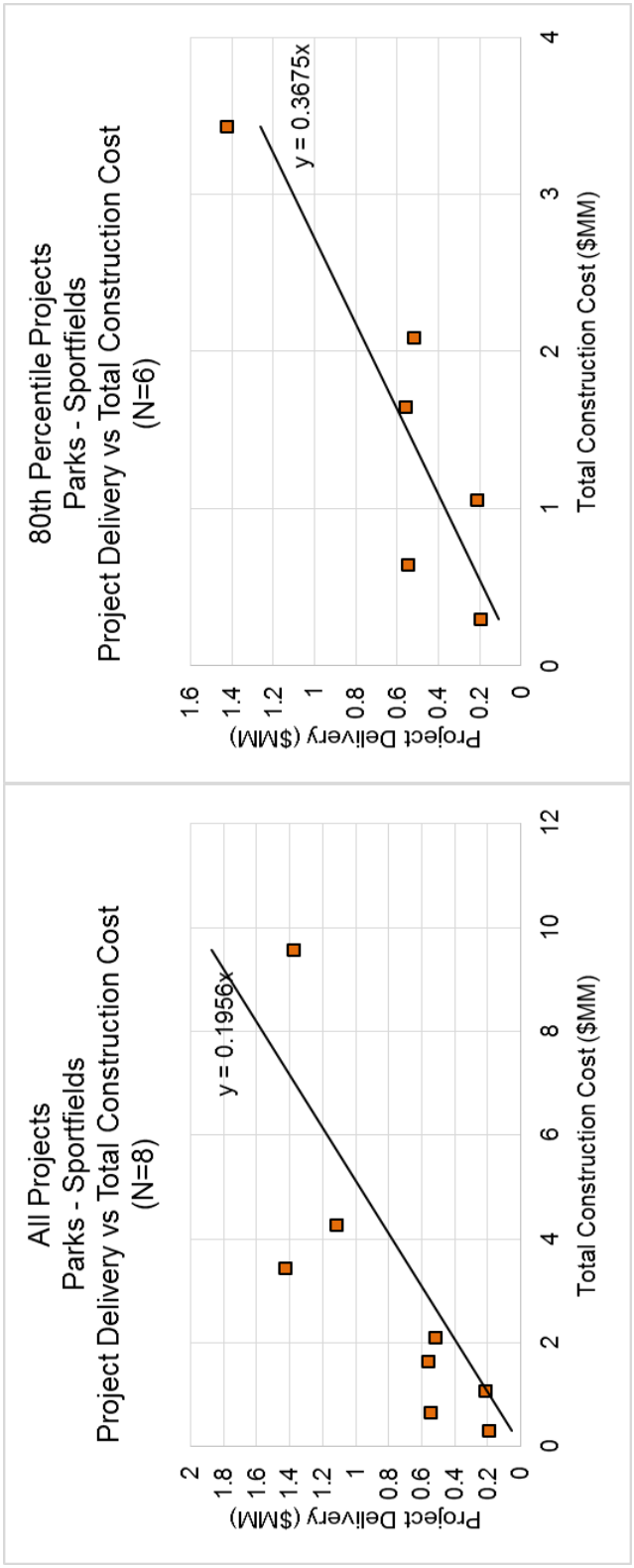

80th Percentile Projects
Pipes - Pressure Systems
Project Delivery vs Total Construction Cost
(N=35)
y = 0.4016x
R2 = 0.78
Project Delivery ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
3
3.5
All Projects
Pipes - Pressure Systems
Project Delivery vs Total Construction Cost
(N=44)
y = 0.3228x
R2 = 0.8
Project Delivery ($MM)
Total Construction Cost ($MM)
0
1
2
3
4
5
6
7

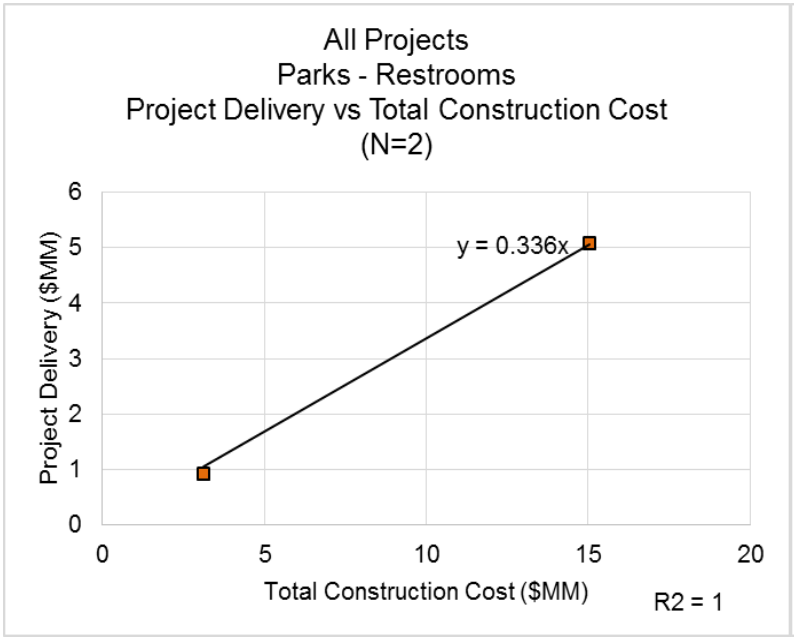

All Projects
Pipes - Pump Stations
Project Delivery vs Total Construction Cost
(N=8)
Project Delivery ($MM)
Total Construction Cost ($MM)
y = 0.5156x
R2 = 0.96
80th Percentile Projects
Pipes - Pump Stations
Project Delivery vs Total Construction Cost
(N=6)
Project Delivery ($MM)
Total Construction Cost ($MM)
y = 0.4147x
R2 = 0.91

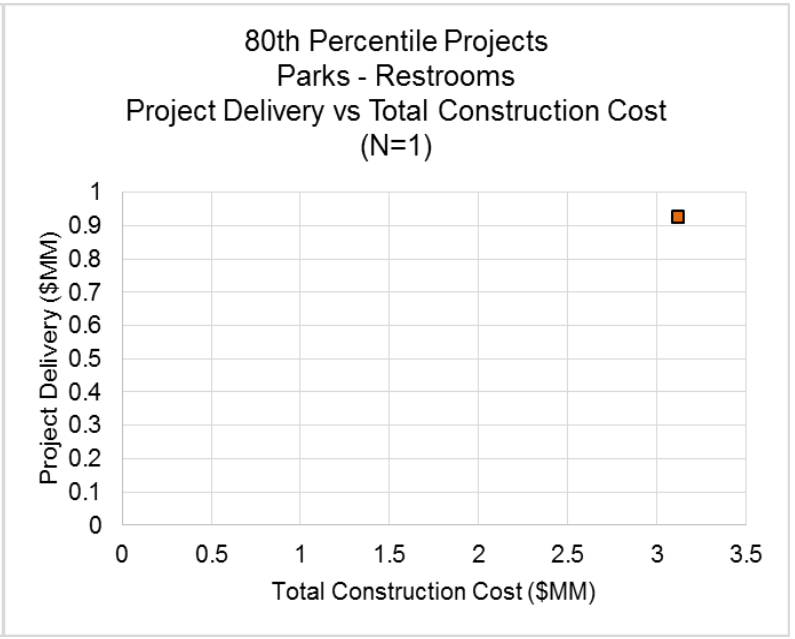

80th Percentile Projects
Pipes - Other
Project Delivery vs Total Construction Cost
(N=10)
y = 0.7382x
Project Delivery ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0
0.2
0.4
0.6
0.8
1
1.2
All Projects
Pipes - Other
Project Delivery vs Total Construction Cost
(N=13)
y = 0.5379x
R2 = 0.97
Project Delivery ($MM)
Total Construction Cost ($MM)
0
0.5
1
1.5
2
2.5
3
3.5
0
1
2
3
4
5
6


80th Percentile Projects
Parks - All Classifications
Project Delivery vs Total Construction Cost
(N=32)
y = 0.359x
R2 = 0.86
Project Delivery ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0
0.5
1
1.5
2
2.5
All Projects
Parks - All Classifications
Project Delivery vs Total Construction Cost
(N=41)
y = 0.3631x
Project Delivery ($MM)
Total Construction Cost ($MM)
0
2
4
6
8
10
12
0
5
10
15
20
25
30

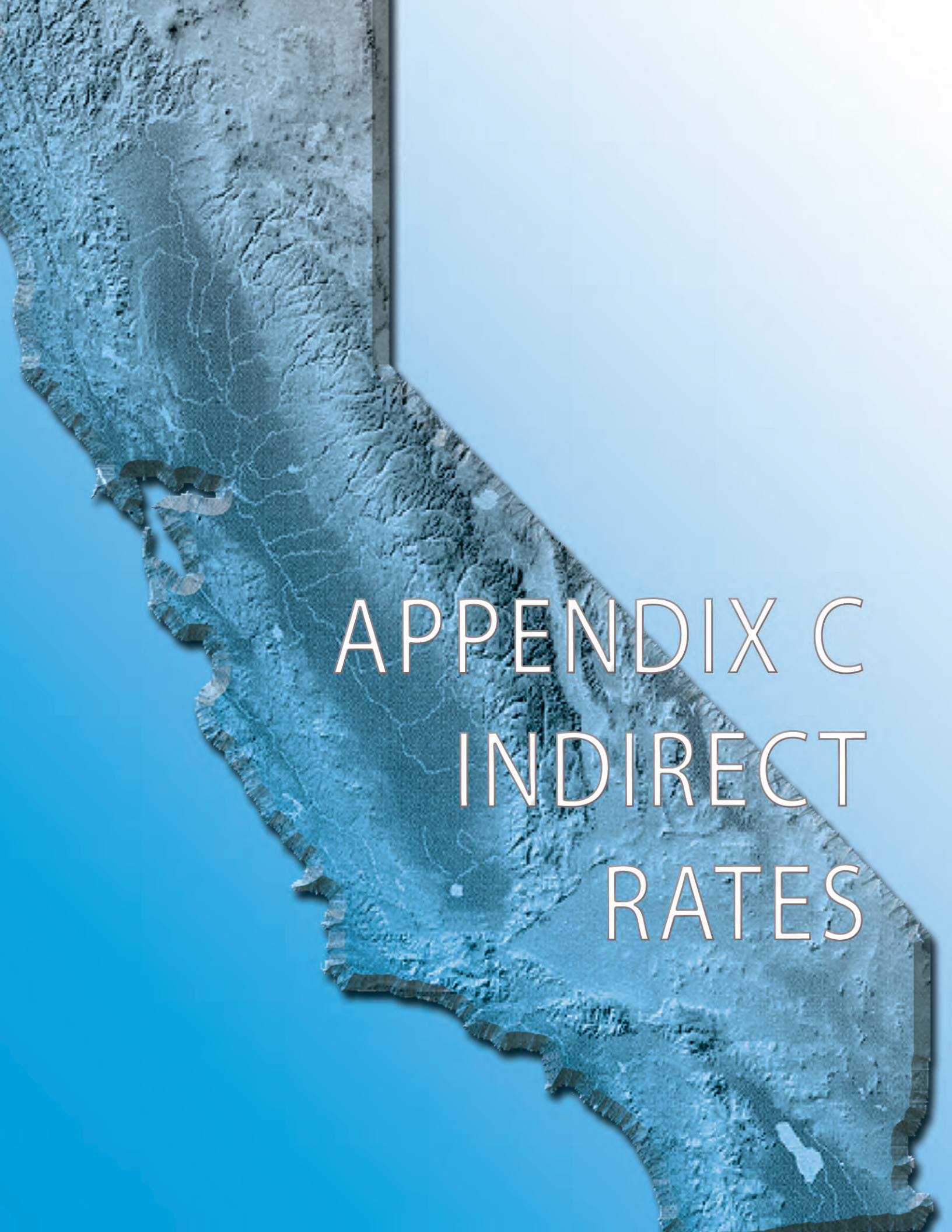

80th Percentile Projects
Parks - Playgrounds
Project Delivery vs Total Construction Cost
(N=24)
y = 0.4522x
R2 = 0.92
Project Delivery ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0
0.5
1
1.5
2
All Projects
Parks - Playgrounds
Project Delivery vs Total Construction Cost
(N=31)
y = 0.3991x
R2 = 0.99
Project Delivery ($MM)
Total Construction Cost ($MM)
0
2
4
6
8
10
12
0
5
10
15
20
25
30


80th Percentile Projects
Parks - Sportfields
Project Delivery vs Total Construction Cost
(N=6)
y = 0.3675x
Project Delivery ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
0
1
2
3
4
All Projects
Parks - Sportfields
Project Delivery vs Total Construction Cost
(N=8)
y = 0.1956x
Project Delivery ($MM)
Total Construction Cost ($MM)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
2
4
6
8
10
12


All Projects
Parks - Restrooms
Project Delivery vs Total Construction Cost
(N=2)
Project Delivery ($MM)
Total Construction Cost ($MM)
y = 0.336x
R2 = 1
0
1
2
3
4
5
6
0
5
10
15
20


80th Percentile Projects
Parks - Restrooms
Project Delivery vs Total Construction Cost
(N=1)
Project Delivery ($MM)
Total Construction Cost ($MM)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
0.5
1
1.5
2
2.5
3
3.5

Page Intentionally Left Blank



APPENDIX C
INDIRECT RATES

Table C-1
Indirect Rates Applied to Capital Projects

Agency	Fringe Benefits	Compensated Time Off	City Overhead	Department Overhead	Agency Overhead	Indirect Rate Factor[1]
City of Long Beach Department of Public Works[2]	41.92%	19.40%	0%	2.5%	49.21%	149.63%
City of Los Angeles[3] Department of Public Works Bureau of Engineering	40.25%	20.96%	9.48%	16.67%	47.79%	135.08%
City of Oakland[5] Department of Engineering & Construction	71.85%	22.90%	20.22%	29.00%	18.90%	162.87%
City of Sacramento Department of Public Works (FY16 Budgeted)	41.88%	21.20%	18.72%	17.90%	77.29%	176.99%
Department of Utilities	29.26%	18.70%	14.65%	61.16%	42.74%	166.51%
City of San Diego Engineering and Capital Projects	65.68%	16.60%	0%	0%	98.70%	180.98%
City and County of San Francisco Department of Public Works Building Design and Construction Infrastructure Design and Construction	38.22%	24.52%	0%	57.69%	62.19%	182.62%
City of San José Department of Public Works (FY15-16)	67.08%	23.46%	34.18%	14.26%	Included	177.90%

Notes:

1. This value may be different from the sum of overhead values since the compounding formula may vary by agency.
2. The City of Long Beach is currently in the process of recomputing its overhead rates. Rates shown in the above table are 2012 rates.
3. Based on averages of all Bureau program overhead rates provided under CAP 37.
4. All costs are captured independently of funding source
5. The City of Oakland has taken a temporary break from the Study and therefore, indirect rates for the agency have not been updated since Update 2016.

Page Intentionally Left Blank

PARTICIPATING AGENCIES

City of Long Beach
Department of Public Works
Harbor Department Port of Long Beach

City of Los Angeles
Department of Public Works
Bureau of Engineering

City of Oakland
Public Works Department
Bureau of Engineering & Construction

City of Sacramento
Department of Public Works
Department of Utilities

City of San Diego
Engineering & Capital Projects Department

City & County of San Francisco
Department of Public Works
Building Design & Construction
Infrastructure Design & Construction

City of San Jose
Department of Public Works
City Manager's Office

http://eng.lacity.org/techdocs/cabm/