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Data Trends and Variability in Quality Control for Performance and Pay for Performance Specifications: Statistical Analysis

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16. Abstract

Quality assurance programs for hot-mix asphalt (HMA) have evolved from method specifications to quality assurance specifications that distribute responsibilities and risks between contractors and owners. The Illinois Department of Transportation (IDOT) developed two acceptance specifications, quality control for performance (QCP) and pay for performance (PFP), integrating contractor pay incentives and/or disincentives associated with air voids (AV), voids in mineral aggregate (VMA), and in-place density limits. A major factor that could compromise contractors' pay in both specifications is the variability of test results due to mix production, construction, sampling, and/or inherent testing variability. Therefore, the objective of this project was to understand the distribution and variability of the test results observed under QCP and PFP specifications, as well as the potential causes of variability. The assessment approach included statistical analysis of the test results obtained for the 2015–2017 construction seasons and on-site field observations of 11 projects visited during the 2018 construction season. The pay factors of the 2015–2017 construction seasons showed contractors earned pay incentives under the PFP specification but received disincentives under QCP and PFP specifications. Contractors appeared to have more experience working with QCP projects than PFP projects. The statistical analysis identified that more than 80% of the test results between the contractor and the district were not significantly different. In those cases, it is likely that issues with mix production or construction were the reasons that led to a disincentive. However, there are possible testing issues that need to be addressed by the district and contractor such as reheating consistency and test weight control. Density was a major factor driving contractor disincentives in both specifications, followed by AV. Finally, the site visit identified mix production and construction issues that can lead to possible causes of pay disincentives, including mix switching, dust control, and aggregate contamination.

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EXECUTIVE SUMMARY

Quality assurance (QA) programs for hot-mix asphalt (HMA) have evolved from method specifications to QA specifications that distribute responsibilities and risks between contractors and owners to ensure that the final product meets acceptable criteria. The Illinois Department of Transportation (IDOT) developed two acceptance specifications, quality control for performance (QCP) and pay for performance (PFP), integrating contractor pay incentives and/or disincentives associated with air void (AV), voids in mineral aggregate (VMA), and in-place density limits.

The main difference between QCP and PFP is the calculation of pay adjustments. QCP is a stepped payment system where fixed pay disincentives increase by various intervals. PFP is a percent within limit (PWL) specification used for the national highway system, state route roadways, and full-depth asphalt pavement projects with a minimum mix quantity of 8,000 tons (IDOT, 2018a). QCP and PFP exclusions exist such as sidestreets, short turn lanes, short-term temporary pavements, and other exclusions defined by IDOT. These sections of asphalt pavements default to the existing QC/QA method of acceptance. All sublot test results are used to estimate the percentage of the lot that is within the limits. QCP, on the other hand, is for smaller mainline HMA projects, where mixture quantities range between 1,200 and 8,000 tons at the time of bidding. Mix samples and density cores are collected from the jobsite under both specifications to measure AV, VMA, and density.

A major factor that could compromise contractors' pay in both specifications is the variability of test results due to mix production, construction, sampling, and/or inherent testing variability. Therefore, the objective of this project was to understand the distribution and variability of the test results included in QCP and PFP specifications, as well as the potential causes of variability.

A multiprobe data analysis program was performed on the test results of QCP and PFP projects constructed between 2015 to 2017. Five data sets were compiled from Districts 1, 2, 5, 6, 8, and 9 for this study: pay factors, mix sublot results, PFP dispute results, IDOT Uniformity Study results (round robin), and jobsite visit data. The data analysis included hypothesis testing to compare test results from districts and contractors, including mean, distribution, and variance using the Mann-Whitney (mean comparison), Shapiro-Wilk (distribution), and Levene's F (variance) tests.

Jobsites in selected districts and respective contractor facilities were visited to collect information that was used to understand the causes of variability. Each jobsite visit included three activities: interviewing district and contractor personnel on testing procedures and data analysis; monitoring sampling, blending, and splitting during mix production at district laboratories, plants, and jobsites; and analyzing data and test results to identify possible causes of variability that could lead to pay incentives/disincentives. Details are presented in Al-Qadi et al. (2020).

The pay factors (PFs) of the 2015–2017 construction seasons showed that contractors generally earned higher payment disincentives under the PFP specification than QCP. However, contrary to QCP, PFP allows pay incentives to the HMA pay. These incentives were given to 54% of the HMA tons placed under the PFP specification (PF > 100). Contractors often had more experience working with QCP projects than PFP, as more QCP projects were awarded than PFP projects. Hence, the pay per

HMA ton has increased with time for the QCP specification. Any disincentive discussed in this report does not include any summary or cost estimate for mixtures that were subject to removal and replacement. Per PFP and QCP specifications, for any mixture result subject to removal and replacement, the pay results are replaced with the new results upon completion.

The statistical analysis of the test results showed that district and contractor results were not significantly different statewide for 82% of density, 88% of VMA, and 91% of AV comparisons. As a result, when contractor and district results are insignificantly different, the chance of the contractor being unfairly penalized or the district accepting nonconforming material is reduced. This suggests that IDOT's quality management program (QMP) for HMA effectively identifies mix production and/or construction issues. Multiple factors drove pay disincentives in both specifications. In PFP, standard deviations impact the calculation of the pay factor. Density was a major factor driving the reduction in pay under both specifications, followed by AV. IDOT recently increased minimum HMA layer thickness for 9.5FG binder mixes from 0.75 to 1.25 in to ensure three times the nominal maximum aggregate size (NMAS) requirements are achieved. This change will help contractors increase density without changing compactive effort. Exclusions specific to scabbing areas will also reduce density variability and failing results.

Density was the parameter that showed the largest percentage of cases with a significant difference between district and contractor test results, followed by VMA and then AV. While density issues were related to mix production and compaction, VMA and AV issues were related to mix design, gyratory compactor calibration and operation, reheating procedures, and specimen preparation. Mix and density disputes typically were in favor of the contractor for AV and VMA, who selected the disputed lot. The jobsite visits revealed that inconsistencies in aggregate gradations and material variability were found in projects that reflected pay disincentives for contractors.

The site visits allowed the researchers to observe some of the root causes that could lead to disincentives. For production/construction, contractors that had a significant number of mix switches during a production day were more vulnerable to having issues with AV and VMA results. Second, mid-construction season changes in the aggregate supplier source could affect the mix AV and VMA, resulting in disincentives. Plants without proper dust control could also have off-target G_{mb} results. For testing issues, the differences in the reheating procedure, gyratory compactor model, technician running the test, or calibrations may cause differences between contractor and district results.

IDOT has taken steps to improve quality management specifications. On June 28, 2017, IDOT modified the PFP composite pay factor (CPF) pay equation (IDOT, 2018c), which included a 2% increase in AV, VMA, and density PFs. The pay for the 2015–2017 seasons was recalculated using the new formula to understand the possible impact in future PFP pay. The results indicated that if the new formula had been implemented during the project period, the percentage of the total tonnage with the pay incentive amount (PF > 100) would have increased from 54% to 76%. Pay factor incentives/disincentives in QCP and PFP specifications were caused by several factors that require collaborative effort by IDOT and contractors to be addressed. However, the QMP's requirements are achievable, appear to be fair, and are appropriate for the kinds of projects for which each specification is used.

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CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

Quality assurance (QA) is the process of ensuring the quality of a product will satisfy given requirements. In this report, all planned and systematic actions that provide confidence that hot-mix asphalt (HMA) will perform satisfactorily in service are referred to as “QA program.” Quality control (QC) is the process with which a contractor monitors, assesses, and adjusts their production or placement processes to ensure that the final product will meet the specified level of quality. Quality control is specified by the agency and includes sampling, testing, inspection, and corrective action (where required) for contractors to maintain continuous control of a production or placement process (TRB, 2018). Most successful contractors accomplish more than the minimum specified by the department.

By the early 2010s, HMA QA specifications had evolved to be related to performance and were statistically based in Illinois and elsewhere in the United States. The Illinois Department of Transportation (IDOT) developed two specifications for the state’s QA program, quality control for performance (QCP) and pay for performance (PFP), to meet the intent of the Code of Federal Regulations and Federal Highway Administration (FHWA) Technical Advisory recommendations (IDOT, 2010). This also helped IDOT to better control the quality of constructed pavements, ensure performance, and overcome previous limitations.

The current PFP specification was implemented for interstate and full-depth asphalt pavement projects having a minimum HMA quantity of 8,000 tons per mix (IDOT, 2018a). PFP may be used for smaller projects in which a more accurate measure of quality is desired. On the other hand, the QCP specification is used for relatively smaller HMA projects (mixture quantities ranging between 1,200 and 8,000 tons) along with certain shoulder applications and for leveling binder mixtures (IDOT, 2018b). Note that leveling binders are no longer part of IDOT’s HMA specifications because of adjustments in minimum lift thickness.

The ultimate goal of QCP and PFP specifications is to reward contractor ingenuity and improve the quality of the HMA end product. Pay factors are a key component of QCP and PFP specifications, defining the incentive or disincentive percentage that a contractor may receive based on the quality provided. Pay factors are determined based on the agency’s test results following QA procedures that involve statistical analysis of test results randomly obtained during and after construction. In Illinois, IDOT is the agency in charge of state-maintained public roadways. IDOT has nine districts that bear acceptance responsibilities.

The QA program requires agency testing of plant-produced loose mix sampled at the jobsite for laboratory-compacted air voids (AV), voids in mineral aggregate (VMA), asphalt content, gradation, and dust/AC ratio. It also includes agency-testing field density from cores obtained according to specific IDOT procedures. Air voids, VMA, and core density are referred to as pay parameters (IDOT, 2018a, 2018b).

Minimum QC-testing requirements are also defined in the QCP and PFP specifications. Contractors are required to test for mixture aggregate gradation, binder content (P_b), maximum theoretical specific gravity (G_{mm}), bulk specific gravity (G_{mb}), as well as field density and dust/asphalt content (AC) ratio in QCP and PFP. Mixture aggregate gradation and P_b are only for process control. They are reflected in the VMA; however, both results are not used directly by the agency in the pay calculation. Both are referred to as non-pay parameters. Testing frequencies vary for QCP and PFP specifications. Jobsite sampling locations are randomly determined in both specifications.

IDOT's QCP and PFP specifications have been successfully used for HMA projects since their inception. Both specifications use pay adjustments solely based on test results of the aforementioned parameters obtained at the district laboratories. At a minimum, contractors are required to perform testing to control production quality according to the QC schedule defined by QCP and PFP specifications.

Selection of the appropriate tests and parameters related to pavement performance is key to the success of current QA specifications. However, inherent variability exists in test results, and this can have an impact on pay factors. Therefore, understanding the distribution and variability of the test results is critical for evaluating the initial quality of constructed pavements. Test parameter variability is attributable to four factors. The total variability of test results is composed of sampling, testing, material, and construction variability (Stroup-Gardiner et al., 1994). The components and total variability can vary among HMA types.

Sometimes differences or bias between the results obtained by two different parties exists, for example between an IDOT district and a contractor's lab. Hence, it is necessary to evaluate test results obtained from projects under QCP and PFP specifications and perform a statistical analysis. The statictical analysis presented allows for an understanding of the test parameter variability and its impact on specifications and pay factors.

1.2 OBJECTIVES AND RESEARCH SCOPE

The objective of this project is to understand the distribution and variability of the test results included in the QCP and PFP specifications, as well as the potential causes of variability. The study is intended to address practical concerns and questions regarding QCP and PFP specifications and evaluate the trends observed when comparing IDOT district and contactor test results. A multiprobe assessment of data obtained from a large pool of projects constructed under the QCP and PFP specifications was conducted. The assessment approach included statistical methods and on-site field observations.

To achieve these goals, data analysis was conducted to evaluate the distribution of test results and variability. The scope of the data analysis included hypothesis testing to compare test results from districts and contractors. These results included mean, distribution, and variance using the Mann-Whitney (mean comparison), Shapiro-Wilk (distribution), and Levene's F (variance) tests. Jobsites in selected districts and respective contractor facilities were visited to collect information that was used to understand the causes of variability. Finally, recommendations were developed to reduce variability created during sampling, testing, material production, and construction processes.

1.3 REPORT ORGANIZATION

The outcome of the data analysis procedures and the evaluation of the jobsite visits are presented in this report. In addition, a list of recommended actions to reduce the sources of variability, provide consistent results between laboratories, and improve HMA quality is presented. The report's chapters are organized as follows:

Chapter 2: A literature review of the development of PFP specifications used in Illinois is presented. Data variability concerns and sources identified in the literature for QA agency and contractor testing are discussed.

Chapter 3: The planned research methodology for assessing QCP and PFP specifications is presented. Additionally, data collected and used in the study is described.

Chapter 4: The evaluation of the distribution of test results and variability, using various statistical approaches, is discussed.

Chapter 5: Observations from several construction project visits during the 2018 construction season and observations from interviews with district engineers and contractors are summarized. The data analysis and results from the jobsite visits are presented.

Chapter 6: The conclusions and observations of this study are summarized.

1.4 IMPACT OF THE STUDY

The results from this study provide discussion on the causes of variability patterns existing in the data collected on projects constructed under IDOT's QCP and PFP specifications. This is expected to lead to better control of variability in the future. The study provides a list of observations to improve quality and consistency of QCP and PFP test results. Upon implementation of the proposed observations, it is expected that comparison between contractor and district test results will reduce potential disputes between IDOT and contractors in the acceptance process.

CHAPTER 2: CURRENT STATE OF KNOWLEDGE ON QUALITY ASSURANCE PROGRAMS AND TEST RESULT VARIABILITY

This chapter summarizes and discusses IDOT's QA program for HMA. The use and development of QA programs in the United States and Illinois are first discussed to understand the origin and purpose of the current program. Then, the review focuses on studies that evaluated the differences in agency and contractor test results within QA programs. Finally, the expected variability of HMA testing and possible causes are discussed relevant to this study.

2.1 USE AND DEVELOPMENT OF QA PROGRAMS IN THE US WITH EMPHASIS ON ILLINOIS

Since the 1960s, Department of Transportation (DOT) QA programs have had to adhere to Title 23 of the Code of Federal Regulations, Part 637 (23 CFR 637) and be approved by FHWA (2007). As per the CFR, each state highway authority (SHA) shall develop a quality assurance program that will assure that the materials and workmanship incorporated into each federal-aid highway construction project on the national highway system are in conformity with the requirements of the approved plans and specifications, including approved changes. The program must meet the criteria in Sec. 637.207 and be approved by FHWA. FHWA conducts stewardship reviews to assess DOT QA program practices and procedures, as well as ascertain the status of DOT implementation of this QA regulation. More recently, FHWA has been evaluating the effectiveness (health) of QA programs to ensure DOTs receive high-quality materials and "minimize the potential for abuse" (FHWA, 2008). Reviews and evaluations are discussed later in this chapter.

Before 1990, IDOT designed HMA and controlled its production at plants by having proportioning technicians stationed at each plant. In the early 1990s, IDOT developed a quality management program (QMP) referred to as "QC/QA." It was used to gradually involve contractors and the industry to design and control HMA production. By the end the decade, IDOT began to evaluate changes to QC/QA and their implications to get specifications that evaluate the quality of the HMA end product and not the construction (Patel et al. 1997). Context and events that led to similar changes on other QA programs nationwide are sumarized in Appendix B.

In 1993, Indiana implemented the Superior Performing Asphalt Pavement (SuperPave) HMA design method, with no QA procedure, initially. The National Cooperative Highway Research Program (1998) included a QA plan of field production, placement, and compaction to ensure that as-placed HMA conformed with the method and to assist the industry with implementation of SuperPave. SuperPave mixes had to be compliant with certain tolerances before and during construction. Presently, many states have established and used their own mix tolerances.

As of 1995, the 23 CFR 637 regulation allowed the use of contractor-performed sampling and testing in acceptance decisions and established a systematic approach for QA and validation of contractor test results when used (FHWA, 2007). Effective use of contractor-performed test results in acceptance is an ongoing area of research, e.g., NCHRP Project 10-58(2) and more recently NCHRP Project 10-100 (NCHRP, 2017). IDOT's previous QMP (QC/QA) used contractor test results in the acceptance decision of HMA.

In 2005, the most-used atributes for QC of HMA included aggregate gradation, binder content (P_b), AV and HMA field density, and VMA (NCHRP, 2005). The most commonly used acceptance criteria included density, P_b, and ride quality, followed by aggregate gradation and AV. QA calculations to assess quality of HMA and placement were mainly completed using percent within limit (PWL), ranges, or averages. Based on the quality of construction, agencies used pay factor adjustments to encourage quality improvements. Nine states used a disincentive (pay factor reduction for poor quality), and 32 states used both incentives (pay factor increment for specified quality with low variability) and disincentives.

In highway construction projects, materials and construction quality characteristics are important factors for the long-term performance of a finished work. Monismith et al. (2004) and Deacon et al. (2001) reported the effects of various HMA characteristics on pavement performance and promoted choosing quality characteristics that relate to or describe performance for QA. Among IDOT's goals in 2013 was moving to a system that included the use of high-speed profilometers to measure the International Roughness Index (IRI) (IDOT, 2013) on roadways with speed limits of 50 mph and greater.

Performance-related specifications focus primarily on quality characteristics that have been found to correlate with fundamental engineering properties that may be used to predict performance. Performance-based specifications describe directly the levels of fundamental engineering properties. This kind of specification has not yet found application in transportation construction (TRB, 2018). FHWA outlined specific policies and programmatic framework in the Moving Ahead for Progress in the 21st Century (MAP-21) act in 2012 (Federal Motor Carrier Safety Administration, 2019). It recommends streamlined policies and specifications that consider performance for surface transportation programs, including pavements. Currently IDOT's HMA QA program, and most QA programs in the United States, include pay parameters that are related to performance.

Performance models can be used to estimate the impact of material properties on pavement service life. Thus, acceptance test results combined with appropriate risk analysis can be used to calculate rational pay factors. These concepts are known and development was encouraged by the research community (NCHRP, 1995). NCHRP (2011) provided a tool that performs pay adjustment factors and payment computations by comparing the as-built pavement performance with that of the as-designed pavement. This approach has not yet been pursued by state agencies, and FHWA has not moved forward with this concept for material quality acceptance decisions.

IDOT developed a QA specification based on PWL and performance-related parameters through collaboration with the Illinois Center for Transportation (ICT). HMA construction projects were constructed and monitored. A tool that mapped the relationship between quality characteristics, engineering properties, and measured distresses (rutting, cracking, moisture damage, etc.) was developed (Buttlar and Harrell, 1998). The resulting QA specification was used for demonstration projects in the 2000s as part of the ICT-R27-23 performance-related specifications research project (Buttlar and Manik, 2007).

By 2019, 34 state agencies used PWL for HMA acceptance (FHWA, 2014). PWL, which is a continuous system, uses the mean and standard deviation to estimate the amount of material within specification limits. The concept of PWL is shown in Figure 2.1 (a). Uncertainties that may occur during production and placement can be incorporated in specification limits of PWL. This was a major improvement from the traditional QA programs that used the pass/fail criterion for acceptance. Alternatively, stepped systems have been used. A pay factor is assigned for each sublot obtained. If the sublot is within the specification limits, then it receives 100% pay. If not, the pay factor depends on how far results from the sublot were from the lower and upper requirements, as seen in Figure 2.1 (b). Using a pay factor system based on a single test is unusual for HMA acceptance. It can be considered acceptable for certain sizes and types of projects.

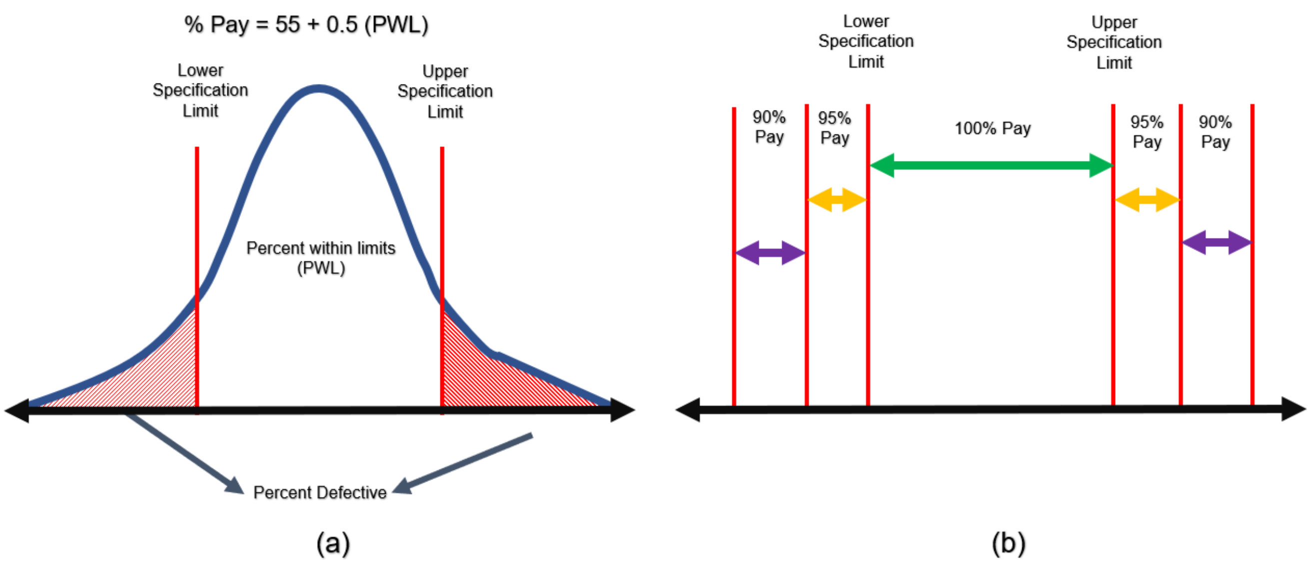


Figure 2.1. Concept of (a) PWL and (b) step system (Buttlar and Manik, 2007).

FHWA assessed the effectiveness of DOT QA programs in 2008, 2010, 2012, and 2014 (FHWA, 2014). The assessment was designed to reflect the strength of each QA program and its ability to minimize the possibility of waste, fraud, and abuse. There was significant improvement by all state agencies compared to previous reviews. The areas in which more agencies improved were in controlling the location of random sampling, material-testing dispute-resolution processes, electronical management of test results used in the acceptance process, and agency technician proficiency verification. There were some areas in which agencies needed to improve. Among them were the statistical method for acceptance if the agency is using contractor test results and independent assurance (IA) programs.

FHWA (2008) classified Illinois among the top-five states with a demonstrated weakness in its QA program in the ability to measure quality or have a weakness that could lead to contractor abuse and fraud. The low effective score reported by FHWA encouraged IDOT to make changes to its HMA QA procedures. IDOT created the PFP specification based on the specification used in the research project ICT-R27-23 (Buttlar and Manik, 2007). Pay adjustments based on agency test results (following Michigan's lead) were added along with jobsite sampling with sample security measures (Trepanier, personal communication, August 2019).

In 2010, IDOT began transitioning projects to the PFP specification. At the time, IDOT's resources were insufficient to fully comply with federal regulations and FHWA's recommendations. A combination of planned engineering technician and civil engineering hires in conjunction with consultant agreements were executed. IDOT's goal was to use PFP for all projects over 4,000 tons by 2014. After adopting PFP, the department would implement a system for projects less than 4,000 tons (IDOT, 2010). The QCP specification was implemented by IDOT first in 2012. It was intended for projects where a minimum of eight tests is not possible or projects in which the nature of construction site conditions make it difficult to achieve uniform production, e.g., thin overlays on existing pavements with poor condition, poor base conditions, non-uniform production operation, etc. IDOT's objective was to complete the transition to QCP specification on projects that qualified by 2014 (IDOT, 2013).

2.2 ILLINOIS QUALITY MANAGEMENT PROGRAM (QMP)

IDOT's current QA program implements QCP and PFP specifications. IDOT's former QA specification, QC/QA, is being phased out, but is still used for smaller and miscellaneous mix applications. Its use will continue to be limited. It was not part of this study's scope.

For PFP, a PWL specification is used for US, state route, and national highway system roadways such as interstate, freeway, and expressway resurfacings, as well as full-depth asphalt pavement projects with a minimum HMA quantity of 8,000 tons per mix (IDOT, 2018a). QCP and PFP exclusions exist such as sidestreets, short turn lanes, short-term temporary pavements, and other exclusions defined by IDOT. These sections of asphalt pavements default to the QC/QA method of acceptance. PFP can also be used for smaller projects, where a more accurate measure of quality is desired, provided the sublot size is reduced to maintain eight or more sublots. On the other hand, QCP is for smaller mainline HMA projects, where mixture quantities range between 1,200 and 8,000 tons. It has also been implemented for narrow shoulder applications and leveling binder mixes (IDOT, 2018b).

As of July 26, 2019, IDOT changed nomenclature (eliminating the term "leveling binder") and increased the minimum compacted lift thickness requirements such that mixtures are not placed at less than three times the nominal maximum aggregate size (NMAS). As a result, all lower lifts of HMA are named binder mixtures (IDOT, 2019). Therefore, QCP and PFP can be implemented for QA of mixes used for levelling purposes. Therefore, both can now be implemented for off-interstate applications. For the data presented in this report (2015–2017), this change had not yet been implemented. In addition, all other QCP and PFP changes made by IDOT in 2019 are not reflected in the data presented in this report.

2.2.1 Sampling

The pay parameters for both QCP and PFP specifications include field VMA, AV, and in-place density. Step-based pay disincentives exist for the dust/AC ratio and, in the case of PFP, unconfined edge density that is out of tolerance. Aggregate gradation, binder content, and VMA, which are affected by mix segregation, are measured by the contractor as part of their process control but are not directly used as pay parameters. Although such information is obtained by districts too, it is not reported at this time.

HMA sampling in Illinois is completed by the contractor:

- Mix samples are usually obtained in the field behind the paver from the mat after placement and prior to compaction.
- Mix samples are randomly obtained from every sublot (typically 1,000 tons), with QCP requiring a minimum of one sublot sample per project and PFP requiring 10 sublots per lot.
- Density is obtained by drilling cores in the road surface once the HMA has been compacted and cooled.
- Cores are obtained from a random location in every density interval (typically 0.2 mi for lift thicknesses of 3 in or less, and 0.1 mi for lift thicknesses greater than 3 in or wide paving).

  In QCP, the average of five consecutive density intervals is taken as the agency's density sublot results.
- In PFP, each density interval is considered a density sublot and 30 density intervals consists of a density lot. Random samples are obtained from the jobsite for mix samples and field cores. The mix samples are split for the contractor (QC) and agency (QA) testing. A third sample is obtained for a third-party dispute resolution in the case of PFP.

Sampling techniques used by contractors are discussed in Chapter 5.

2.2.2 Pay Factor Calculation

A major difference between QCP and PFP is the calculation of the pay parameters. QCP is a stepped system whereas PFP is a PWL system (see Figure 2.1). PFP pay factors are computed per Equation (2.1):

$$\text{Pay Factor} = 55 + 0.5(\text{PWL}) \tag{2.1}$$

where pay factor (PF) is defined and calculated for each pay parameter. The pay factors range from 90% to 100% for QCP projects and from 55% to 105% for PFP projects.

Equation (2.1) used to be Pay Factor = 53 + 0.5(PWL) and the maximum pay factor for QCP was 103% before June 2017 (IDOT, 2018c). For the data presented on this report (2015–2017), this change had not yet been implemented.

In addition, for density calculation, PFP uses a single density measurement, while QCP uses an average of five density measurements.

2.2.3 Pay Calculation

For both specifications, the pay factors of each parameter are combined into one composite pay factor (CPF) for final pay using Equation (2.2):

$$\text{CPF} = 0.30_{(\text{PF AV})} + 0.30_{(\text{PF VMA})} + 0.40_{(\text{PF Density})} \tag{2.2}$$

where, PF AV is the pay factor for AV, PF VMA is the pay factor for VMA, and PF density is the pay factor for density, all are expressed as percentages. The composite pay factor is then used to compute the final pay of the project, as shown in Equation (2.3):

$$\text{Final Pay} = \text{Mixture Unit Price} * \text{Quantity} * \text{CPF} \tag{2.3}$$

Under the PFP specification, contractors can earn pay incentives when the CPF is greater than 100%. Under the QCP specification, pay factors of each pay parameter are truncated to 100% prior to calculating the CPF.

In the QCP specification, if the difference between QC and QA contractor and agency test results are outside the precision limits shown in Table 2.1, sublots are retested by agency personnel. If the retested sublot results are outside precision limits or have a pay factor less than 100%, all sublots in a lot are tested by IDOT.

Table 2.1. Precision Limits for QCP

Test Parameter	Precision Limits
G_{mb}	0.030
G_{mm}	0.026
VMA	1.0%

2.2.4 Disputes in PFP Specifications

PFP projects allow contractors to dispute district (QA) sublot results when the difference between the results exceeds the precision limits shown in Table 2.1. All sublots are tested in PFP. The contractor must request the sublot to be disputed. Thus, not all sublots that exceed the precision limits are disputed.

Currently, two methods are used for dispute resolution (IDOT, 2018a). The first method allows the contractor to dispute the pay parameter result such as AV, VMA, dust/AC ratio, or core density when the results are outside the limits of precision, as shown in Table 2.1. The Central Bureau of Materials (CBM) laboratory would then proceed to test the third sample of the disputed sublot and replace the district test results with the CBM test results. In 2018, IDOT began a second method that allows the contractor to dispute only an individual test, such as G_{mm}, G_{mb}, or P_b, that exceeds the precision limits shown in Table 2.2. This method applies only to contractors who participate and comply with the "AASHTO re:source Proficiency Sample" program. In this study, data collection occurred before 2018; therefore, all disputed sublots were tested according to the first method.

Table 2.2. Precision Limits for PFP Dispute Resolution Method Nos. 1 and 2

Method No. 1		Method No. 2	
Test Parameter	**Precision Limits**	**Test Parameter**	**Precision Limits**
Air Voids (AV)	1.0%	G_{mm}	0.008
VMA	1.0%	G_{mb}	0.012
Dust/Asphalt Binder	0.2	Asphalt Binder	0.2
Core Density	1.0%		

2.3 REPORTED DIFFERENCES IN AGENCY AND CONTRACTOR HMA TEST RESULTS

Disagreements between contractor (QC) and agency (QA) testing have been reported (Benson, 1999). Parker and Hossain (2002) used the F-test to run a comparative assessment between contractor and Alabama DOT (AlDOT) test results. P_b, AV, and density data from projects constructed from 1997 to 2000 presented statistically significant differences, with a few exceptions. During that time, AlDOT was only beginning to implement SuperPave mixes; thus, it is understandable that issues of this type were found.

Turochy et al. (2006) used F- and t-tests and found statistically significant differences between agency QA and contractor QC for aggregate gradation and P_b of mixes placed in Georgia during the 2003 construction season. This occurred in less than 10% of the projects when analyzing the means. Additionally, 10% to 13% of the projects had statistically significant differences in variance.

Conversely, Hall and Williams (2002) indicated that test data from six projects throughout Arkansas, such as P_b, AV, VMA, and density, reported by three different operators (contractor, Arkansas DOT, and a third party) were statistically similar. (It is not stated whether the operators used the same equipment.) Similarly, Mahboub et al. (2008) reported no significant difference between testing by contractors and Kentucky Transportation Cabinet (KYTC) data. However, the contractor-reported standard deviations were sometimes smaller than those reported by KYTC. For their acceptance procedure, KYTC performs tests on the contractor's equipment or on the department's equipment. Data was not distinguished in the report.

LaVassar et al. (2009) analyzed pay parameters from four state departments of transportation, including Texas and Washington. HMA pay parameters were assumed to be normally distributed and various statistical tests were performed, including F- and t-tests, to compare QC and QA variances and mean values. For the data from Texas, the study reported statistically significant differences for 60% of the mixes for in-place AV, and 40% in density and asphalt content measurements. For the data from Washington, the study reported statistically significant differences for 20% of the mixes for P_b.

Mohammad et al. (2013) performed a single-factor ANOVA on AV, P_b, VMA, voids filled with asphalt (VFA), and density test data from projects in Florida and Kansas. In Florida, no significant difference occurred in at least 90% of the cases. Kansas, however, had 20% of its mixes showing significant differences in variances for state and contractor measurements. When t-tests were performed, 14% of the mixes showed differences in AV measurements while 48% showed differences in density measurements. The authors, as part of a NCHRP (2016) phase I study, noted that, in general, variability in the contractor measurements were less than that of the agency, and third-party test results had the highest variability.

The aforementioned research studies identify and describe differences between agency and contractor test results of samples of the same HMA batch or specified mat. Understanding where the differences between contractor and district results originate, however, remains a necessity to improve those programs and are not clearly identified. Test variability and bias are repeatedly noted. Finally, the sample pool of QA and QC testing results comparison are usually small, with fewer than 30 data points. Regardless, researchers have used parametric tests, assuming populations of the compared samples are normally distributed. Of the mentioned studies, only Hall and Williams (2002) validated this typical assumption in their study. The assumption has been validated for HMA properties mentioned in other studies, e.g., Chakroborty et al. (2010) and Aguiar-Moya and Prozzi (2011).

2.4 VARIABILITY IN HMA TEST RESULTS

Apart from material and construction variability, HMA test results yield variability caused by testing (equipment, operator, method) and sampling. Identifying variability sources and understanding its magnitude of importance are required when differences between contractor and agency test results are evaluated. Hand and Epps (2000) performed Monte Carlo simulations to evaluate the effect of precision limits on optimum asphalt binder selection. The study reported that testing variability within the precision required by AASHTO standards could translate to differences of 0.7% to 1.4% in the selected optimum P_b.

2.4.1 Comparing the Volumetric and Mechanical Properties of Laboratory and Field Specimens of Asphalt Concrete

NCHRP (2016) explained how construction processes and handling may influence the magnitudes of the differences within and among three specimen types: plant-mixed and field-compacted (PF), plant-mixed and laboratory-compacted (PL), and laboratory-mixed and laboratory-compacted (LL). The report quantified the levels of variability in the measurements of volumetric properties and aggregate gradation of dense-graded HMA based on test data from agencies and contractors of 13 states (Table 2.3).

Table 2.3. HMA Property Levels of Variability (NCHRP, 2016)

Volumetric Properties			
Property	**Sample Type**	**Standard Deviation Range**	**Average Standard Deviation**
P_b	PL	0.17–0.29	0.20
AV	PL	0.33–0.99	0.62
VMA	PL	0.38–0.64	0.54
VFA	PL	3.40–4.92	4.03
G_{mb}	PL	0.008–0.018	0.015
	PF	0.008–0.033	0.019
G_{mm}	PL	0.005–0.012	0.011
Density	PF	0.74–1.49	1.11

Table 2.4 presents the tolerance values developed in that study. The tolerance values encompass mixtures from around the country. The proposed tolerances are 1.96 times the standard deviation of the differences found among specimens. The report recommends that states review their current tolerances with respect to these values. The tolerances used in Illinois were found to be less than the reported values.

Table 2.4. Volumetric Tolerance Recommendations (NCHRP, 2016).

Property	Comparison			Tolerance Recommendation (±)
AV (%)	Design (LL)	-	Production (PL)	0.8
VMA (%)		-		1.2
VFA (%)		-		5.4
P_b (%)*	Design (LL)	-	Production (PL)	0.2
	Design (LL)	-	Construction (PF)	
	Production (PL)	-	Construction (PF)	
G_{mm}	Design (LL)	-	Production (PL)	0.02
	Design (LL)	-	Construction (PF)	0.013
	Production (PL)	-	Construction (PF)	0.018
G_{sb}	Design (LL)	-	Production (PL)	0.014
	Design (LL)	-	Construction (PF)	0.019
	Production (PL)	-	Construction (PF)	0.017
Aggregate Passing 0.075mm Sieve	Design (LL)	-	Production (PL)	0.5
	Design (LL)	-	Construction (PF)	0.7
	Production (PL)	-	Construction (PF)	0.5

*Note the tolerance reported for P_b was developed by solvent extraction. The standard deviation of the solvent extraction results is lower than the ignition method. Consequently, the tolerance for ignition would be slightly higher.

2.4.2 Variability of Volumetrics

The G_{mb} and G_{mm} tests are usually the main source of variability of the other volumetric results, including AV, VMA, and density (Hand and Epps, 2000). G_{sb} has also been found to be a factor in causing variability (NCHRP, 2016). This depends on whether the state allows the value to change. Testing method, equipment, and sampling are sources of variability affecting test results and are discussed hereafter.

Crouch et al. (2002) evaluated the precision and accuracy of four methods to determine AV of compacted HMA: CoreLok, parafilm, SSD (method used in Illinois), and dimensional analysis (AASHTO T269 [volume method]). All methods were found to be capable of producing high-precision results; the precision of the SSD method was the highest. However, AV values based on G_{mb} obtained by this method were always the lowest. The authors demonstrated that results obtained using this method do not change if a sample has a different percentage of internal voids. Because of this limitation, they ruled out the use of the SSD method for HMA. Although the authors did not recommend a method, the study showed the CoreLok method was the most accurate test for 90% of the samples.

The assumption of equivalency of properly calibrated SuperPave gyratory compactors has historically been called into question. Buchanan and Brown (2001) and Mahoney and Stephens (2003) were two examples. Internal-angle measurements and calibrations were introduced and specified by many states and AASHTO to correct this. FHWA (2010) drew attention to the physical condition of compaction equipment. Its cleanliness, excessive wear in molds (inside diameter in the area of the mold wall subject to compaction, i.e., 1 to 5 in from the bottom), how sampling can affect test results, and how these sources of variability should be corrected.

In 2013, segregation was considered a continuing problem for IDOT's HMA construction projects (IDOT, 2013). Coarse-graded HMA may increase the potential for segregation during sampling and subsequent sample handling/preparation (FHWA, 2010). HMA with segregation causes AV to vary by

0–4%, 2–6%, and > 6% for low, medium, and severe segregation, respectively. The three main causes of segregation are related to aggregate gradation, temperature, and asphalt content. Aggregate gradation segregation is the most common because of aggregate stockpiling and handling (NCHRP, 2000). Segregation may cause sampling variability. FHWA (2013) suggests sampling of loose HMA should be done strictly from behind the paver where the final "in-place" properties are evaluated.

2.4.3 Variability of Asphalt Content

In Illinois, P_b is usually determined using the ignition oven method or reflux extractors. Less frequently, it is determined with centrifuge extractors. Recently, automated extractors have been used by Districts 1, 3, and 4. Contractors and independent labs in Illinois have also begun to use automated extractors.

Sholar et al. (2002) used an approach to encompass the variability associated with the following sampling locations and other variables: (a) differences in HMA within the truck bed, (b) collection of samples from the truck, (c) splitting of the HMA mixture into samples for testing, (d) differences in ignition oven equipment, and (e) operator. Six SuperPave mixtures and three open-graded friction courses of different NMAS were used for the experiments. The results of the study indicate that the allowable difference between two test results for asphalt binder content should be no greater than 0.32% within a laboratory and 0.44% between laboratories.

2.4.4 Quality Levels of Pay Parameter's Mean and Variability

Hall and Williams (2002) reported an approach to establish the variability for HMA construction in Arkansas. As shown in Table 2.5, the data were grouped into high-, medium- and low-quality levels. The values provided by NCHRP (2016) in Table 2.4 would be considered of medium quality for density, whereas P_b, AV, and VMA values would be considered high quality.

Table 2.5. Summary of Material Properties by Quality Level (Hall and Williams, 2002)

Property	Quality Level					
	High		Medium		Low	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
P_b (%)*	0.06	0.184	0.21	0.251	0.33	0.413
AV (%)	3.58	0.649	3.09	0.768	5.02	2.097
VMA (%)	14.92	0.346	14.32	0.589	14.94	1.136
Density (%G_{mm})	92.57	0.79	91.82	0.959	90.43	1.313

*expressed as percent difference from design P_b

2.4.5 Variability Sources in HMA Test Results

Table 2.6 presents the most important factors identified affecting HMA test results. Specifications or test methods should explicitly address each of these items, providing clear requirements if an agency wishes to reduce variability among test results obtained by multiple laboratories.

Table 2.6. Summary of Variability Sources in HMA Testing*

Category	Variability Source
Production	• Baghouse fines variation • Silo storage time of asphalt • Plant type and settings • Segregation • Aggregate absorption (field vs lab) • Aggregate moisture • Aggregate degradation • Aggregate G_{sb}
Construction	• Segregation control • Use of material transfer device • Competency of contractor • Construction equipment
Testing	• Reheating procedure • Sampling location • Sampling method • Splitting method • Sample type • SuperPave gyratory compactor's cleanliness, physical condition, and wearing of molds • G_{mb} determination method • Equipment calibration or lack of • Equipment maintenance

*This table includes the sources of variability listed in NCHRP (2016).

2.5 QUANTITY OF SAMPLES

IDOT's current QCP and PFP specifications and latest updates are in line with FHWA's (2019) recommendations regarding density. The most common frequency of density testing (identified by FHWA as best practices) was every 250 to 500 tons. IDOT's QCP and PFP require density core tests every density interval of typically less than 250 tons (and as small as approximately 120 tons). The number of test results considered for pay calculations of IDOT's current QA program is appropriate.

2.6 SUMMARY

The main ideas discussed in this chapter are summarized below:

- Three decades ago, design and process control responsibilities of HMA construction shifted from agencies to contractors. The importance of statistically based pay calculation and performance-related parameters became evident in the 2000s. In the early 2010s IDOT's QA transitioned to QCP and PFP specifications to fully comply with federal regulations (23 CFR 637) and FHWA's recommendations.

- The specifications implemented in IDOT's QMP are described in section 2.2: Illinois Quality Management Program. The QMP relies on QCP for mixtures in the 1,200–8,000 ton range and PFP for mixtures greater than 8,000 tons. The main difference between QCP and PFP is the pay calculation and density calculation approach. The PFP specification incorporates the PWL method, whereas QCP uses a stepped procedure to determine pay factors.
- IDOT's QCP and PFP specifications are appropriate when compared to the previously referenced documents for the type of projects for which each is used.
- Since SuperPave mix-design specifications were completed and implemented nationally, differences in agency and contractor results have been found. The root causes were not clearly identified. Sampling and test result variability and bias, however, cause a significant portion of these differences. Variability in test results has repeatedly been found to be greater for agencies than for contractors, perhaps because of the number of samples. A detailed list of possible causes and variabilities is listed in the chapter.
- Reducing test variability would control apparent differences between agency and contractor test results and help distinguish bias from expected variability. The variability of the G_{mb} and G_{mm} tests are usually the main driver of variability in the volumetric results.
- To comply with FHWA's recommendations and reduce potential variability, IDOT requires the contractor to sample loose HMA from behind the paver with a standardized random sampling procedure.

CHAPTER 3: DATA COLLECTION AND ANALYSIS

A data analysis program was developed per the objectives of the study. The scope of the data analysis program includes descriptive statistics, hypothesis testing, data visualization, and correlations. This chapter introduces the research methodology followed by data sets compiled from the Illinois Department of Transportation (IDOT) and contractors in Illinois. Finally, the statistical tests used for the data analysis are described.

3.1 RESEARCH METHODOLOGY

The research methodology consists of the following parts: (1) pay factor analysis, (2) pay parameter statistical analysis, (3) volumetric results analysis, (4) mix composition analysis, (5) round robin evaluation, and (6) data analyses from site visits. Assessing data variability was performed in accordance with the flowchart illustrated in Figure 3.1.

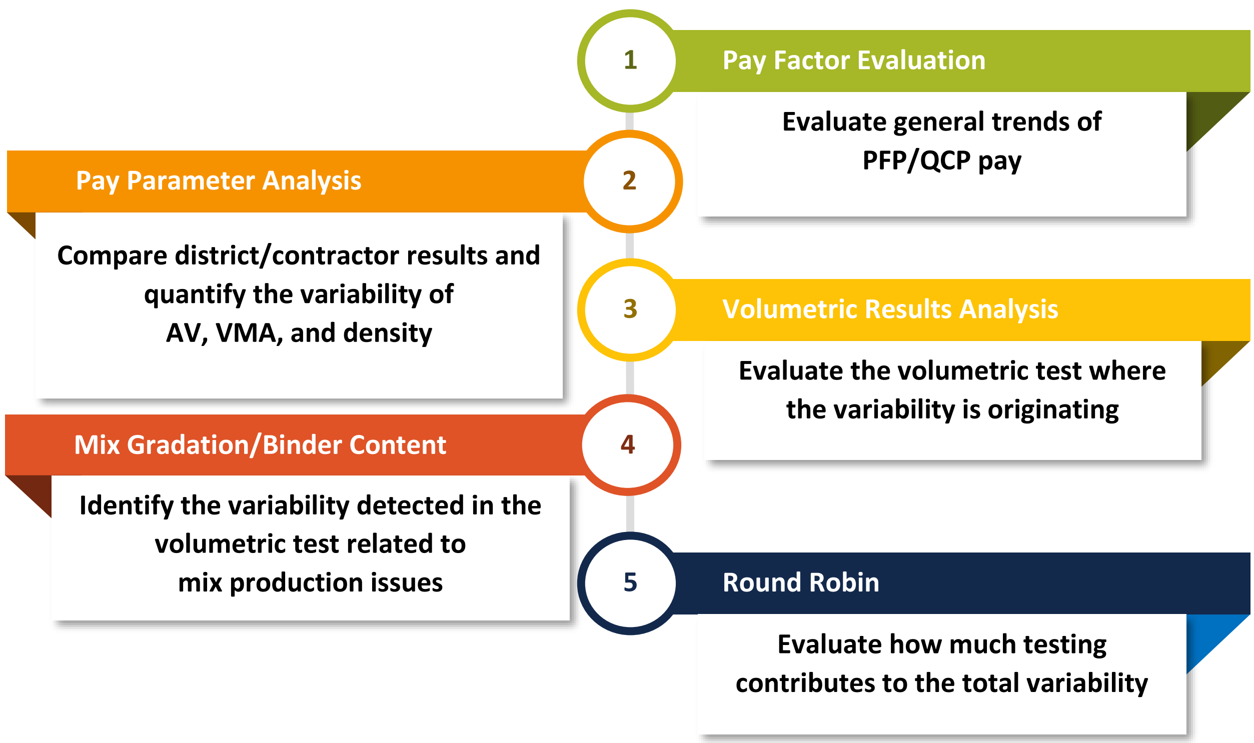


Figure 3.1. Research methodology.

The first part of the analysis observed the pay factor trends to compare variation in data trends as a function of key factors that may contribute to variability in QCP and PFP projects. First, the pay factors were grouped per district and year to check uniformity between districts and changes over time, respectively. In addition, each pay factor parameter (AV, VMA, and density) trend was analyzed individually to evaluate the effect of each parameter on payment. Finally, the pay factors were grouped and analyzed according to mix type groups.

The second and third parts of the evaluation consisted of conducting descriptive statistics and hypothesis tests on QCP and PFP sublot results. Again, the analysis focused on the pay parameters (AV, VMA, and density). The analysis used descriptive statistics and hypothesis testing to quantify the magnitude of the variability in the test results and to identify any significant difference between the results reported by the contractor and district. In the case of a significant difference existing, the magnitude of the difference was reported. Afterwards, statistical analysis was conducted on G_{mm} and G_{mb} results, from which the AV and VMA were computed. G_{mm} was also used to compute core density. Finally, test results related to mix composition, aggregate gradation, dust, and asphalt binder content were analyzed considering the variability observed in the G_{mb} and G_{mm} tests to identify mix production issues.

The fourth part of the analysis focused on the evaluation of the variability due to testing using data from IDOT Volumetric Uniformity Study results, also known as round robin studies. The uniformity studies consist of the test results for G_{mm} and G_{mb} obtained from a group of 40 laboratories for five consecutive years. Each laboratory received the same mix sampled by IDOT Central Bureau of Materials (CBM). As a result, it was assumed that differences in test results and variability were related to testing procedure, operator, and/or equipment. Sampling-related variability was eliminated.

The last part of the analysis focused on the evaluation of data compiled from the jobsite visits. Jobsite shadowing visits were conducted on 11 construction projects during the 2018 construction season to monitor sampling, blending, splitting, and testing during production and construction. The collected information was analyzed to determine potential root causes of pay disincentives and variabilities, if they existed. This would assist in developing recommendations regarding mix production, construction, and testing provided in the report.

3.2 DATA COLLECTION

Five data sets were compiled for this study: pay factors, mix sublot results, PFP dispute results, IDOT Uniformity Study results (round robin), and jobsite visit data. The data collected corresponds to the projects constructed under the QCP and PFP specifications in Districts 1, 2, 5, 6, 8, and 9, as shown in Figure 3.2. Only the 2015, 2016, and 2017 construction seasons were included in the scope of the data collection. For the 2018 jobsite shadowing visits, additional data that included individual mix test results, plant datalogger, and temperature records were collected.

A total of 710 mix contract combinations were identified for the districts and construction years within the scope of the project. A mix contract case is a unique combination of a specific contract and mix. For example, if a contract has more than one mix (i.e., surface mix and a leveling binder), then each mix was analyzed separately and referred to as a mix contract case. As a result, data from the same mix but used in different construction contracts were not grouped together for the analysis. The report uses the term “cases” to refer to each mix contract combination.

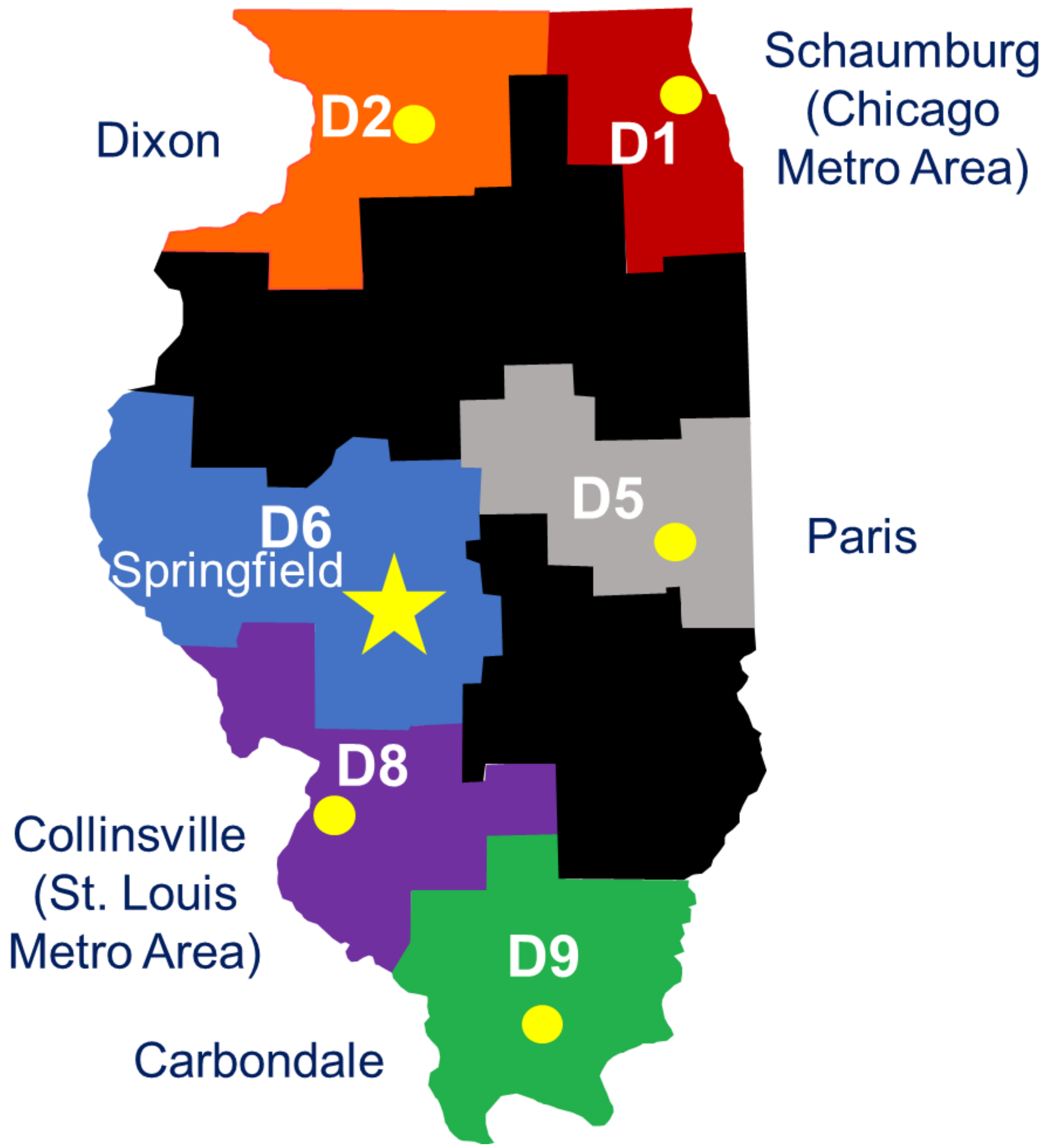
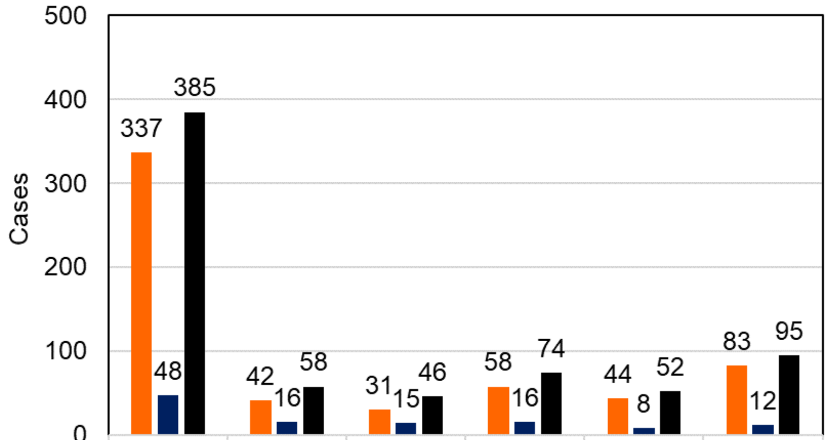


Figure 3.2. IDOT districts included in the project's scope and respective district office locations.

3.2.1 Pay Factors

The pay factors correspond to the percentage pay adjustment for AV, VMA, and density received based on the quality assurance (QA) test results. The AV, VMA, and density pay factors are computed using a step-based system for QCP projects and percent within limits (PWL) for PFP projects according to "PFP Quality Level Analysis, Appendix E.1" and "QCP Pay Calculation, Appendix E.6"(IDOT, 2017).

The pay factors were collected from each individual district's file records and compiled into a database. A total of 710 pay factors were collected for the 2015–2018 construction seasons. Figure 3.3 shows a breakdown of the 710 pay factors per district and quality management program. District 1 has a substantially larger number of cases than the rest of the districts because it covers the Chicago metropolitan area, where many state projects are located.



	1	2	5	6	8	9
QCP	337	42	31	58	44	83
PFP	48	16	15	16	8	12
Total	385	58	46	74	52	95

Figure 3.3. Total number of pay factors collected from each district.

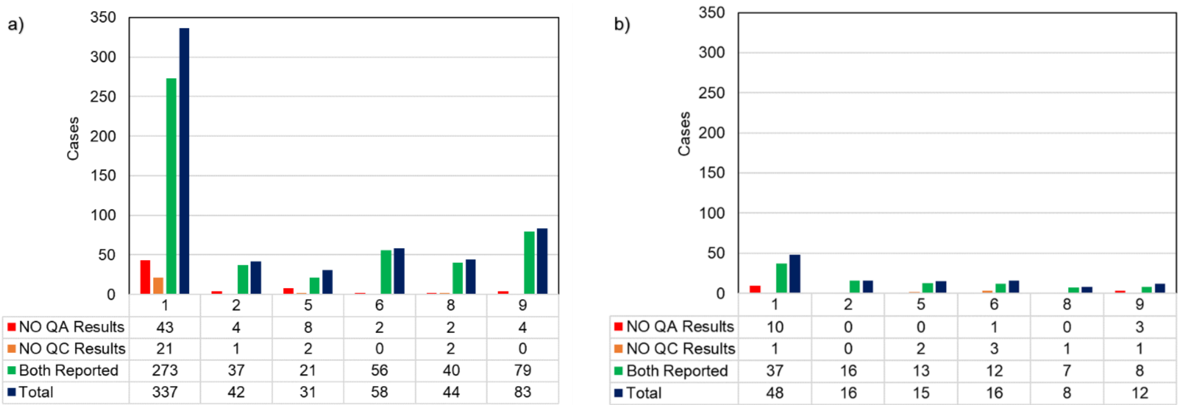
3.2.2 Quality Assurance and Quality Control Sublot Test Results

The QA and QC sublot results for QCP and PFP projects were collected. The results correspond to the plant-produced materials sampled at the jobsite in accordance with the "PFP and QCP Hot-Mix Asphalt Random Jobsite Sampling, Appendix E.4" (IDOT BDE, 2017). Other contractor QC results were not included but were an important part of the QC process. The density results originated from the cores obtained in accordance with the "PFP and QCP Random Density Procedure, Appendix E.3" (IDOT, 2018c). The mix and density sublot results were used to calculate the pay factors described in section 3.2.1: Pay Factors. Table 3.1 describes the data collected from the sublot test results with respect to the pertinent Illinois modified AASHTO specifications.

Table 3.1. Sublot Test Result Data

Data Type	IL Modified AASHTO Specification
Gradation	T 30
Binder Content	T 308 & T 164
Bulk Specific Gravity (G_{mb})	T 166
Maximum Specific Gravity (G_{mm})	T 209
Air Voids	M 323
Field VMA	M 323
Dust/AC Ratio	Calculation from gradation and binder content test results. Defined in IDOT Art. 1030.04
Density	T 166

The sublot test results were obtained from the IDOT MISTIC database and Excel and PDF spreadsheets provided by the districts. QC and QA tests were conducted for all cases in the 2015–2017 period. However, not all results were digitally accessible for the research team; some data were stored in paperwork. Figure 3.4 shows a breakdown of the cases: digitally accessible for both QC and QA (“Both Reported”), not digitally accessible for QA (“No QA Results”), or QC (“No QC Results”).” In summary, for a total of 595 QCP cases, 506 digitally reported the results from QC and QA. For PFP, from a total of 115 cases, 93 digitally reported the QC and QA results.



a)

	1	2	5	6	8	9
NO QA Results	43	4	8	2	2	4
NO QC Results	21	1	2	0	2	0
Both Reported	273	37	21	56	40	79
Total	337	42	31	58	44	83

b)

	1	2	5	6	8	9
NO QA Results	10	0	0	1	0	3
NO QC Results	1	0	2	3	1	1
Both Reported	37	16	13	12	7	8
Total	48	16	15	16	8	12

Figure 3.4. Sublot test results received for (a) QCP and (b) PFP projects.

3.2.3 PFP Dispute Data

The sublot results for PFP dispute resolution were collected from CBM records. A total of 149 disputed sublot results were received for the years and districts within the scope of the project. The sublot breakdown per dispute type (mix or density), year, and district is shown in Figure 3.5. From the figure, the majority of the disputed sublots were in Districts 1, 2, and 6, with 63%, 19%, and 12% of the reported sublots, respectively. Mix disputes (AV, VMA, dust/AC ratio) constitute 70% of the total number of disputes while density disputes are 30%. Finally, there has been a reduction in the number of sublots disputed over the last three years, except for District 1. In 2016, District 1 reported one density sublot disputed.

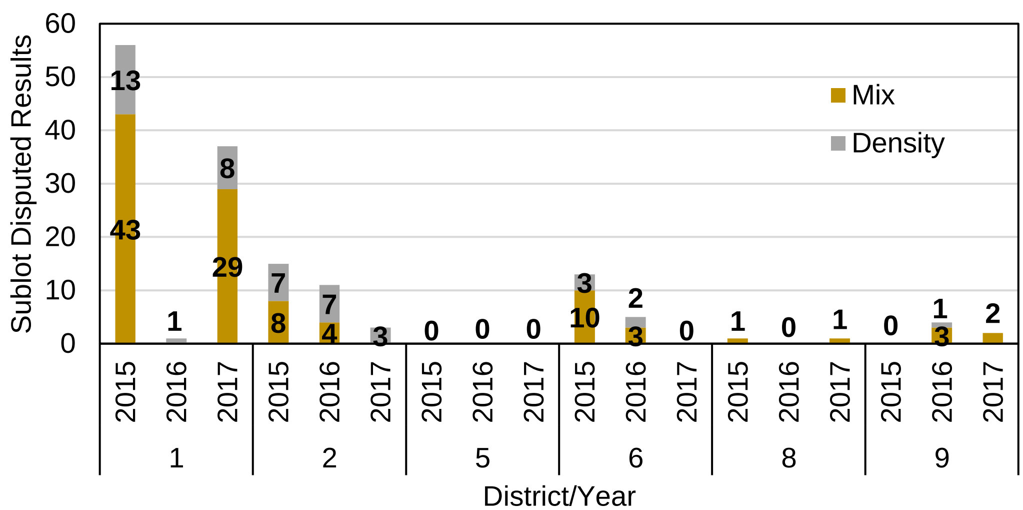


Figure 3.5. PFP dispute resolution sublots results.

3.2.4 IDOT Volumetric Uniformity Study Results (Round Robin)

The results from IDOT round robin studies for the years 2015 to 2019 were received. The uniformity study is an annual interlaboratory testing program to assess laboratory performance in terms of the volumetric testing within IDOT districts and participating laboratories. The statewide round robin testing program is administered by the CBM. A similar program was also separately held in District 1. The data from both round robin programs were obtained and compiled for data analysis. Each year, the CBM selected one plant-sampled batch of HMA surface mixture. The 40 participating laboratories were supplied with one sample. Each laboratory reheated the mixture and conducted the tests described in Table 3.2 according to the applicable Illinois modified AASHTO specifications and the IDOT *Manual of Test Procedures (MoTP)* requirements (IDOT, 2018c).

Table 3.2. Test Conducted in IDOT Uniformity Studies

Test Conducted	IL Modified AASHTO Specification
Mix Gradation	T 30-13
Binder Content	T 308-10
Bulk Specific Gravity (G_{mb})	T 166-13
Maximum Specific Gravity (G_{mm})	T 209-12
Moisture-induced Damage	T 283-07

A total of 161 results from the IDOT volumetric uniformity study were received for the years 2015–2019 for Districts 1, 2, 5, 6, 8, and 9, for both state and private labs. The results breakdown per laboratory, year, and district are shown in Figure 3.6. The figure illustrates the received results for each round robin conducted during the years 2015–2019.

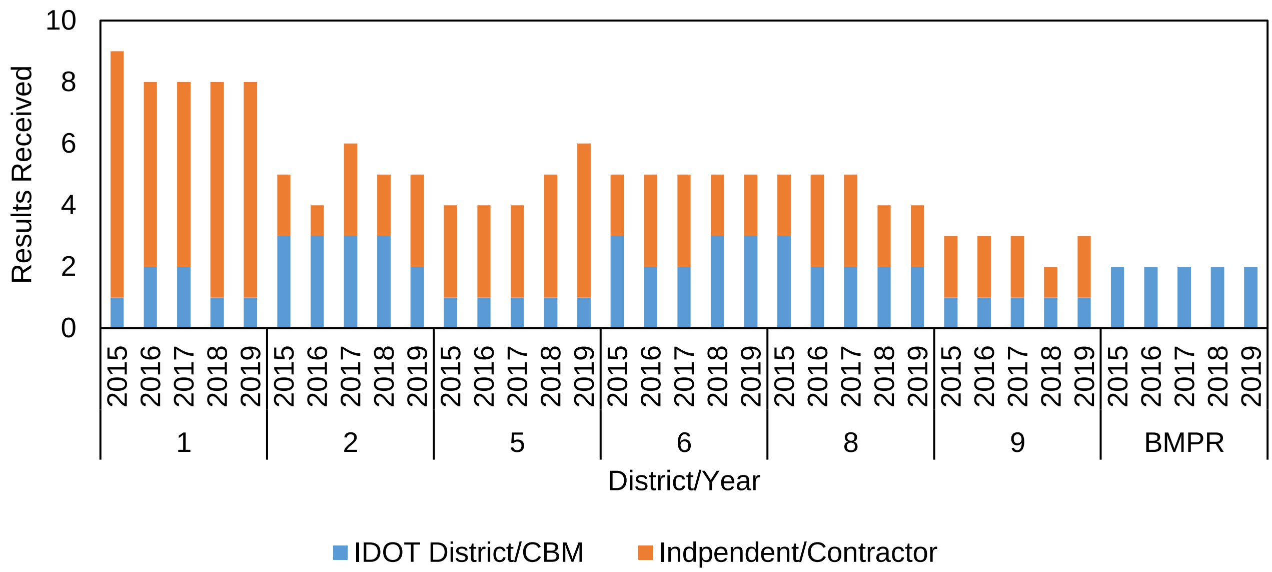


Figure 3.6. IDOT volumetric uniformity study (round robin) results.

3.2.5 Site Visit Data

During the 2018 construction season, 11 construction projects were visited to understand the root causes of deviation, variability, and loss of pay. The visits were conducted at the jobsite, plant, contractor lab, and district lab. The QMP sublot test results, pay factors, and dispute results (if any) were collected. In addition, the mix design, QC/QA packages files (individual test weight), datalogger, and temperature records were collected.

The mix design information was collected to compare the test results to the target values. From the mix design sheets, the following items were considered:

- Aggregate blend
- Design aggregate gradation and AC content
- Dust/AC ratio
- N-design, G_{mm} vs AC content, and G_{mb} vs AC content curves
- Optimum design data (AC content, G_{mb}, G_{mm}, AV, VMA)

The IDOT QC/QA package program contains standardized IDOT MS Excel files that complete the calculations used to obtain the mix sublot test results. These files contain the following information for each of the two replicates used:

- Bulk Specific Gravity (G_{mb}), per Illinois modified AASHTO T 166, sample weight for submerged and saturated surface dry conditions (SSD).
- Maximum Specific Gravity (G_{mm}), per Illinois modified AASHTO T 209, sample and pycnometer weights at submerged and dry conditions.
- Mix Aggregate Gradation, per Illinois modified AASHTO T 30, raw weights and ignition oven calibration factors.
- Calculations for the AV, VMA, and dust/AC ratios.

The datalogger is the HMA plant computer record that stores the amount of material that entered the drum during the day of production. The plant computer system stores the cumulative weight (in tons) added for each aggregate, binder, and additive. Then, approximately every 6 min, the computer system produces a printout that displays the cumulative tonnage. The datalogger allows for the calculation of the following information for the production day:

- Production speed
- Number of mixes produced/times mix design was changed
- Asphalt binder content
- Percentage of each aggregate stockpile
- Moisture content
- Recycled binder content
- Dust content

In addition to the datalogger, the plant temperature charts and/or record were collected to observe the binder and mix temperature fluctuation through the production day.

3.3 DATA ANALYSIS APPROACHES

This section discusses the statistical tests used to compare and analyze district and contractor results: descriptive statistics, Mann-Whitney, Shapiro-Wilk, and Levene's test.

3.3.1 Descriptive Statistics

Three descriptive statistics parameters were used during the evaluation: mean, standard deviation, and coefficient of variation. Mean is a measure of central tendency. The population mean can be defined as the summation of the values of all random variables divided by their count. The exact population mean is a constant and a characteristic of the population that cannot realistically be obtained because all values of the population are not measured. Therefore, an unbiased estimate of the sample mean is given by the average of the samples defined in Equation (3.1).

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} \tag{3.1}$$

where $\bar{x}$ is sample average and n is sample size.

Standard deviation is a measure used to quantify data dispersion and variation. The standard deviation is the square root of the variance. As in the case of the mean, the standard deviation can also be a population standard deviation or a sample standard deviation. The best estimate of the population standard deviation is the sample standard deviation, defined in Equation (3.2):

$$s = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n}} \tag{3.2}$$

where s is sample standard deviation and x_i is the value of i^{th} observation (sample).

Finally, the coefficient of variation is used as a standardized way to show variability. The coefficient of variation (COV), which is used in some parts of the report, is the standard deviation divided by the mean. It is usually used to normalize the spread of the data by the expected value of the data (the mean) as shown in Equation (3.3):

$$COV = \frac{s}{\bar{x}} \tag{3.3}$$

3.3.2 Hypothesis Testing

Hypothesis testing was used to compare the sublot results from the QA (districts) and QC (contractors). Hypothesis tests evaluate the significance of the differences between the two parties' results or the chance at a prespecified level of significance. Non-parametric tests were used to analyze the data consistently because part of the case analysis did not satisfy parametric test assumptions. Unlike parametric tests, non-parametric tests do not require a (normal) distribution of the given data.

3.3.2.1 Shapiro-Wilk Test

The Shapiro-Wilk test (1965) is a test of whether a population with a given sample is normally distributed. This test is needed for two reasons. First, the PFP quality management specification assumes a normal distribution of the population samples. It fits a normal distribution to the given sample results to find the percent within limit (PWL) based on which pay factor is calculated. The second reason is to check whether parametric testing of the equality of the mean can be conducted (for both QCP and PFP), which has normality as a prerequisite. The test is qualitatively based on sorting the property test result by value, giving it a weight, and dividing it by the total deviation from the sample mean. The significance level (α) was taken as 0.05. The null (H_0) and alternative (H_a) hypotheses of the test are as follows:

- H_0: The sample belongs to a normal distribution.
- H_a: The sample does not belong to a normal distribution.

The statistic used in this test is shown in Equation (3.4):

$$W = \frac{\sum_{i=1}^{n}(a_i x_{(i)})^2}{\sum_{i=1}^{n}(x_i - \bar{x})^2} \quad (3.4)$$

where, W is Shapiro-Wilk statistic; a_i is tabulated weights; $x_{(i)}$ is ith ordered random observations; $\bar{x}$ is mix contract property mean; and x_i is ith random observation.

For each Shapiro-Wilk test statistic, there is a corresponding p-value. A p-value is the probability of getting a false positive, or the probability of rejecting the null hypothesis (saying the data is not normally distributed) when it should not be rejected. Based on this p-value, the normality of the test is judged. If the p-value corresponding to the test statistic is smaller than the prespecified α, then the distribution is said to be non-normal. Otherwise, it is said to be normal.

3.3.2.2 Mann-Whitney Test

The Mann-Whitney U-test is used to check whether two samples belong to similar distributions. The test is qualitatively based on dividing the test results to intervals, finding the rank of each interval between the two sides, and taking the smaller U statistic (Equation 3.5) between the two sides. The null and alternative hypotheses can be stated as follows:

- H_0: The two samples come from populations with the same distribution.
- H_a: The two samples come from populations with different distributions.

The statistic used in this test is shown in Equation (3.5):

$$U = n_1 n_2 + \frac{n_2(n_2+1)}{2} - \sum_{i=n_1+1}^{n_2} R_i \quad (3.5)$$

where, U is Mann-Whitney test statistic; n_1 is number of sublots in the first side's sample; n_2 is number of sublots in the second side's sample; and R_i is rank of the interval based on the number of sublots.

For each U statistic, there is a corresponding p-value. If this p-value is lower than α, which was taken as 0.05, then the averages of the two samples are said to be significantly different (Mann and Whitney, 1947). Figure 3.7 shows two samples, one with the same distribution (a) and one with different distributions (b).

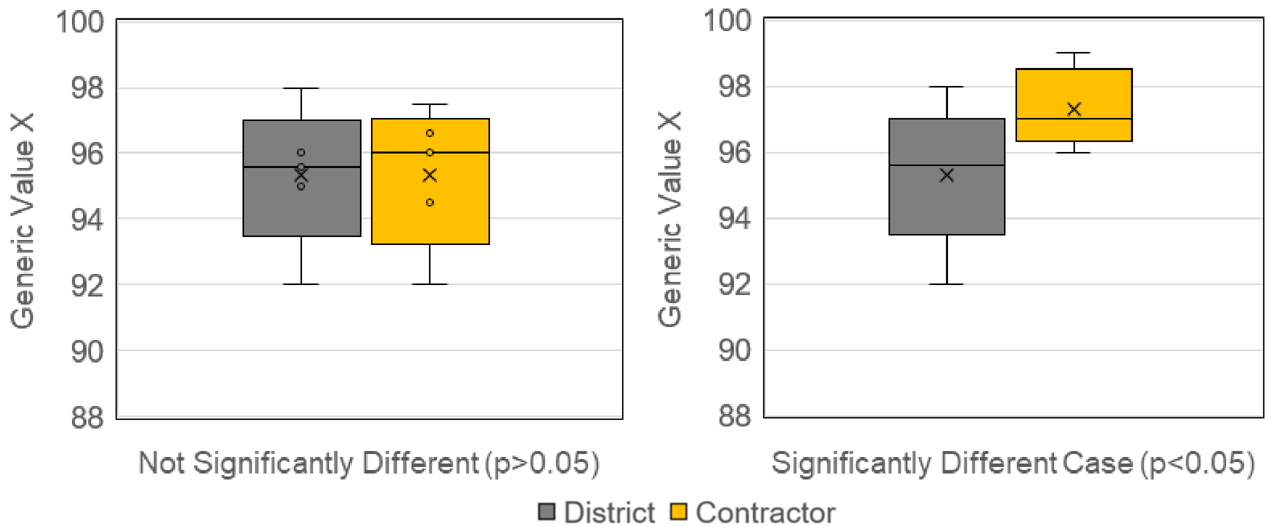


Figure 3.7. Mann-Whitney example cases.

3.3.2.3 Levene's Test

Levene's test is used to check the equality of the variances of two populations given samples from these distributions. The two goals of using this test are to evaluate if the two parties (the contractor and the agency) have the same precision for the test results and to know whether parametric testing of the mean, which requires the equality of variances, works. The null (H_0) and alternative (H_a) hypotheses are as follows:

- H_0: The two samples with the same variability.
- H_a: The two samples with different variability.

The statistic used in this test is shown in Equation (3.6):

$$W = \frac{N-k}{k-1} * \frac{\sum_{i=1}^{k} N_i (Z_{i.} - Z_{..})}{\sum_{i=1}^{k} \sum_{j=1}^{N_i} N_i (Z_{ij} - Z_{i.})} \qquad (3.6)$$

where,

W: Levene's test statistic;

k: The count of different groups from which the samples come;

N_i: The count of cases in the i[th] group;

N: The total count of cases in all groups;

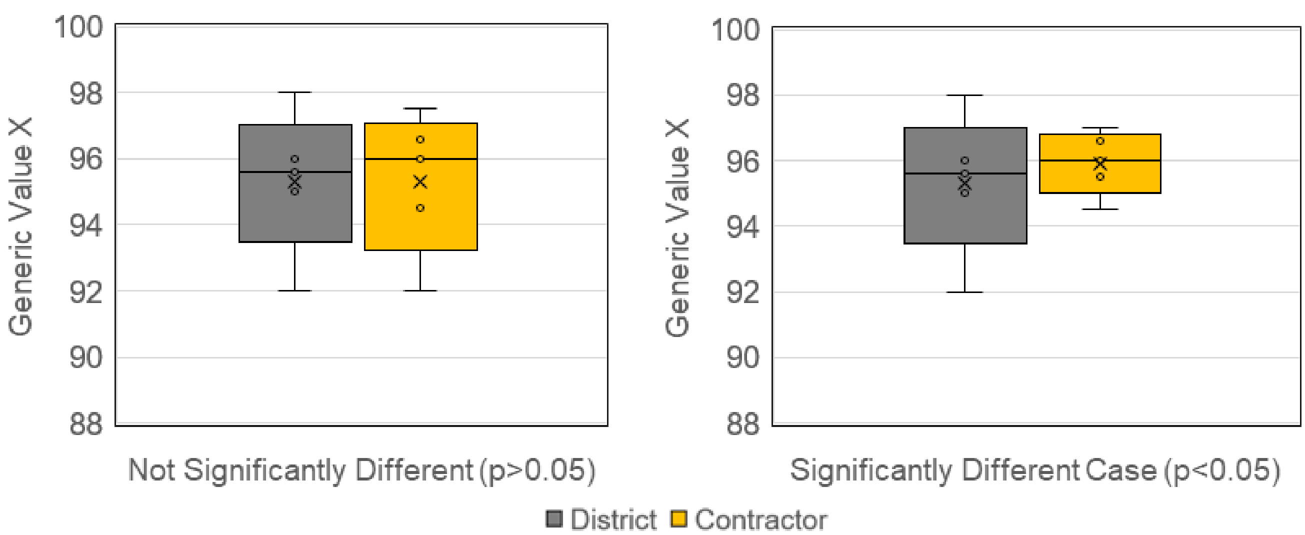
Z_{ij}: The absolute difference between Y_{ij} and the mean or the median of group i;

Y_{ij}: The level of the j[th] variable in the i[th] group;

$Z_{i.}$: The mean of Z_{ij} for group i; and

$Z_{..}$: The mean of all Z_{ij}.

The groups compared in this project are district and contractor. There is a p-value corresponding to the calculated Levene's statistic. If this p-value is lower than the prespecified α (taken as 0.05), then the standard deviations are said to be significantly different. Otherwise, the standard deviations are said to be equal. Figure 3.8 shows two samples, a case with the same variability (a) and a case with different variability (b).



(a) (b)

Figure 3.8. Levene's test example cases.

CHAPTER 4: DATA ANALYSIS RESULTS

This chapter presents a summary and a discussion of collected data from the districts and statistical analysis results. Pay factor trends are presented to identify which pay factors generated pay incentives and disincentives for the QCP and PFP specifications. Mix sublot volumetric test results and core densities are discussed. Data results were analyzed to identify differences between district and contractor test results. To identify potential mix production issues, aggregate gradations were evaluated. CBM results of PFP disputed sublots were compared to better understand the source of variation. To identify potential issues with laboratory testing, IDOT round robin test results were evaluated.

4.1 PAY FACTOR TRENDS

General trends in QCP and PFP specifications were evaluated in the pay factor analysis. The total tonnage is presented to provide distribution of pay factors with respect to specification type and size in various districts for different production seasons. The composite pay factor (CPF) was evaluated to identify differences between the QCP and PFP specifications and among district's pay performance. The pay factors for AV, VMA, and density are grouped per specification and mix type.

4.1.1 Specification Size

A total of 595 mix contract cases were recorded between 2015 and 2017 in the QCP specification while 115 were received for the PFP specification. These cases accumulated to 3,255,000 tons and 2,690,000 tons of HMA produced for QCP and PFP, respectively. Hence, QCP and PFP specifications have comparable total produced HMA tonnage sizes from 2015 to 2017. This represents an average of 5,470 tons per QCP mixture and 23,391 tons per PFP mixture. This is expected because QCP is meant for less than 8,000 tons, whereas PFP is meant for more than 8,000 tons.

The total tonnage for both specifications is presented per district in Figure 4.1. District 1, which covers Chicago's metro area with a total of 1,657 mi of state highways (IDOT, 2018c), had the highest production. Districts 2, 9, and 6 followed, with a similar share of tonnage that ranged between 13% to 20%. District 2 covers the Quad Cities metro area, I-88, I-80, and I-74, with a total of 671 mi of state highways (IDOT, 2018c). District 9 covers I-57 and I-24, with a total of 532 mi of state highways (IDOT, 2018c). District 6 covers Springfield, with a total of 830 mi (IDOT, 2018c). Districts 5 and 8 had the smallest amount of total HMA production. Finally, Districts 5 and 8 have a total of 548 and 774 mi of state highways, respectively (IDOT, 2018c).

Figure 4.2 shows the number of mix contract cases per contractor. Forty-two contractors produced mixes using QCP while 22 produced mixes with PFP. Sixteen contractors had contracts in District 1, seven in District 2, three in District 5, five in District 6, eight in District 8, and three in District 9. Contractors have more experience working with QCP projects than PFP projects. Out of the 22 contractors working with PFP cases, 11 had fewer than five PFP cases during the last three years, because there are fewer PFP projects available for bidding. This results in contractors who are less experienced in designing, producing, and constructing mixes under PFP requirements, including the statistical principles used to evaluate their mixes when calculating the pay factor. There are contractors that achieve at least 100% pay for most of the executed contracts while other contractors achieve the opposite. Both cases were observed in all districts.

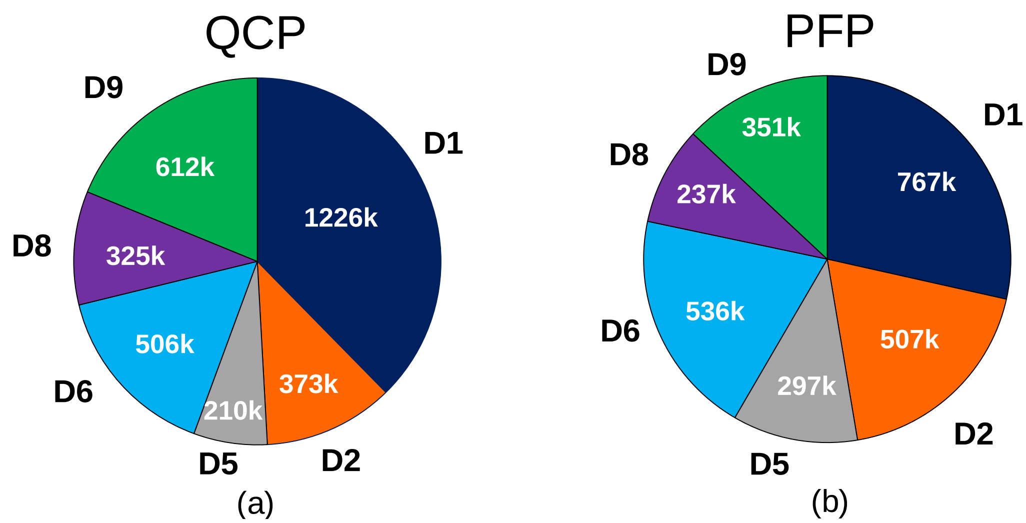


Figure 4.1. District HMA production size for (a) QCP and (b) PFP specifications from 2015 to 2017.

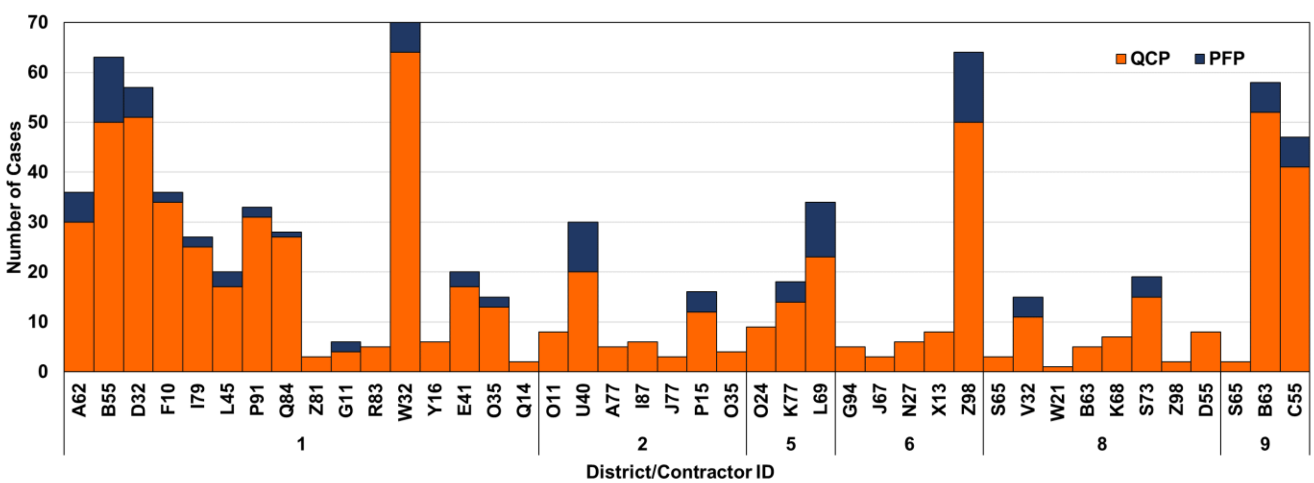


Figure 4.2. Cases recorded per contractor by IDOT's QCP and PFP specifications from 2015 to 2017 (random IDs indicate different contractors).

4.1.2 Composite Pay Factor

Figure 4.3 presents the CPF for both QCP and PFP specifications from 2015 to 2017. For QCP, only 45% of the total tonnage received full pay. Most of the pay disincentives led to a total combined pay factor of 97.5% to 99.9% for 46% of the tonnage (close to full pay). Only 9% of the projects had a total combined factor pay lower than 97.4%. For PFP, 54% of the tonnage received a bonus while 44% of the tonnage resulted in pay disincentives. On the other hand, only 4% of PFP production had a total pay lower than 90%. Hence, it appears that QCP projects have less probability of receiving a high pay disincentive, which is expected because QCP has a maximum disincentive of 10%. Conversely, for PFP projects, a contractor has more odds of receiving a pay disincentive, for which they are compensated by having a chance to get a pay incentive that is not available in QCP. In general, PFP is a stricter specification than QCP because PFP considers variability in the pay calculation. For example, if sublot results are within the upper and lower limits for 100% pay in QCP, they achieve 100% pay. However, in PFP, even if the test results are within the lower and upper limits, the pay factor depends on the variability of the results. This is because contractor pay is calculated based on the t-distribution that was fit to the results of the sublot. In QCP, the pay is computed based only on the sublot results.

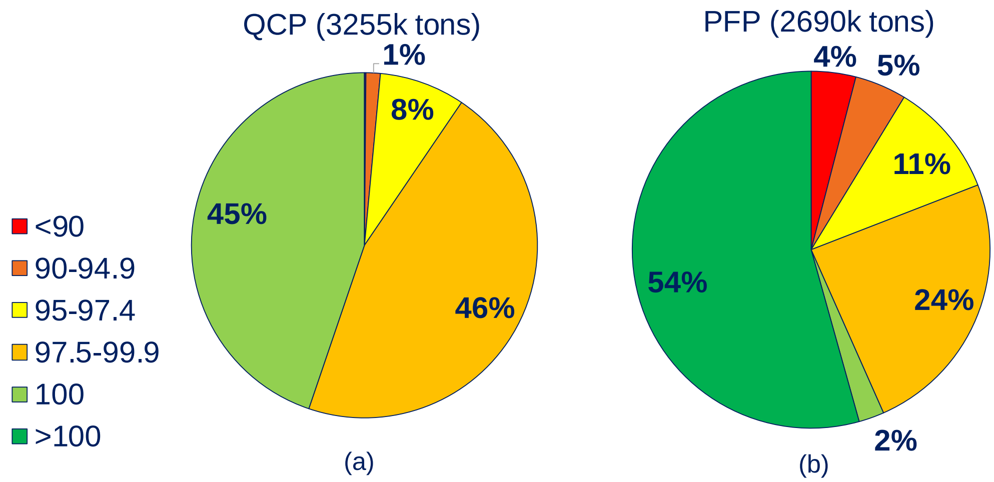


Figure 4.3. Distribution of CPF for IDOT's (a) QCP and (b) PFP specifications from 2015 to 2017.

To understand yearly variations in each specification's total pay, the CPF is presented per year and per specification in Figure 4.4. For QCP, the production receiving full pay has increased from 34.1% in 2015 to 61% in 2017, indicating that contractors have improved their performance in the QCP specification during that time. For PFP, the percentage of the tonnage that received a pay incentive or full pay decreased from 65.9% to 45.1%. This could be related to the greater number of QCP projects and contractors' growing experience working under this specification. Note that no changes were made to QCP or PFP pay factor calculations for the studied data over this time period.

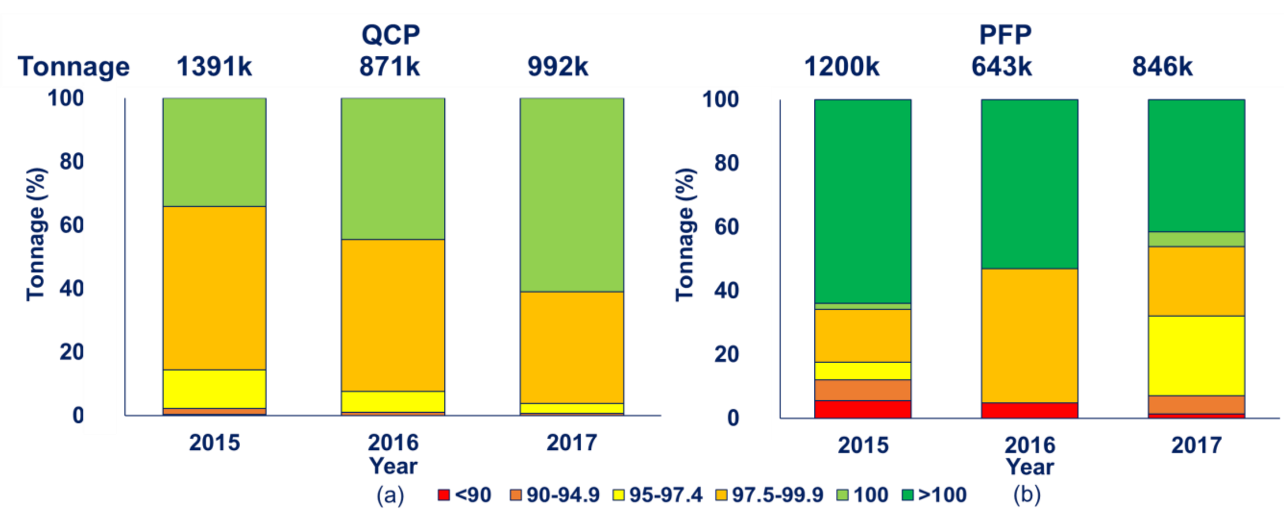


Figure 4.4. Distribution of pay factors for IDOT's (a) QCP and (b) PFP specifications from 2015 to 2017.

Districts 5 and 6 have higher pay performance than the rest of the districts in both QCP and PFP specifications (Figure 4.5). The production in these districts received full pay or a pay incentive between 70% to 100% of the total tonnage. On the other hand, District 2 had the most pay disincentives in QCP. Only 17.3% of the total tonnage received full pay. For PFP, Districts 1 and 9 received the most pay disincentives in the specification. Less than 40% of their projects achieved full pay or a bonus.

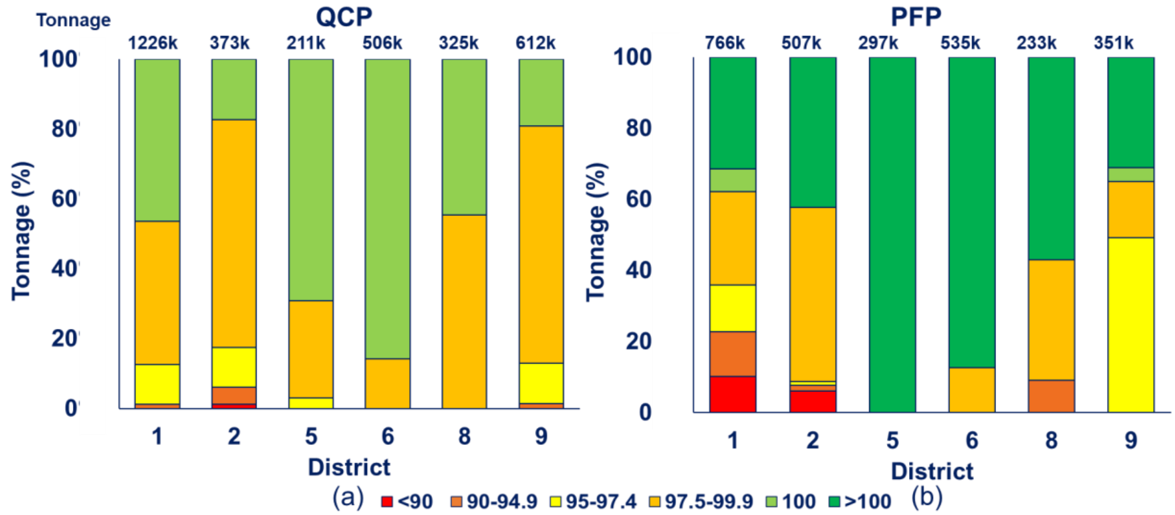


Figure 4.5. Pay factors per district for IDOT's (a) QCP and (b) PFP specifications from 2015 to 2017.

4.1.3 Air Voids, Voids in Mineral Aggregates, and Density Pay Factors

As discussed in Chapter 2, the CPF is based on AV, VMA, and density pay factors, some of which influence pay reduction more than others. Figure 4.6 presents the total tonnage for the QCP and PFP specifications and the corresponding AV, VMA, and density pay factors. For the QCP specification, the influence of AV, VMA, and density was similar. Based on AV, VMA, and density, 67.8% to 72% of the tonnage produced received full pay. However, for the PFP specification, density has the lowest average pay factor. Less than 44% of the PFP production received at least 100% payment for density, followed by AV and VMA.

Note that there are projects that received less than 100% pay in AV and full pay in VMA. This could be attributed to the fact that AV has more variability than VMA. The testing variability of G_{mb} and G_{mm} could affect AV while only the G_{mb} test affects VMA (as well as the binder content, which is used to compute the percentage of stone). Another possible reason for these changes is a mix switch; aggregate gradation might be controlled during production but not the binder content (as discussed in section 5.4.4: Mix Switches). As a result, the VMA (an indicator of the aggregate structure) meets the requirements, while the AV, which is affected by binder content, may not. The absorption of the aggregates could also have differed because of reheating conditions.

The sublot test results used to calculate the pay factors in Figure 4.6 were evaluated to observe if the penalties were due to a failure in achieving the lower limit (LL) or upper limit (UL) of the QCP and PFP specification for 100% pay. Figure 4.7 presents the results for QCP and PFP cases. The limits used for

QCP are lower limits to achieve 90% pay for the respective volumetric. For PFP, there is only one upper limit and one lower limit for each volumetric parameter and the results are shown taking these limits into account. Figure 4.7 shows similar trends between QCP and PFP.

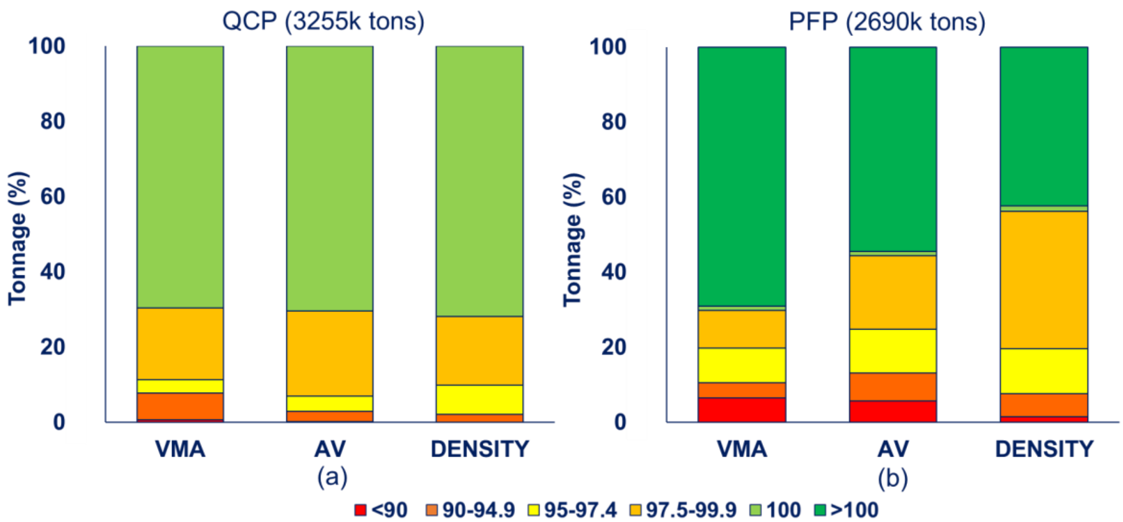


Figure 4.6. Pay factors per pay parameter for IDOT's (a) QCP and (b) PFP specifications from 2015–2017.

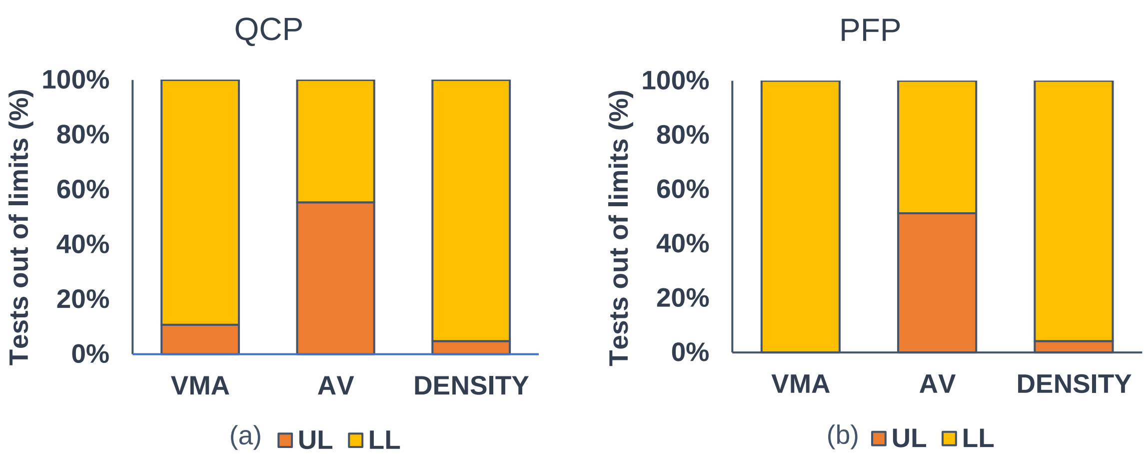


Figure 4.7. Disincentivized sublots were classified by failing the upper or lower limit of either the QCP or PFP specification.

Tests out of limits for AV were evenly distributed, which is expected for random deviations induced by variability. Tests out of limits for VMA tended to be under the lower limit, i.e., the disincentives on the VMA PF were usually due to producing under the specified VMA. This would be expected because increasing the VMA for fixed aggregate sources and gradations, without altering AV significantly, requires adding more asphalt binder, which is the most expensive component of HMA. Tests out of limits for density tended to be under the lower limit, i.e., the disincentives were associated with not achieving HMA within-limits density (assuming all tests were accurate). This could be related to field-encountered difficulties and/or mix production.

For all considered mix-contract cases, 15.6% of the cases had a density disincentive (density PF < 100) only. This suggests the disincentive is related to the construction phase. Of the cases that had a density disincentive, 52.7% also had an AV or VMA disincentive (AV PF < 100 or VMA PF < 100). In these cases, a density disincentive could potentially had been caused by a mix production issue.

4.1.4 Effect of Mix Type

The CPF (described in section 2.2: Illinois Quality Management Program (QMP) for both QCP and PFP specifications is grouped by mix type in Figure 4.8. IDOT has three main mix categories: leveling binder (LB), binder course (BC), and surface course (SC). LBs are typically fine-graded mixes used in resurfacing projects to level milled surfaces before a SC is applied. The BC is a structural layer. The SC is the wearing layer that mainly provides the needed friction and skid resistance. Figure 4.8 shows that LB was the most-penalized mix (31.5% received full pay) in the QCP specification, while 47.65% of the SC received at least 100% pay. The performance of SC mixes in QCP and PFP was comparable. SC mixes received full pay in 49% of the cases in QCP while 47.65% in PFP received at least 100% pay for SC mixes. BC pay performance in PFP was better than that in QCP: 70.6% received at least 100% pay in PFP and 43% received full pay in QCP.

Figure 4.9 shows the AV, VMA, and density pay factors per mix type. As expected, LB density had the highest impact because of difficulties in achieving density in thin LB layers that have a low NMAS/thickness ratio. In addition, LB is laid as the first lift after milling (on irregular surface). For example, approximately 68% of the LB 4.75 mm mix tonnage received a density PF of 100% compared to 35% of the tonnage of the LB 9.5 mm mix. For BC and SC constructed in QCP, the three pay factors had a similar effect on the total pay. However, density was the driving factor in the pay loss in PFP. In BC, it was the main reason for pay loss and the second in SC; AV was the main factor in the SC layer.

AV is more penalized than VMA in the PFP specification because of the former's higher variance. Variance influences the pay factor because of the PWL calculation. Figure 4.10 presents the density pay factor per NMAS for the three mix types. IDOT uses four NMAS in the mixes: 4.75 mm, 9.5 mm, 12.5 mm, and 19 mm.

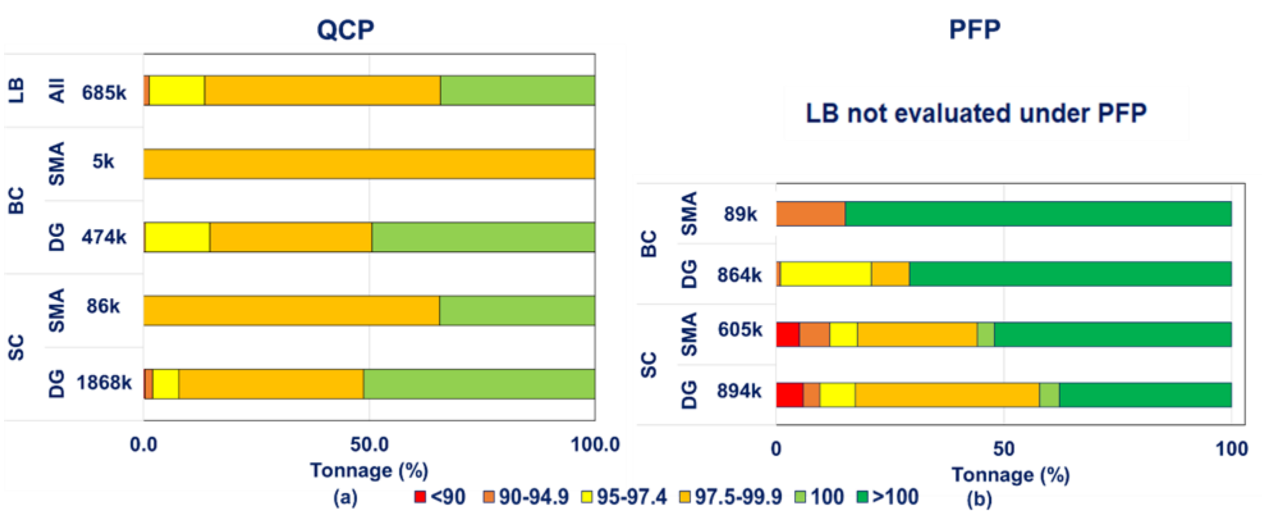


Figure 4.8. Pay factors per AC layer type for IDOT's (a) QCP and (b) PFP specifications from 2015–2017.

Figure 4.9. Pay factors per pay parameter for SC, BC, and LB mixes for IDOT's QCP and PFP specifications from 2015 to 2017.

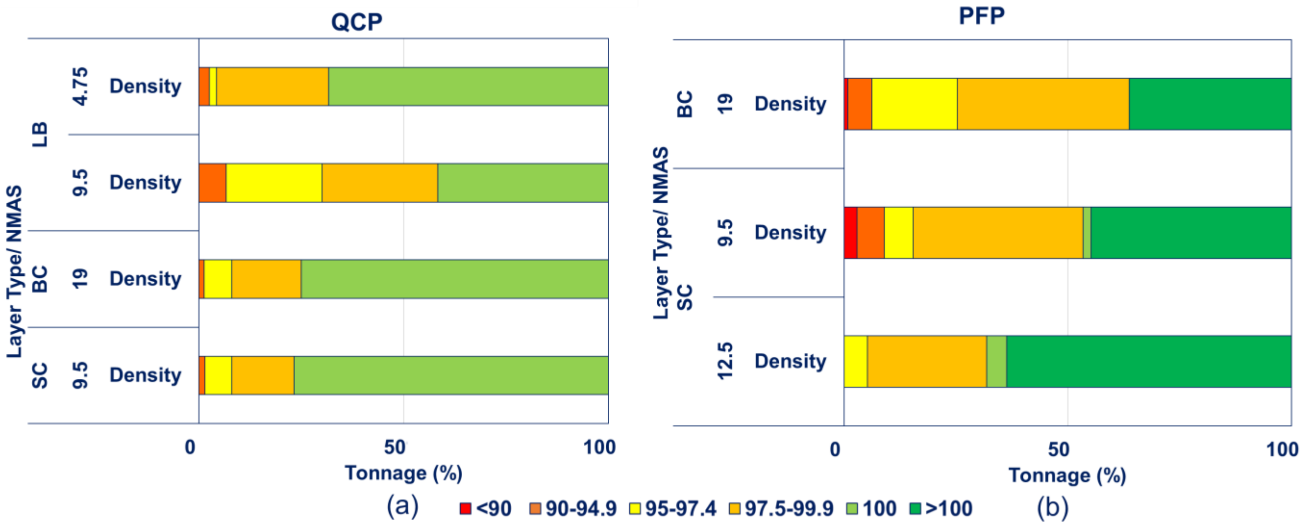


Figure 4.10. Density pay factors per course type for IDOT's (a) QCP and (b) PFP specifications from 2015 to 2017.

4.1.5 2017 PFP CPF Equation Revision

On June 28, 2017, IDOT modified the PFP CPF pay equation (IDOT, 2018c) to the current one (Equation 2.1). The previous equation was the following:

$$\text{Pay Factor} = 53 + 0.5(\text{PWL}) \qquad (4.1)$$

where Pay Factor (PF) is defined and calculated for each pay parameter. The change between Equation 2.1 and 4.1 was a 2% increase in the AV, VMA, and density pay factors. The change was considered to increase the pay of contractors to make the specification more achievable to get at least 100% pay.

The pay factors for all the contracts analyzed in this study were calculated using Equation 4.1. Analysis was performed using Equation 2.1 to estimate the impact of the specification change. Hence, the pay factors obtained from 2015–2017 were adjusted according to the new specification and recalculated using Equation 2.1 (2018c).

Figure 4.11 shows the distribution of the pay factors recalculated using Equation 2.1. Overall, the pay incentive amount (PF > 100) increases from 54% to 76% (Figure 4.11 [a]). In Figure 4.11 (b) the increment would have most impacted the pay of contractors in Districts 1, 2, and 9, which were the most impacted by the pay disincentives. In addition, the density pay, which was most impacted by the PFP specification, would benefit the most (Figure 4.11 [d]) if the change would have been implemented in 2015. In summary, a fixed increment of 2% for each pay factor roughly translated to an overall increase in the total pay of each mix contract.

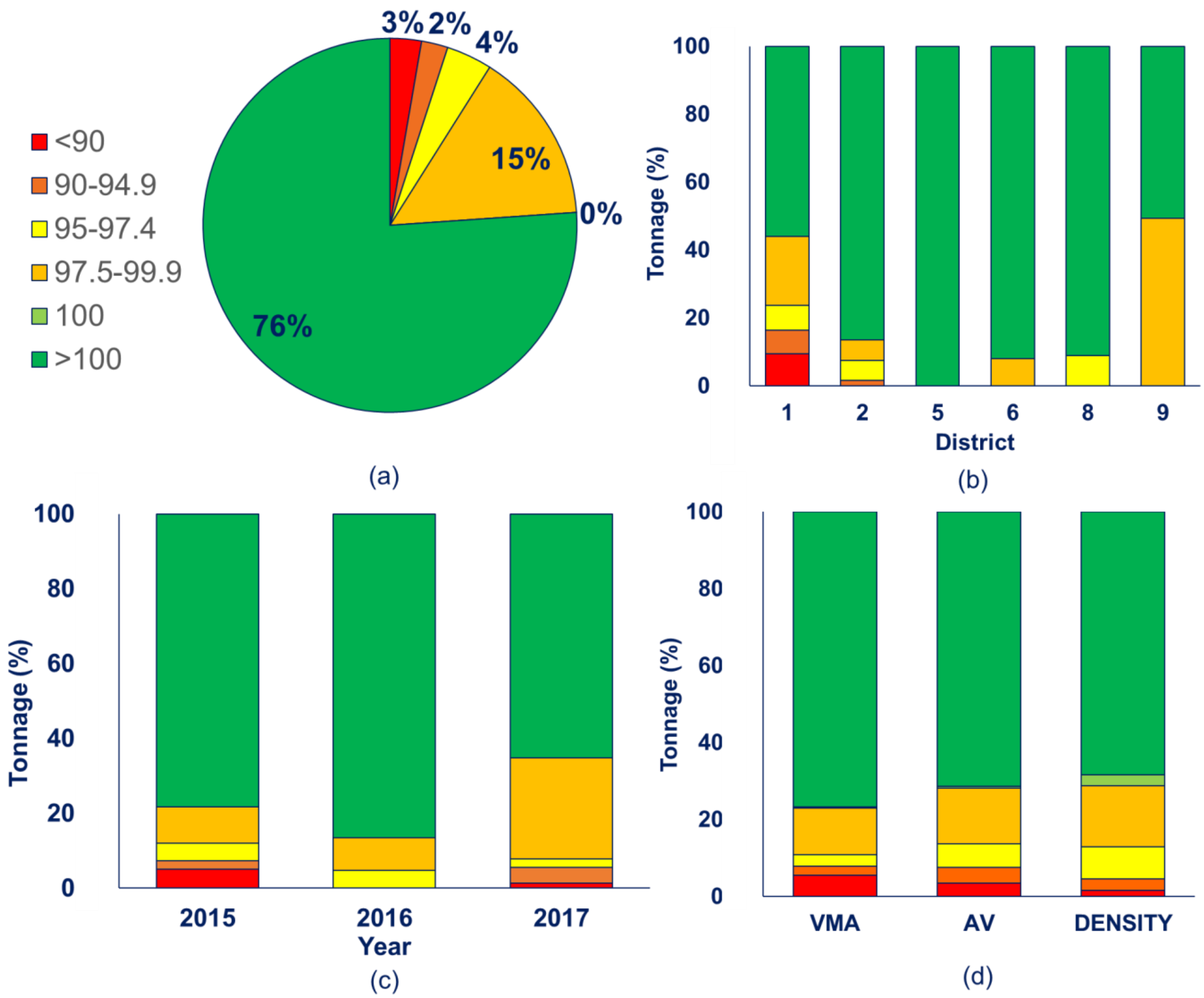


Figure 4.11. Distribution of CPF and pay parameters for PFP specifications from 2015 to 2017 recalculated with 2017 pay factor equation: (a) statewide, (b) district, (c) yearly, and (d) per pay parameter.

4.2 PAY PARAMETERS (AV, VMA, DENSITY) RESULTS

This section presents the results of statistical testing including Shapiro-Wilk, Mann-Whitney, and Levene's tests for pay parameters. The mix pay parameters are AV, VMA, and density, which are directly used to calculate the pay factors. The differences in the mean and standard deviation between the contractor and district mix test results are presented.

4.2.1 Normality

Prior to performing any statistical tests, the Shapiro-Wilk test was used for a normality check to select appropriate hypothesis testing: parametric or non-parametric (Figure 4.12). If the p-value of the test is greater than 0.05, then the sample's population is normally distributed. This is an assumption used by the PFP specification. From 590 cases, 9% (PFP, district data) to 18% (PFP, contractor data) of the cases have p-values lower than 0.05 for AV. However, 13% (PFP, district data) to 21% (PFP, contractor data) of VMA have p-values lower than 0.05. Hence, most cases appear to follow a normal distribution for AV and VMA, as previously stated by Hall and Williams (2002). Note that the cases with a few sublot replicates failed the Shapiro-Wilk test.

For density, 560 cases were tested; 23% to 29% of the cases have p-values lower than 0.05 in QCP, which are slightly greater than the AV and VMA p-values. However, for PFP, 56% to 57% of district and contractor results do not follow the normal distribution. Density in PFP failed the normality assumption regardless of the sample size. Figure 4.13 (a) and (b) illustrates two samples that fail and pass the Shapiro-Wilk test, respectively. The case that fails the Shapiro-Wilk test shows skewness: the tail in the test result distribution extends longer to a lower density value. On the other hand, the passing case shows both tails are evenly distributed. Because a large number of Shapiro-Wilk test results suggest sample populations are not normally distributed, a non-parametric test was selected to compare the tests from districts and contractors.

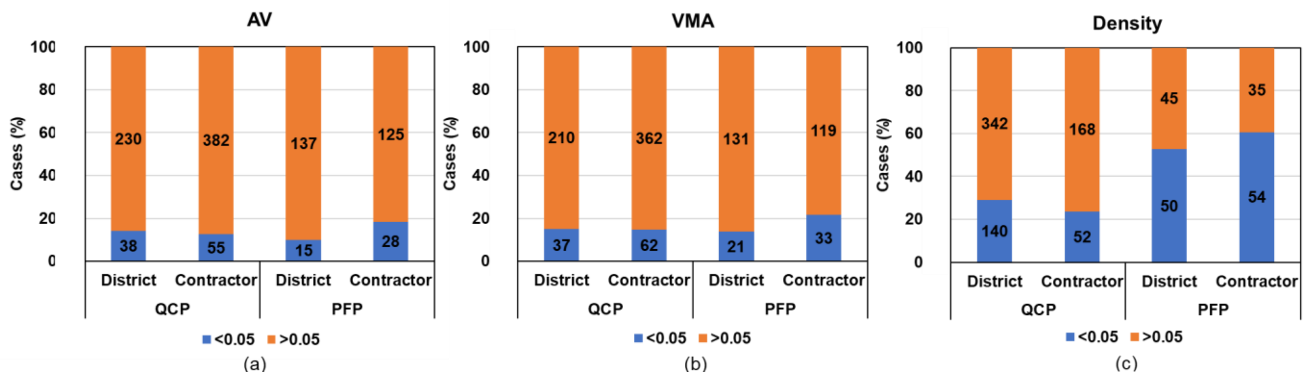


Figure 4.12. Shapiro-Wilk normality test results for (a) AV, (b) VMA, and (c) density.

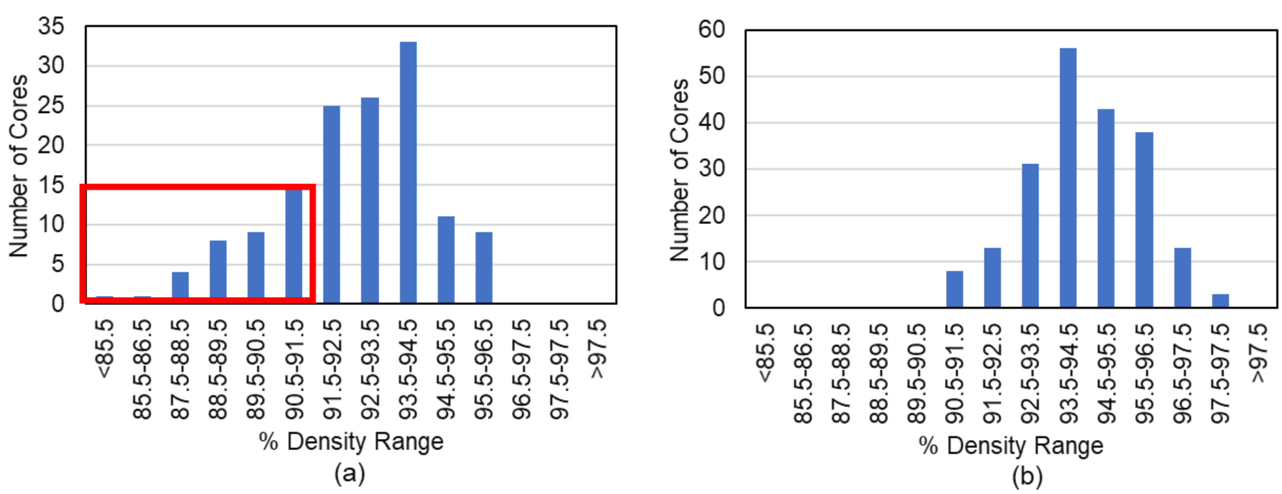


Figure 4.13. Example of a SC N90 9.5 NMAS density cases for (a) non-normally distributed ($p < 0.05$) and (b) normally distributed ($p > 0.05$).

4.2.2 Pay Parameter Results

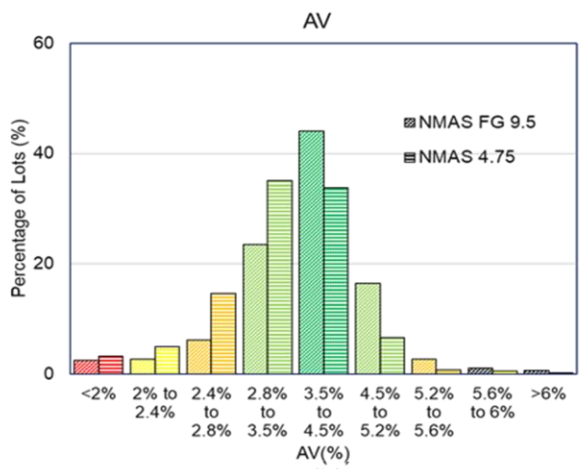
The statewide distribution of the pay parameter results per sublot are presented for LB, BC, and SC mixes in Figures 4.14, 4.15, and 4.16, respectively, for QCP and PFP specifications. The results for each mix type are presented per NMAS. In Illinois, LB is designed using 9.5 mm or 4.75 mm NMAS, BC uses 19 mm or 12.5 mm (for SMA), while SC uses 9.5 mm or 12.5 mm (for SMA). For LB mixes, Figure 4.14 (a) presents the minimum design VMA, design AV, and the total number of sublots per mix type used to calculate the distribution of AV, VMA, and density. Figure 4.14 (b) shows the AV results for each of the two NMASs. Figure 4.14 (c) presents the deviation from the minimum VMA per Equation (4.2). The pay disincentive is based on the deviation from the minimum VMA. Finally, the density results are shown in Figure 4.14 (d). Similarly, other layers are presented in the corresponding figures.

$$\boldsymbol{Deviation\ from\ Min\ VMA = VMA_{\ sublot} - VMA_{Min}} \quad (4.2)$$

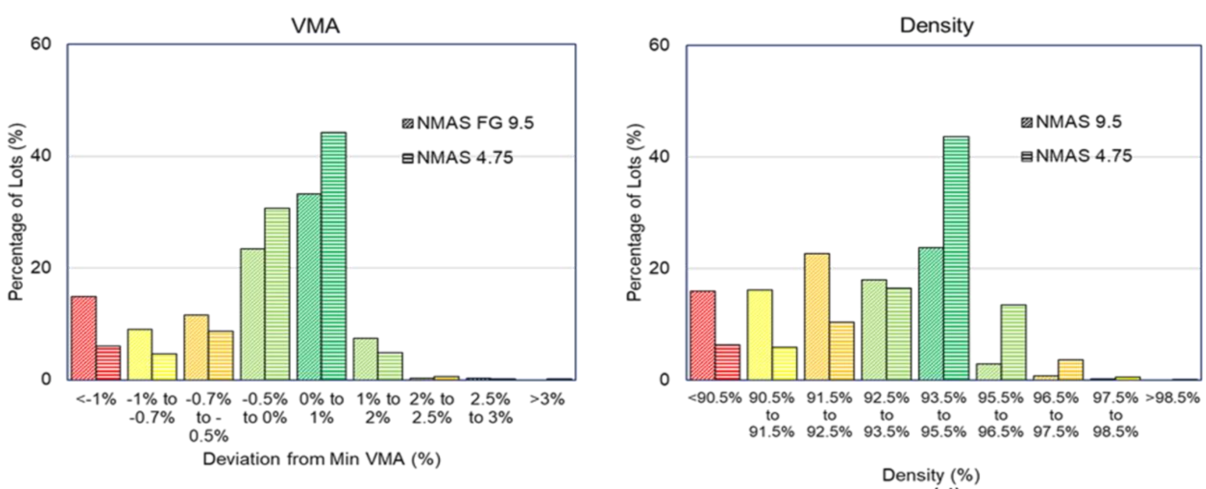
where *VMA* $_{design}$ is the design VMA, $VMA_{\ sublot}$ is the sublot VMA, and VMA_{Min} is the minimum design VMA.

Type	LB	LB
NMAS	9.5 FG	4.75
Target AV	4.0	4.0 (3.5 in D1)
Min VMA	15.0	18.5
Mix Sub-Lots	442	877
Density Sub-Lots	1783	9084

(a)



(b)



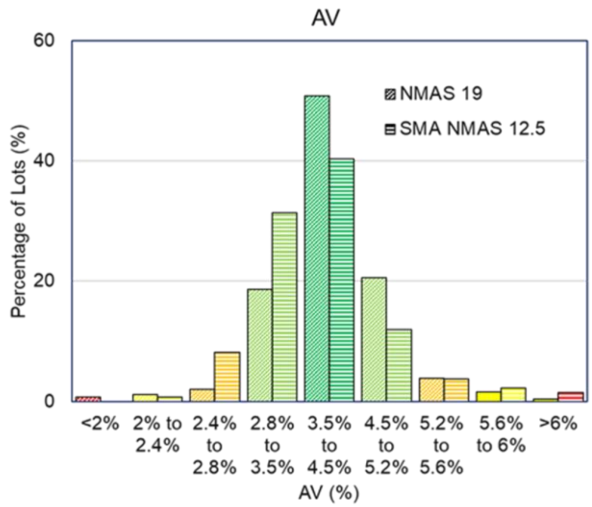
(d)

Figure 4.14. Pay parameter results for LB mixes.

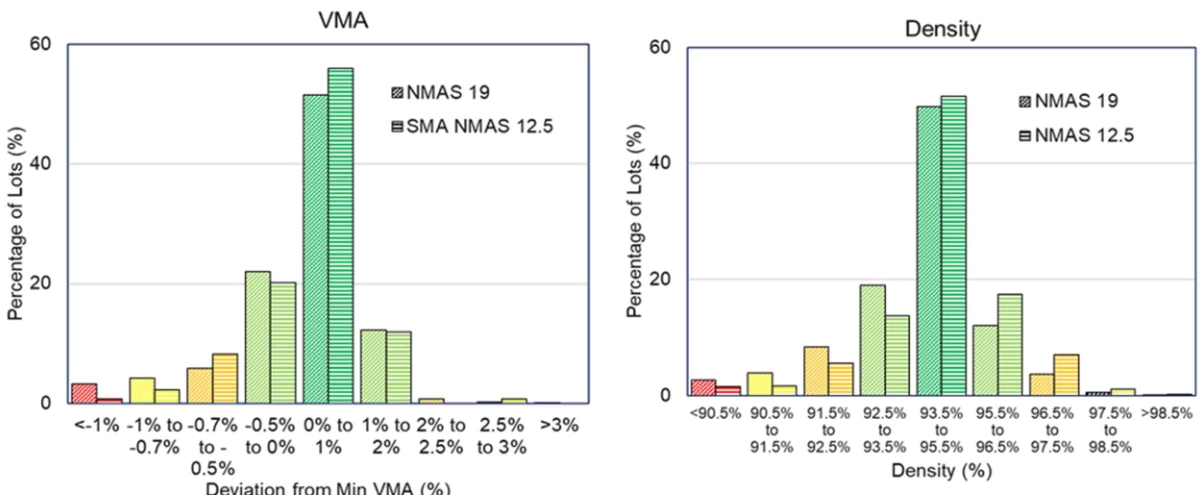
From Figure 4.14, AV results in the fewest pay disincentives (less than 5%). Approximately 11.3% of the LB 9.5 mm FG NMAS sublots were lower than 2.8%, and 22.9% of the LB 4.75 mm NMAS sublots were lower than 2.8%. The rest of the sublots were within 2.8% to 5.2% AV. The LB 9.5 mm FG mixes failed VMA more than 4.75 mm NMAS mixes. Of the LB 9.5 mm sublots, 35.4% had VMA at least 0.5% lower than the minimum design VMA, while 19% for the LB 4.75 mm. Finally, density is the main reason for LB pay disincentives, especially 9.5 mm mixes, possibly due to being laid at less than three times NMAS. Hence, 4.75 mm mixes appear to be more appropriate considering lift to NMAS ratio.

Type	BC	BC
NMAS	19.0	12.5 SMA
Target AV	4.0	4.0 (3.5 in D1)
Min VMA	13.5	16.0
Mix Sub-Lots	3469	134
Density Sub-Lots	16921	993

(a)



(b)



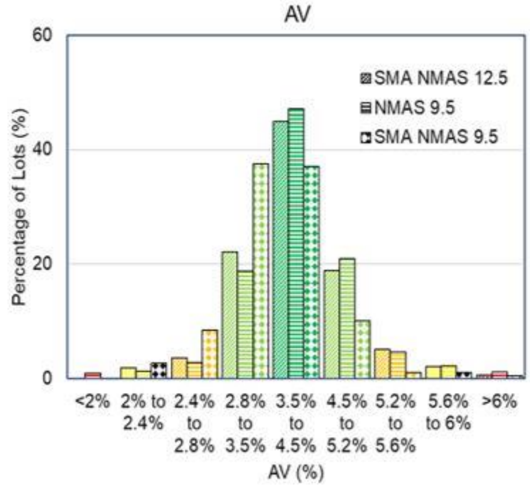
(c) (d)

Figure 4.15. Pay parameter results for BC mixes.

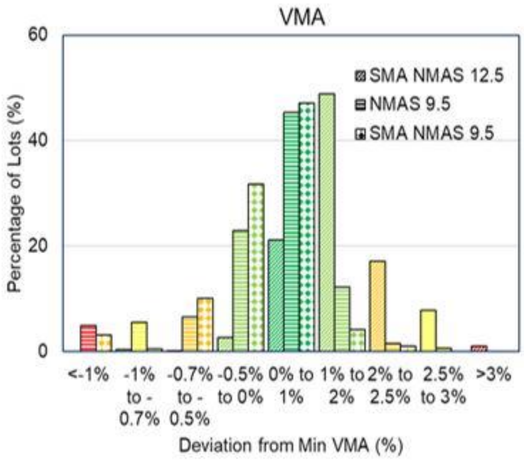
Figure 4.15 shows the results for BC mixes. The AV results show that both BC mixes (19.0 and 12.5 SMA) have similar chances of AV pay disincentives. VMA pay disincentives were a result of lower VMA values, irrespective of the NMAS. Of the BC 19.0 mm NMAS sublots, 14.9% had densities lower than 92.5% compared to 8.9% for the BC SMA 12.5 mm NMAS sublots. These values were slightly less for BC 19 mm.

Type	SC	SC	SC
NMAS	12.5 SMA	9.5	9.5 SMA
Target AV	4.0 (3.5 D1)	4.0	3.5
Min VMA	17.0 (16.0 D1)	15.0	17.0
Mix Sub-Lots	1284	6092	182
Density Sub-Lots	8389	36317	1803

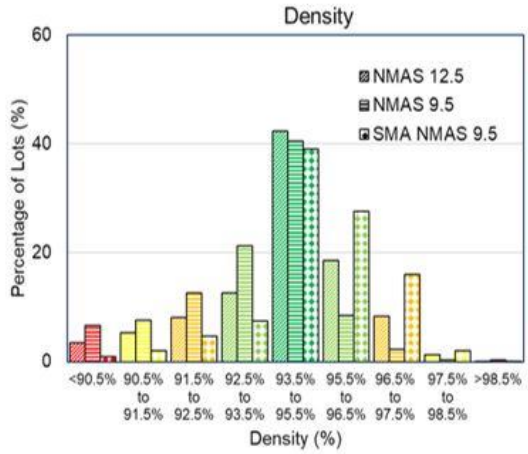
(a)



(b)



(c)



(d)

Figure 4.16. Pay parameter results for SC mixes.

For SC mixes, AV results show that both SC mixes (9.5 and 12.5 mm) have similar chances of pay disincentives (Figure 4.16). Of the SC 9.5 mm mixes, 16.7% have VMA 0.5% or lower than the minimum design VMA compared to 1% for the 12.5 mm SMA. For density, 13.4% of the 12.5 mm mixes have low densities compared to the 9% that have high densities. The lower density increases for the 9.5 mm mixes (25.8%).

4.2.3 District vs Contractor Results

The differences between district and contractor results could be indicative of offsets, sampling/blending, and/or high variability that could be caused by sample collection, reheating, and testing procedures. Statistical analysis was performed on district and contractor test results. Figure 4.17 illustrates the Mann-Whitney sublot results for AV, VMA, and density per district for both QCP and PFP specifications. If the p-value is lower than 0.05, then there is a significant difference between district and contractor results. At a statewide level, the district and contractor results were not significantly different for 91% of AV, 88% of VMA, and 82% of density results.

The significantly different cases in AV ranged from as low as 4% (District 5) to 20% (District 6). On the other hand, the results ranged from 8% (District 1) to 25% (District 6) for VMA. Note that the highest percentage of significant differences for AV and VMA were in District 6, which had the best pay performance. Figure 4.17 (d) shows the results of the Mann-Whitney test for the density cores. District 2 had the lowest variation, while Districts 8 and 9 showed the highest variation. Note that the latter districts had smaller sample sizes that could be attributed to the higher variation.

For the significantly different cases that received full pay, contractor results had sublots outside of the QCP and PFP upper limits, while district results were within the limits. For cases that were significantly different and had a pay disincentive, district results were outside the limits (density and VMA results were mostly low and AV results were either low or high), while contractor results were not.

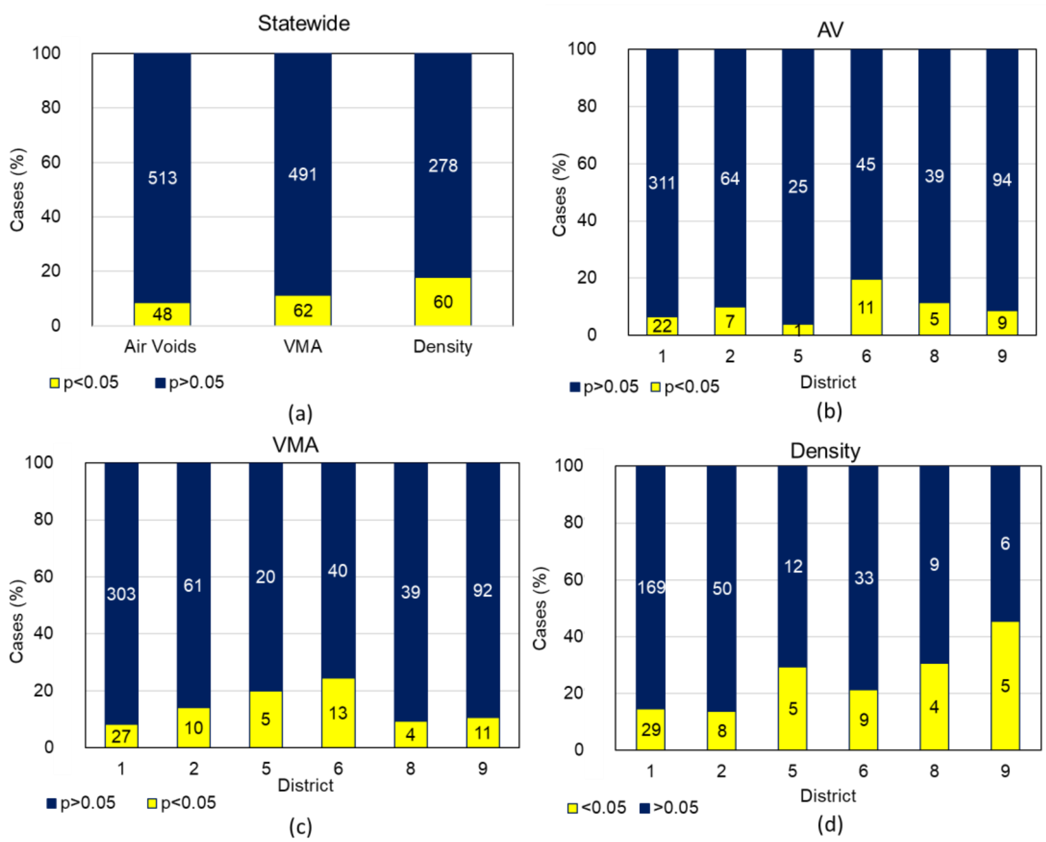


Figure 4.17. Mann-Whitney results for QCP and PFP mix contract cases.

Figure 4.18 presents the magnitude of the differences between contractor and district results. The calculation is based on Equation (4.3). A positive difference indicates the district's average result is greater than that of the contractor's.

$$\boldsymbol{D = Pay\ Parameter_D - Pay\ Parameter_C} \quad (4.3)$$

where, D is difference in the parameter; $Pay\ Parameter_D$ is average of parameter district sublot results; and $Pay\ Parameter_C$ is average of parameter contractor sublot results.

Figure 4.18 (a) shows the statewide results for AV, VMA, and density. For AV, the chance is the same that district results are either higher or lower than contractor test results. For VMA, district results were more likely to be lower than contractor results. For density, which is the parameter that had the most significant differences, there was a higher chance for district results to be lower than contractor results.

Figure 4.18 (b) shows the AV differences per district. District 1 and 2 results have the same chance of being either higher or lower than the contractor test results. However, AV results in Districts 5 and 6 appeared to be higher than those of the contractor. District 6 had the best pay performance but also the highest rate of significantly different results, and district AV values were higher than those by the contractor. These were indications of bias in AV and VMA test results of District 6. Contractor average results were biased to be higher than Districts 8 and 9 results.

In general, when there were differences between district and contractor results, district VMA was lower than contractor results, except in District 8 (see Figure 4.18 [c]), where VMA pay factor was significantly better than AV pay factor. Also, contractors have higher density average results than districts, Figure 4.18 (d). Consistency in submerged period and submerged surface dry (SSD) was desirable.

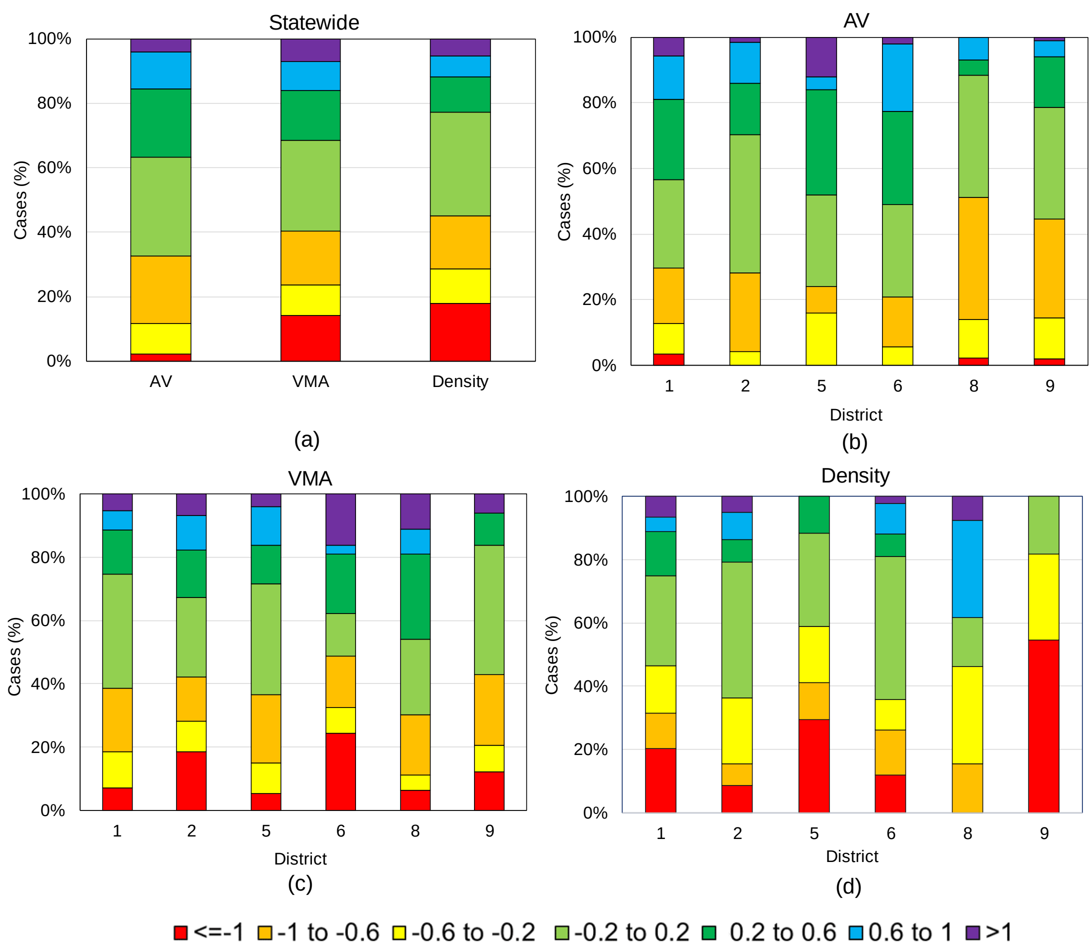


Figure 4.18. Magnitude of the differences between contractor and district results by district.

4.2.4 Variability

The variability in the data may result from testing as well as mixture characteristics and production. Levene's test was conducted to check the significant difference in variance of contractor and district results. If the variance is similar, then the source is most likely due to changes in mix production or construction. On the other hand, if there is difference in the variance, this could be attributed to sample splitting and/or testing. Figure 4.19 shows Levene's test results for VMA, AV, and density. The results were similar to that of the Mann-Whitney test results. At a statewide level, contractor and district results were not significantly different for 91% of AV, 89% of VMA, and 82% of density results. In general, Levene's test results show an agreement between district and contractor data variances. As a result, the variabilities in the variances of contractors and those of districts are comparable. This may suggest that mix production is the main factor causing high variabilities between sublots, and, hence, affecting the same tests conducted by the two independent parties. Laboratory test variability exists but is not the main cause for the variances found in the analyzed data. Suggestions have been provided to minimize such variabilities in Chapter 6.

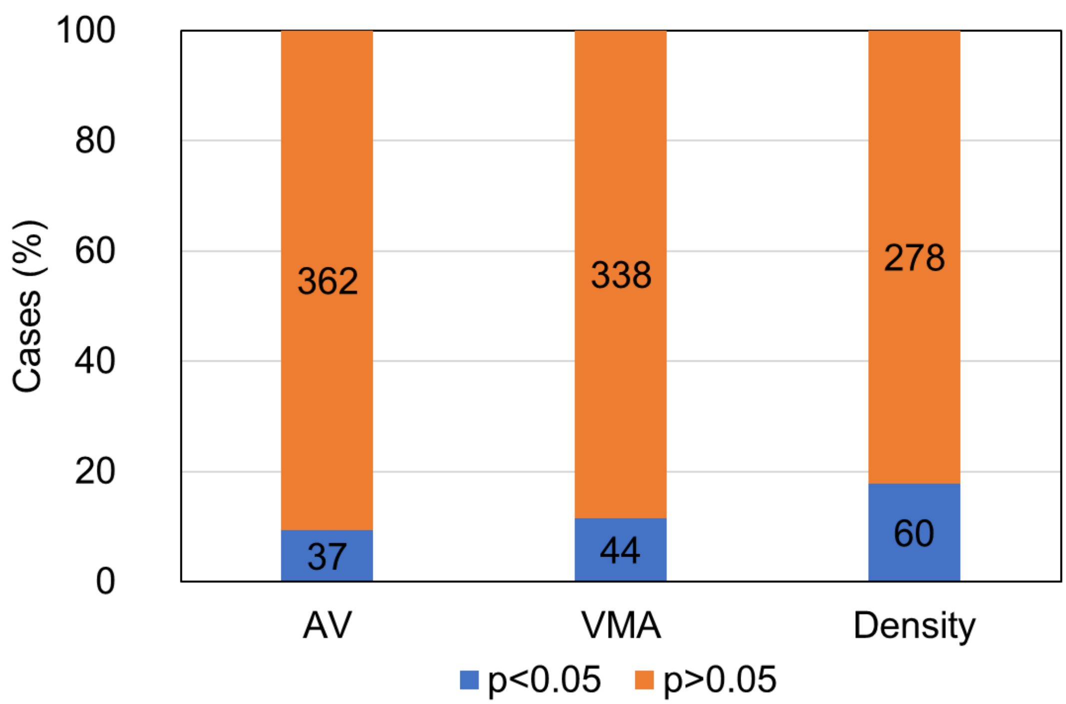


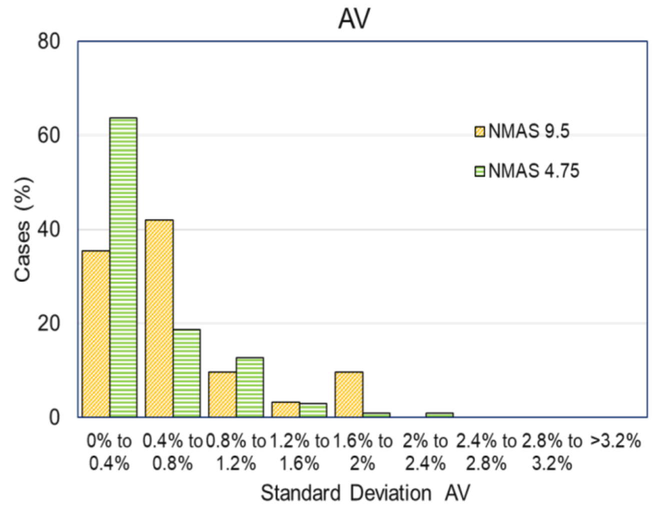
Figure 4.19. Levene's results for AV, VMA, and density.

For LB mixes, the AV results show that 4.75 mm mixes had lower AV standard deviation than 9.5 mm NMAS (Figure 4.20). More than 60% of the 4.75 mm NMAS cases had AV standard deviations between 0% to 0.2% while less than 40% of the 9.5 NMAS mm had a standard deviation in the same range. Figure 4.20 (c) shows the standard deviation for VMA. The distribution for the 4.75 and 9.5 mm NMAS was similar. Figure 4.20 (d) shows the standard deviation results for density. Density is the most variable parameter for all the mixes. The distribution of the 4.75 mm NMAS standard deviations is centered around 1.6% to 2% while 9.5 mm mixes are around 0.8% to 1.2%.

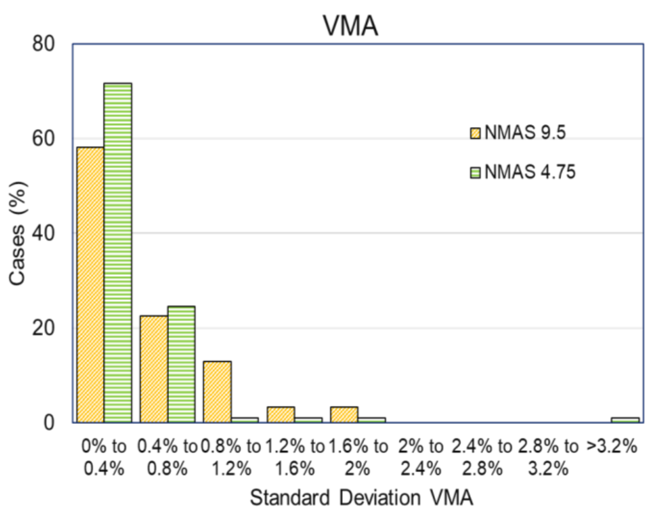
For BC 12.5 mm SMA and 19 mm mix (Figure 4.21), density was the most variable of the evaluated parameters, with approximately 80% having a standard deviation of 0.8% to 2%. AV was the second most variable parameter, followed by VMA.

Type	LB	LB
NMAS	9.5	4.75
Target AV	4.0	4.0 (3.5 in D1)
Min VMA	15.0	18.5
Mix Cases	31	108
Density Cases	39	105

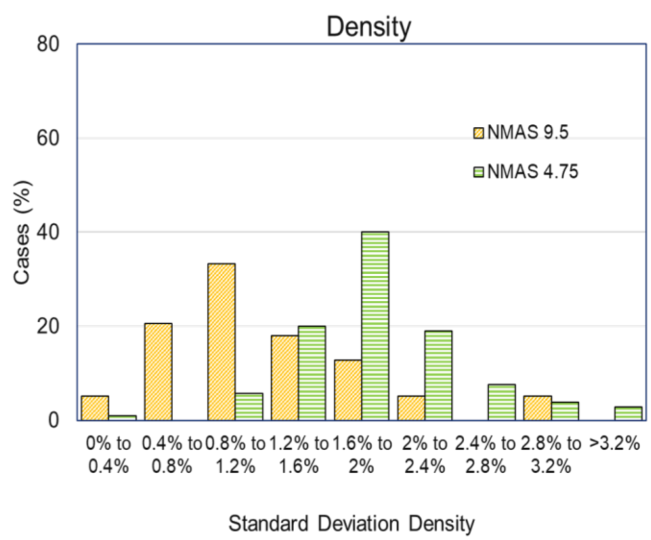
(a)



(b)



(c)



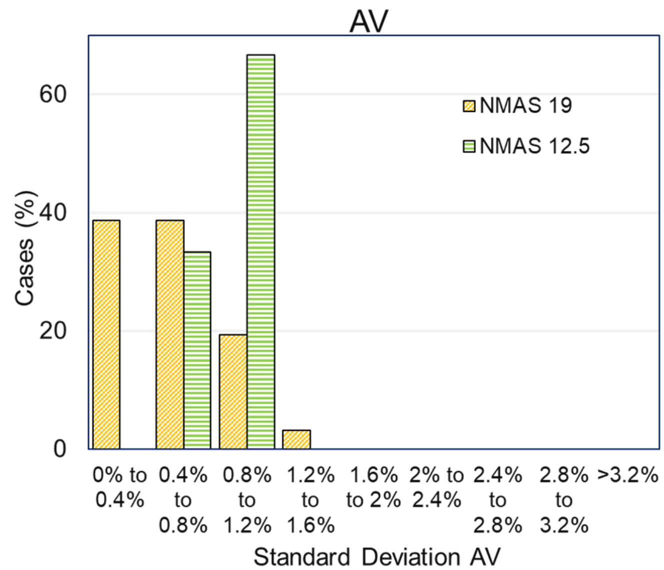
(d)

Figure 4.20. Standard deviations in AV, VMA, and density for LB mixes.

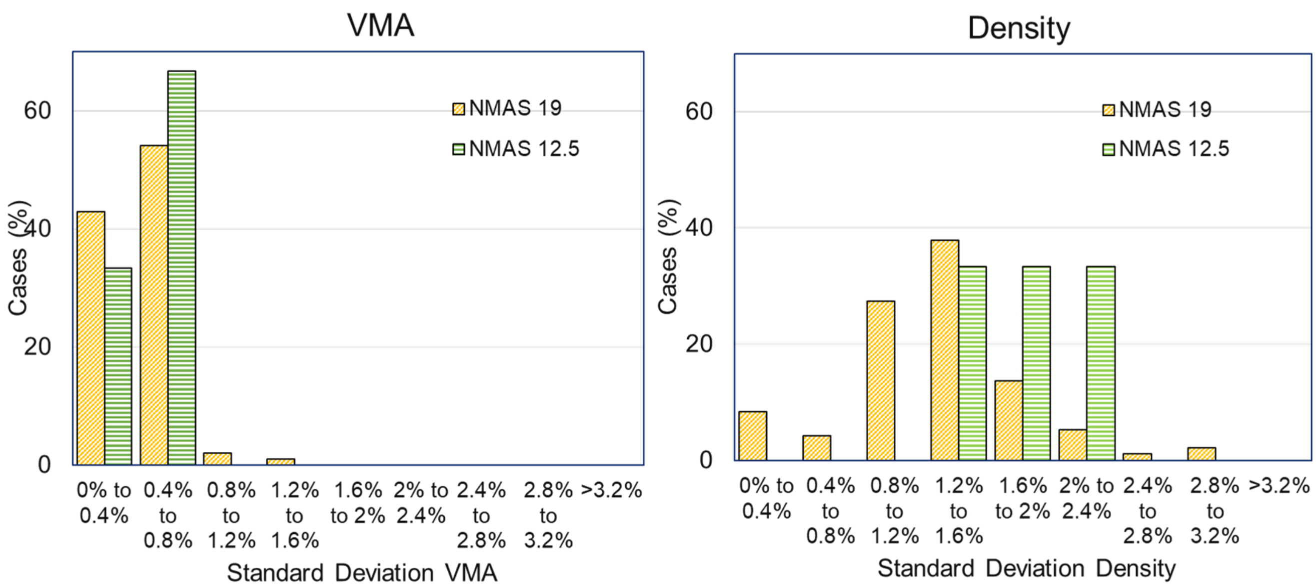
Figure 4.22 shows the results for 12.5 mm SMA and 9.5 mm SC mixes. The trend was similar to BC and SC mixes. Density showed the highest variances among the three parameters, with 90% having a standard deviation of 0.8% to 2.4% for both mixes. However, the 12.5 mm SMA showed slightly less standard deviation than the 9.5 mm mix, 65% and 53%, respectively, with a standard deviation lower than 1.6%. AV showed less variability in the 9.5 mm mix than the 12.5 mm SMA. VMA is the least variable. In general, the 9.5 mm mix appears less variable for AV and VMA and more variable for density than the 12.5 mm SMA.

Type	BC	BC
NMAS	19.0	12.5 SMA
Target AV	4.0	4.0 (3.5 in D1)
Min VMA	13.5	16.0
Mix Cases	99	3
Density Cases	95	3

(a)



(b)



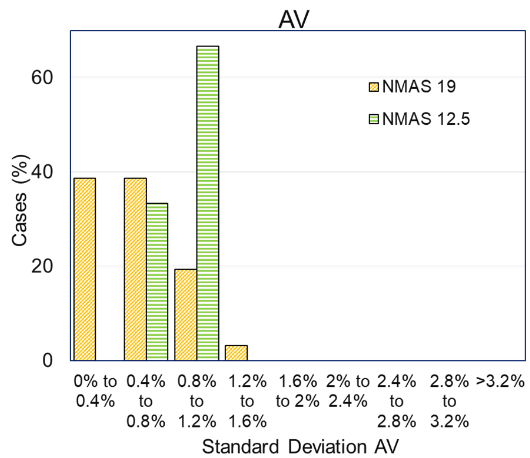
(c) (d)

Figure 4.21. Standard deviations in AV, VMA, and density for BC mixes.

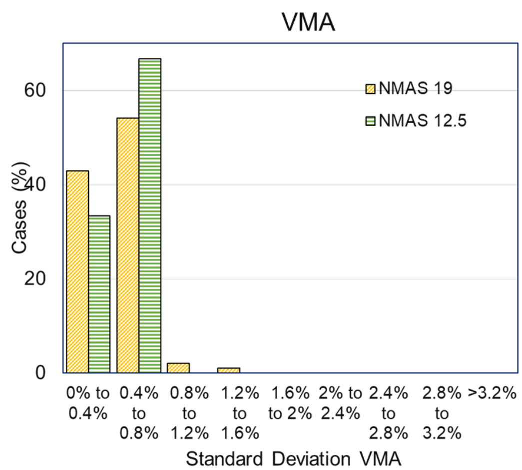
Districts had higher standard deviations than contractors for AV (Figure 4.23). Similarly, for VMA (Figure 4.24), Districts 8 and 9 had the largest share of cases, with a standard deviation exceeding 0.6% (56% and 44%, respectively). District 5 had smaller AV and VMA standard deviations, which contributed to the pay performance success. For density (Figure 4.25), district standard deviations were generally higher than the contractor's. Districts 1, 5, and 6 were higher; Districts 2 and 9 were comparable; while District 8 had higher contractor standard deviation.

Type	BC	BC
NMAS	19.0	12.5 SMA
Target AV	4.0	4.0 (3.5 in D1)
Min VMA	13.5	16.0
Mix Cases	99	3
Density Cases	95	3

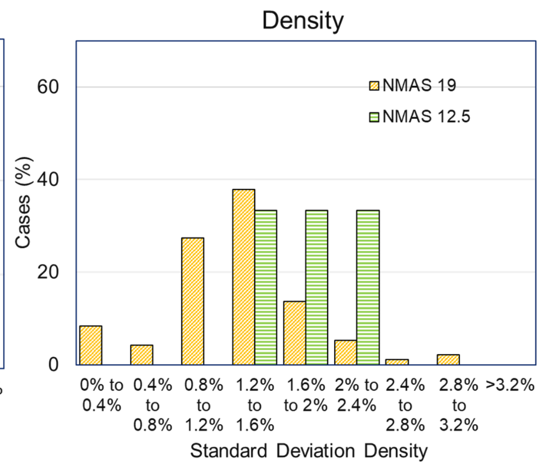
(a)



(b)



(c)



(d)

Figure 4.22. Standard deviations in AV, VMA and density for SC mixes.

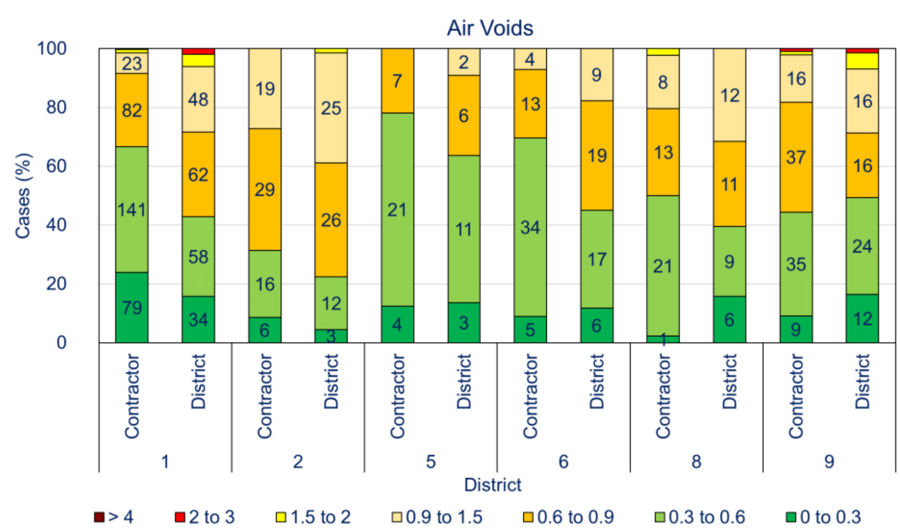


Figure 4.23. Standard deviations of AV (%) per district and contractor.

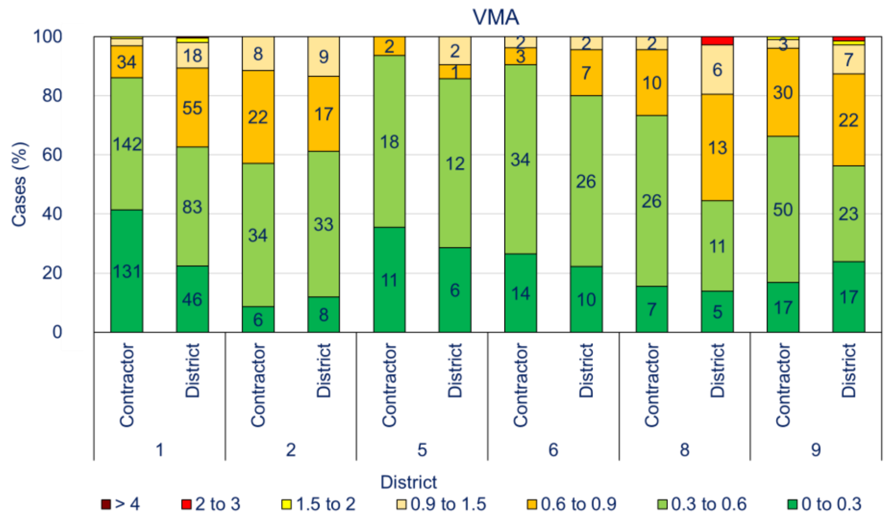


Figure 4.24. Standard deviations VMA (%) per district and contractor.

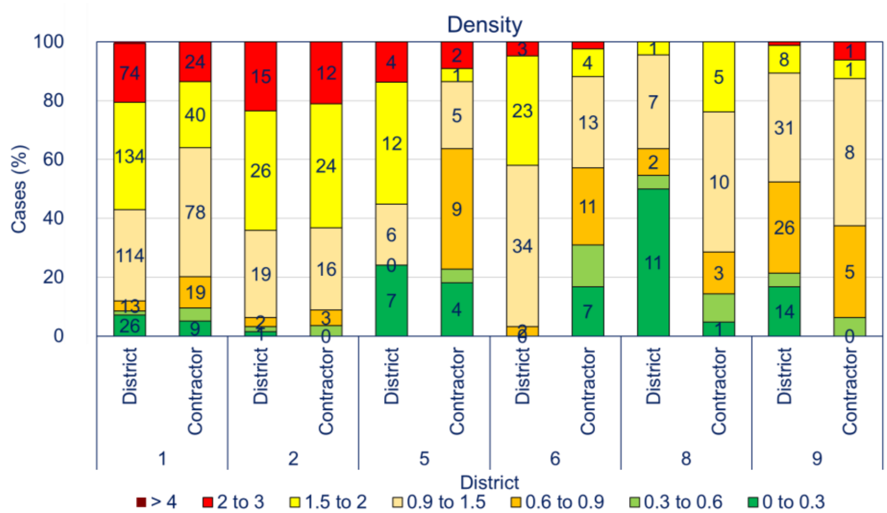


Figure 4.25. Standard deviations of density (%) per district and contractor.

4.2.5 Density Variability Sensitivity Analysis

In the PFP specification, contractors are not only evaluated for meeting the specification ranges but also for variability. In the pay factor calculation process, a distribution is fitted to the data, and high variability leads to the tails being outside the pay limits, inducing pay disincentives. For these reasons, it is crucial to understand how variability affects pay factors in the PFP specification and to quantify the financial impact of having higher variability on the pay factor.

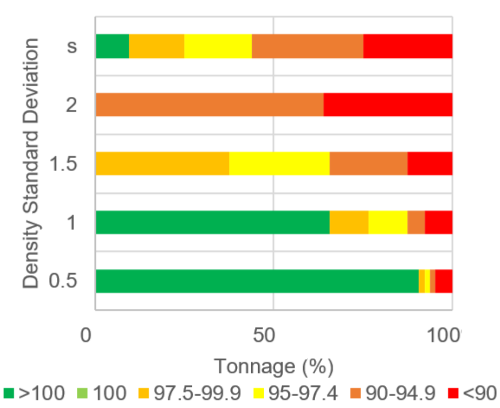
Density is the most variable pay parameter. This causes more pay disincentives in PFP compared to QCP because of PFP's evaluation of variability in the pay calculation. Before simulating different standard deviation levels and their impact on pay factors, it is important to check the pay factor data distribution. Table 4.1 presents levels of density values and corresponding standard deviation categories with their respective pay factors. A total of 77 mix contract cases were used.

Table 4.1. Average Density Pay Factor for Various Mixes

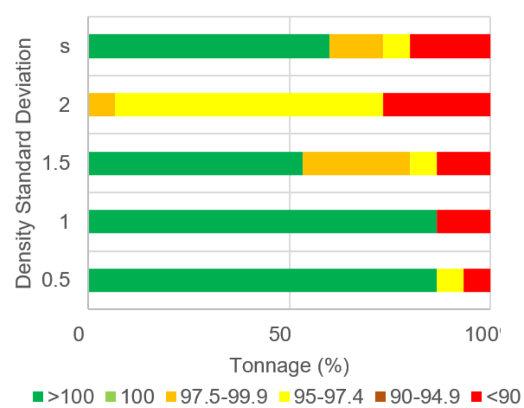
Mix Type	Density (%)	Density Standard Deviation (%)	Average Density Pay Factor
SC	91.5–93.0	0–1	N/A
		1–2	98.42
		>2	91.29
	93.0–94.5	0–1	N/A
		1–2	98.71
		>2	97.55
	94.5–96.0	0–1	100.73
		1–2	100.39
		>2	N/A
BC	91.5–93.0	0–1	98.00
		1–2	84.00*
		>2	96.80
	93.0–94.5	0–1	102.30
		1–2	98.92
		>2	96.45*
	94.5–96.0	0–1	N/A
		1–2	100.47
		>2	N/A

*Data are based on 77 cases divided into 18 categories. Hence, outcome interpretation is limited.

In general, the higher the density variability, the lower the pay factor. To quantify this, different scenarios of standard deviation were simulated to evaluate the impact on pay factor. Standard deviation varied from low (0.5) to high (2) with an increment of 0.5; the mean density values remained constant. Seventy-seven mix contract cases were used: 64 SC and 15 BC. Figure 4.26 shows the density pay distribution by standard deviation. The category “s” refers to the pay distribution calculated using the standard deviation values from the actual collected data from districts.



(a)



(b)

Figure 4.26. (a) SC and (b) BC density pay factors distribution for various standard deviation values.

The standard deviation has a high impact on pay distribution in the PFP specification (both for BC and SC). The higher the standard deviation, the more notable the shift to lower pay factors. To quantify this impact, Figure 4.27 shows the pay factor average change as a function of standard deviation. This shows that uniformity of density results is important. To illustrate this, the average tonnage of a PFP project is approximately 23,000 tons and the average bid price is approximately $86/ton. However, this average does not consider cost inflation. Therefore, Consumer Price Index (CPI) data from the Bureau of Labor Statistics was used for base year 2019. A year's CPI change was taken as the difference between the average of CPI change of June and July of the base year 2019. The CPI of the year 2019 was not available at the time this report was published. The inflation of one USD in 2015 was found to be 7.5%. The inflation rates of 2016 and 2017 were found to be 6.5% and 5%, respectively. The value average price per ton of a PFP project was found to be around $92 in 2019. Achieving a density standard deviation of 1 leads to an average *increase* in pay factor of around 4.5% compared to the actual pay factor. This amounts to an average monetary value as calculated in Equation (4.4):

$$MV = 0.4 * C * P * T \tag{4.4}$$

where, MV is monetary value corresponding to the change in pay factor (2019 USD); C is change in Pay Factor; P is price per ton (2019 USD/ton); and T is tonnage (ton).

Substituting *C* as 0.045, *P* at 92 of 2019 USD/ton, and *T* at 23,000 ton, the value of MV is roughly US$38,000 ($1.7/ton) in 2019. If a standard deviation of 0.5 is used, then the total pay difference would be US$59,000 in 2019. The average standard deviation of density for PFP projects used in the analysis is around 1.67. Although there are many factors affecting field compaction and thus density, better quality control and lowering density variability as much as possible leads to the aforementioned financial benefits.

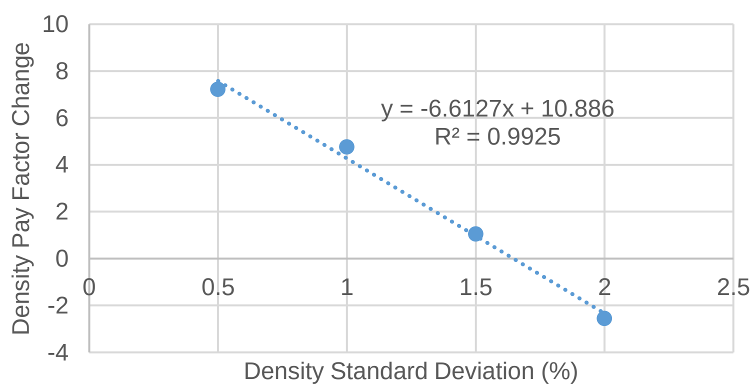


Figure 4.27. Density pay factor average change against density standard deviation.

4.3 AGGREGATE GRADATION AND ASPHALT CEMENT CONTENT EVALUATION

As indicated earlier, most contractor and district results (91% of AV, 88% of VMA, and 82% of density results) are not significantly different. As a result, when there is a pay disincentive related to AV and

VMA and both the contractor and district test results indicate significantly similar results, it is probably because of an issue with the mix production. To confirm the claim is true, other supporting data related to production should be evaluated such as the extracted aggregate gradation and dust/AC content to identify a possible mix issue.

4.3.1 Analysis Approach

IDOT is required to report AC content for each mix sublot, which includes running a washed aggregate gradation. However, mix aggregate gradations are not a pay parameter. Twelve sieve sizes are reported: 1.5 in, 1 in, 3/4 in, 1/2 in, 3/8 in, #4, #8, #16, #30, #50, #100, and #200. IDOT obtains the aggregate gradation from an exclusive HMA sample, utilizing ignition oven, centrifuge, or reflux. (Note that several districts and contractors currently use automated extraction devices.) The ignition oven is the most widely used method in Illinois for separating binder from the aggregates in HMA samples.

Bailey method control sieves were used to analyze the aggregate gradation because the impact of each sieve size is different depending on the NMAS (TRB, 2002). For example, the amount of material passing sieve #8 has a greater impact on a 9.5 mm mix than on a 19 mm mix. The Bailey method identifies four control sieves that are used to characterize the behavior of the aggregate gradation. The primary control sieve (PCS) defines the threshold between coarse fraction and fine fraction of the blend. The half sieve (HS) is used to break the coarse fraction into two parts. The secondary control sieve (SCS) and tertiary control sieve (TCS) divide the fine fraction of the blend in a similar way as the PCS with the total blend (TRB, 2002).

Table 4.2. Sieve Sizes Used to Evaluate Aggregate Gradation on the Bailey Method

NMAS*	19 mm (3/4”)	12.5 mm (1/2”)	9.5 mm (3/8”)	4.75 mm (#4)
HS	3/8”	1/4”	#4	#8
PCS	#4	#8	#8	#16
SCS	#16	#30	#30	#50
TCS	#50	#100	#100	#200

* half sieve (HS), primary control sieve (PCS), secondary control sieve (SCS), and tertiary control sieve (TCS)

For each mix contract case, the sublots that fail to meet either the AV or VMA requirements were identified for evaluation. Bailey method critical sieves were used for the evaluation: HS, PCS, SCS, and TCS (Table 4.2). In addition, the NMAS and the dust/AC ratio were considered in the evaluation. Then, the amount passing in each sieve was compared to IDOT aggregate gradation limits, as reported in the Standard Specification for Road and Bridge Construction (IDOT, 2016), to identify any deviation from the required limits. Contractors are required to design HMA within the limits specified in the standard specifications.

4.3.2 Aggregate Gradation Results

The aggregate gradations for 690 cases were analyzed (Figure 4.28). From Figure 4.28 (a) and (b), 27% and 6% of AV and VMA pay disincentive cases, respectively, did not show noticeable differences in the aggregate gradation or AC content results when compared to design values. On the other hand, when the mixes were not penalized with a pay reduction (disincentive) for AV and VMA, 82% and

73%, respectively, of the cases did not show irregularity in the aggregate gradation or AC content results (Figure 4.28 [c] and [d]). Cases that have a pay disincentive either in AV or VMA were likely to have corresponding issues with aggregate gradation results. Multiple reasons, such as aggregate variability, mix control, segregation when sampling, or others, could have caused aggregate gradation of a mix not to meet the specifications. The gradation results eventually affect AV and VMA results. Five major issues were identified: PCS LL, SCS LL, TCS UL, dust/AC ratio, and NMAS; LL and UL refer to lower and upper limits, respectively.

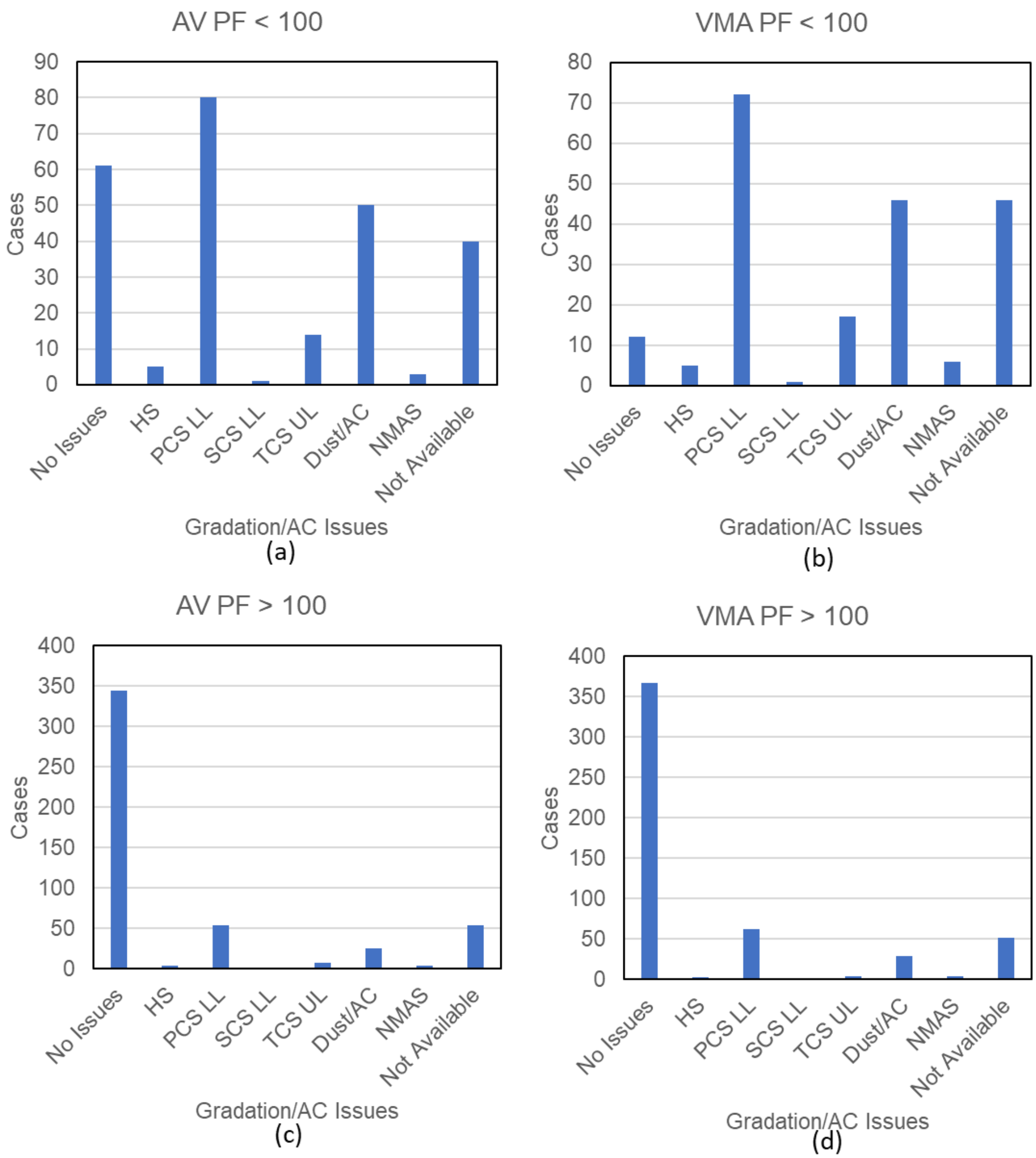


Figure 4.28. Aggregate gradation issues identified for cases with and without pay disincentives.

To describe the aggregate sizes that caused issues with aggregate production, the standard deviation and coefficient of variation (COV) of all the gradation results per mix contract case was computed for each required sieve size used. The standard deviation of each mix contract case was grouped for LB (Figure 4.29), BC (Figure 4.30), and SC mixes (Figure 4.31) to create boxplots that show the distribution between the 690 cases that were analyzed. For all mix types, coarser aggregates were more susceptible to higher variability, which led to the issues in aggregate gradations discussed. In LB mixes sieves #4, #8, #16, and #30 showed the highest standard deviation. Also, 9.5 NMAS LB mixes had higher standard deviation for these sieves than 4.75 LB NMAS. For BC mixes, sieves 1/2", 3/8", and #4 (which corresponded to the coarse aggregate fraction) showed the largest amount of variability. Similarly, 3/8" and #4 also showed the highest variance in SC mixes. The COV analysis typically showed that the smaller the sieve size, the more susceptible to higher COV for most mix types (Figures 4.29–4.31). Finally, between all mix types, LB 4.75 mixes showed the least amount of aggregate gradation variance.

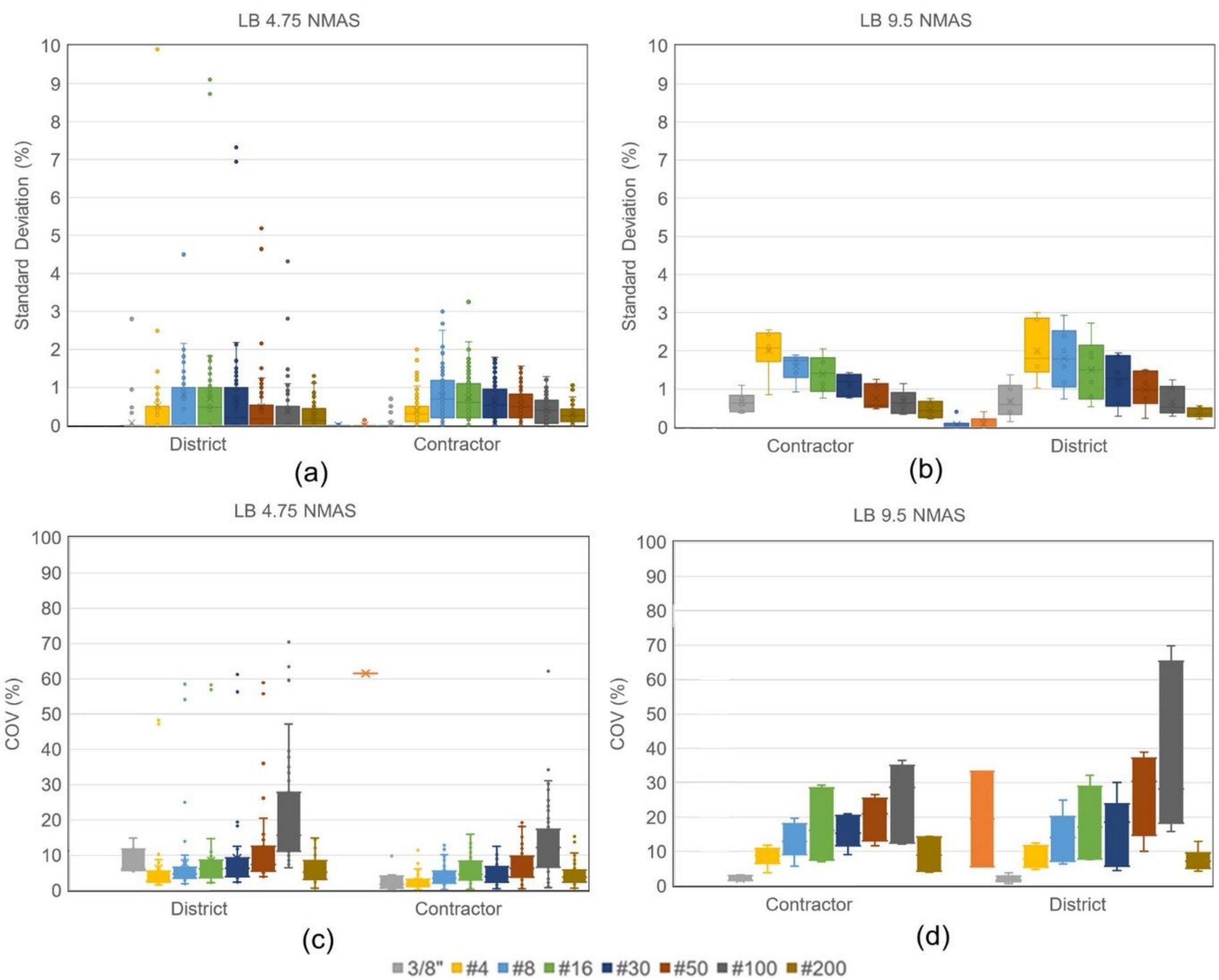


Figure 4.29. Distribution of aggregate gradation standard deviations per sieve size for LB mixes.

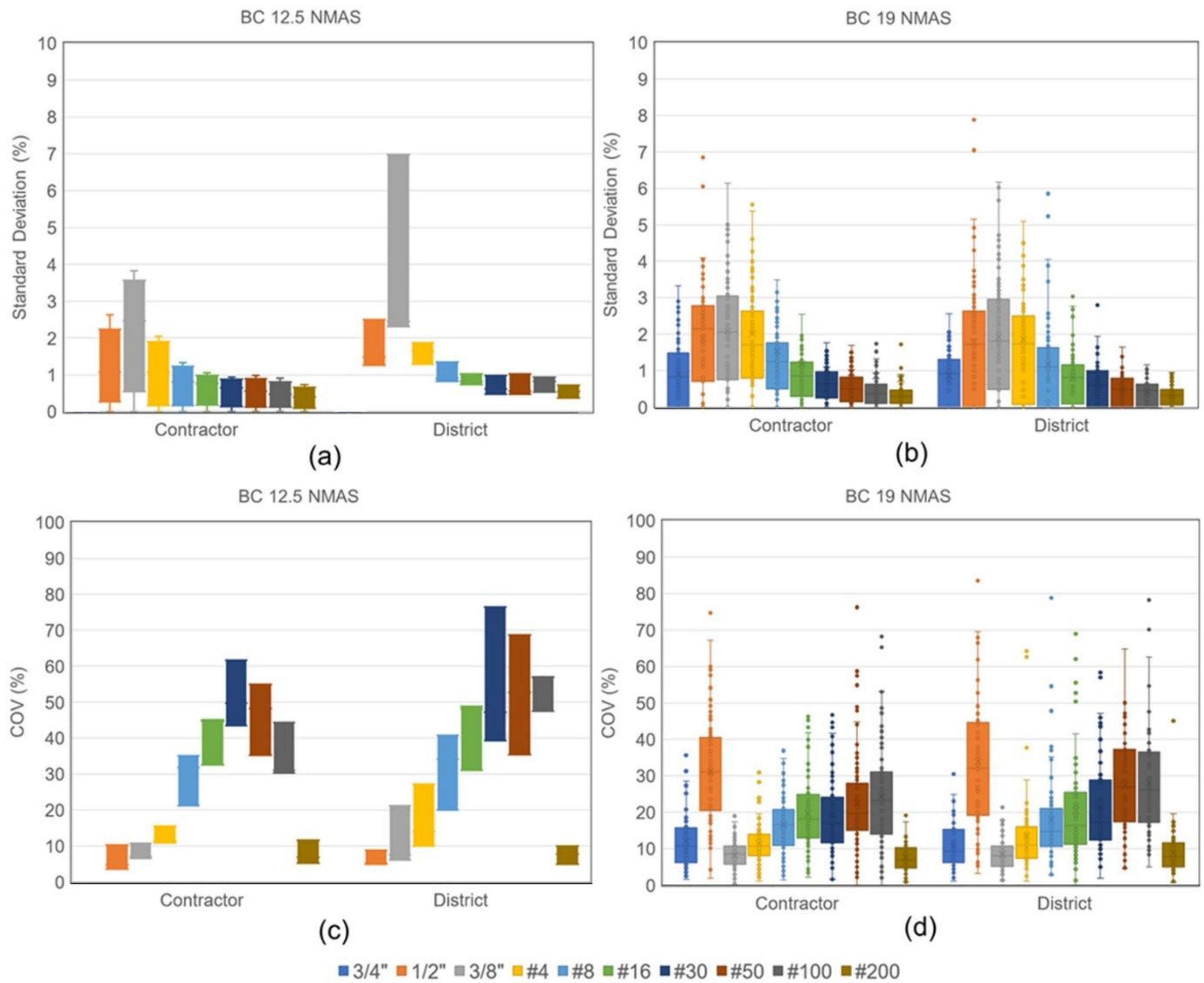


Figure 4.30. Distribution of aggregate gradation standard deviations per sieve size for BC mixes.

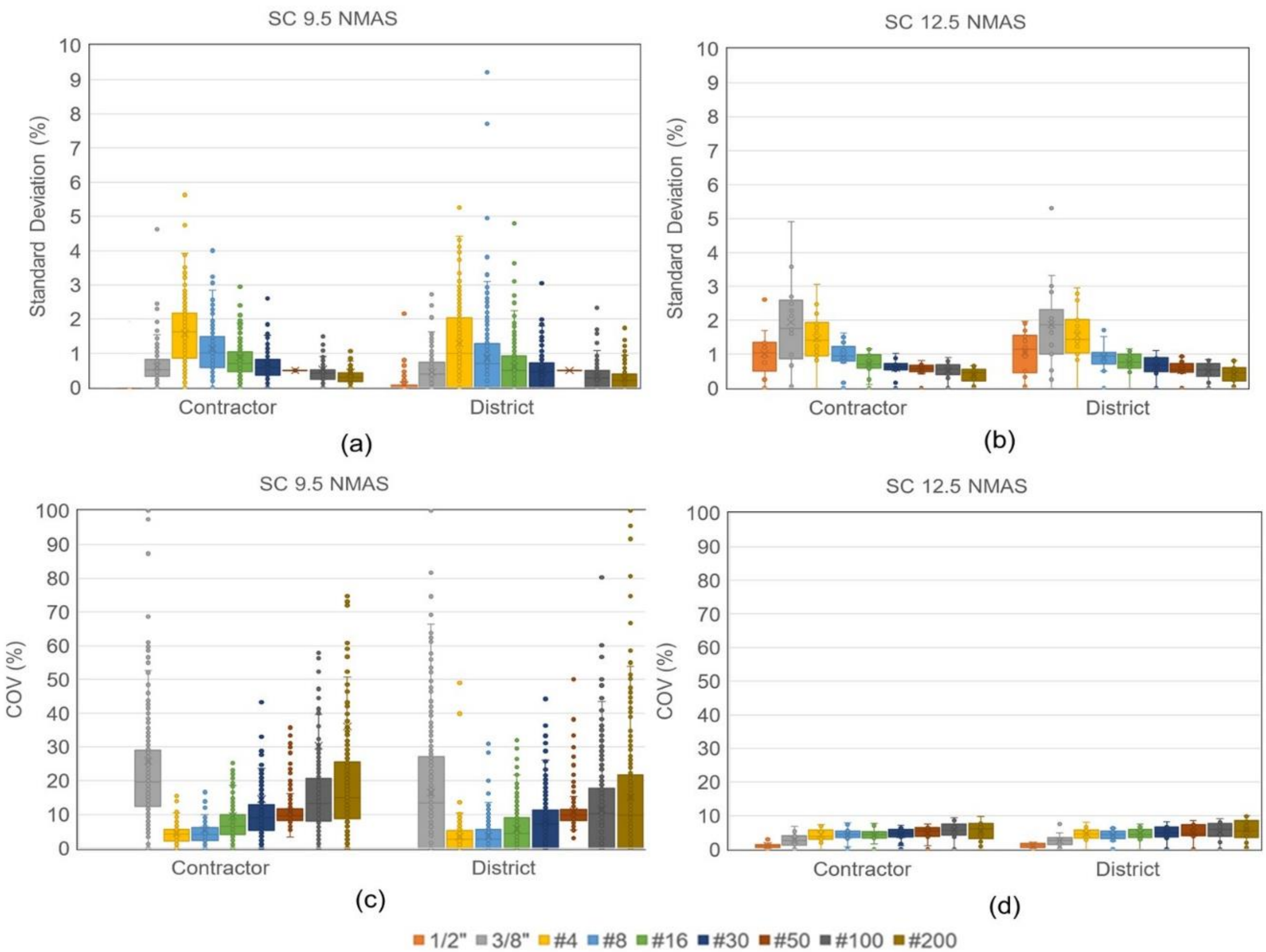


Figure 4.31. Distribution of aggregate gradation standard deviations per sieve size for SC mixes.

4.4 VOLUMETRIC TESTS (G_{MB} AND G_{MM}) RESULTS EVALUATION

Most contractor and district results (91% of AV, 88% of VMA, and 82% of density results) were not significantly different. However, the Mann-Whitney test results did not account for the effects of testing because cases with significant differences between contractor and district results were detected. As a result, the major source of testing differences between contractor and district results was investigated.

Despite not being pay parameters (i.e., not being used to calculate pay factors), it is important to analyze theoretical maximum specific gravity of the mixture (G_{mm}) and bulk specific gravity of the mixture (G_{mb}) data, as they can shed light on the variability and bias in AV and VMA. This section presents the results of statistical testing, including Shapiro-Wilk, Mann-Whitney, and Levene's tests for G_{mm} and G_{mb}.

4.4.1 Distribution and Average Comparison

Figure 4.32 (a) and (c) shows the differences in the two parameters (G_{mm} and gyratory G_{mb}) between the districts and the contractors calculated using Equation (4.3).

$$\boldsymbol{D = Volumetric\ Result_D - Volumetric\ Result} \tag{4.3}$$

where, D is difference in the volumetric result; $Voumetric\ Result_D$ is average of G_{mb} or G_{mm} district sublot results; and $Volumetric\ Result_C$ is average of G_{mb} or G_{mm} of the contractor sublot results.

The difference in G_{mm} of less than (±0.010) in the average sublot results between districts and contractors is 76%. On the other hand, G_{mb} has only 62% of the cases with differences of less than ±0.01. The greater differences for G_{mb} may be attributed to the following sources: testing variability, reheating, compaction, sample soaking, gyratory compactive effort, and SSD weight, as opposed to only reheating and sample soaking in the case of G_{mm}. The AASHTO acceptable range for the G_{mb} tests of two results (d2s) is 0.017. The percentage of the cases exceeding the acceptable limits for the G_{mb} is 15%. As a result, this may indicate that a bias between the testing parties exists because of the differences in sample handling between contractors and districts.

Figure 4.32 (b) and (d) divides differences between the average G_{mb} and G_{mm} results per district. District G_{mm} results were more comparable to the contractor results than those of G_{mb}. When the difference between contractor and district results for G_{mm} is relatively high, district results are greater than those from the contractor. This could be affected by the variation in reheating procedure and time, which would affect the adsorbed binder. The longer the heating time, the higher the G_{mm}. Soaking time in the water bath is regulated by IDOT specifications.

Some districts were more likely to have G_{mb} results higher than the contractor results, such as Districts 5, 8, and 9. On the other hand, Districts 1, 2, and 6 tended to have a similar proportion of the G_{mb} results either higher or lower than the contractor results. These differences can also be a function of the fixed offsets that contractors and districts have. Contractors often keep track of the offsets between their results and the districts' results. These offsets allow the contractors to estimate where the results of the districts will probably lead. Data from Districts 5, 8, and 9 showed larger offsets of G_{mb} values; district results were higher than the contractor values.

Figure 4.32 shows District 5 results are more likely to be higher than contractor results for both G_{mm} and G_{mb}. There were more cases that had a difference of 0.005 (district being higher than the contractor) or higher than there were cases with -0.005 difference (contractor being higher) or lower. This was noticed for both G_{mm} and G_{mb}. This difference in AV is more manifested than in VMA. VMA was only affected by G_{mb} (as well as AC content) but in AV both the G_{mb} and G_{mm} contributes to the variability of this parameter. In summary, G_{mb} is more critical, at this point, than G_{mm} because the reported difference is greater for the former.

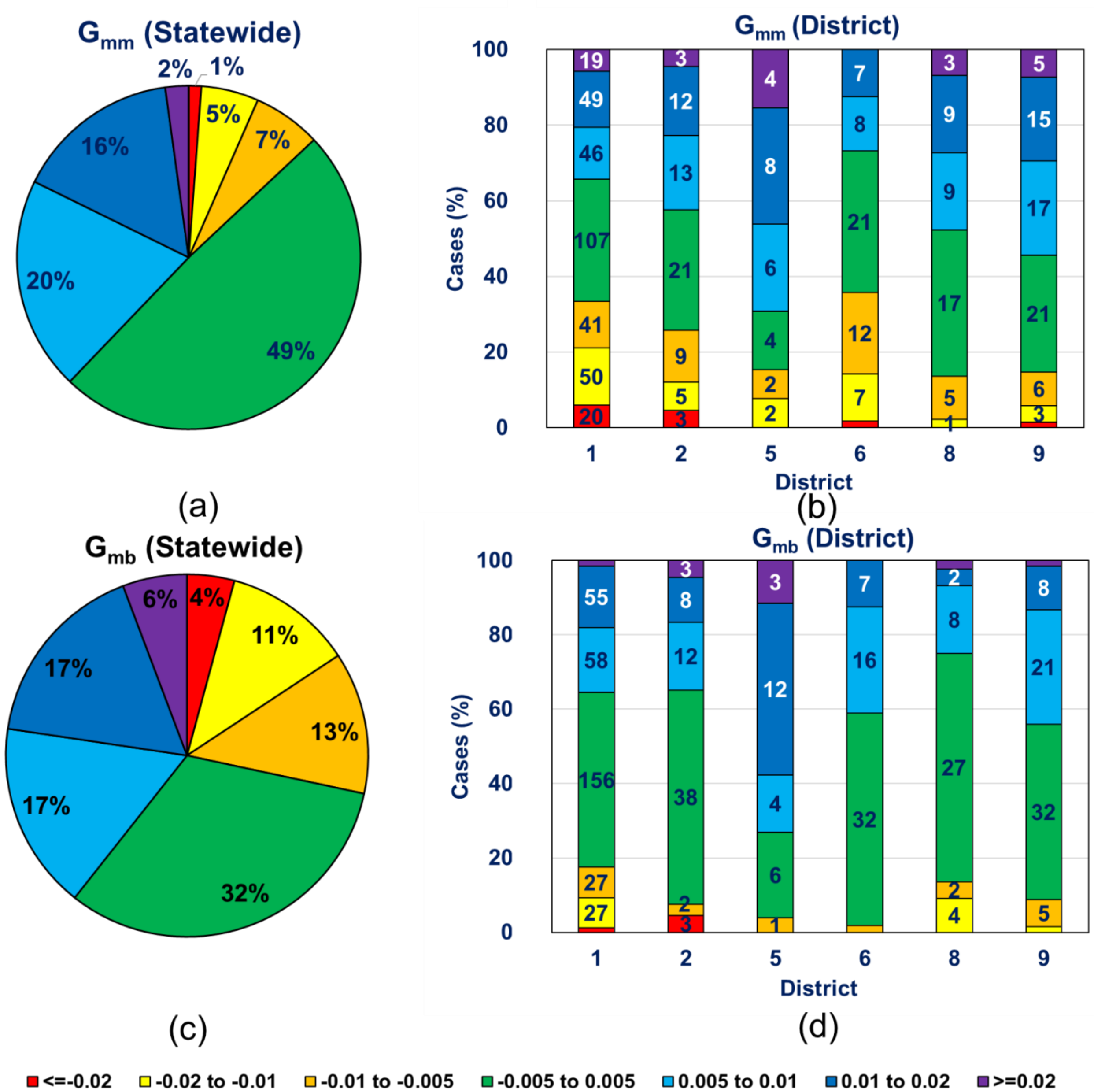


Figure 4.32. G_{mb} and G_{mm} differences between contractor and district results.

4.4.2 Variability

G_{mm} presents less variability than G_{mb}; 81% of the total cases have standard deviation values lower than 0.005, while G_{mb} has 44% of values lower than 0.005 (Figure 4.33). Figure 4.34 presents the G_{mb} and G_{mm} standard deviations per contractor and district. In general, for the G_{mb} test, district results have slightly lower or similar standard deviations to contractor results. In the case of G_{mm}, the standard deviations for contractor and district results were similar and varied less than G_{mb}.

Figure 4.33. Statewide ranges of standard deviations in G_{mb} and G_{mm}.

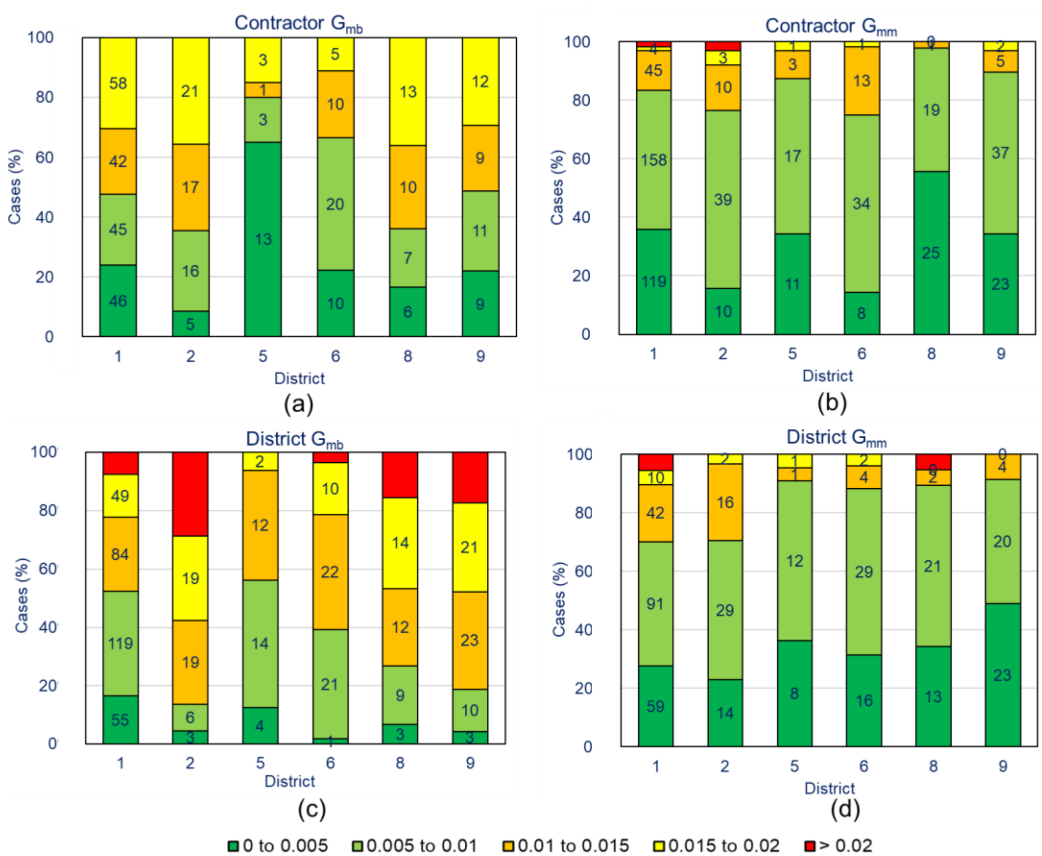


Figure 4.34. Ranges of standard deviations in G_{mb} and G_{mm} per district.

4.5 PFP DISPUTE ANALYSIS

The sublot results for the PFP dispute resolution collected from CBM records were analyzed. In PFP, contractors can dispute district sublot results if the difference exceeds the precision limits or if the result is outside the acceptable limits. The dispute of district and contractor results is conducted by the CBM. Contractors select the sublot(s) to be disputed and are required to pay for dispute testing if the dispute favors the district. Therefore, contractors do not dispute all results that are eligible for dispute because winning the dispute would either decrease pay or favor the district. In this study, all sublot results were grouped to allow an overall perspective on how each district and contractor compares with the central laboratory.

4.5.1 Comparison Approach

The analysis requires a one-to-one comparison to determine which of the contractor and district test results is closer to the CBM test result. The difference between CBM and the contractor (ΔCC_{mix_i}) or the district (ΔCD_{mix_i}) results were computed using Equations (4.5) and (4.6).

$$\Delta CC_{mix_i} = Mix\ Property_{CBM_i} - Mix\ Property_{contractor_i} \quad (4.5)$$

$$\Delta CD_{mix_i} = Mix\ Property_{CBM_i} - Mix\ Property_{district_i} \quad (4.6)$$

$$|PCC_{mix_i}(\%)| = \frac{|\Delta CC_{mix_i}|}{Mix\ Property_{CBM}} \times 100\% \quad (4.7)$$

$$|PCD_{mix_i}(\%)| = \frac{|\Delta CD_{mix_i}|}{Mix\ Property_{CBM}} \times 100\% \quad (4.8)$$

where:

- (ΔCC_{mix_i}): difference between CBM and contractor mix property (AV, VMA, G_{mb}, G_{mm}, and density) result;
- (ΔCD_{mix_i}): difference between CBM and district mix property (AV, VMA, G_{mb}, G_{mm}, and density) result;
- (PCC_{mix_i}): difference between CBM and contractor normalized in percentage to the mix property magnitude; and
- (PCD_{mix_i}): difference between CBM and contractor normalized in percentage to the mix property magnitude.

For the one-to-one comparison between $|PCC_{mix_i}|$ and $|PCD_{mix_i}|$, the smaller of the two indicates its proximity to the CBM test results, Equations (4.7) and (4.8). The mix properties evaluated were AV, VMA, G_{mb}, G_{mm}, and density.

4.5.2 Mix Dispute Analysis

The results of dispute analysis for the mix pay parameters (AV and VMA) are presented in Figure 4.35. The blue (contractor) and orange (district) bars represent CBM's result proximity to contractor and district results, respectively. The gray (neither) bar refers to the number of tested samples when the absolute percent difference between the CBM results and contractor/district results is the same. Statewide, in more than 63% of the cases, the CBM results were closer to the contractor results for AV and VMA. Contractors typically were closer to the CBM test results in 60% to 70% of the cases for AV. For VMA, contractors were closer to the CBM test results in 60% to 70% of the cases in Districts 1, 2, and 6. Only District 9 had comparable percent ratios for contractor and district. In general, District 5 had no dispute for any mix property.

The contractor and CBM AV and VMA test results were comparable because the G_{mb} values were more comparable than G_{mm}. Figure 4.36 shows the results of the G_{mb} and G_{mm} tests. Contractors typically are closer to CBM's test results in 60% to 70% of the cases for G_{mb} (similar rates as seen for AV and VMA). For the case of G_{mm}, contractors were closer to CBM's test results in Districts 1, 8, and 9. In District 2 and 6, district test results were closer to CBM's.

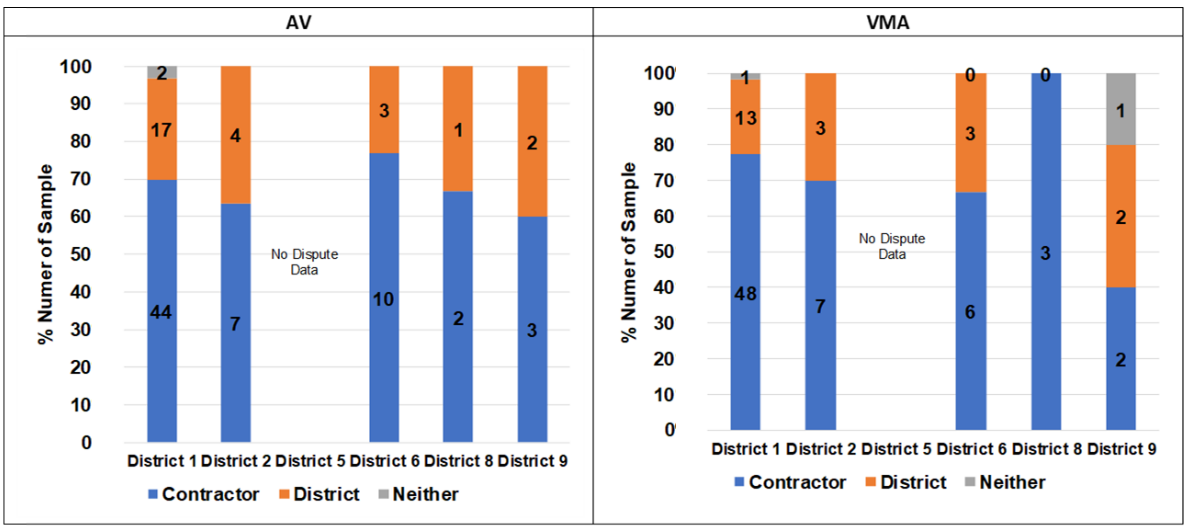


Figure 4.35. AV and VMA dispute analysis results by district.

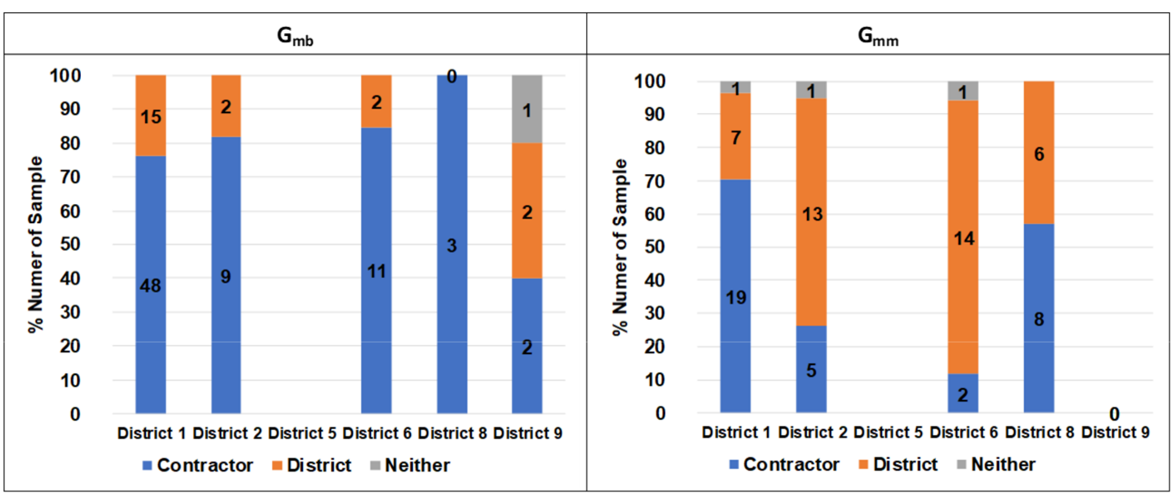
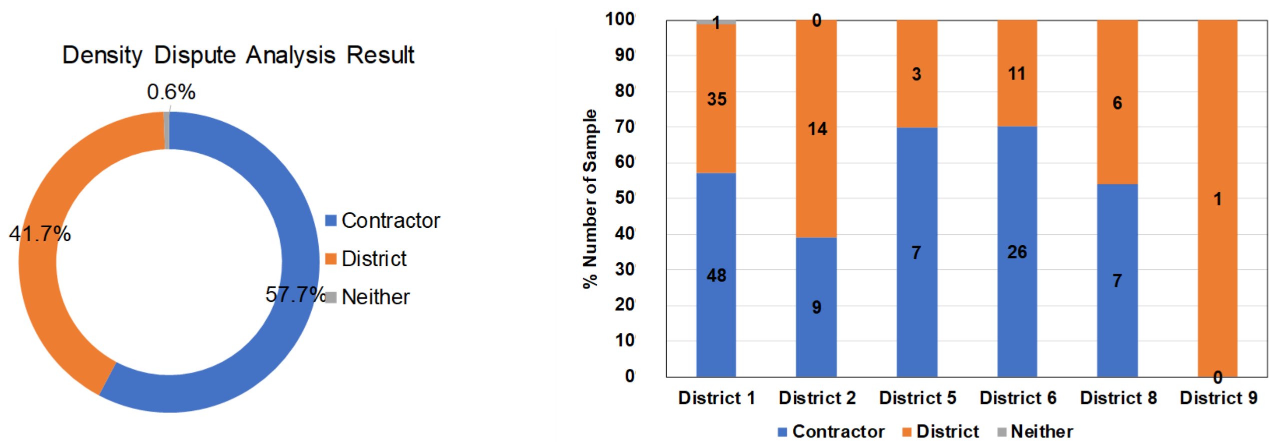


Figure 4.36. G_{mb} and G_{mm} dispute analysis result by district.

4.5.3 Core Density Dispute Analysis

According to the core density comparison shown in Figure 4.37 (a), 57.7% and 41.7% of the sublots indicate the proximity of CBM test results to contractor and district results, respectively. The remaining 0.6% indicates that $|PCC_{density}|$ and $|PCD_{density}|$ are the same. The results are presented per district in Figure 4.37 (b). Blue (contractor) and orange (district) bars indicate the proximity of CBM results to contractor and district results, respectively. The gray (neither) bar indicates that the absolute percent difference between CBM results and contractor/district results was the same. Districts 5 and 6 (and District 1 to a lesser degree) results favored the contractor more than the district. Of the District 2 results, 60% of the samples were similar to CBM's. District 8 was close to a 50–50 comparison with CBM. The top three disputed PFP mixes were SMA SC N80 12.5 F REC, HMA SC N70 D REC, and SMA SC N80 9.5 REC. While the top three density disputed PFP mixes were HMA BC N90 19.0R, HMA SC N90 D REC, and HMA SC N70 D REC.



(a) (b)

Figure 4.37. Statewide density dispute analysis result.

4.6 ROUND ROBIN DATA ANALYSIS

Round robin neutralizes construction- and production-associated variability and concentrates only on testing issues. During each yearly round robin test, a plant-produced mix is sampled and sent to selected district and contractor laboratories. The laboratory-conducted G_{mm} and G_{mb} tests for the samples follow IDOT specifications. Therefore, under ideal situations, all test laboratories should report the same values. Differences may be attributed to equipment, operator factors, and/or potentially testing a non-representative sample. Data from the 2015 to 2018 round robins were collected.

4.6.1 Variability Rating Method

The round robin results were analyzed based on the average of the results. Outliers were removed to prevent inaccurate data from affecting the evaluation. The average and standard deviation for each data set were computed and used to determine Z-scores. The Z-score measures how far the results of a laboratory were from the mean. Round robin data were assumed to be normal. Consequently, Z-scores were calculated using Equation (4.9). To illustrate the Z-score, Figure 4.38 shows the normal distribution probability density function.

$$Z_i = \frac{\bar{x}_i - \bar{x}}{s} \quad (4.9)$$

where, Z_i is Z-score in lab i; $\bar{x}_i$ is average of the two tests conducted at lab i; $\bar{x}$ is average of all tests conducted statewide in that specific year; and s is standard deviation calculated based on all tests statewide.

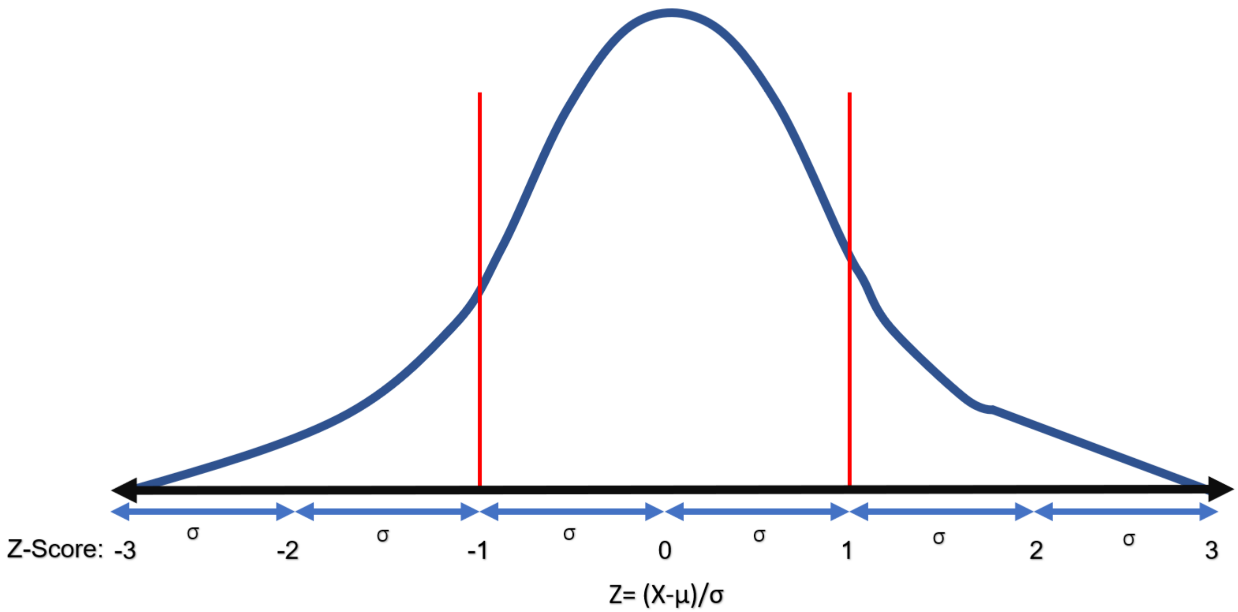


Figure 4.38. Normal distribution of round robin data.

4.6.2 Z-Score Evaluation of District and Contractor Laboratories

The Z-score analyzed for both G_{mb} and G_{mm}. G_{mm} standard deviations did not exceed 0.005 for all districts, while G_{mb} standard deviations varied per district, as shown in Figures 4.39 and 4.40. The following were observed:

- G_{mm}: All district laboratories were close to the average G_{mm} result. However, because of the low standard deviation, the Z-score varied, and the district results were either higher or lower than the average G_{mm} and no bias was observed.
- G_{mb}: For District 1, the district laboratory was consistently lower than the round robin means, and the contractor results were around the mean (Figure 4.41). District 2 laboratory results were kept within 0.5 of the standard deviation. District 5 was the second-closest laboratory to the mean. In the first three years, District 6 consistently had lower G_{mb} results from the mean. The laboratory in District 8 was the closest to the state mean in the five years analyzed. The contractors of the district were equally spread or either higher or lower than the district result. G_{mb} round robin results show that District 9 results were consistently higher than the mean.

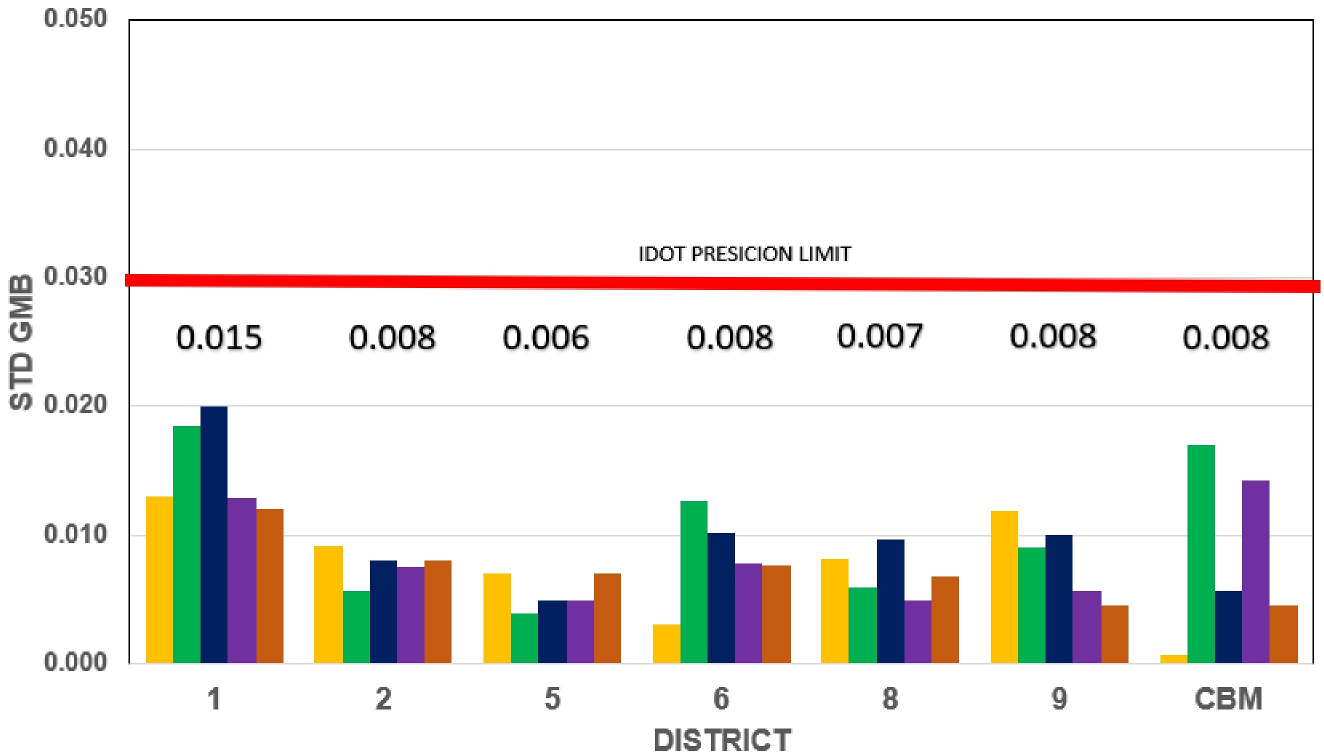


Figure 4.39. G_{mb} standard deviations per district. (Each color represents a different round robin year.)

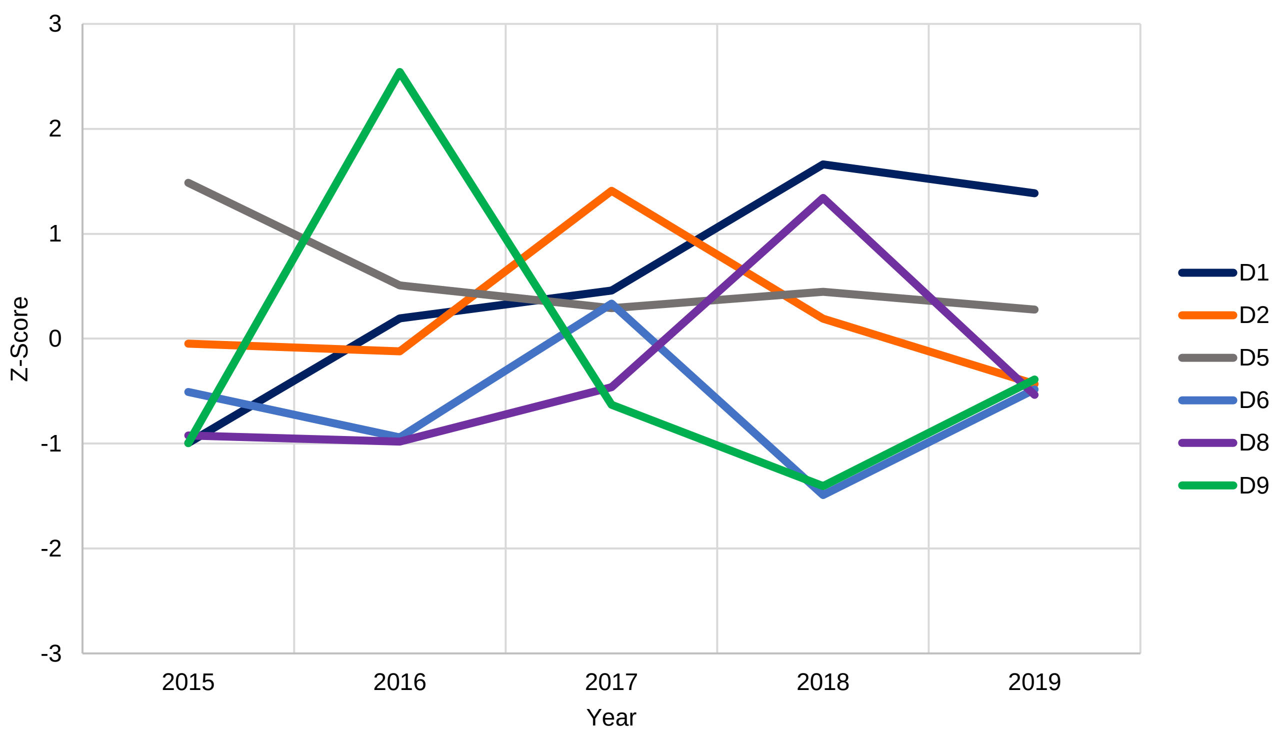


Figure 4.40. G_{mm} Z-scores for district laboratories.

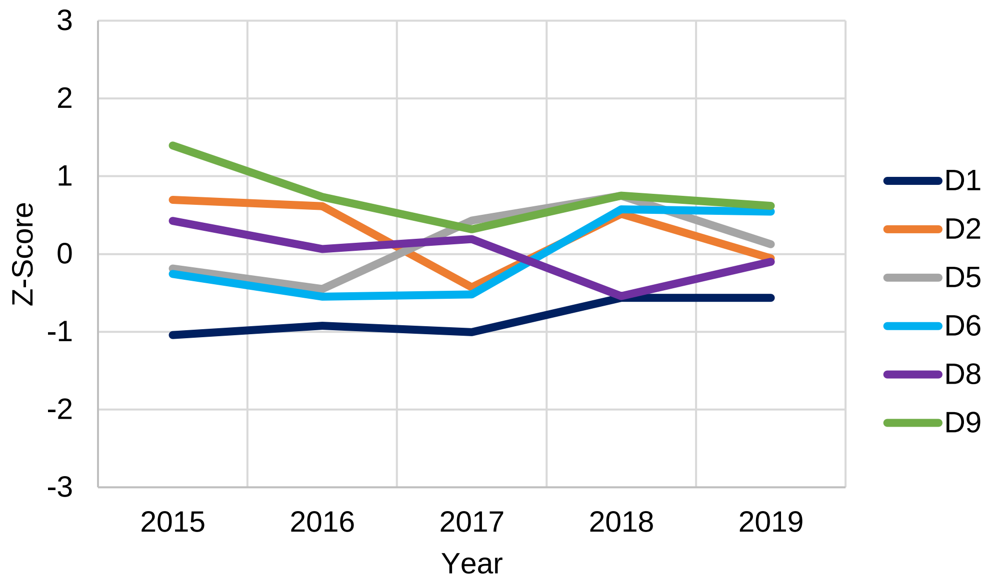
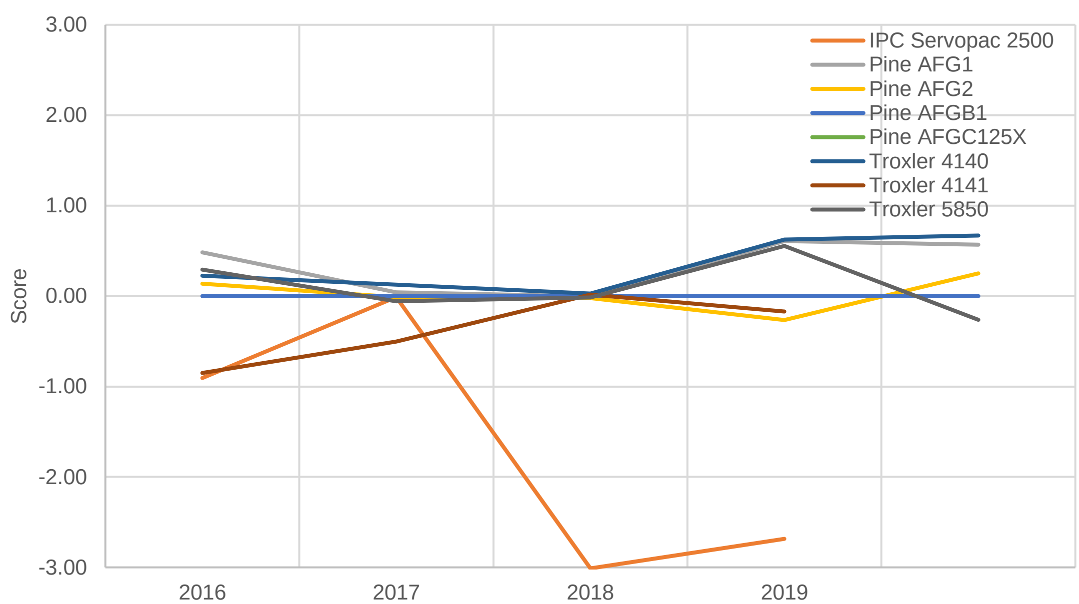


Figure 4.41. G_{mb} Z-scores for district laboratories.

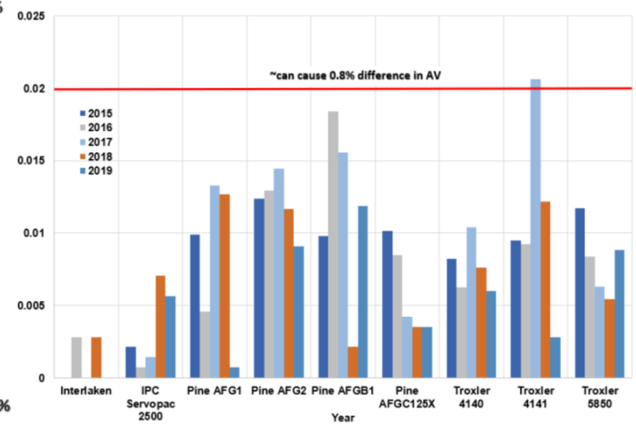
4.6.3 Gyratory Compactor Effect

G_{mb} test results were grouped separately by gyratory compactor to see if the type of gyratory compactor notably influences the results, Figure 4.42. For the gyratory compactor type, the Z-scores were within ±0.5 standard deviation, except for the IPC Servopac 2500 (used only by one round robin participant), which produced G_{mb} results lower than the average, Figure 4.42 (b). Hence, equipment calibration and operation and sample handling, rather than the brand, may be responsible for the bias. Figure 4.42 (c) shows the standard deviation for gyratory compactors per year.



(a)

(b)



(c)

Figure 4.42. Gyratory compactor evaluation results: (a) Z-scores, (b) average result, (c) standard deviations.

4.7 SUMMARY

Statistical analysis showed that contractor and district results were not significantly different for most cases evaluated. In cases where contractor and district results were not significantly different, but a pay disincentive was assigned, aggregate gradation and/or asphalt content may affect the produced mix because of production and/or aggregate source variability. Twenty to thirty percent of cases had a significant difference in test results, suggesting potential testing issues. The main observations from the data analysis are the following:

4.7.1 Pay Factor Observation Summary

- The QCP specification is used more frequently than PFP by the number of cases; however, the total mix tonnage produced is slightly lower than PFP.
- Contractors have more experience working with QCP projects as compared to PFP projects. Of the 22 contractors working with PFP cases, 11 had fewer than five cases during the last three years. It is suggested to educate contractors about the PWL calculations used in the PFP specification.
- PFP has reported consistently higher pay disincentives than QCP. This is due to PFP's more stringent PWL approach than the step-based system used by QCP. However, it is possible to make a pay incentive in PFP as opposed to QCP. Over the three years evaluated in this study, contractors have increased their pay in QCP. The pay is typically between 97.5 to 100. PFP pay performance has not increased over the last three years.
- Projects in Districts 5 and 6 received higher pay than the rest of the districts in both PFP and QCP specifications. In QCP, District 2 had the most pay disincentives. In PFP, Districts 1 and 9 received the most pay disincentives in PFP specifications.

- Contractor pay varies within the same district. Some contractors received full pay while others received pay disincentives.
- In the QCP specification, the performance of the contractors for individual pay factors (density, AV, and VMA) was similar. However, in the PFP specification, density was the most influential factor driving the pay disincentive. This might be because PFP is a more stringent program and considers variability, especially in density.
- Leveling binder was found to be the most penalized in QCP; while in PFP, it was the SC mix. Note, however, that no LB cases were studied for PFP.
- In QCP, density was the major factor contributing to the LB pay disincentives, while the three pay factors (AV, VMA, and density) had a similar influence in the total pay for BC and SC.
- In PFP, density was a major factor driving pay disincentives for BC and SC. As expected, AV had higher pay disincentives than VMA because AV was more variable.

4.7.2 Pay Parameter Summary

- Most of the AV and VMA cases seemed to follow a normal distribution. Cases with fewer sublot replicates failed the Shapiro-Wilk test. However, for density, the distribution fails to be normal. This was more pronounced for both smaller and larger numbers of replicates.
- 4.75 mm mixes resulted in better pay because VMA and density were easier to achieve than the 9.5 mm level binder mixes that were placed at a thickness less than the recommended three times NMAS. For SC and BC, NMAS did not play a significant distinction between the results.
- In general, the results failing VMA and density were usually lower, while AV could be lower or higher.
- Production issues with AV and VMA could have been reflected as disincentives associated with all three pay factors (AV, VMA, and density).
- At a statewide level, the results of contractors and districts were not significantly different for 91% of AV, 88% of VMA, and 82% of density results. Density was the parameter that showed the largest percentage of significant differences, followed by VMA and AV.
- Note that significant differences were seen in cases that obtained full pay and those that received a pay disincentive. For the significantly different cases that received full pay, contractor results had sublots outside of the QCP and PFP upper limits, while district results were within the limits. On the other hand, in cases that were significantly different and have a pay disincentive, the district results were outside the limits and the contractor results were not. Note that contractors keep track of the offsets between their results and those of the districts, which could influence the observed difference in the data. However, these offsets are per each contractor and district combination.
- When there are differences between district and the contractor results:
    - AV: District results could be higher or lower than contractor results.

    - VMA: District results are lower than contractor results.
    - Density: District results are lower than contractor results.
- District 6 results for AV and VMA are close to the contractor values or higher than the contractor. If the district overestimates the results consistently, mixes within the limits still obtain full pay. Sampling, splitting, and testing observed in District 6 were consistent and acceptable.
- District 5 test result variability in AV and VMA are lower than the rest of the districts, which contributed to better pay performance. District 5 VMA values have more significant differences between contractor and district results.
- As expected, AV standard deviation values are higher than those of VMA. In PFP, variability impacts pay calculation in the PWL specification.
- The cases that resulted in a pay disincentive either in AV or VMA were also likely to have issues with the aggregate gradation results.
- G_{mm} is a test in which the contractor and the district achieved more comparable results than in the G_{mb} test.
- PFP mix disputes typically are in favor of the contractor for AV and VMA, while PFP density disputes were close to a 58–42 ratio in favor of the contractor. However, the contractors select which sublot(s) to dispute.
- From IDOT round robin results, inconsistent results between districts and contractors could be related to equipment calibration, operation, and/or non-representative samples.

CHAPTER 5: 2018 JOBSITE VISITS

5.1 INTRODUCTION

During the 2018 construction season, 11 contracts were studied by the ICT research team to assess the possible causes of data variability and bias. Each contract study comprised of three parts: interviewing district and contractor personnel on testing procedures and data analysis; monitoring sampling, blending, and splitting during mix production and construction at district laboratories, plants, and the jobsites; and analyzing data and test results to identify possible causes of pay incentives/disincentives and differences between contractor and district test results.

This chapter describes the procedure used to select and evaluate each contract; the outcome of each evaluation is available in a second report (Al-Qadi et al., 2020). Issues observed during production, construction, and testing were identified and described.

5.2 SITE SELECTION

Location and contractor pay factors were the main criteria for selecting the visited contractors. A minimum of one project per district was identified, except for District 1. Five projects in District 1 were selected because the district has approximately 38% of the total contractors. For the pay factor, the QCP and PFP pay success rate (100% pay or more) was considered. Figure 5.1 shows the 2015–2017 pay factor distribution for the visited contractors. The goal was to choose contractors that consistently achieve full pay and who struggle to achieve full pay, representing different pay performance realities. For example, in QCP, four contractors achieved 100% pay for 75% or more of the total produced tonnage; five contractors achieved 100% pay for approximately 50% of their produced tonnage; two contractors achieved 100% pay for 25% of the total tonnage or less; and the contractors to be visited were chosen accordingly. A similar selection approach was used with PFP.

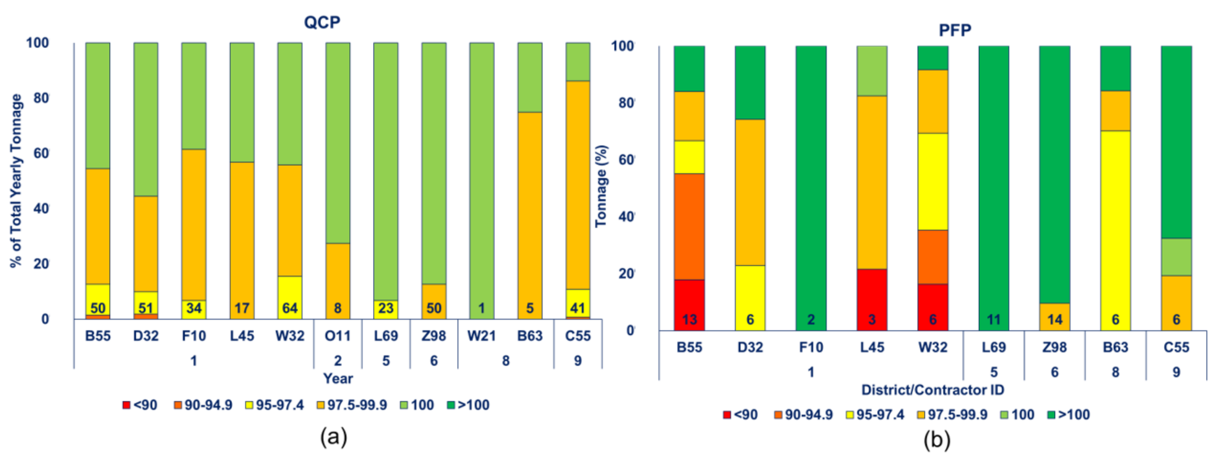


Figure 5.1. 2015–2017 pay factors of contractors visited during the 2018 site visits.

After choosing the contractors, a contract was selected to cover possible combinations of road type, pay specification, and mix type. A summary of the contract studied on each site visit is shown in Table

5.1. The project selection includes three roadway types: interstate, state routes, and avenues. Five contracts were QCP and six were PFP. For the mix type, six mixes were SC, two BC, two LB, and one SMA.

Table 5.1. Summary of Selected Project Sites

Site Visit No.	District	No. of Lanes	Road Type	Specification	Mix Type
1	1	4	Minor Arterial	PFP	SC N70 D REC
2	1	4	Other Principal Arterial	PFP	SMA N80 9.5 REC
3	1	2	Other Principal Arterial	QCP	SC N70 D REC
4	1	4	Other Principal Arterial	PFP	SC N70 E 9.5 REC
5	1	2	Minor Arterial	PFP	SC N70 E
6	2	4	Interstate	PFP	BC N90 19.0R
7	5	4	Other Principal Arterial	QCP	SC N90 D REC
8	6	4	Interstate	PFP	BC N90 19.0R
9	8	2	Other Principal Arterial	QCP	LB N70 REC
10	8	2	Other Principal Arterial	QCP	SC N70 E
11	9	2	Other Principal Arterial	QCP	LB N90 FG REC

5.3 SITE VISIT DESCRIPTION AND ANALYSIS PROCEDURE

As stated previously, each contract study comprised of three parts: interviews, site visits, and data analysis. The interviews and site visits were conducted during the 2018 construction season (June–October). The district and contractor interviews were conducted on the same day during the jobsite visit for all districts, except District 1. In District 1, the interviews were completed on a different day than the site visit. District interviews were performed at district HMA laboratories. The data analysis was conducted once the pay was determined; data were made available in winter 2018–2019.

5.3.1 Interviews

The interviews with contractor and district personnel identified any deviations from standard procedures that may have caused data variability or testing bias. The first part of the interview discussed the views and concerns related to QCP and PFP specifications. The mix design procedure was discussed to identify any differences for QCP or PFP projects. The interview focused on discussing mix production to understand the effect of mix switches, hot stops, or any other deviation. In addition, the contractor or district engineer discussed techniques observed or implemented that help achieve better mix production and consistent test results between QC and QA. Finally, suggestions on improving the current QA program were collected.

After the interview was concluded, district and contractor HMA laboratories were visited. The team observed cleaning procedures and conditions of equipment used for reheating, blending, and compaction. The equipment included ignition oven, gyratory compactor, oven, splitter, pycnometer, and water bath. There are multiple methods to perform aggregate extractions in Illinois, including: reflux, centrifuge, ignition oven, and automated extractor. During the site visits only the ignition oven and auto extractors were used. The procedure to obtain and handle samples from QCP and PFP projects used by the visited contractor was observed, including storage, reheating, and re-blending.

5.3.2 Jobsite Visit

The jobsite visits started at the contractor asphalt plant. The team observed the plant, stockpiles, and tower control conditions. From the plant, the following details were observed:

- Manufacturer
- Plant type and condition
- Years in operation
- AC pump type
- Dust control
- Silo capacity and storage times
- Operator's experience
- Loading of trucks

Afterwards, the stockpiles were observed for the base material type, entry/exit points, and barriers between stockpiles. Finally, the team visited the control tower to observe the panel and talk with the plant operator about procedures to control the mix, hot stops, and mix switches. Hot stops occur when HMA production is paused during the production day. Finally, the datalogger of the day the site was visited was requested to evaluate the final production of the mix.

After the plant production was visited, the team drove the haul truck route to the jobsite to record the time and observe the type of trucks used to haul the mix. Then, the pavement construction was observed, focusing on the following:

- Weather condition
- Dumping procedure
- Paver model
- MTD model
- Placing procedure
- Roller equipment

Finally, at least one mix sampling and density coring was observed in all visited jobsites. During the sampling, the following was observed:

- Mix sampling method
- Number of times the sample was split and re-blended
- Coring equipment
- Storage and sample security

After the visit was concluded, test results, sample weights, and additional data, listed under section 5.3.3: Data Analysis, were requested from contractors and districts via email for analysis.

5.3.3 Data Analysis

Data were requested from the contractor or district for each visit, including: pay summary report, mix design, mix and density sublot test reports, QC/QA package data, and datalogger.

The first part of the analysis was performed to identify the pay factors for AV, VMA, and density, as well as any deduction from the pay summary report because of the dust/AC ratio. The pay factors show the source of pay disincentives. In addition, the pay factors were compared to contractors' historical data on pay disincentives. The mix design was then reviewed for the following aspects:

- Number of stockpiles
- Type of aggregate
- Percent of mix used from each stockpile
- Design blend compared to specification limits
- Design VMA compared to specification minimum

The second part of the analysis consisted of evaluating the mix sublot results. The contractor and district AV and VMA results were paired per sublot, as shown in Figure 5.2 (a) and (b), to identify any significant differences between the two results. A potential mix production problem could be indicated if the contractor and district results were not significantly different but the AV, VMA, and density did not meet the limits. However, if a significant difference is noted, then this could be an indication of a potential testing issue.

The district and contractor G_{mm} and G_{mb} results were paired and plotted per sublot to compare differences. The dispute precision limits and round robin offsets observed in both laboratories during the site visits were also plotted. Because G_{mm} and G_{mb} depend on AC content, the comparison was done against the mix design G_{mb} and G_{mm} versus the AC content curve instead of a specific target value, as shown in Figure 5.2 (c) and (d). Production may vary from designs when different targets were needed to produce acceptable material, as reflected in the adjusted job mix formula (AJMF). Otherwise, when G_{mm} and G_{mb} results deviate from the mix design curve, this could be related to differences in material, lab mix design versus plant mix production (aggregate gradations, material variability), and/or testing issues (inconsistent sample weights, gyratory compaction, and/or temperature). Therefore, aggregate gradation, sample weight, gyratory compactor height, and datalogger data were evaluated.

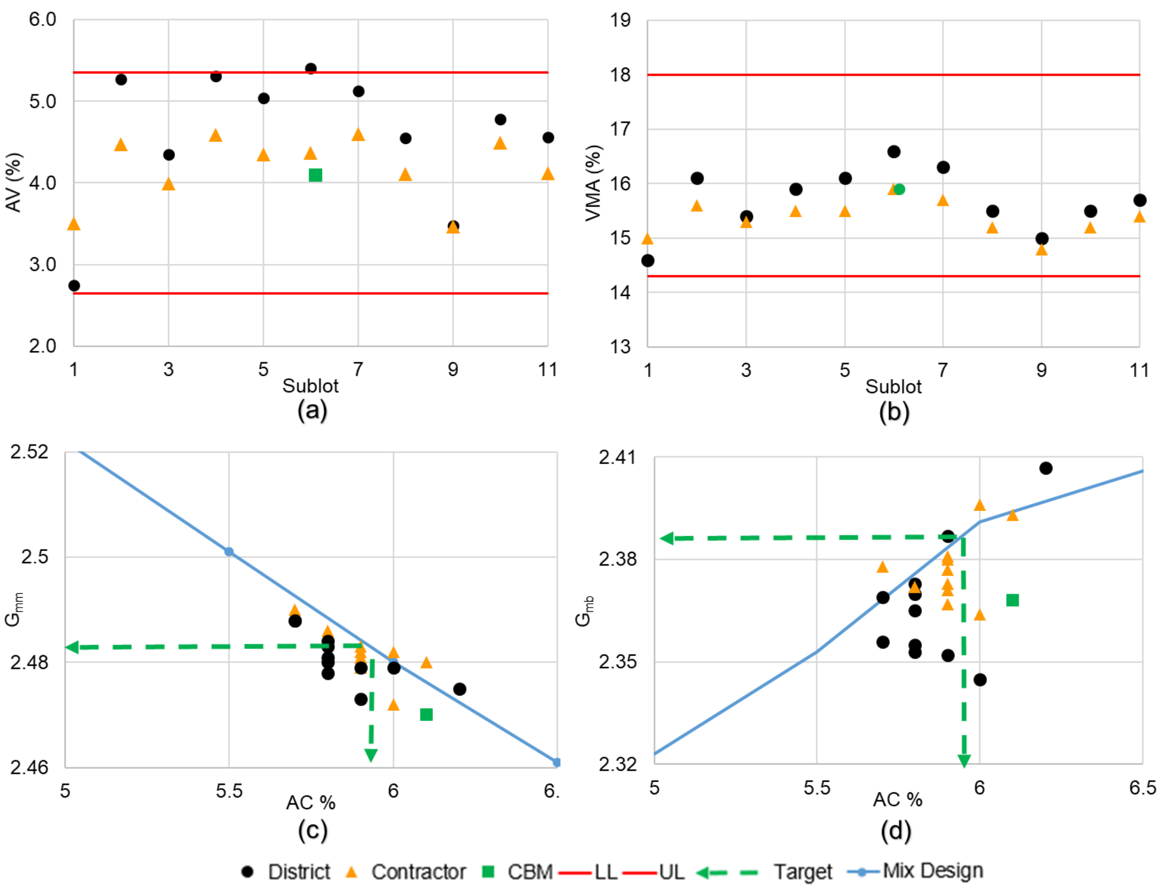


Figure 5.2. Example of a PFP jobsite visit mix sublot results for (a) AV, (b) VMA, (c) G_{mm}, and (d) G_{mb} (LL and UL refers to lower and upper limit, respectively).

The recovered aggregate gradation results and AC content were compared to those from the plant datalogger. The datalogger was analyzed to identify variations in production speed, dust control, and AC content. Also, the datalogger showed mix switches, hot stops, or other operational activities during mix production. Aggregate gradation results were compared against the mix design and IDOT aggregate gradation requirements. When G_{mb} values deviated from the design and AJMF, this may be a result of differences in laboratory production and plant production (mixing, aging, storage, etc.), potential segregation, management of baghouse fines, or elevated material variability.

The G_{mm} and G_{mb} sample weights and G_{mb} specimen heights were checked for consistency. The difference in split test weights was compared to IDOT requirements. IDOT requires that the difference between each split test specimen not exceed 10% for G_{mm} samples and 1% for G_{mb} replicates. The specimen height between the samples was also compared. If the materials are identical, then the same heights should be obtained if splitting and compaction are consistent. For example, if two test specimens have different heights but the same weight, then compaction temperature may be a cause. This assumes the aggregate gradations are identical. As NMAS increases with coarse-graded mixtures, some difference could be due to aggregate gradation differences.

5.4 MIX PRODUCTION ISSUES

5.4.1 Aggregate Consistency

Because aggregate is the primary component in HMA, changes in consistency may impact the contractor's ability to meet HMA requirements. Changes in aggregate production or high material variability are two common issues that affect the contractor's ability to meet a mix requirement. During the contractor interviews, it was indicated that for certain aggregate suppliers, the stockpile properties may change from one shipment to another, resulting in high variability. One of these scenarios was observed during the jobsite visit in District 9.

The District 9 jobsite visit was to a two-lane pavement resurfacing project. A leveling binder N90, 9.5 FG, was placed over a milled surface. The mix was evaluated using the QCP specification, resulting in pay factors of 101.5% for AV, 95% for VMA, and 97.5% for density. The AV and VMA test results are shown in Figure 5.3 (a) and (b). The results from the contractor and the district show that the VMA dropped from the design value of 15.7 to 14.6. The AV fluctuated between 3.5% to 4.4%. Figure 5.3 (c) and (d) shows G_{mm} and G_{mb} versus AC content. The results of the G_{mb} deviated from the design.

The researchers did not receive the datalogger to evaluate the mix production. However, the contractor indicated that the drop in VMA was a result of aggregate supply. The quarry that supplies the contractor shifted into a new ledge, and the G_{sb} values needed to be updated. As a result, all mix designs were affected. When the contractor noticed the changes, it was too late to adjust the mix for the project. However, the mix designs were adjusted for the remainder of the year. This could be avoided with regular G_{sb} checks and corresponding volumetric designs.

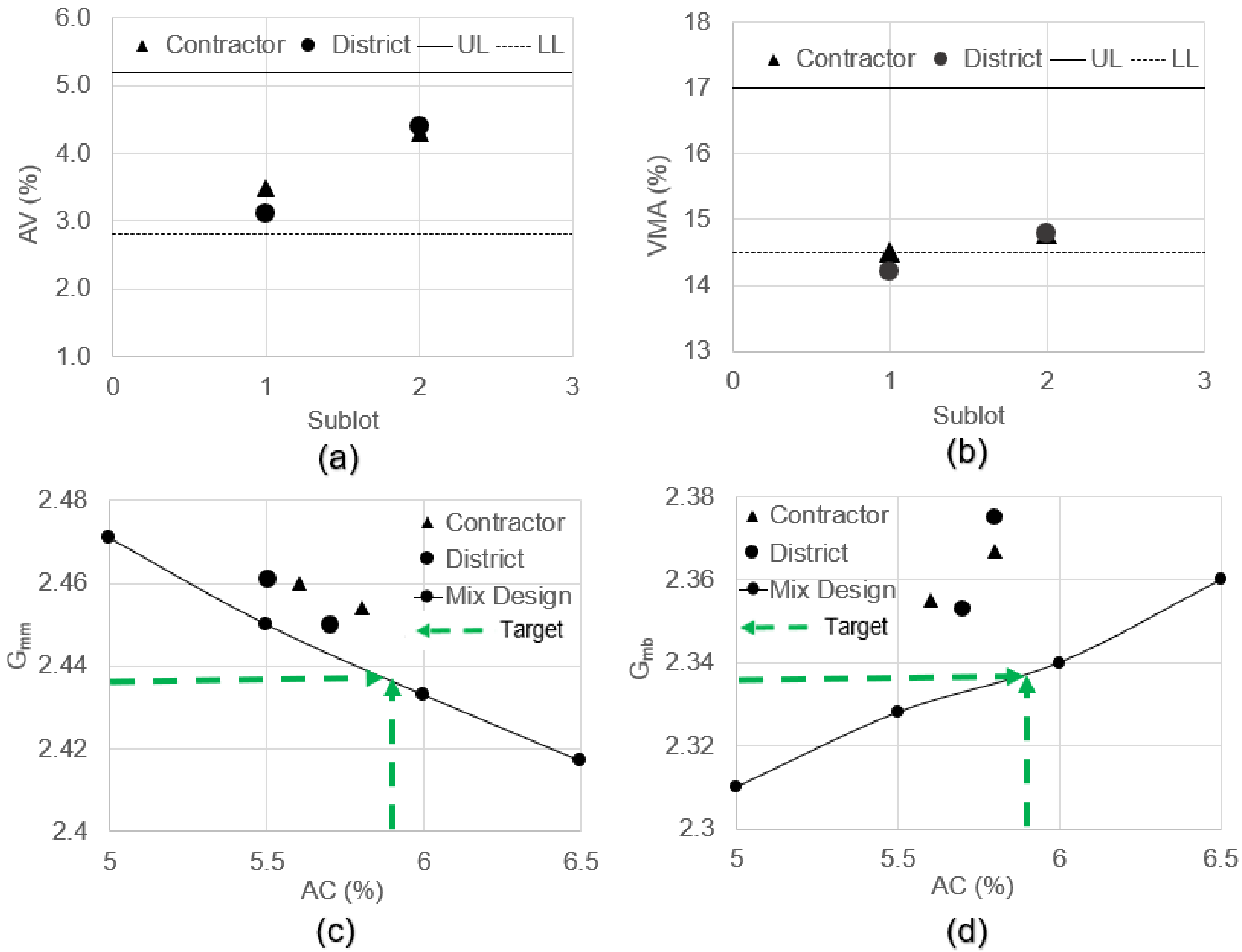


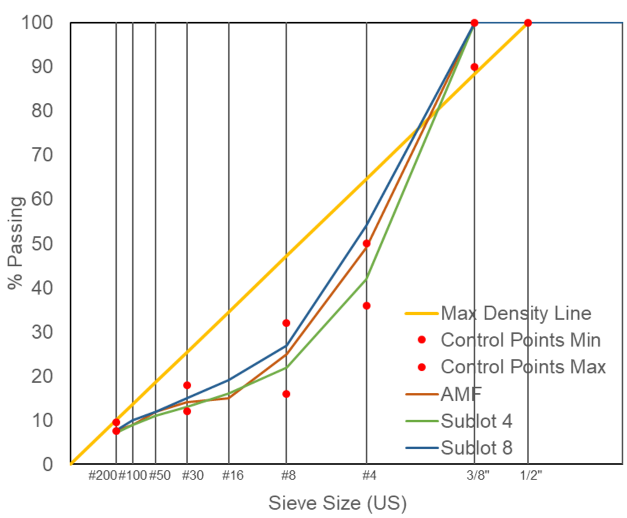
Figure 5.3. District 9 QCP jobsite visit mix sublot results for (a) AV, (b) VMA, (c) G_{mm}, and (d) G_{mb}.

5.4.2 Stockpile Space and Barriers

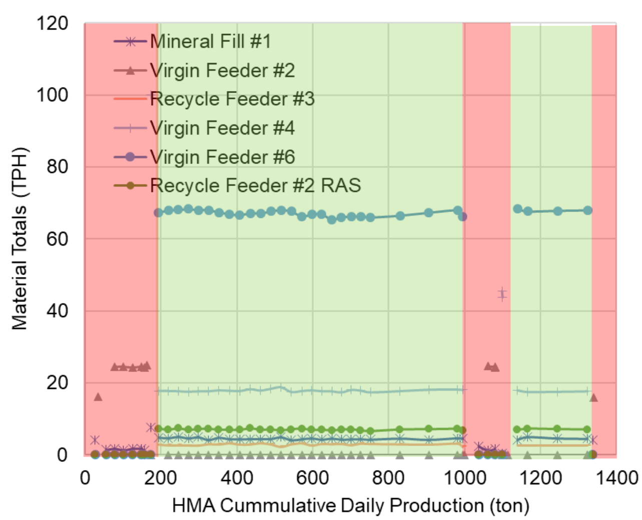
Space is limited for aggregate stockpiles at certain plants in District 1. Figure 5.4 illustrates this concept and shows a plant not located in Illinois, while not disclosing the contractor's identity. If aggregate stockpiles are placed next to each other with no barrier between them, blending of the aggregates can occur at the interface of the stockpiles, which may impact mix quality. When there is one side for aggregate entry/exit for the stockpiles, newly arrived material is loaded to feeders. Therefore, any change in the aggregate properties gets immediately reflected in the mix production because of limited time to check aggregate gradation or G_{sb} values. Hence, loading aggregate to the feeder from multiple sides of the stockpile and full stockpile separation are important to maintain mix quality if inconsistency exists in the aggregate supply. Additionally, height of the stockpiles may cause segregation.

Figure 5.4. Stockpile handling in a plant illustrating space constraint.

Issues in aggregate stockpile are usually reflected in the mix blend gradation. At site visit no. 3, in District 1, the amount of material passing the #4 and #16 sieves was up to 6% higher than the target in the first five sublots. In the last two sublots, the material passing the #4 sieve was lower than the target by 7%. Figure 5.5 (a) shows an example of the two aggregate gradations from the adjusted mix formula (AMF) for sublots 4 and 8. Sublot 8 illustrates the cases with aggregate gradation higher than the target, and sublot 4 indicates the opposite. The possibility of mix control issues was dismissed because the datalogger for the two days of production did not reflect any significant difference in production. Figure 5.5 (b) shows the datalogger output. The portion of the production destined for the visited IDOT project is highlighted in green. Mix switches were limited, and the contractor kept a consistent production. Finally, the issues with aggregate variability eventually resulted in G_{mb} results deviating from the design, which were reflected in the AV and VMA pay factors.



(a)



(b)

Figure 5.5. Gradation results for (a) sublots 4 and 8 and (b) HMA production from datalogger.

5.4.3 Stockpile Contribution to Total Design

Mix designs that rely on few stockpiles are more susceptible to aggregate gradation variability. In the mix design described in section 5.4.1: Aggregate Consistency, 71% of the mix blend comes from a single stockpile identified as crushed dolomite (CM16). As a result, the mix design was susceptible to variability of this individual stockpile. The impact of variability may be reduced by dividing single aggregates that contribute more than 30% between multiple cold feeds instead of a single cold feed.

5.4.4 Mix Switches

Contractors commonly produce multiple mix designs in the same day. As a result, the plant needs to switch properly between different designs. When mix switches are made, a plant needs to respond quickly or a small amount of mix produced during transitions may be wasted.

Figure 5.6 shows AC content during the production day of site visit no. 4, as reported by the plant datalogger. The plant was not able to keep the AC content stable; it fluctuated between 5.7% to 7.2% for three different mixes, with a range of target value being 0.8%. The actual range of AC percent for the individual mix design collectively was 0.0–0.6%, and the average within a mix design was a range of 0.3%. The issues were with bias between target and actual, as well as transition control. In this case, the main cause of pay disincentives was the mix production inconsistency. Hence, better mix control and plant operation are needed.

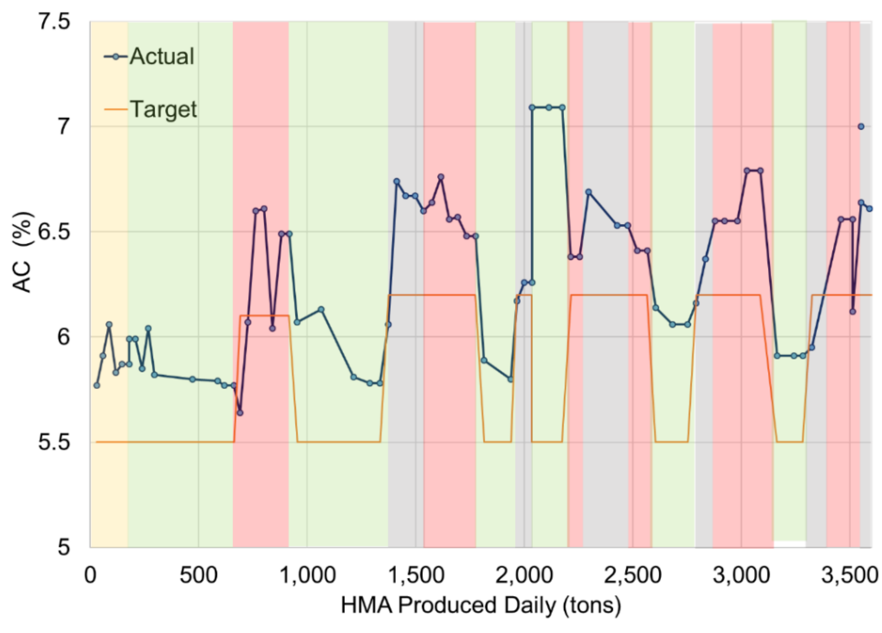


Figure 5.6. Total AC content during the day of the jobsite visit.

5.4.5 Dust Control

During the downstate site visits (Districts 6, 8, 9), it was common to encounter HMA plants without positive dust control, which resulted in pay disincentives. Dust affects G_{mb} test results, which is reflected in AV and VMA results. Although AV, VMA, and density received 100% in QCP, a pay disincentive was assigned on dust/AC. Note that if a PWL specification is used, then a pay disincentive on AV and VMA would be assigned because the tail of the distribution exceeds the limits.

The datalogger of the jobsite visit day was evaluated to understand the issues with mix production. An example of dust removed from the mix and AC content are shown in Figure 5.7 (b), indicating variations in dust removal while AC content remained the same. The plant had issues keeping consistent dust control. The datalogger of the next day of production was requested. It reflected the same variation, which may suggest an operational issue. As a result, the main cause of pay disincentives in this contract was attributed to dust control. The plant was not able to keep a consistent dust removal rate and, at the same time, did not have positive dust control. The aggregate gradation was slightly off from the target, which impacted AV and VMA.

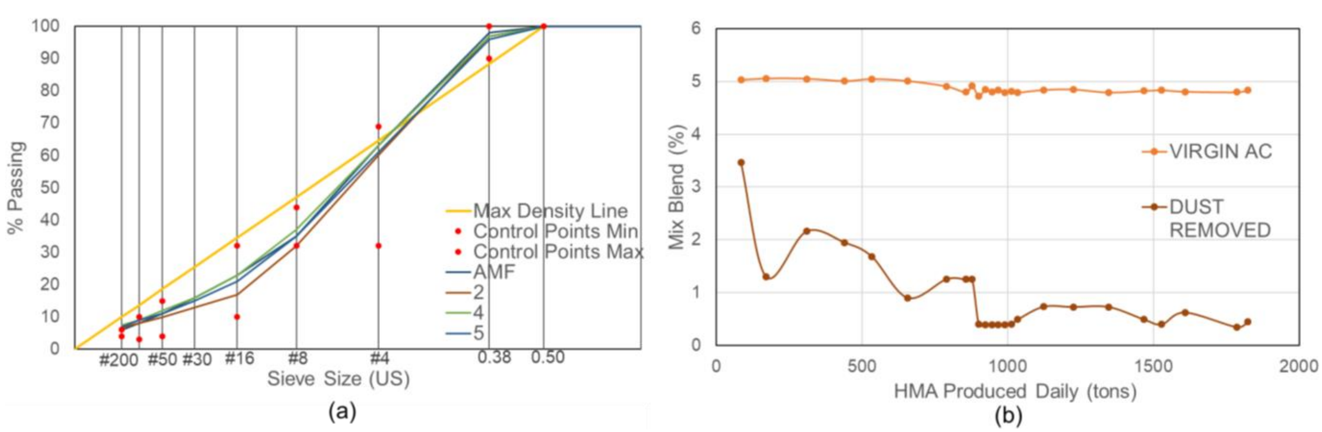


Figure 5.7. Aggregate gradation results and datalogger for virgin AC percentage and dust removal rate.

5.5 TESTING ISSUES

5.5.1 Absorption

Absorption was an observed factor that led to consistent one-directional bias in the G_{mm} and possibly G_{mb} results when comparing district and contractor results. This issue was observed in the District 2 site visit. The visit was to an 8.67-mi interstate pavement resurfacing project. A 2.25-in polymerized N90 IL-19.0 HMA BC was placed over a continuously reinforced concrete pavement. The PFP specification was used to evaluate 29,000 tons of BC. The minimum design VMA was 13.5% and the production limits were from -0.7% to +3.0% from the minimum design requirement; AV at 4% ± 1.35%, and density at 92.2% to 97.5%. The mix pay was 101.2% for AV, 100.3% for VMA, and 97.7% for density, with a composite pay factor of 99.7%.

The results show an offset between contractor and district AV and VMA results, Figure 5.8 (a) and (b), resulting from differences in both G_{mm} and G_{mb} test results. On average, the paired G_{mm} results between the contractor and district were off by 0.009 between the 31 sublots tested. The difference exceeded the precision limits of 0.008. When paired, the average G_{mb} results were off by 0.023, which also exceeded the precision limits of 0.017. Reheating drove the differences in G_{mm}. In the case of G_{mb}, additional issues, such as the gyratory equipment, can also affect the differences between district and contractor results. However, reheating cannot be discarded to affect G_{mb} because the bias in both tests was in the same direction. This could be related to a systematic difference in reheating procedure, because AV and VMA data is biased. District samples absorbed on average 0.7% more binder than contractor samples, which resulted in higher specific gravities than contractor results. Hence, a uniform reheating procedure must be adopted.

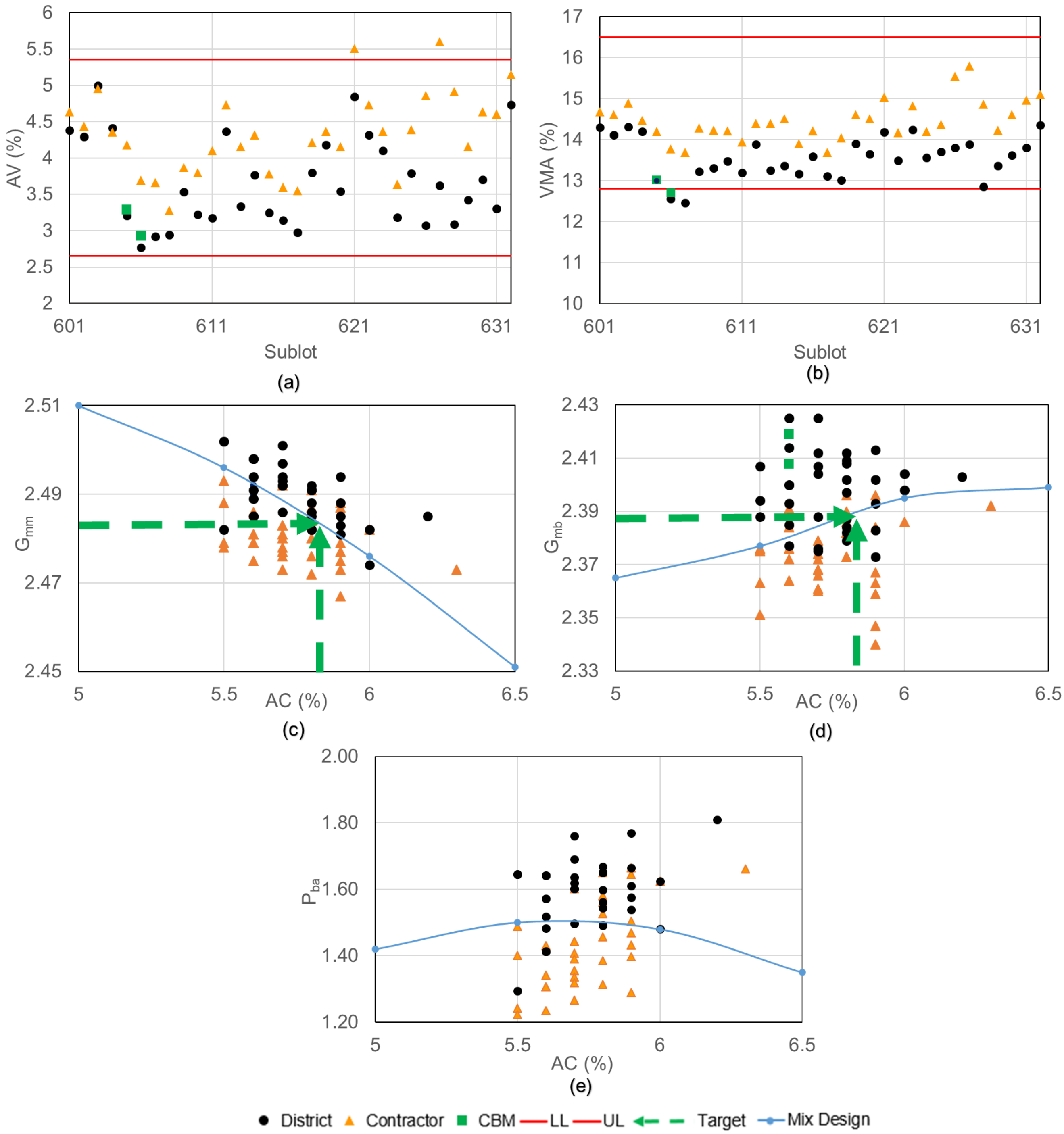


Figure 5.8. Mix sublot results for (a) AV, (b) VMA, (c) G_{mm}, (d) G_{mb}, and (e) P_{ba} (Percentage of absorbed binder)

5.5.2 Gyratory Compactor Model Bias

A common concern reported by the contractors is the inherent test result variability among different gyratory compactors. A possible bias was observed in one of the District 1 site visits. There were consistent differences in the results of AV and VMA between the district and contractor, which were attributed to the consistent differences only in the gyratory G_{mb} test results (Figure 5.9).

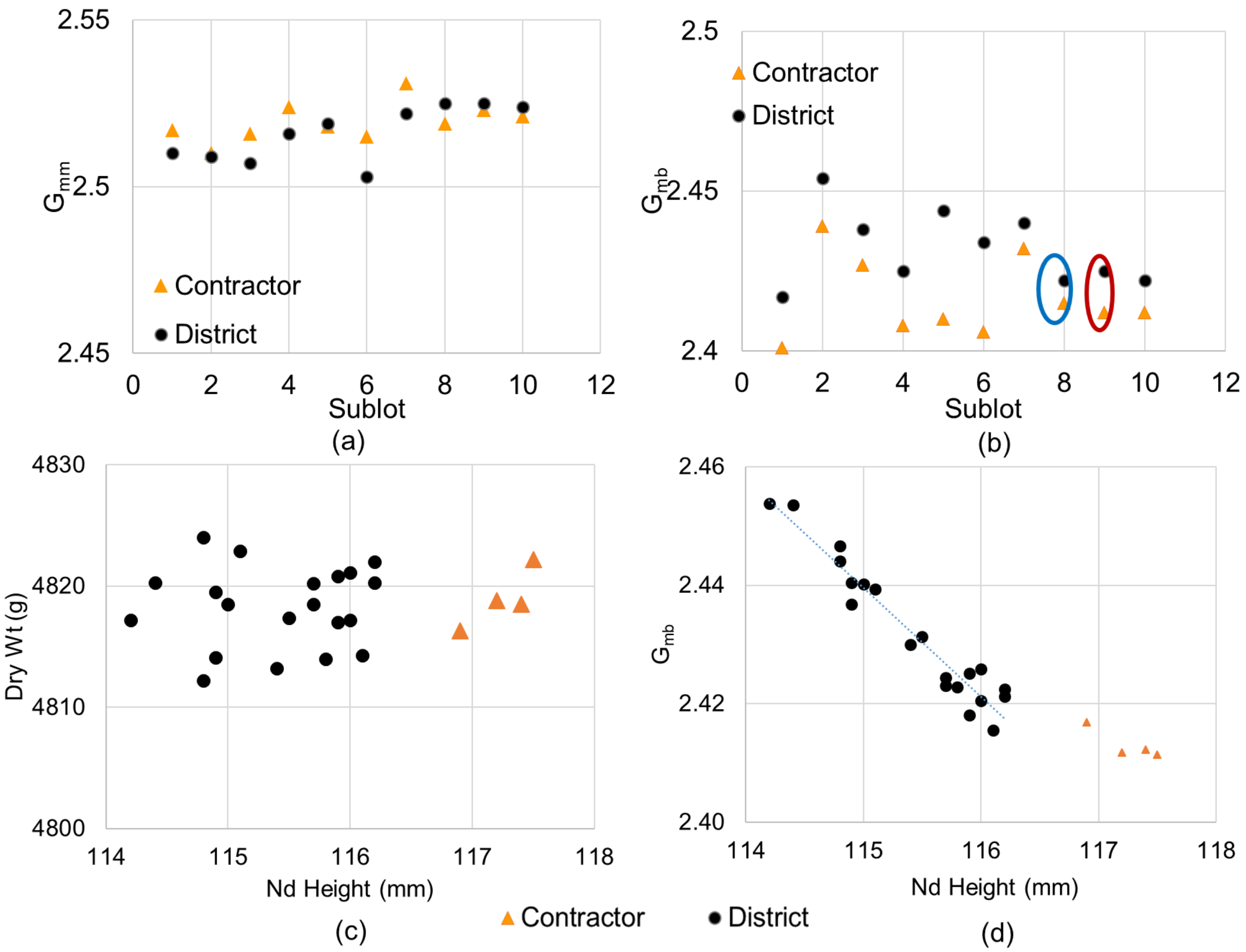


Figure 5.9. Mix sublot results for (a) G_{mm}, (b) G_{mb}, (c) dry weight, and (d) G_{mb}.

5.5.3 Inconsistencies in Test Weights

Inconsistencies in the test weight and/or compaction temperature were observed, which could affect the height of the test specimens. If the gyratory compactors are operating properly, temperature may cause two samples with the same weight to be compacted to different heights. In a visit, a difference of 80 g between specimens with the same height was observed. This difference resulted in a spread of 0.022 in the G_{mb} (Figure 5.10); this could be related to temperature. A constant weight should be used by both the district and the contractor for gyratory specimens.

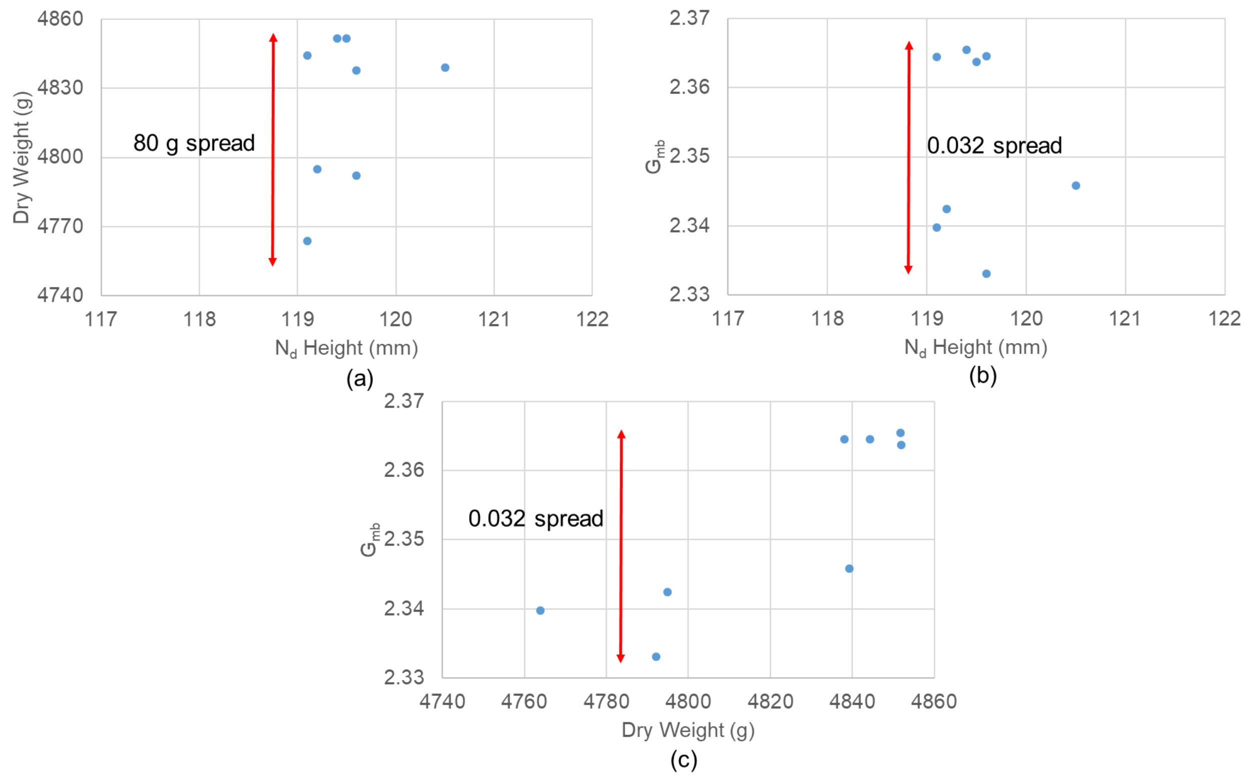


Figure 5.10. Inconsistent test weights—example of (a) dry G_{mb} weight vs N_d height, (b) G_{mb} vs N_d height, and (c) G_{mb} vs dry G_{mb} weight

5.6 MANAGEMENT ISSUES

During the site visits, the research team observed three issues related to the management of the construction from the district personnel that may compromise the work of the contractor: absence of an experienced engineer supervisor in the field, insufficient time provided to contractors for sampling, and contractors' and districts' inability to resolve in situ difficulties in a fast manner (e.g., broken material transfer device MTD).

The first and second issue occurred during a site visit where the resident engineer (RE) was supervising more than one job at a time. When the research team arrived, the RE was not at the visited site and an assistant was supervising the job. Typically, the RE informs the production tonnage where the sample will be once the truck that contains it has arrived at the site. This practice prevents any special treatment to the material that will be sampled. It also allows enough time for the contractor's quality control personnel to prepare the equipment for sampling and splitting. During the site visit, the assistant in charge was not aware of the practice and notified the sampling tonnage when the truck containing the sample was already feeding the paver. As a result, there was not enough time to prepare, which stopped the paving operation.

The third issue occurred during a site visit where a N80 9.5 NMAS SMA surface layer was placed. The MTD broke down during the site visit. The district and contractor personnel were not sure if the specifications allowed the contractor to place the 9.5 SMA mix without using an MTD. The confusion caused an hour and a half delay with approximately eight trucks waiting on the lane with mix. The conflict was resolved when both parties agreed that the specifications allowed the mix to be placed without the MTD.

5.7 SUMMARY

Table 5.2 shows a summary of the issues observed at project sites. A detailed explanation per project site is reported in a second report (Al-Qadi et al., 2020). In summary, most pay disincentives observed were a direct result of issues with mix production. However, testing issues also caused contractor-district disputes.

Table 5.2. Summary of Observed Issues at Project Sites

Site Visit No.	District	Program	AV	VMA	Density	CPF	Sampling Technique	Reblending	Testing	Mix	Density
1	1	PFP	98	90	101.7	97.1	Shoveling at Mat	Yes	5.5.2	5.4.4	
2	1	PFP	94.5	101	104.4	100.4	Shoveling at Mat	No	5.5.4	5.4.3	
3	1	PFP	98	105	101.1	101.3	Shoveling at Mat	Yes		5.4.1	
4	1	PFP	84.5	103	95.5	94.5	Shoveling at Mat	Yes		5.4.4	High Variabiltiy [2]
5	1	QCP	100	100	100	100.0	Shoveling at Mat	Yes			
6	2	PFP	101.2	100.5	97.9	99.7	Bottom Compartment MTD	Yes	5.5.1	Binder Content[1]	High Variabiltiy [2]
7	5	QCP	100	100	100	100.0	Plates at Mat	Yes			
8	6	PFP	104.8	104.8	103.5	104.3	Quarter Master at MTD	Yes	5.5.1	5.4.1	
9	8	QCP	95	96.7	100	97.5	Auger (Levelign Binder)	Yes		5.4.5	
10	8	QCP	100	100	100	100.0	Plates at Mat	Yes			
11	9	QCP	101.5	95	97.5	98.0	Plates at Mat	Yes		5.4.1	Roller Issues [3]

[1] Binder Content: Binder content not on the target.
[2] High Variability: Density results varied all over the allowed range.
[3] Roller Issues: Contractor did not provide the required roller.
[4] The numbers under Testing, Mix, and Density indicate the sections of the chapters that describe the issues observed.

CHAPTER 6: CONCLUSIONS AND OBSERVATIONS

The purpose of this study is to identify causes of variability as well as to ensure that specifications are fair and achievable and risks are well balanced between contractors and owners. To achieve this, a multiprobe assessment of a large QCP and PFP data pool was performed. The main objective was to understand the distribution and variability of test results. The outcome of the study was intended to address the difference between contractor and district results to identify potential causes and to identify issues affecting mix production, construction, and testing quality. Finally, several observations are offered to improve mix consistency and quality.

The assessment consisted of two major parts for both QCP and PFP projects: data analysis and site visits. The first part involved an analysis of test results from QCP and PFP construction projects between 2015 to 2017. The test results evaluated included AV, VMA, core density, G_{mb}, G_{mm}, mix aggregate gradation, and binder content. Descriptive statistics and hypothesis tests were used to compare test results from districts and contractors, including mean, distribution, and variance using Mann-Whitney (mean comparison), Shapiro-Wilk (distribution), and Levene's (variance) tests. In addition, average and standard deviation results per mix contract case were evaluated.

The second part of the analysis involved 11 project site visits to identify possible root causes of data variability and bias. The site visits allowed the research team to monitor the construction process in the field and to evaluate related test results. Hence, issues could be identified during the site visits. As part of the site visits, district and contractor personnel were interviewed, and industry concerns related to testing procedures and production were reported. In general, plants, labs, and jobsites were visited to observe sampling, blending, splitting, and testing during mix production and construction. Finally, test results were analyzed to identify possible root causes of pay disincentives and differences between contractor and district test results, if any. Details on the site visits and corresponding data analysis are presented in Al-Qadi et al. (2020).

6.1 FINDINGS

The findings of the study are listed below:

1. Proper quality control protocols and achieving uniformity have a tangible monetary impact on final pay factors for contractors. If a contractor producing a density variance (square of standard deviation) of 2.79 could reduce it to 1, the contractor would have been paid approximately $38,000 (2019 USD) more than what they were paid on an average project.
2. Approximately, 82%, 88%, and 91% of core density, VMA, and AV, respectively, were statistically similar when comparing contractor and district test results. Mix production and construction issues, in addition to sampling and blending in accordance with IDOT *MoTP* (2018c), were considered the main cause of contractors' pay loss. Better control of these parameters during production is an opportunity for contractors to correct these issues and increase their pay and the quality of asphalt provided. Hence, the QMP is appropriate to identify mix production and/or construction issues.

3. When statistically different test results are encountered, the mean, distribution, and variance of a sample by either the contractor or district may not be representative of the population. In such cases, there is potential for uncertainties in payment: for the district to have paid in full (or with a pay incentive) for low-quality material or for the contractor to have been paid with a pay disincentive for high-quality material (known as α risk). Monetary losses or risks associated with these uncertainties were not quantified in this report. However, it is possible to demonstrate that there is no bias in pay when there is potential for uncertainties in payment (see Table 6.1).

Table 6.1. Percentage of Cases with Significantly Different Test Results in Which Pay Was Equal or Higher Than 100% for Both Specifications

Percentage of Cases		QCP			PFP		
Average Comparison (Mann Whitney)	Pay Factor	AV	VMA	Density	AV	VMA	Density
Not Significantly Different	PF < 100	26.7	25.5	41.4	41.7	24.2	50.6
	PF ≥ 100	66.9	66.6	39.2	39.6	48.4	34.5
Significantly Different	PF < 100	3.4	3.1	5.5	9.4	9.5	8.0
	PF ≥ 100	3.0	4.8	13.8	9.4	17.9	6.9
Total		100	100	100	100	100	100

4. When statistical differences in the parties' test results were identified, testing variability must be questioned. The main contributor to differences in AV and VMA results were the G_{mb} test results. The difference was usually caused by sampling, splitting, specimen preparation, reheating temperature, gyratory compaction effort, and/or test procedure adherence. A 0.015 difference in G_{mb} between the contractor and district is considered a significant variation; the AASHTO precision limit is 0.017 and QCP precision limit is 0.030.

5. Core density variability was the main cause of reduction in pay, followed by AV and VMA, respectively. Air voids fail (PF < 100) because of both upper and lower limits, while core density and VMA fail mainly because of the lower limit.

6. Mix compaction control and condition of the underlying pavement were found to be important factors causing disincentives. Data show that mixes typically constructed over a milled surface had higher density variability. It is expected that the increased minimum lift thickness requirement would reduce the variability and disincentive pay adjustments.

7. The high AV variability was due to mix production issues (e.g., AC content and dust control), and testing (e.g., variability of G_{mb} and G_{mm} tests). Suggestions to reduce variability are offered under recommendations.

8. Coarse aggregate gradation variability or segregation during sampling and paving affected AV and VMA and, hence, mix pay factors. Relatively high standard deviations were observed in aggregate gradation regardless of the mix NMAS.

9. Testing turn-around time (between sample delivery and receiving test results) should be limited. In 2018, District 1 was able to achieve a two-day testing turn-around time.

10. In general, contractors are more experienced with the QCP specification compared to the PFP specification. The QCP projects obtaining full pay increased between 2015–2017, while PFP decreased. This could be attributed to the lack of experience with PFP contracts.
11. It was also noted that contractors design and produce HMA too close to minimum targets. This eventually translates to pay loss.

In addition to the findings of the study, an acknowledgement of IDOT's efforts to increase incentives for contractors and make their QMP more achievable is relevant. These efforts include the following:

- IDOT changed the CPF equation for PFP, resulting in an increase in pay of 2%. If this change would have been applied for the analyzed period, then 76% of produced HMA tons would have been paid with a pay incentive (in comparison to the actual 54%). This change is expected to increase pay for contractors working on future projects under the PFP specification. Note that values in Table 6.1 would be higher if this change would have been considered.
- IDOT adjusted lift thickness for all lifts (including levelling lifts), which was increased recently to at least three times the NMAS. This should help address the concern with density pay disincentives by avoiding low compactability scenarios and is expected to reduce those pay disincentives in the future. However, variability may also be affected by base structural capacity.

In conclusion:

- Pay disincentives in QCP and PFP specifications are caused by several factors that require collaborative efforts by districts and contractors to be addressed.
- Per the findings (2, 3, and 4), QCP and PFP specifications appear to be fair and are appropriate (when compared to the reference documents) for the kinds of projects for which each is used.
- Fifty-four percent of the HMA tons, controlled by the PFP specification, were paid with an incentive (PF > 100). The pay per HMA ton has increased with time for the QCP specification. Hence, the QMP's requirements are achievable.

Considering the statistical analysis results and field observations, several observations are offered.

6.2 OBSERVATIONS

It is suggested that IDOT and industry consider the identified risks and make changes to improve mix consistency and quality. The following observations and suggestions are related to mix production and construction, sources of pay factor pay incentives/disincentives, sampling, and testing, among others.

6.2.1 Mix Production

- Mix switches during production: Limit the number of mix switches during production. The more mix switches per day, the greater the material variability and the more challenging to control AC content.
- Dust control: The specification should clearly identify that a baghouse return system meters the fines to a specific percentage value.
- Stockpile handling: Utilize proper stockpile construction and recommended stockpile loadout procedures from IDOT quality management training courses (Aggregate Technician and HMA Level II).
- Cold feed control: A single mix aggregate that contributes 30% or more to the design aggregate blend should be divided into more than one cold feed.
- Stockpile barriers: Plants should use barriers between aggregate stockpiles in accordance with IDOT Standard Specifications Section 1102.01(2).

6.2.2 Sampling Observations

- Sampling location: To limit segregation potential, sampling location should be identified in accordance with the following (e.g., behind a paver for most mixes and at an auger for 4.75 NMAS):

6.2.2.1 Uniformity in Sampling, Blending, Storage, and Preparation

- To fulfill requirements by all parties, specifications must be met. HMA Level I practice for sampling, blending, and splitting will help as well as using consistent reheating practices to improve uniformity.
- Reheating protocol: To improve consistency, it is suggested that district and contractor personnel follow the reheating protocol in the IDOT *MoTP* (2018c) for QCP and PFP.

6.2.2.2 G_{mb} and G_{mm} Testing Observations

- G_{sb}: It is recommended that the VMA calculation be completed with the yearly updated G_{sb} of the aggregates used for production in accordance with the IDOT *MoTP* Appendix B.9. Tracking G_{sb} is recommended as a QC activity to allow the monitoring of incoming aggregate and test protocols of AC content, RAP, and production issues.
- Gyratory bias monitoring: It is recommended to extend the internal district round robins to all contractors and districts every year. It is suggested to conduct them early in the construction season to allow contractors to detect differences in their test results due to gyratory compactor results and adjust accordingly, given that procedure, maintenance, and calibration are well-documented. Both parties may agree to consider AASHTO re:source inspection or accreditation as a requirement.
- Test weights: *MoTP* should be updated to require G_{mb} test sample weight consistency is within 10 grams for dense graded and 15 grams for SMA.

6.2.3 Other Observations

- Aggregate gradation variability from the supplier may significantly impact pay factors. Therefore, contractors should understand which aggregate sources exhibit a high degree of variability and communicate concerns to the supplier to improve consistency. In addition, IDOT should review AGCS to determine any improvements from the aggregate supplier.
- Mix design VMA target: Contractors should be aware that designing close to the minimum design VMA will increase the chances of receiving disincentives. The plant-produced VMA was observed to be lower than the design value. A production of 0.5% VMA above the minimum design value is suggested.
- Importance of production control: Production issues have the potential to cause significant disincentives in the CPF.
- PFP training: To help contractors optimize their pay factors, their knowledge in the PFP specification must be enhanced through workforce training. This includes training courses and developing documentations to identify production issues they should address based on the procedures used to evaluate the site visits.
- Data storage and monitoring: IDOT collects a significant amount of mix production and construction data. Currently, only final sublot average volumetric results and aggregate gradation are stored at the central database. The rest of the data, e.g., individual replicate results and raw test weights, are stored separately by districts. Improvement of the central database to include all information available is recommended through the new IDOT Construction and Materials Management system.
- Department staff: Resident engineers/technicians should comply with the IDOT Quality Management Training Program requirements, as stipulated by FHWA requirements. Acceptance testing should be completed by the same experienced and approved technician for each project. If changes are made to technicians and/or equipment, the contractor should be notified as soon as possible.
- Further investigation of the causes of the poor quality (low payment) observed in specific districts should be performed. Statistical analysis may be considered.
- IDOT’s newly recruited personnel should always be under the supervision of experienced personnel to avoid sampling issues with location and time.
- Based on field visits, it would be beneficial for all testing labs to closely adhere to the “Best Practices for PFP and QCP Implementation” document in the IDOT’s *MoTP* (2018c).

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APPENDIX A: 2018 SURVEY RESULTS

A.1 CONTRACTOR SURVEY

During spring 2018, a survey was sent to IDOT contractors to gather their opinions about QCP and PFP. Twenty-four responses were received. The responders typically conducted business with more than one of the IDOT districts. Figure A.1 shows the districts with which these contractors did business.

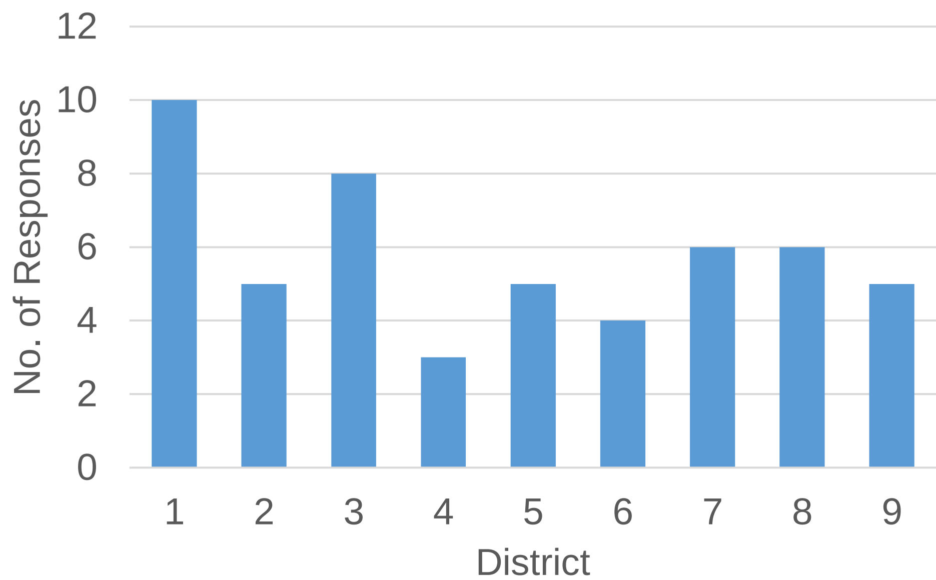


Figure A.1. Districts that had business with the contractors that were surveyed.

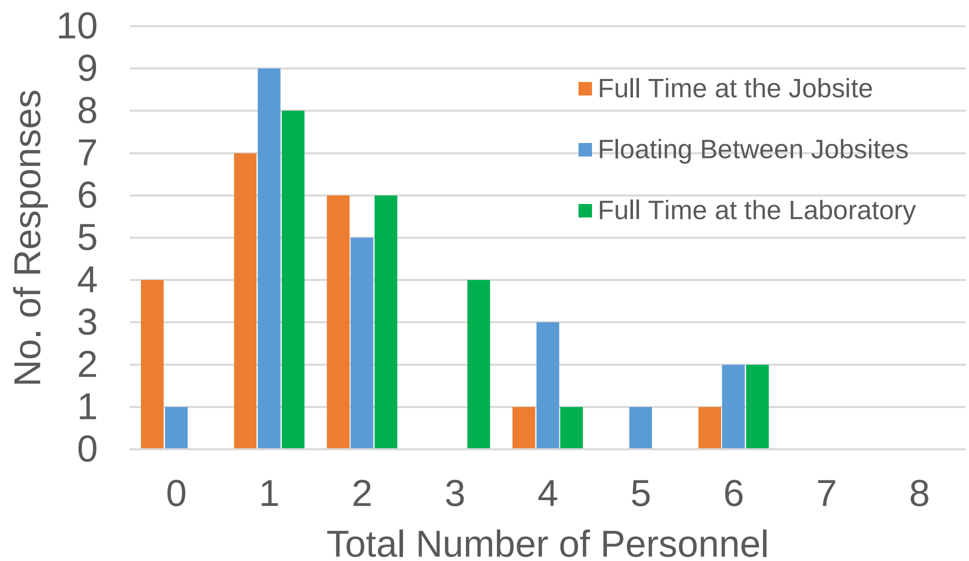


Figure A.2. Number of personnel assigned exclusively for quality control tasks.

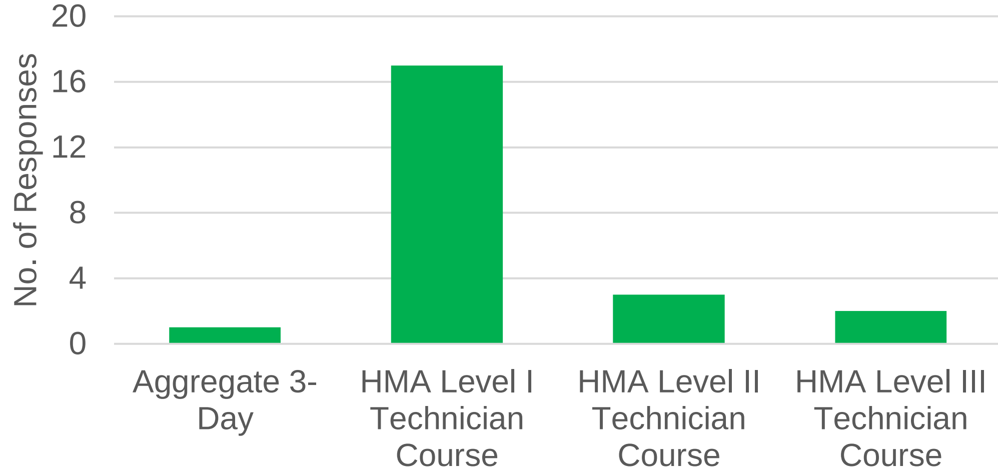


Figure A.3. Minimum level of training required for technicians.

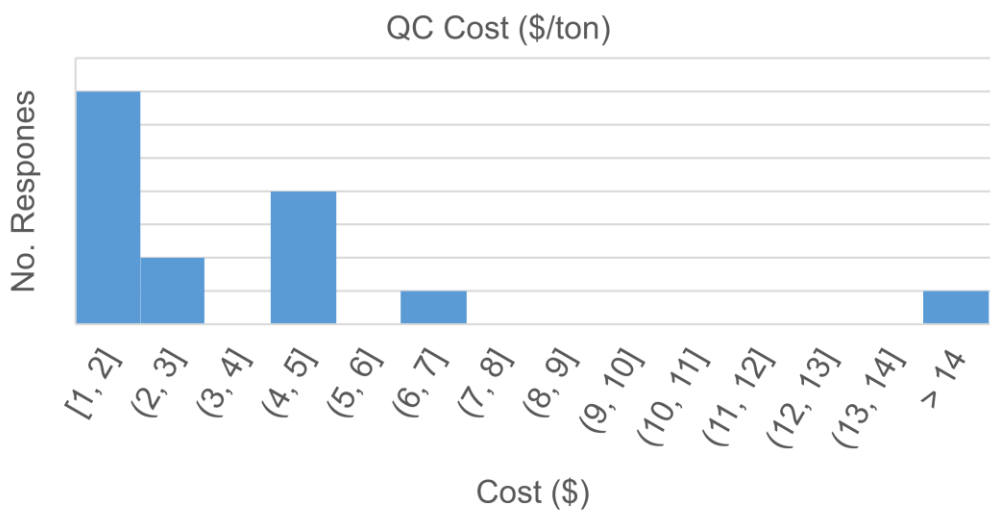


Figure A.4. Quality control cost per mix ton.

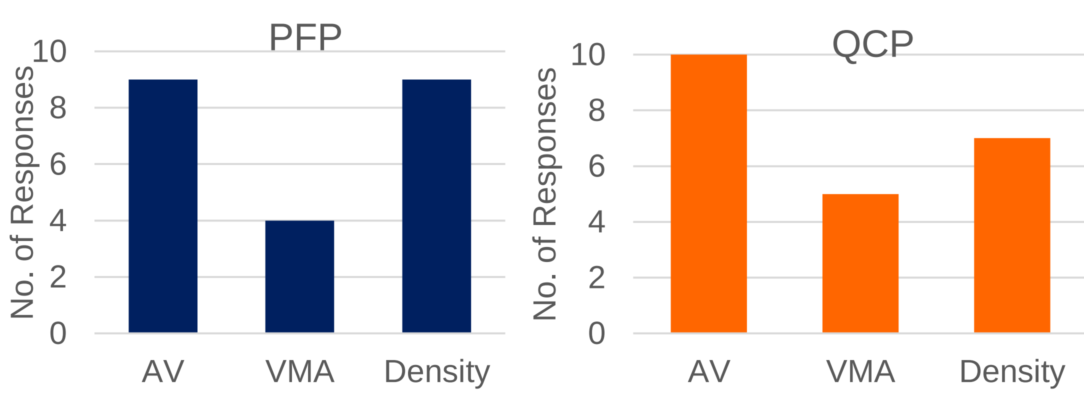


Figure A.5. Parameter driving pay loss.

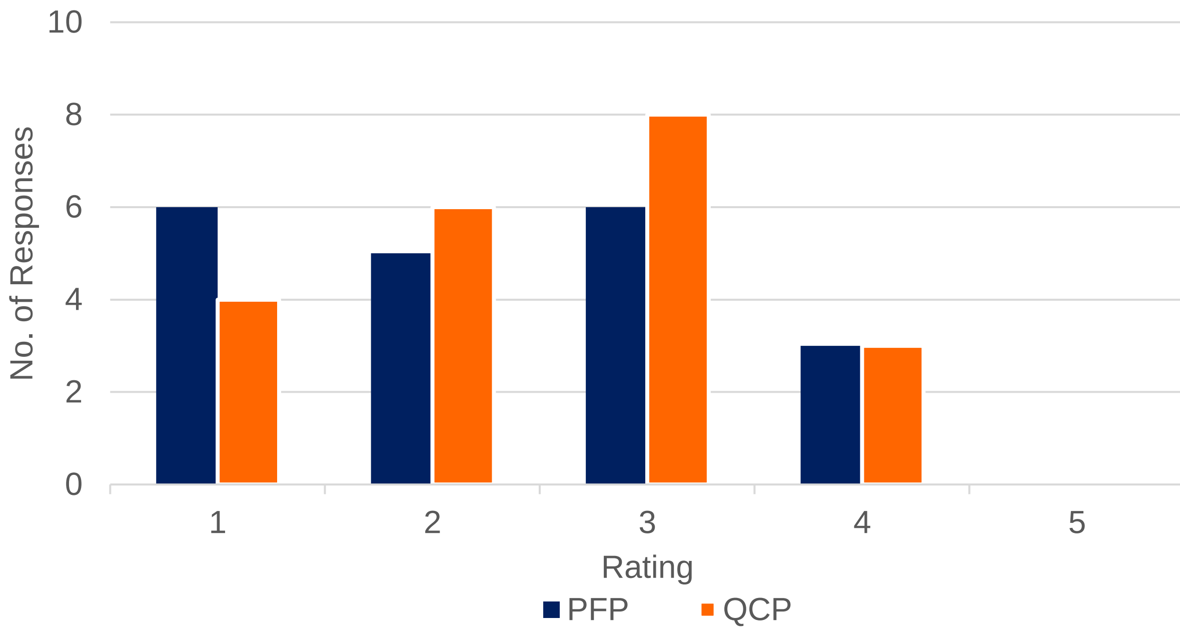


Figure A.6. Rate the QC programs.

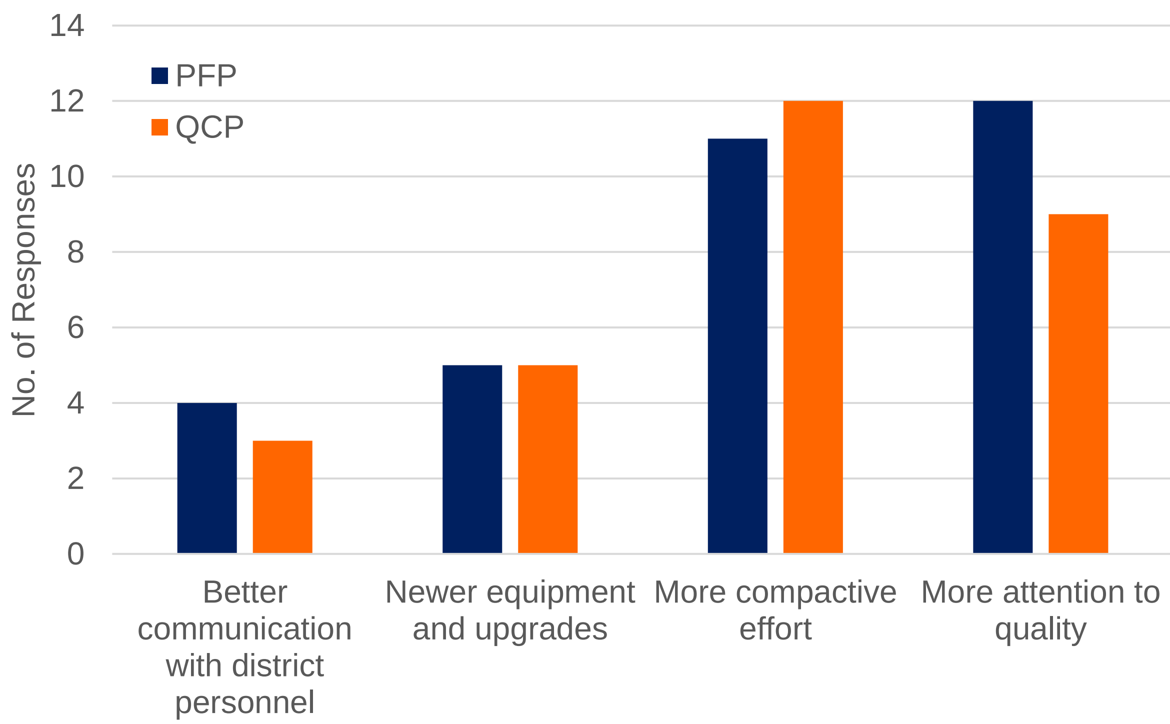


Figure A.7. QC programs benefits.

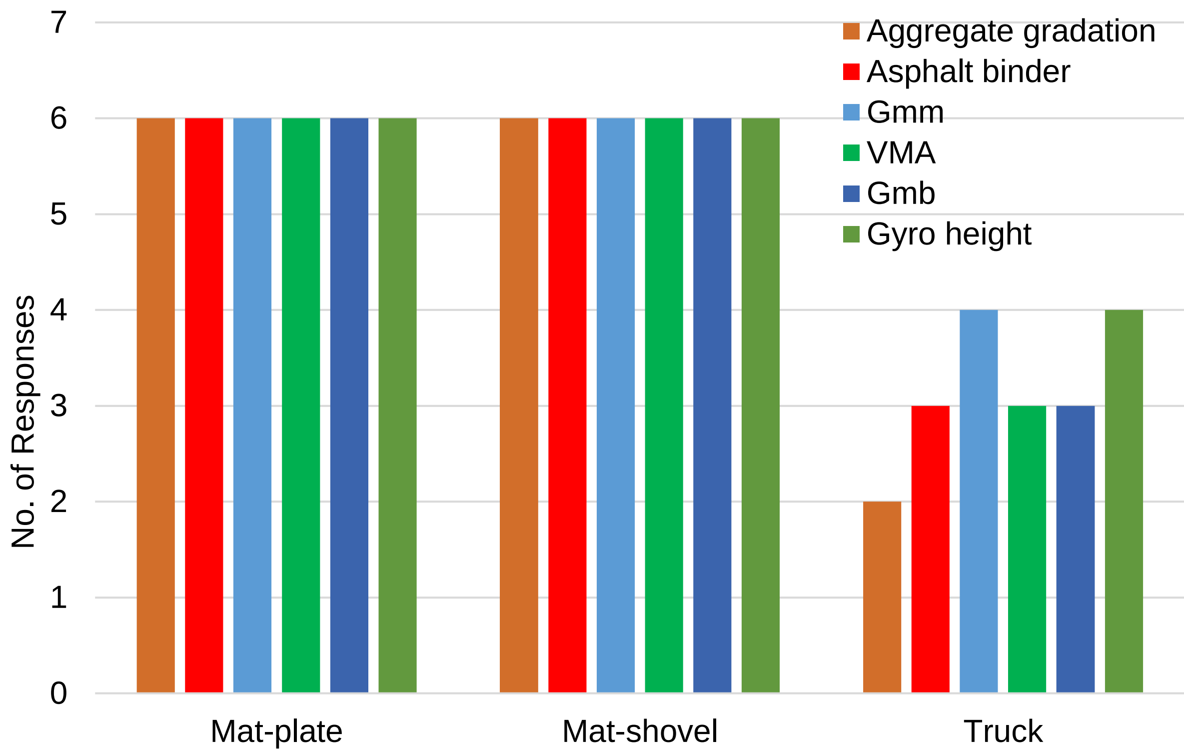


Figure A.8. QC sampling location.

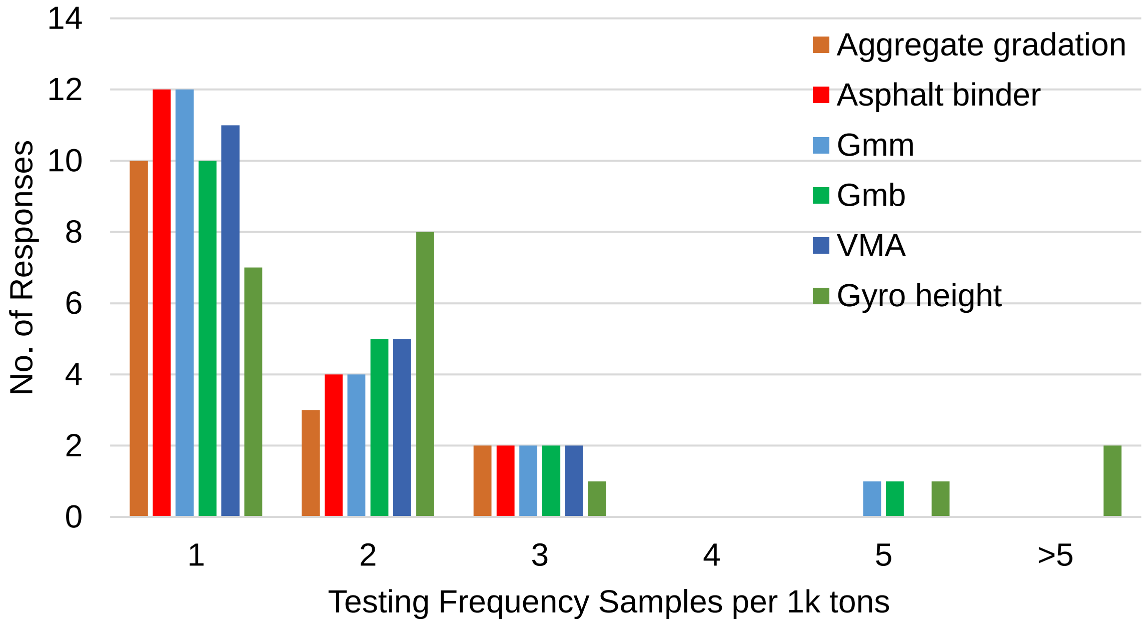


Figure A.9. QC program benefits.

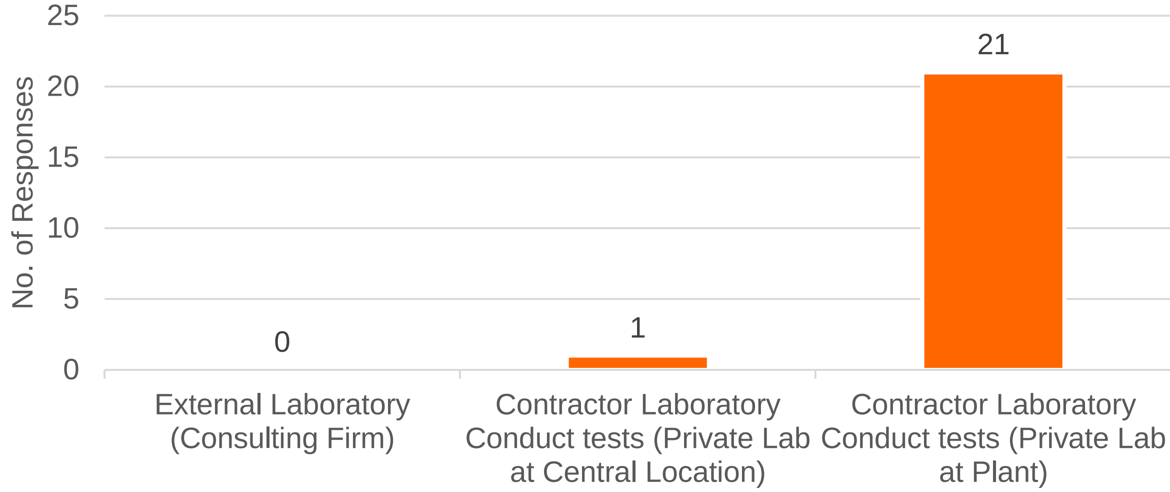


Figure A.10. QC testing location.

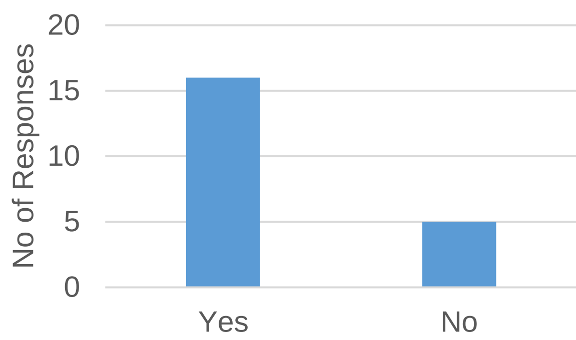


Figure A.11. Does the company have the same person running all samples on a project?

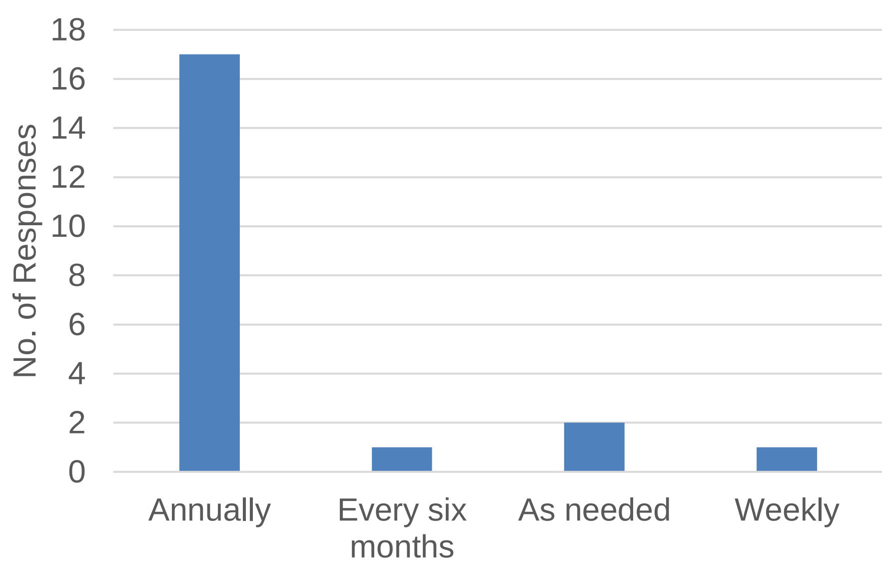


Figure A.12. How often are the molds inspected with a bore gauge?

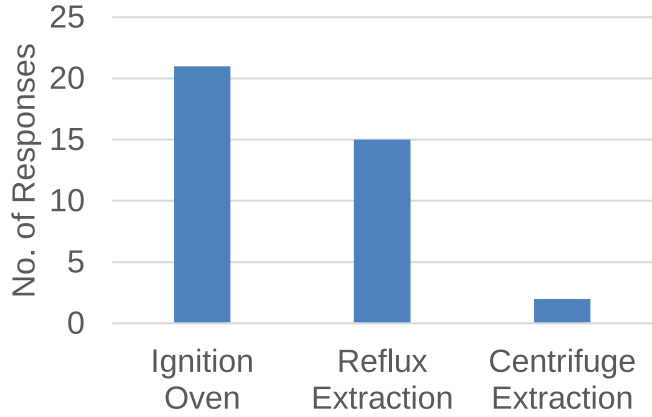


Figure A.13. What equipment is used to determine AC content?

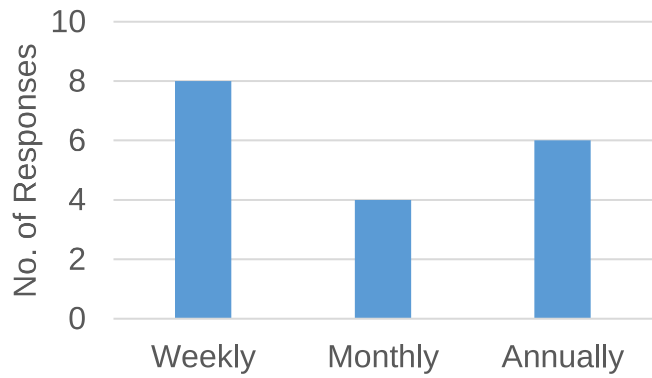


Figure A.14. How often is the lift test performed on the ignition oven?

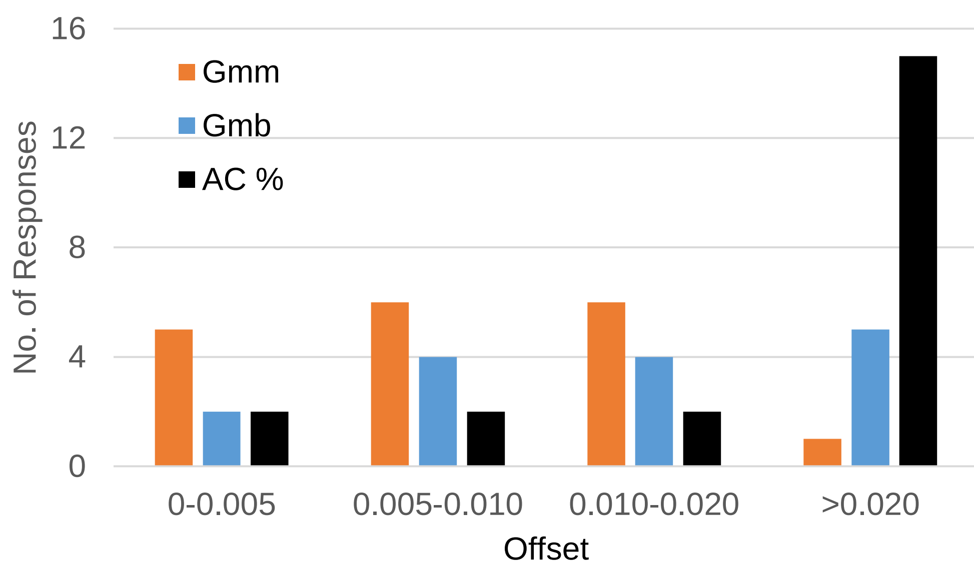


Figure A.15. What is your typical offset between your lab and the district lab for?

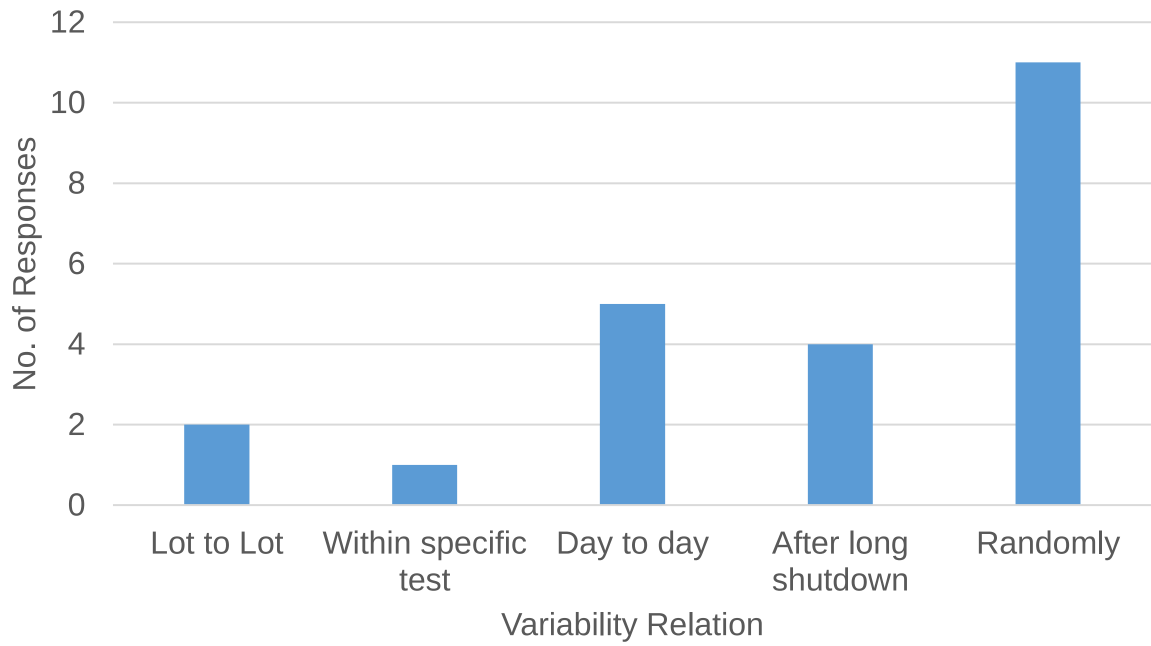


Figure A.16. For those mixes that seem to have more variability, is the variability related to one or more of the following?

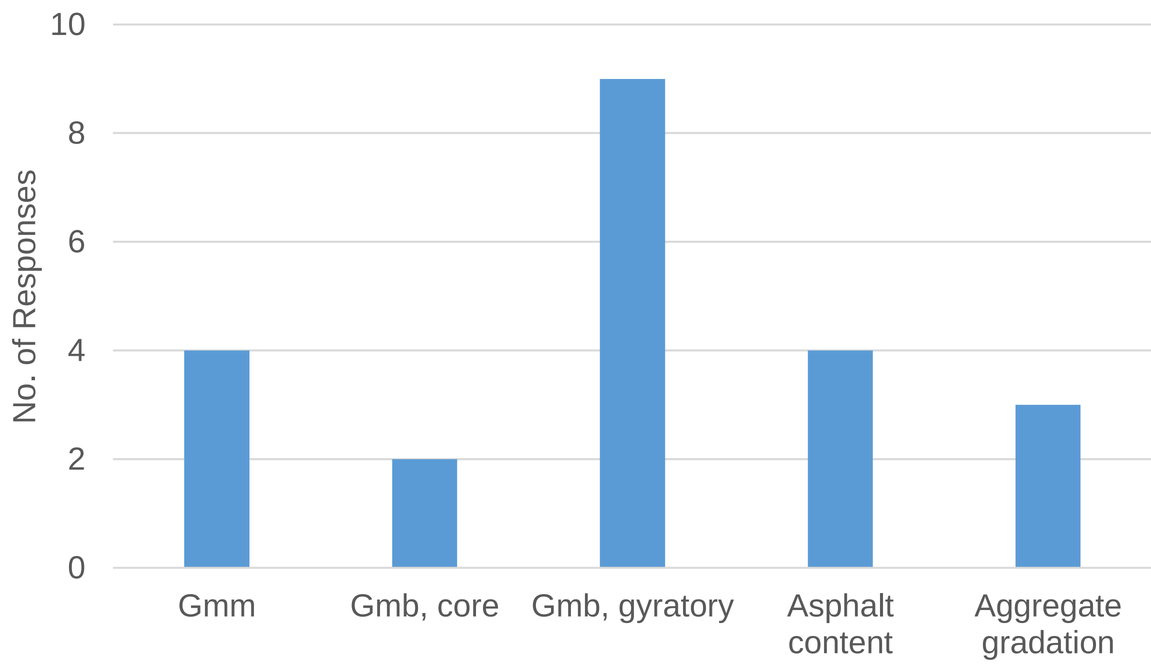


Figure A.17. For contractors working with multiple department district labs, do you notice a difference in the following tests results between labs for pay samples?

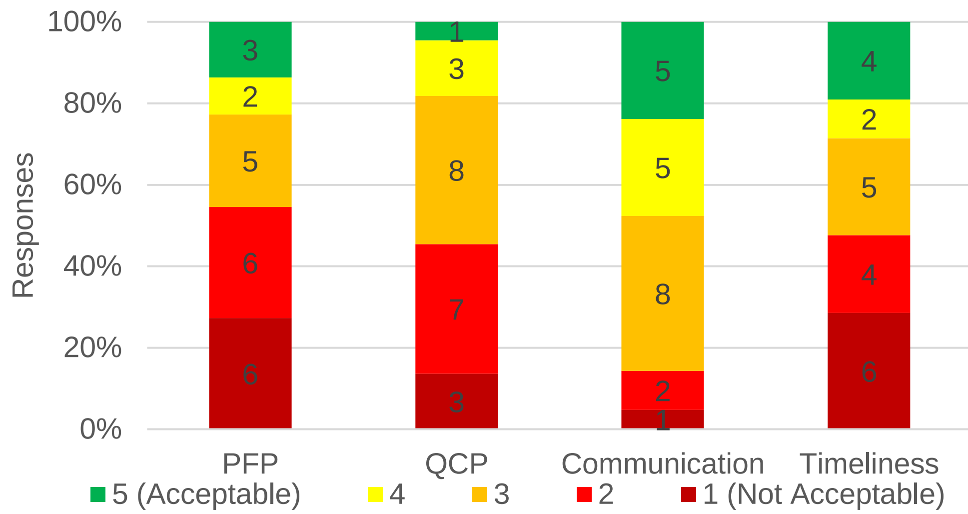


Figure A.18. Please rate from 1 to 5, where 1 is not acceptable and 5 is acceptable: PFP specification, QCP specification, communication with IDOT, timeliness or turnaround time of the results by IDOT.

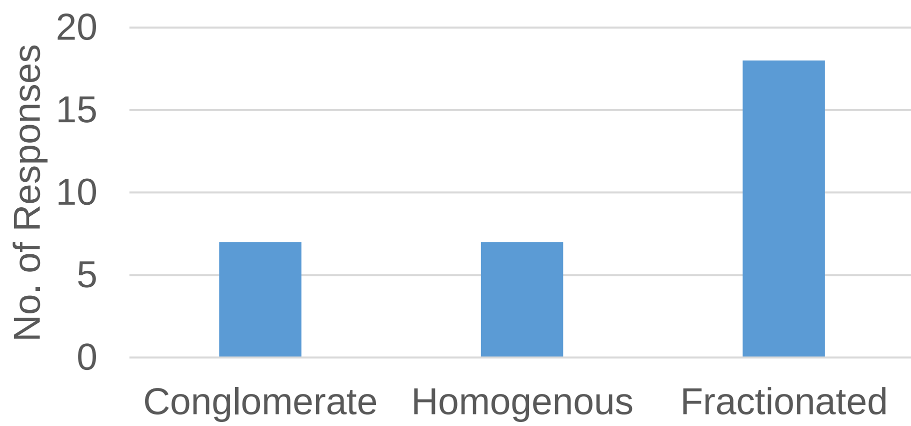


Figure A.19. What type of RAP stockpiles do you have? (Check all that apply.)

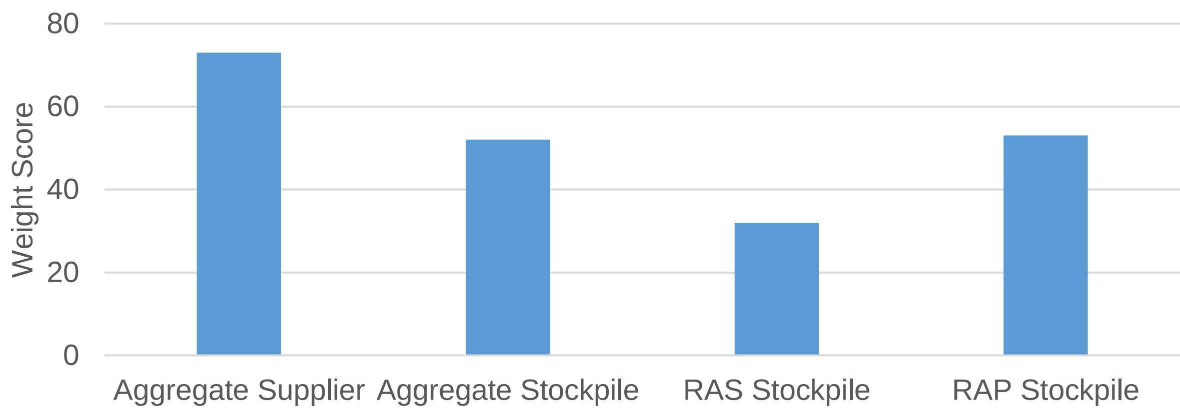


Figure A.20. Rank the source of variability at the plant (1 is least and 5 is greatest); RAS was not used by all producers.

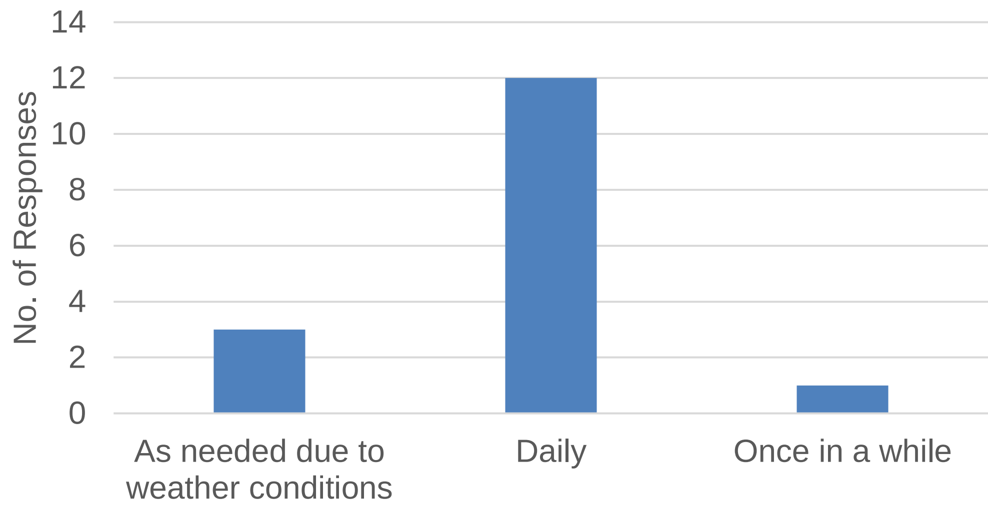


Figure A.21. How often is the aggregate stockpile moisture test conducted?

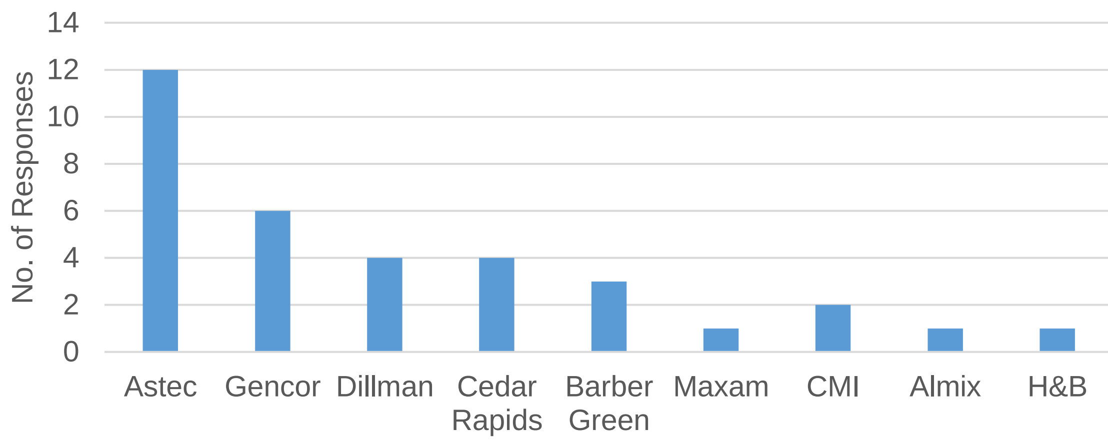


Figure A.22. Plant manufacturer.

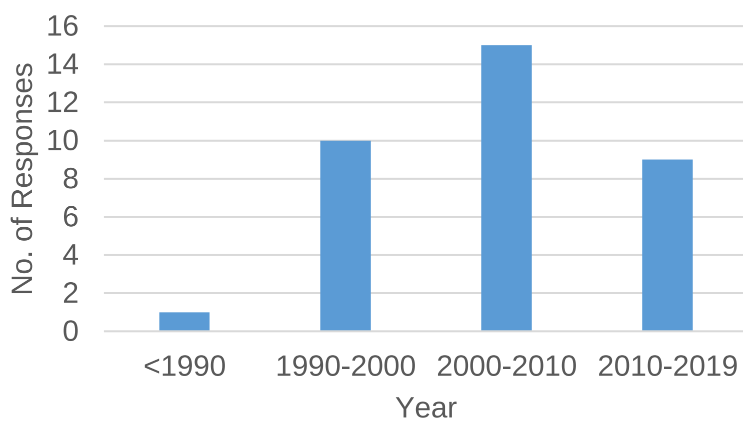


Figure A.23. Plant year.

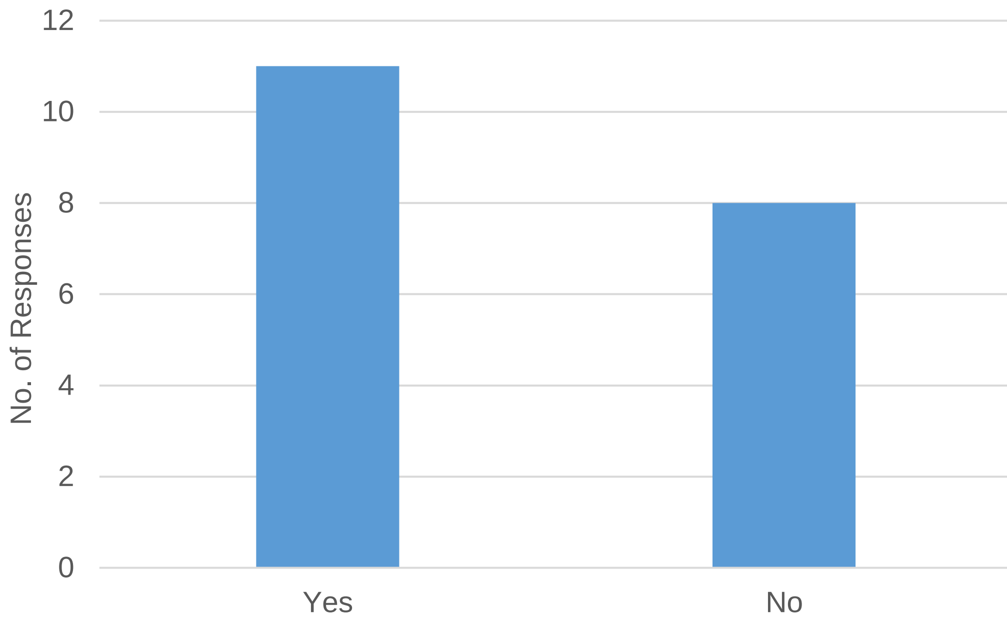


Figure A.24. Do you switch mixes while producing for PFP/QCP projects?

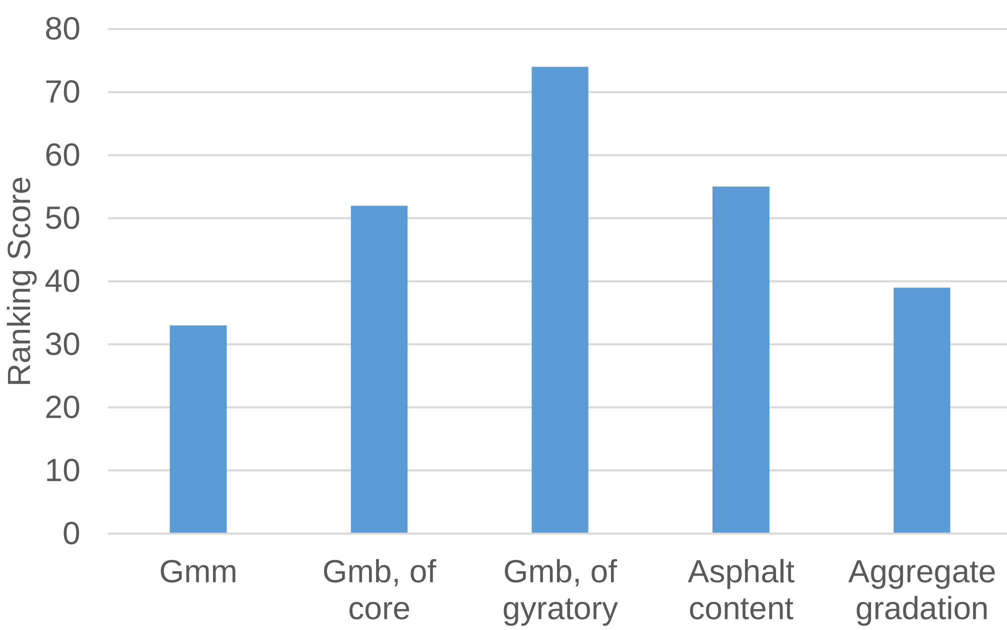


Figure A.25. Rank the following criteria for cause of error (or pay disincentive).

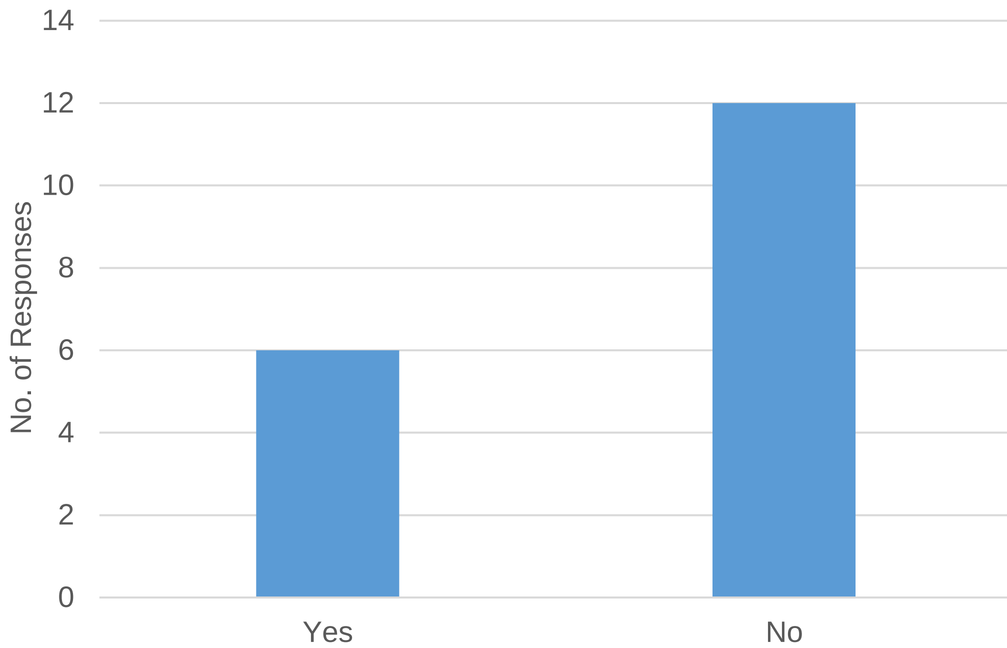


Figure A.26. Are the QC managers directives ever overruled by others (project superintendent, chief estimator, etc.)?

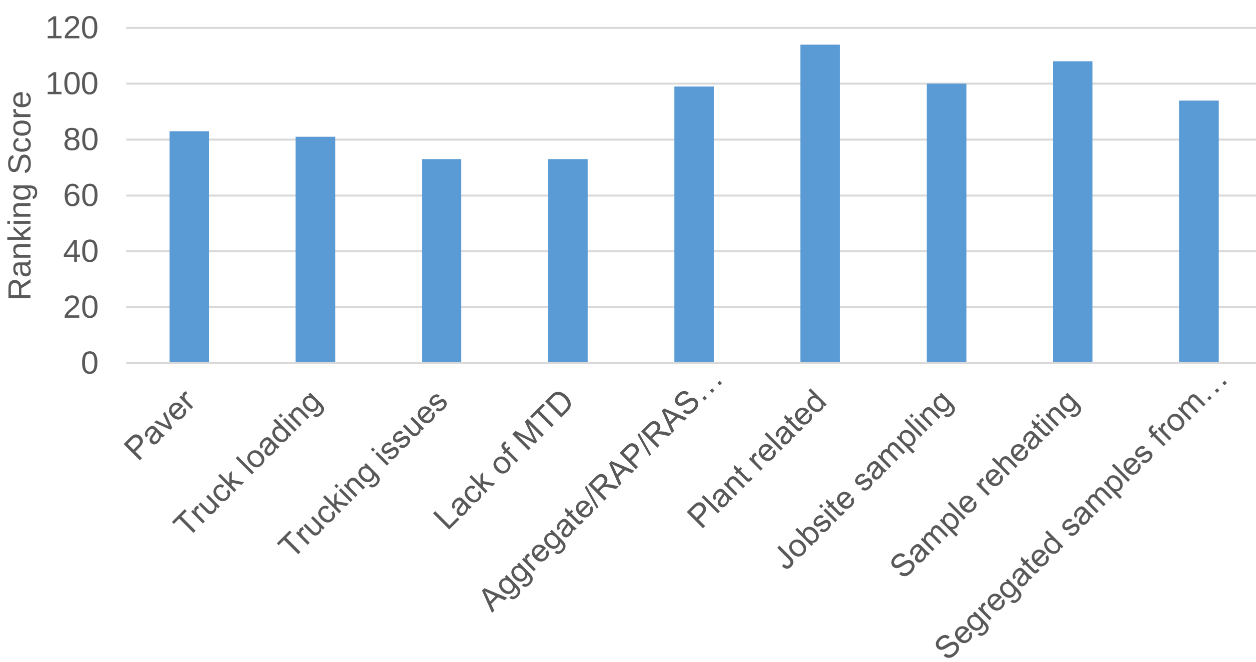


Figure A.27. Rank the following nine sources of error that typically lead to failure to meet PFP/QCP volumetric requirements (1 is least and 9 is greatest).

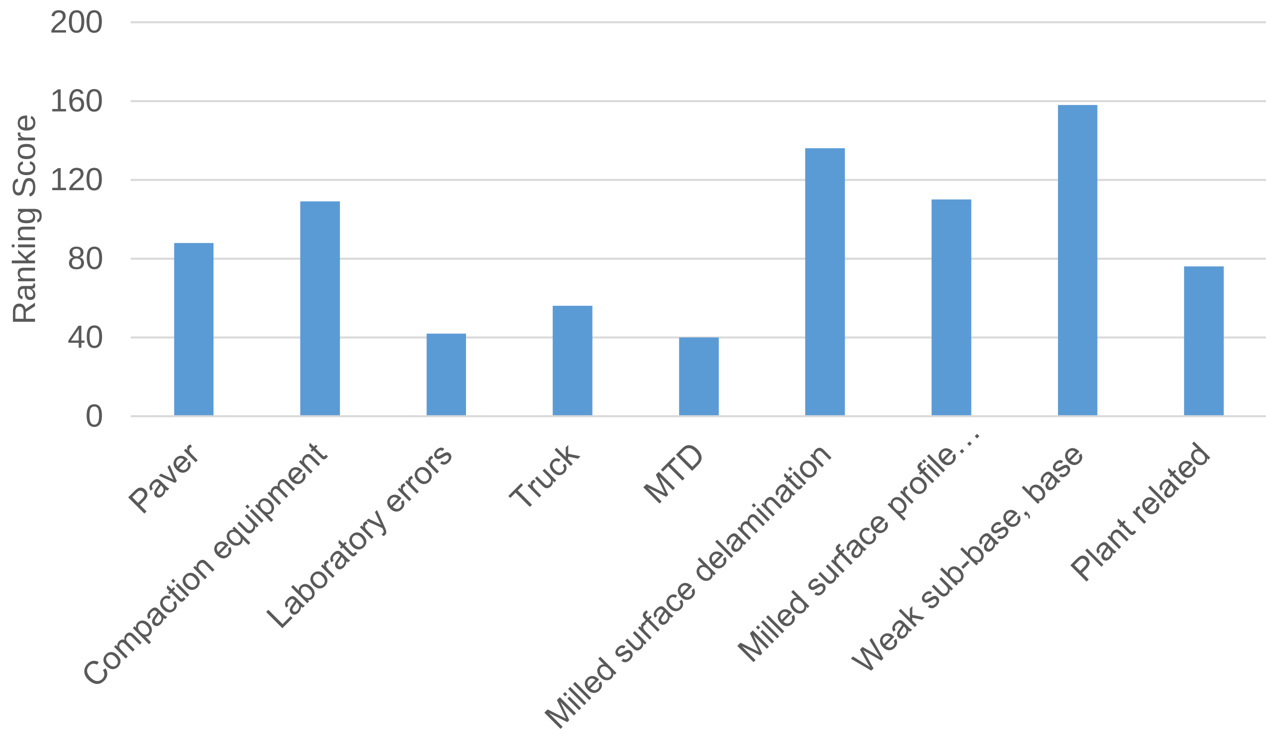


Figure A.28. Rank the following ten sources of error to meet PFP/QCP in-place density requirements (1 is least and 10 is greatest).

Table A.1. Main Reason for Success in PFP

Responses
We treat PFP/QCP testing the same as every other mix that we run. With focus on having accurate and consistent results that we can make good decisions on to control the mix. But there is also a lot of luck involved with IDOT getting good test results also.
Extra testing on all factors, continual testing above and beyond required frequency. We receive test results from IDOT next day. This is extremely important!
Team Work & Communication.
Because it was a PFP project there was an opportunity for a bonus. Timely adjustments to mix and density. Was proactive instead of reactive.
Communication between everyone involved. Including but not limited to, aggregate suppliers, loader operators, plant crew, paving crew, QC staff and management.
Good QC in the lab and the field
Consistency of mix.
Was able to play the correct windage with IDOT samples and had no flyer that time.
24 hour turn around time on results

Table A.2. Benefits from QC Programs

Responses:
Is all I have is frustration!
I think everyone in our company makes sure that they are doing whatever it takes to ensure we are placing the best product we can on the roads.
None. More compactive effort is applied but many times it is too much and we are reducing the life of the mat. It has cost all contractors monetarily. It is tough in a competitive market to receive .90/.97% on the $1.00 bid.
PFP has made quicker responses to mix issues a necessity.
More testing takes place only to find out I can't apply any windage to D1 because they are all over the place with their numbers.
None. IDOT is not receiving any better of a product than the QC program gave them
More compactive effort detrimental to pavement. More attention to quality more attention to detail.

Table A.3. Comments to Improve QCP

Responses:
Let's us do our job. We can test and adjust in a timely manner, as opposed to the waiting and uncertain results generated by IDOT.
Yes - Remove density from the level binder pay factor calculation - Currently the pay factor for full depth pavement is calculated by equally weighting each HMA course type. Instead the pay factor should be calculated by prorating the tonnage. - Current treatment of thin level binder cores need to be re-examined.
Same as the comments for the PFP.
Set a higher minimum ton before it is used.
No Bonus only penalty. Thin lift binder an issue (hard to get a good road sample, Plant or Cores)
Under 8000 tons just let us pave (QCQA)
More education for everyone involved. We (IDOT and Industry) need to work together to make sure everyone is doing things accurately.
why not let me get a bonus. why not average a 103% rating on my VMA test to raise my payfactor above 100%.?
Too much compactive effort Size of sublots on lower tonnage jobs
Lack of ability to challenge
Allow truck sampling as an official sample method. This will allow the department and contractor to maintain a more uniform process. This will also allow contractors to make small adjustments within their process and will create a more real time QC process.
Use contractor results.
Not good for small production days. Although intended for smaller tonnage jobs there are realistic limits and conditions that should not be lump summed.
More use of engineering judgement
Marry up QCP with PFP and have only one testing format regardless of tonnage. Take the pros from each and retire the cons from each. (I.e. edge density vs. +2% for edge cores)

Table A.4. How Is the Decision Made on What Gyratory Compactor to Use for What Materials/Projects?

Responses
We only have one in each lab.
Randomly to serve as a check and balance
Based on which District we are running the mix for. All the labs are different on their bulks.
Same one is always used. The extra is a backup.
Match IDOT
Location (gyratory at each plant site)

Table A.5. Information for Your HMA Ovens

Please identify the manufacturer, model, and size of the oven used to heat HMA samples.	Does your lab use temperature alarms for ovens?	How often is the oven temperature checked?
Thermolyne NCAT	Yes	Weekly
DesPatch, LAC2-18-6, 18CF	Yes	Every three months
Despatch LBB1-69A 6.9cuft	No	As needed
Humboldt; H-30160.2F; 7.2 cu. ft. / Humboldt; H-30145; 7.8 cu. ft.	No	Daily
Blue M	Yes	Annually
Blue M SPX	Yes	Daily
Despatch LAC Series 6.6 cubic feet	Yes	As needed
Despatch	Yes	Annually
Despatch, LAC1-67 (6.7 cubic feet)	Yes	Daily
1680 VWR its big.	No	Annually
Despatch LBB2-12-1 12 Cubic Ft	Yes	Daily
Blue M/DC-246-F-PM Blue M/DC-246-F-HP Hot Pack/TruTemp 212061	Yes	As needed
blue m 336 size 336	Yes	Daily
Grieve Ovens	Yes	Daily
Despatch LBB2-18-2 Same as D1 Lab	No	Annually
Despatch forced Air LC18	Yes	Daily
2 each Deptach LAC, 3 cu ft	Yes	Every month
Despatch, Protocol Plus, 22CF	Yes	Daily
Blue M DC-246-F-ST350	Yes	Every three months
Quincy Labs 31-350 10.6 cuft.	No	Every three months

Table A.6. Are There Specific Mixes (Mix Type, Nominal Maximum Aggregate Size (NMAS), Binder Grade, Recycle Content, etc.) That Tend to Show More Variability in Test Results Than Others?

Responses
D mixes.
IL 4.75 mm mix have more variability
To a minor extent mixes utilizing recycled materials present an issue
Any mix with steel slag
We tend to have more variability in mixes that use Dolomite (CM16 and FM20).
N70 Surface for me, Voids = IDOT came in 2% higher on test strip (mine was actually below spec), 1% on Lot 1, 0% on lot 2.......
IL19.0, IL9.5 D Mix aggregate segregation/ high absorptions
19.0 mm mixes have been the hardest to get a good comparison
Depends on the day. Sometimes 4.75mm, 9.5mm, or 19.0mm
Binder mixes
9.5 surface

Table A.7. In the Order of Importance (First Is the Most Important), What Are the Top Three Improvements You Suggest to the Department Specifications to Enhance Payout and Reduce Penalties?

Responses:		
1 (most important)	2	3
Timely turnaround of results so I can adjust in a timely manner		
Use consultant labs	Quick turn around on sample results	delete unconfined joint spec
Use contractor lab results for pay calculations	For QCP, allow 105% pay factor for each component to carry through to final pay calculation	Remove level binder density from the QCP program
Testing: use common sense, if something looks wrong it generally is. Then they should rerun tests.	Test in our labs. Contractor provided gyratory.	Control reheating the material which effects our G_{mm}.
PFP should be pass/fail not statistical analysis	Better IDOT turnaround time on samples	IDOT districts should determine any credits not Central Bureau
No thin lift cores	Edge cores on two lanes	loosen up spec for pay for projects which have low tonnage days.
Eliminate QCP	Dist 2 need to follow 8000 ton spec for PFP	Correct 1 flyer in a sublot, maybe average the other 9
Do not use QCP / PFP where it is not appropriate	Verify that everyone is doing things the same	Provide some best practices seminars for PFP / QCP
Adjusting sublot tonnage on lower tonnage QCP	Less reliance on density	Less coring
Loosen tolerances	Guarantee 100% Payment	
Work together instead of against one another	Test samples in the contractor’s lab witnessed by trained IDOT inspectors for prof of testing procedure compliance	Provide results within a timely manner so that the customer can get what is required within the specifications

Responses:		
1 (most important)	2	3
loosen statistical limits		
Use of supporting information	Dispute samples (QCP)	Proper assignment of QCP/PFP
24 hour turnaround	increase QCP tonnage <20,000, PFP >20,000	3rd party dispute sampling
Marry QCP/PFP, alter penalties to only affect tonnages pay factors on the specific paving days/tonnages for which penalties occurred	Rewrite edge density spec, 6" from edge +2% added to final density must be >90%	

Table A.8. What Test(s) Do You Perform Quality Control Testing on Aggregate Stockpiles and How Do You Use That Information?

Responses
Gradation results to adjust blend, control mix.
Bulk gravity and Moistures
Follow the AGCS program, grad checks to ensure that we are within our targets of the mix design parameters
Bailey Method to understand how stockpile variability impacts VMA and Voids.
Incoming aggregates are tested as well as stockpile samples. Let's us know if we're getting good materials in from the quarries which is not always the case.
Occasionally specific gravity

Table A.9. Please Explain If You Requite Aggregate Suppliers to Comply with Tighter Aggregate Specifications than the Department?

Responses
We ask suppliers to try and supply material within half of the tolerance then normal spec. Most of the time we do get materials with in those ranges
At our request in order to better control the quality of the mix during production
We try too. But most will only do what IDOT requires them to do.
If they only meet AGCS standards our PFP/QCP pay will suffer. We give them tighter master bands especially on dust.
In receiving aggregates from a supplier, we request that they are within tolerance of what gradation percent's we design with.
We look at the average and standard deviations that suppliers have shown us in the past and expect them to remain consistent. This is done with communication. Unfortunately, IDOT specifications are not tight enough to produce HMA consistent enough for PFP and QCP.
we require it, but they don't always.
We try to keep targets within 4% and have very good communications with most of our suppliers
We crush our own material, so we know what tighter standards we need to meet

Table A.10. If Multiple Ignition Ovens Are Used in Your Lab, How Do You Decide Which Ignition Oven to Use?

Responses:
We calibrate each mix to both ovens.
For PFP / QCP, we often use two ovens and use the average results.
Calibrate per mix
Only one machine at each site.

Table A.11. Do You Switch Mixes While Producing for PFP/QCP Projects?

Responses:
if absolutely have to. Lots of waste before we send it to the silo.
As little as possible
"No" is our preference, but with completion dates and multiple crews it is not always practical.
Too often. Depends on work load. Try to keep to a minimum.
We try to dedicate to a PFP / QCP job but when that is not possible, we do switch. It depends on the job, if we can make enough for the other job and hold it in 1 silo, we make that first and then go to the PFP / QCP. If not, we may have to switch back and forth multiple times.
1-2
try not to but it does happen
Depends on daily tonnage. Tonnage <1000, 1-2 times day, >1000 tons very seldom

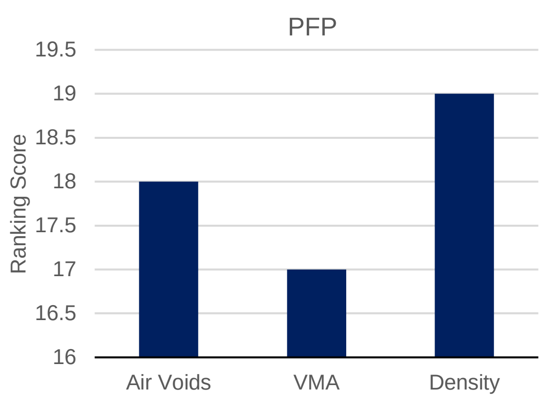
Table A.12. Please Answer the Following Question Regarding Shutdowns.

How often do you need to shut down during daily production?	What are the top three causes for the shutdowns?	How much material do you waste on each start-up? (tons)
2-4 times	Waiting on trucks	6-8
once or twice a day	plants running faster than paving, reduce over curing on mix	20-30
not often	Full silo, breakdown, weather	15
Only when the silo's are full or the when the required amount of mix is made.	Silo full; Plant problems; Weather	3
Depends on production schedule	Job production, end of day, weather	5
Varies	Too far ahead of paving crew; weather	10-15
2	End of day, trucking isssues, production issues (plant equipment)	5-10
minimal	crew moving/full silo/no trucks	20-30
2	Issues with the paving crew, making sure RAP chutes are not plugging up	25

How often do you need to shut down during daily production?	What are the top three causes for the shutdowns?	How much material do you waste on each start-up? (tons)
1-2	mix changes	3
hopefully not ever, but occasionally	field breakdowns of equipment	20
2	Plant issues/road issues/material issues	10
Depends on TPH paving and traffic	1. Maintain a constant inventory 2. Haul time and jobsite issues/trucking 3. Weather	30
not much	break down	5
occasionally	out of trucks, holding,	1
0 to 1	mix balance, breakdown, weather	3
1-3 at most	inaccuracy on tonnage orderd by crew, aggregate change, weather concerns	20
Aim to not shut down	field breakdown, bad estimate of material, plant too far ahead of field	15

A.2 DISTRICT SURVEY

During spring 2018, a survey was sent to IDOT districts to gather opinions about PFP and QCP quality control programs. One response per district was received.



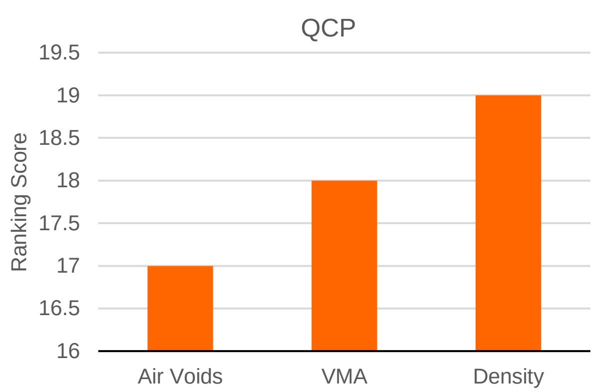


Figure A.29. Parameter driving pay loss.

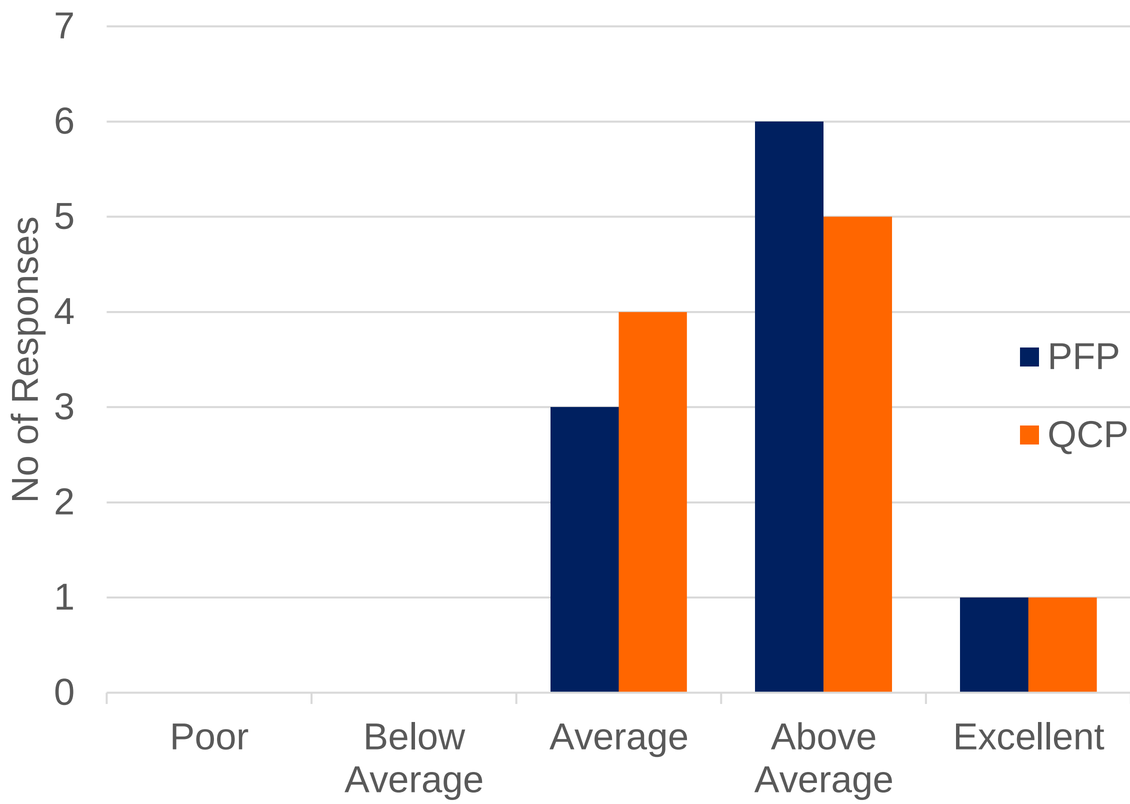


Figure A.30. Rate the QC programs.

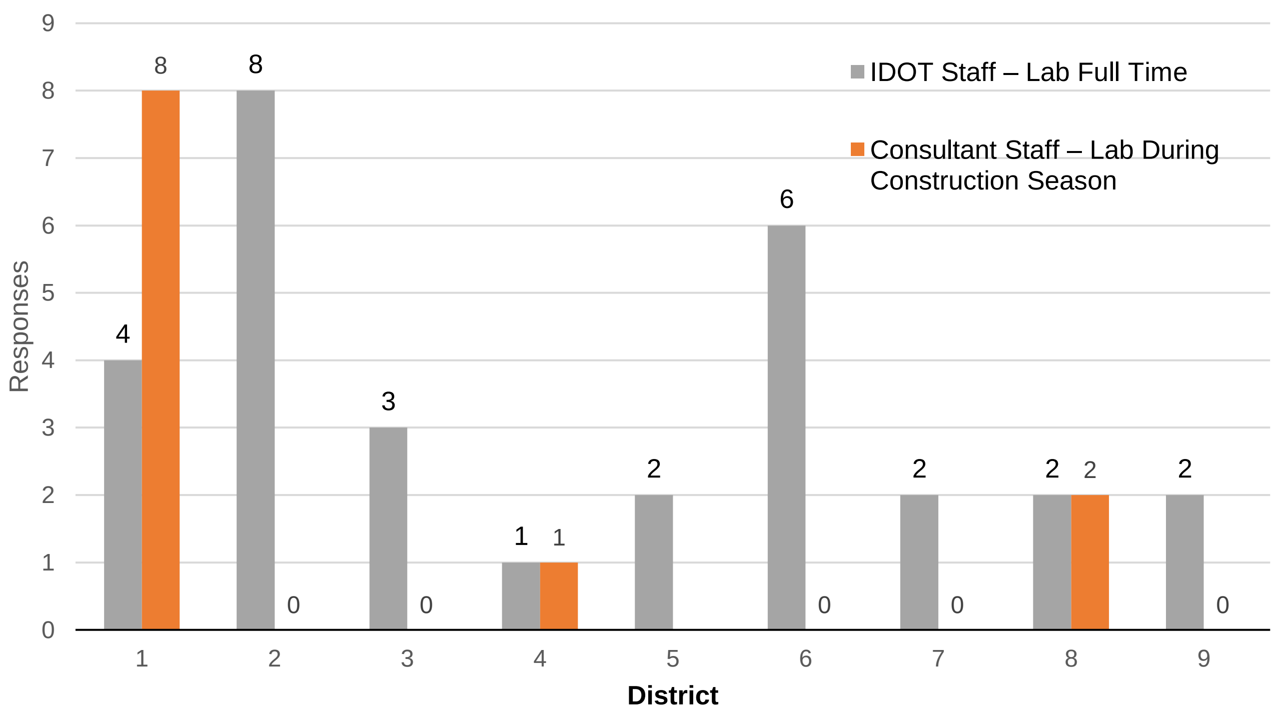


Figure A.31. Total number of personnel assigned to QC testing.

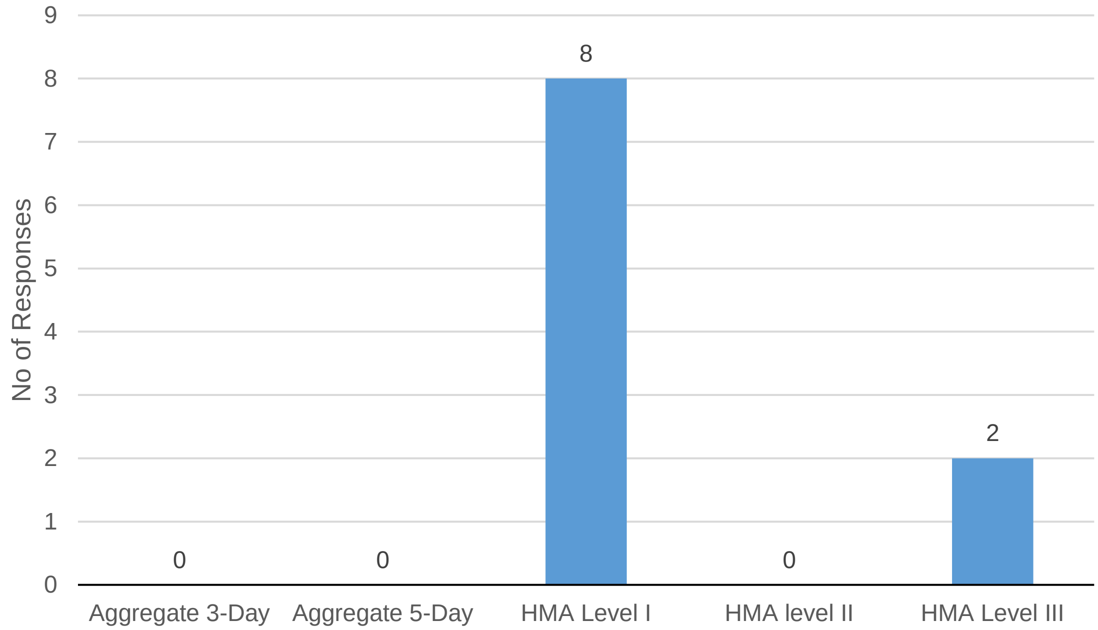


Figure A.32. What is the minimum level of training required for a technician performing volumetric testing?

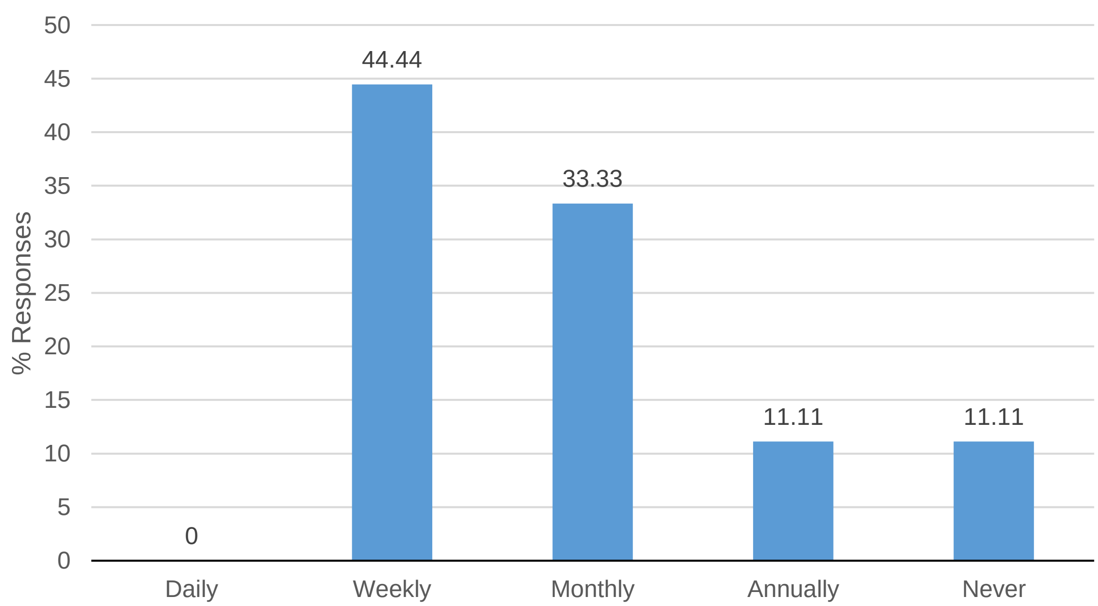


Figure A.33. How often is the lift test performed on the ignition oven?

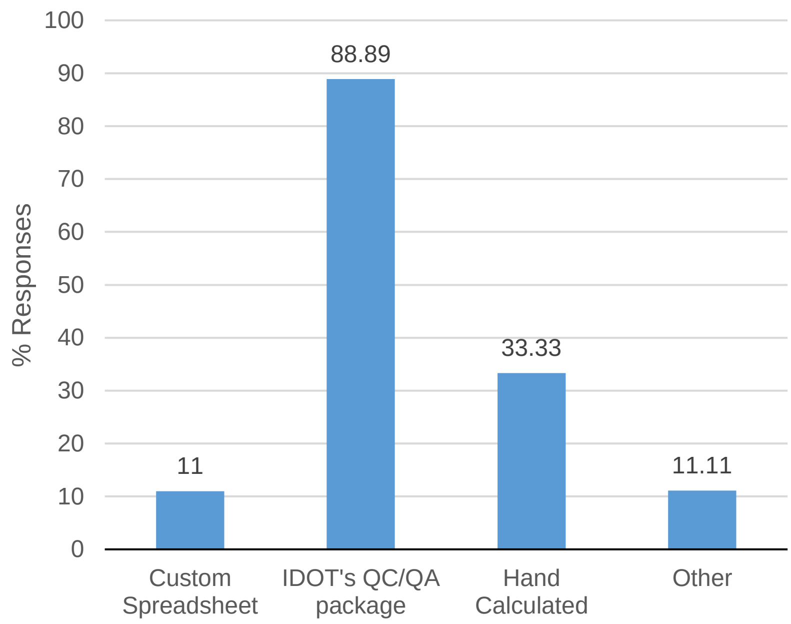


Figure A.34. How are volumetric parameters (G_{mm}, G_{mb}, VMA, etc.) calculated?

Table A.13. Provide the Following Information for Gyratory Compactors

District	Make & Model	Location	Measured Internal Angle	Frequency of internal angle correction (months)	Measured Pressure	Frequency of pressure correction (months)
1	Pine AFG2 (8005)	District central laboratory	1.17	> Every year	600	> Every year
	Pine AFG2 (8118)	District central laboratory	1.16	> Every year	600	> Every year
	Pine AFG2 (8687)	District central laboratory	1.16	> Every year	600	> Every year
2	Dixon = Troxler - 5850	District central laboratory	1.14	> Every year	605	> Every year
	Rockford = Troxler - 5850	Satellite laboratory	1.15	> Every year	600	> Every year
	Quad Cities = Troxler - 4140	Satellite laboratory	1.16	> Every year	600	> Every year
3	Troxler 4140	District central laboratory	1.15	> Every year	600	> Every year
	Troxler 4140	District central laboratory	1.15	> Every year	600	> Every year
4	Troxler 4140	District central laboratory	1.17	> Every year	600	> Every year
	Pine AFGC125XA	District central laboratory	1.15	> Every year	600	> Every year
5	Troxler 4140	District central laboratory	1.15	> Every year	600	> Every year

District	Make & Model	Location	Measured Internal Angle	Frequency of internal angle correction (months)	Measured Pressure	Frequency of pressure correction (months)
	Pine AFG2 (backup - do not use for testing)	District central laboratory	1.16	> Every year	600	> Every year
6	Troxler 4140	District central laboratory	1.18	> Every year	605	> Every year
	Troxler 5850	District central laboratory	1.17	> Every year	600	> Every year
	Troxler 5850	Satellite laboratory	1.16	> Every year	600	> Every year
7	Troxler 5850	District central laboratory	1.14	> Every year	595	> Every year
	Troxler 4140	District central laboratory	1.16	> Every year	600	> Every year
8	Pine AFG2AS	District central laboratory	1.16	> Every year	600	> Every year
	Pine AFG2A	District central laboratory	1.16	> Every year	600	> Every year
9	Pine G2	District central laboratory	1.16	> Every year	600	> Every year
	Pine G2	District central laboratory	1.16	> Every year	600	> Every year

Tables A.14 and A.15 are the districts' responses. There are ten responses because two responses were received from the same district. CBM responses are not included; questionnaires were addressed only to district personnel.

Table A.14. If Multiple Gyratory Compactors Are Used, How Is the Decision Made on What Gyratory Compactor to Use for What Materials/Projects?

If multiple gyratory compactors are used, how is the decision made on what gyratory compactor to use for what materials/projects?
8005 is the only one used for PFP projects. 8118 is the only one used for QCP projects. 8687 is used for other samples.
Location of the project
Unit 1 is used for all contracts unless we foresee a larger number of upcoming contracts, in which case unit 2 would also be utilized. At no time are the two gyratory compactors used interchangeably between contracts.
Pine solely used due to better consistency. Troxler only if Pine will be down for long period of time, haven't used it in over 5 years for any work.
D5 uses the Troxler 4140 for all HMA testing. The Pine AFG2 is used as a backup machine.
Troxler 5850 is the Primary, the 4140 is the backup
4140 is just a backup
Material Code/Job Specific
We use the same compactor to run all tests. the second machine is a backup

Table A.15. Is a Review Process Used for Checking Test Results before Determining Pay?

Answer	Explanation
Yes	Technician performs the test and calculation. The Senior lab tech for HMA checks all numbers and calculations. The District Lab Supervisor will review a portion of the test samples (paying particular attention to out of tolerance results). These results are sent to the Field Inspector and Mixtures Area Supervisor for the Asphalt plant. They review all results before submitting to the Contractor and a Phase III consultant. The Phase III consultant performs all pay calculations to ensure uniformity throughout the District.
Yes	The lab technician will review their notes for a "double check". No other review of the material test results is done. The Mixtures Control Engineer then reviews final test results put into the QC/QA Package that are outside the acceptable limits of the PFP/QCP provision used. Those results are submitted to CBC for review and recommended additional credits. If allowed to remain in-place, those sublots are placed into a separate sheet and the additional credit from CBC is calculated. The sublot is then at "final pay" status.
No	
Yes	The bituminous mixtures unit collaborates with the area laboratory personnel to confirm final pay factors prior to sending them to the contract resident engineer
Yes	Results are hand calculated in the lab. Reviewed by different personnel while being entered into the QCQA Package. Double checked by another staff member after placing in PWL.
Yes	Both the Mixtures Control Engineer and Construction R.E. compile data and enter into the QC/QA package. A pay factor is calculated by both and compared.
Yes	Lab Supervisor reviews results before submitting to HMA Supervisor, who checks all data before giving to Mixtures Control Engineer. Mixtures Control Engineer reviews all test results before sending out memo for pay / disincentive.
Yes	tech's check each other's math
No	
Yes	The lab supervisor checks all of the work before entering in QC/QA program. The Mixtures Control Engineer reviews the results and compares with contractor results. If there is a discrepancy, we will check our equipment and possibly retest the result in question depending on what we find.

Table A.16. Information for Your HMA Ovens

Oven	Does your lab use temperature alarms for ovens?	Response
Despatch LAC2-18 18cf	Yes	Annually
5 Despatch / LAC2-18-6 / 18 cu.ft.	Yes	Annually
Despatch LAC-18	Yes	Annually
Grieve; Model SA-550; 70.9 cuft	Yes (NIST Digital Thermometers equipped with set-point alarms)	Annually
Despatch LAD2-24-3 Grieve model 333	No	Annually
Grieve Model SA-550 ~30 Cu. Ft. - Central District Lab Shellab Model HF 25-2 ~27 Cu. Ft. - Satellite Lab	Yes	Annually
Gilson 270A 27 cu ft	Yes	Annually
Blue M Electric DC-206F (for compaction) Despatch LBB2-27-2 (for samples before splitting)	Yes	As needed
Blue M - model 326 Batch Oven 51"x50"x24" Dispatch - model LBB1-69A-1 30"x22"x18" Horizontal - model 1685 32'x67"x26" Blue M - model DC series oven 25'x22"x20"	Yes	Annually

APPENDIX B: EARLY DEVELOPMENT OF QA PROGRAMS IN THE US

The 1956 AASHO Road Test is the milestone that changed the “recipe” or method specifications for road construction in the United States. During the test track construction, a large number of test results were noncompliant with specification limits (Highway Research Board, 1962). It was clear that specifying materials and methods was not enough; controlling the construction process, evaluating the end product, and reducing variability was found to be necessary.

According to the 1962 report of the House Committee on Oversights and Investigation of Congress, test data for road construction were often out of specifications and were not enough to determine the quality of construction (NCHRP, 1979). Verification performed by State DOT personnel was introduced to reveal improper testing and reporting in some federally funded highway projects. This became known as independent assurance (IA). The Federal Highway Administration (2011) recommends that results coming from an IA program should not be used for acceptance of the product; instead, they should only be used for verification of procedures.

In the 1970s, QA programs adopted a statistically oriented approach and quality assurance responsibilities were assigned differently. Contractors performed QC tests to control the production and construction of HMA. For acceptance, agencies performed tests to ensure that the quality delivered by the contractor complied with their requirements. Agency testing was typically used for quantifying the quality delivered and calculating contractor payment. This was required on Federal-aid projects until 1995. With responsibilities assigned this way, the possibility of legal proceedings by the contractor and/or producer were reduced and flexibility in contractor operations was allowed (NCHRP Synthesis 38, 1976).

Before statistical methods for acceptance were specified, acceptance of HMA was a matter of engineering judgment, which led to controversial decisions (NCHRP Synthesis 65, 1979). This triggered a need for change. By 1976, 33 state transportation agencies were already using or planning to use a statistically oriented QA program. In fact, many state transportation agencies penalized unit prices if the product did not satisfy the required quality statistics. By then, agencies performed random sampling and used statistical probability for acceptance testing or relied on product certification. Bonus incentives were not permissible on federal-aid projects (NCHRP Synthesis 38, 1976). Few states used a statistical approach for HMA acceptance until SuperPave was implemented in the 1990s.

APPENDIX C: STATISTICAL ANALYSIS RESULTS

C.1 AV ANALYSIS RESULTS

Table C.1. AV Analysis Results Summary

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
1	2015	19524R	1	QCP	0.33	0.66			4.1	2.9	0.28	0.49
2	2017	19524R	1	QCP	1.00				2.9	2.9	0.07	0.00
3	2017	19524R	1	QCP	1.00				3.9	4.0	1.27	0.00
4	2016	19524R	1	QCP	0.28	0.39	0.65	0.81	4.0	3.6	0.55	0.96
5	2015	19514R	1	QCP					5.2		0.00	
6	2015	19514R	1	QCP	0.67				4.6	4.2	0.28	0.00
7	2015	19524R	1	QCP	0.59	0.25	0.17	0.00	4.4	4.1	0.47	0.17
8	2015	19524R	1	QCP					4.4		0.00	
9	2015	19524R	1	PFP	0.45	0.46	0.10	0.59	4.4	4.1	0.59	0.77
10	2015	19512R	1	QCP	0.50		0.78		4.0	4.8	0.38	0.00
11	2015	19512R	1	QCP	1.00				3.8	4.1	0.50	0.00
12	2015	19522R	1	QCP	0.03	0.02	0.15	0.02	3.9	3.1	0.50	1.08
13	2017	19522R	1	QCP	0.33	0.69			4.4	5.9	0.35	0.21
14	2015	19510R	1	QCP	0.50		1.00		3.9	4.5	0.10	0.00
15	2015	19510R	1	QCP					4.2		0.71	
16	2015	19510R	1	QCP	0.85	0.23	0.98	0.28	4.2	4.1	0.32	0.56
17	2015	19512R	1	QCP	1.00				4.2	3.9	0.00	1.56
18	2015	19510R	1	QCP	0.13	0.63	0.22		3.1	2.2	0.24	0.28
19	2015	19536R	1	QCP				0.00		4.2		1.44
20	2017	19525R	1	QCP	0.53	0.90	0.65		4.0	4.8	0.95	0.64
21	2015	19524R	1	QCP	0.67				3.8	3.2	0.07	0.00
22	2015	19524R	1	QCP	1.00				4.1	4.3	0.64	0.00
23	2015	19512R	1	QCP	0.50		1.00		2.8	3.2	0.05	0.00
24	2016	19532R	1	QCP	1.00	0.00			3.0	2.7	0.00	0.57
25	2017	19532R	1	QCP	0.40		0.44		4.1	3.3	0.62	0.00
26	2017	19510R	1	QCP	1.00				4.0	4.3	0.00	0.00
27	2015	19510R	1	QCP	0.25	0.93	0.56	0.00	3.6	4.0	0.35	0.29
28	2017	19665R	1	QCP					2.7		0.00	

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
29	2015	19665R	1	QCP	0.91	0.10	0.16	0.22	2.8	2.9	0.14	0.44
30	2017	19524R	1	QCP	0.67	0.17	0.52	0.96	4.2	4.3	0.52	0.89
31	2017	19525R	1	QCP	0.67				4.4	4.6	0.21	0.00
32	2016	19510R	1	QCP	0.50		0.46		3.2	2.7	0.10	0.00
33	2015	19525R	1	QCP			0.65		4.1		0.59	
34	2016	19512R	1	QCP			0.99		3.3		0.26	
35	2015	19512R	1	QCP	0.67				3.7	3.0	0.39	0.00
36	2015	19522R	1	QCP	0.43		0.33		3.9	4.9	0.61	0.00
37	2015	19522R	1	QCP						5.1		0.00
38	2015	19524R	1	QCP	0.05	0.08	0.33	0.61	4.3	5.5	0.70	1.39
39	2015	19510R	1	QCP	0.93	0.45	0.34		2.8	3.0	0.56	0.85
40	2015	19510R	1	QCP					4.3		0.00	
41	2015	19510R	1	QCP	1.00	0.83			3.1	3.1	1.13	1.48
42	2015	19524R	1	QCP			0.32		4.5		0.44	
43	2015	19524R	1	QCP	0.55	0.76	0.39	0.63	3.8	4.0	0.74	0.82
44	2015	19510R	1	PFP	0.90	0.44	0.22	0.31	3.9	3.9	0.43	0.53
45	2015	19510R	1	PFP					3.1		0.00	
46	2015	19524R	1	QCP	0.20	0.37	0.56	0.61	4.6	5.8	0.53	0.93
47	2015	19655R	1	PFP	0.02	0.00	0.77	0.98	3.4	4.3	0.59	1.41
48	2015	19536R	1	PFP	0.75	0.00	0.74	0.51	4.9	5.1	0.58	1.37
49	2017	19510R	1	QCP	0.40		0.31		3.1	3.7	0.43	0.00
50	2017	19510R	1	QCP	0.44		0.56		3.2	4.2	0.66	0.00
51	2016	19510R	1	QCP	0.27	0.86		0.26	4.2	5.0	0.71	0.78
52	2017	19524R	1	QCP	0.67				4.1	5.3	0.99	0.00
53	2017	19525R	1	QCP	0.67		0.50		3.6	4.4	0.69	0.00
54	2017	19525R	1	PFP	0.04	0.26	0.52	0.40	4.1	4.6	0.57	0.37
55	2016	19525R	1	QCP	0.17	0.20	0.67	1.00	4.3	5.0	0.61	0.20
56	2016	19536R	1	QCP					5.0		0.28	
57	2015	19536R	1	PFP	0.73	0.10	0.00	0.01	4.5	4.4	1.06	1.70
58	2015	19524R	1	QCP	0.02	0.57	0.06	0.83	3.1	1.5	0.48	0.65
59	2017	19524R	1	QCP	0.10	0.75	0.04	0.58	3.4	1.9	0.20	0.26
60	2015	19522R	1	QCP	0.97	0.30	0.10	0.27	4.5	4.1	0.44	0.87
61	2015	19522R	1	QCP	0.05	0.36	0.74	0.82	3.8	2.7	0.69	1.03
62	2015	19510R	1	QCP	0.67				2.8	2.3	0.49	0.00
63	2015	19510R	1	PFP	0.78	0.22	0.07	0.66	3.2	3.0	1.51	0.84

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
64	2017	19524R	1	QCP	1.00				4.7	5.5	0.00	0.00
65	2017	19524R	1	PFP	0.62	1.00	0.41	0.66	3.9	3.9	0.59	0.60
66	2017	19524R	1	QCP	0.67				3.6	4.4	0.00	0.00
67	2017	19510R	1	QCP	0.10	0.22	0.14	0.02	2.7	1.8	0.09	0.26
68	2015	19532R	1	QCP	0.96	0.66	0.26	0.36	3.7	3.6	0.70	0.79
69	2017	19510R	1	QCP	1.00	0.38	0.86	0.97	3.8	4.2	0.80	1.65
70	2016	19510R	1	QCP	1.00				3.6	4.0	0.57	0.00
71	2017	19524R	1	PFP					4.2		0.00	
72	2017	19510R	1	QCP	0.80	0.58		0.19	3.6	3.5	0.21	0.49
73	2017	19510R	1	QCP	0.80	0.05	0.00	0.00	3.8	3.5	0.12	0.69
74	2016	19525R	1	QCP	0.07	0.23	0.80		4.4	5.6	0.46	0.07
75	2017	19665R	1	QCP	1.00	0.34			4.2	4.4	0.42	1.56
76	2017	19655R	1	QCP	0.33	0.00			3.1	3.6	0.57	0.00
77	2017	19665R	1	QCP	0.60	0.29	0.00		4.0	4.2	0.35	0.07
78	2015	19512R	1	QCP	0.37	0.17	0.47	0.68	3.7	4.2	0.59	1.05
79	2015	19522R	1	PFP	0.71	0.71		0.14	3.9	4.1	0.46	0.94
80	2017	19522R	1	QCP	0.44	0.23	0.07		3.2	3.0	0.54	0.08
81	2015	19522R	1	QCP						6.9		0.00
82	2015	19514R	1	QCP	0.35	0.20	0.18	0.49	3.8	4.4	0.58	0.97
83	2015	19524R	1	QCP	0.56	0.83	0.49	0.16	4.0	4.4	0.90	0.75
84	2015	19512R	1	QCP	0.96	0.17	0.11	0.42	3.9	3.9	0.44	0.71
85	2015	19512R	1	QCP	1.00		0.36		4.0	4.1	0.79	0.00
86	2015	19525R	1	PFP			0.15		4.5		0.47	
87	2015	19510R	1	QCP	0.80		0.68		4.2	4.3	0.24	0.00
88	2017	19510R	1	QCP	0.26	0.59	0.09	0.29	3.9	3.5	0.81	1.01
89	2017	19532R	1	QCP	1.00				3.9	3.9	0.64	0.00
90	2016	19524R	1	QCP	1.00		0.51		3.6	3.8	0.57	0.00
91	2016	19524R	1	QCP						3.8		0.78
92	2017	19536R	1	QCP	1.00				3.4	3.4	0.00	0.00
93	2015	19536R	1	QCP	0.18	0.97	0.72	0.17	3.9	3.3	0.61	0.55
94	2015	19524R	1	QCP	0.80	0.17	0.00	0.41	4.9	5.3	0.23	0.77
95	2015	19512R	1	QCP	0.36	0.74	0.04		3.3	3.7	0.56	0.56
96	2015	19512R	1	QCP	0.07	0.51	0.94	0.64	3.1	2.7	0.28	0.38
97	2015	19514R	1	QCP	0.83	0.36	0.12	0.08	4.3	4.4	0.86	1.30
98	2017	19522R	1	QCP	1.00				3.5	4.3	0.00	0.00

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
99	2017	19522R	1	QCP	0.57		0.22		4.5	3.4	0.65	0.00
100	2016	19522R	1	QCP	0.04	0.10	0.47	0.18	3.5	2.8	0.56	0.94
101	2015	19510R	1	QCP	0.67				3.2	2.7	0.42	0.00
102	2015	19510R	1	QCP			0.57		3.0		0.51	
103	2015	19510R	1	QCP	0.33	0.41			2.8	1.8	0.42	0.14
104	2015	19510R	1	QCP	0.67				3.4	2.7	0.00	0.00
105	2017	19510R	1	QCP	0.02	0.16	0.49	0.37	2.7	2.2	0.11	0.27
108	2017	19532R	1	QCP	0.40	0.91	0.49		3.3	2.4	0.69	0.64
107	2017	19532R	1	QCP	0.37	0.96	0.27	0.69	4.0	3.5	0.79	0.71
108	2017	19532R	1	QCP	0.72	0.71	0.50	0.43	4.2	4.2	0.82	0.95
109	2015	19536R	1	QCP	0.50		0.33		5.5	3.6	2.02	0.00
110	2015	19536R	1	QCP	0.50		0.46		4.2	4.9	0.21	0.00
111	2015	19524R	1	QCP	0.50		0.00		4.3	4.9	0.40	0.00
112	2015	19524R	1	QCP	1.00				4.6	4.7	0.71	0.00
113	2015	19524R	1	QCP	0.86	0.79	0.68	0.11	5.0	5.2	0.86	0.76
114	2017	19510R	1	QCP	1.00	0.31			3.7	3.9	0.21	0.85
115	2017	19510R	1	QCP			0.64		2.8		0.46	
116	2016	19510R	1	QCP						3.3		0.28
117	2017	19510R	1	QCP	0.11	0.35	0.00	0.15	3.8	3.5	0.06	0.13
118	2016	19510R	1	QCP	0.04	0.00	0.04		2.6	2.3	0.14	0.00
119	2017	19510R	1	QCP	0.40	0.71	0.36		3.3	3.6	0.26	0.14
120	2017	19510R	1	QCP	1.00	0.65			3.7	3.9	0.35	0.64
121	2017	19510R	1	QCP	0.33	0.00			4.0	4.1	0.07	0.00
122	2015	19522R	1	QCP	0.67				4.1	4.8	0.64	0.00
123	2015	19522R	1	QCP	1.00		0.92		3.8	4.0	0.65	0.00
124	2017	19524R	1	QCP	1.00				3.3	2.9	0.00	0.00
125	2017	19524R	1	QCP	0.50	0.45	0.22	0.24	3.3	2.9	0.44	0.81
126	2017	19524R	1	PFP			0.95		3.1		0.54	
127	2016	19524R	1	QCP	0.67				3.9	4.8	0.57	0.00
128	2017	19524R	1	QCP	0.67		0.23		3.9	4.6	0.66	0.00
129	2017	19524R	1	QCP	1.00	0.99	0.49		3.5	3.6	0.46	0.35
130	2017	19524R	1	QCP	1.00	0.51			5.5	5.7	0.35	0.84
131	2015	19510R	1	QCP	1.00				2.7	3.1	0.00	0.00
132	2015	19510R	1	QCP	0.45	0.03	0.90	0.16	2.3	2.3	0.57	1.24
133	2015	19536R	1	PFP	0.31	0.28	0.48	0.31	3.7	3.1	0.77	1.15

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134	2015	19522R	1	PFP					3.8		1.06	
135	2015	19522R	1	QCP	0.27	0.36	0.68		4.2	4.6	0.24	0.42
136	2015	19536R	1	QCP	1.00				5.5	5.7	0.00	0.00
137	2015	19524R	1	QCP	0.91	0.16	0.16	0.47	3.5	3.5	0.21	0.52
138	2015	19510R	1	QCP	1.00	0.89			3.4	3.4	1.91	2.26
139	2015	19510R	1	QCP	1.00				4.5	4.9	0.00	0.00
140	2015	19524R	1	QCP	0.01	0.23	0.29	0.11	4.0	3.4	0.40	0.53
141	2015	19665R	1	QCP	0.81	0.23	0.02	0.31	3.0	3.1	0.73	0.50
142	2015	19524R	1	QCP	0.20	0.37		0.19	3.0	1.8	0.99	0.49
143	2015	19524R	1	QCP	0.29	0.31	0.97	0.98	3.7	3.2	0.39	0.74
144	2017	19510R	1	QCP	0.86	0.23	0.30		3.2	3.3	0.41	0.78
145	2017	19510R	1	QCP	1.00				3.3	3.2	0.17	0.00
146	2017	19510R	1	QCP	0.20	0.92	0.47		2.9	2.2	0.23	0.21
147	2015	19510R	1	QCP	0.67				3.1	3.5	0.07	0.00
148	2017	19522R	1	QCP	0.40		0.76		3.3	4.3	0.46	0.00
149	2015	19522R	1	QCP	0.39	0.63	0.20	0.30	4.2	4.7	0.66	0.79
150	2015	19536R	1	QCP	0.02	0.69	0.31	1.00	4.2	5.3	0.45	0.30
151	2017	19524R	1	QCP	0.33	0.26			4.1	5.7	0.08	0.38
152	2017	19524R	1	QCP				0.03		3.1		0.53
153	2017	19524R	1	QCP	0.33	0.56			4.6	5.5	0.30	0.64
154	2015	19525R	1	QCP	1.00		0.90		4.2	4.8	0.55	0.00
155	2017	19525R	1	QCP	0.67				3.7	3.9	0.22	0.00
156	2015	19525R	1	QCP	1.00	0.66	0.66		4.8	4.8	0.26	0.28
157	2015	19524R	1	QCP	1.00	0.41	0.73	1.00	4.4	4.7	0.40	0.80
158	2017	18436R	1	QCP	0.67	0.84			3.0	2.4	1.00	0.78
159	2016	19655R	1	QCP	0.67	0.27	0.35		3.6	3.2	0.91	1.70
160	2017	19655R	1	QCP	0.40		0.13		2.8	3.4	0.50	0.00
161	2015	19525R	1	QCP	0.39	0.97	0.54	0.64	4.2	4.6	0.65	0.61
162	2017	19653R	1	QCP	0.24	0.13	0.01	1.00	4.7	5.7	0.49	1.10
163	2016	19665R	1	PFP	0.17	0.00	0.91		3.7	4.6	0.55	0.00
164	2017	19665R	1	QCP	0.80		0.13		2.6	3.0	0.47	0.00
165	2015	19512R	1	QCP	0.26	0.95	0.42	0.99	3.6	2.8	0.77	0.76
166	2015	19512R	1	QCP	0.53	0.29		0.07	2.6	2.2	0.85	0.43
167	2017	19525R	1	QCP	0.70	0.84	0.73	0.94	4.1	3.3	0.81	0.95
168	2017	19525R	1	QCP	0.80	0.67		0.83	4.0	3.4	1.20	0.95

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169	2017	19525R	1	QCP	0.50		0.64		3.7	4.0	0.15	0.00
170	2017	19525R	1	PFP	0.56	0.22	0.78	0.21	3.8	3.6	0.56	0.31
171	2017	19655R	1	PFP	0.81	0.09	0.11	0.53	3.2	3.8	0.67	1.65
172	2015	19512R	1	QCP					3.0		0.00	
173	2015	19522R	1	QCP					3.0		0.00	
174	2015	19522R	1	QCP			0.49		3.7		0.53	
175	2015	19536R	1	QCP	0.53	0.85		0.00	2.5	1.6	0.71	1.13
176	2015	19510R	1	QCP	0.20	0.00	0.00		4.4	5.1	0.17	0.00
177	2015	19510R	1	QCP						5.9		0.00
178	2015	19510R	1	QCP	0.17	0.49	0.26	0.26	3.2	3.6	0.48	0.33
179	2015	19522R	1	QCP			0.06		3.6		0.30	
180	2015	19522R	1	QCP			0.53		4.0		0.39	
181	2015	19522R	1	QCP			0.06		3.9		0.37	
182	2015	19522R	1	QCP	0.29		0.05		3.7	3.3	0.29	0.00
183	2015	19524R	1	PFP	0.02	0.64	0.69	1.00	4.6	5.6	0.46	0.34
184	2015	19510R	1	QCP			0.92		3.6		0.36	
185	2015	19510R	1	QCP	0.03	0.71	0.09	0.00	3.0	2.0	0.19	0.15
186	2017	19510R	1	QCP	1.00		0.88		3.3	3.3	0.45	0.00
187	2015	19522R	1	QCP	0.50		0.60		3.8	4.4	0.44	0.00
188	2015	19524R	1	QCP	1.00		0.69		3.6	3.4	0.26	0.00
189	2015	19524R	1	QCP	0.13	0.33	0.86		3.6	2.1	0.31	0.07
190	2015	19510R	1	QCP	0.14	0.89	0.13		3.2	3.7	0.26	0.21
191	2015	19510R	1	QCP	0.67				3.4	3.8	0.00	0.00
192	2015	19510R	1	PFP	0.25	0.15	0.11	0.83	3.2	3.5	0.48	0.80
193	2015	19510R	1	QCP	0.67	0.48			2.9	3.2	0.14	0.35
194	2015	19510R	1	QCP	0.79	0.67	0.85		2.9	3.0	0.35	0.35
195	2015	19510R	1	QCP			0.97		3.1		0.16	
196	2017	19510R	1	QCP	1.00				3.1	3.4	0.00	0.00
197	2017	19510R	1	QCP	0.67				3.2	2.9	0.07	0.00
198	2017	19510R	1	QCP	1.00				3.7	3.9	0.49	0.00
199	2017	19510R	1	QCP	0.50			0.36	3.2	4.6	0.00	0.26
200	2017	19510R	1	QCP	0.67				3.1	3.9	0.85	0.00
201	2017	19510R	1	QCP	0.67		0.26		3.2	3.5	0.42	0.00
202	2017	19510R	1	QCP	0.40		0.68		3.6	3.3	0.08	0.00
203	2017	19510R	1	QCP	1.00				3.1	3.0	0.07	0.00

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204	2015	19665R	1	PFP	0.95	0.01	0.63	0.80	3.6	3.5	0.26	0.61
205	2015	19665R	1	PFP	0.61	0.16	0.00	0.06	3.3	3.6	0.53	0.81
206	2015	19665R	1	PFP	0.46	0.93	0.17	0.19	3.0	2.8	0.50	0.49
207	2015	19522R	1	QCP	0.34	0.83	0.27	0.40	3.1	4.1	1.04	1.16
208	2015	19524R	1	QCP	0.20	0.00	0.26	0.44	3.5	2.7	0.34	1.09
209	2015	19524R	1	QCP	0.37	0.02	0.48	0.14	4.0	4.4	0.46	0.85
210	2015	19524R	1	QCP	0.50		0.58		3.9	5.1	0.67	0.00
211	2015	19524R	1	QCP	0.17	0.39	0.54	0.46	4.3	4.8	0.32	0.52
212	2015	19524R	1	QCP						5.3		0.00
213	2017	19522R	1	QCP			1.00		3.1		0.20	
214	2015	19536R	1	PFP	0.43	0.04	0.05	0.38	3.6	3.4	0.43	0.76
215	2015	19510R	1	QCP	1.00				3.3	3.7	0.00	0.00
216	2015	19510R	1	QCP	0.67	0.84	0.27	0.63	3.3	3.4	0.51	0.52
217	2015	19510R	1	QCP	0.67				3.4	3.5	0.07	0.00
218	2015	19510R	1	QCP	0.38	0.33	0.52	0.13	4.3	4.7	0.41	0.69
219	2015	19510R	1	QCP	1.00				3.0	3.0	0.35	0.00
220	2015	19510R	1	QCP	0.67				3.5	4.3	0.78	0.00
221	2015	19522R	1	QCP	1.00				2.1	2.2	0.00	0.00
222	2015	19522R	1	QCP	0.46	0.72	0.40	0.78	3.2	2.8	1.02	1.15
223	2015	19536R	1	QCP	0.27	0.62	0.86	0.39	4.7	5.2	0.42	0.54
224	2015	19536R	1	QCP	0.75		0.33		4.5	4.7	0.61	0.00
225	2015	19536R	1	QCP	0.09	0.25	0.01	0.26	3.6	4.4	0.52	0.24
226	2015	19536R	1	QCP					4.3		0.00	
227	2016	19536R	1	QCP					3.7		0.00	
228	2015	19524R	1	PFP	0.19	0.25	0.98	0.66	3.6	3.9	0.51	0.33
229	2016	19524R	1	QCP					3.3		1.70	
230	2016	19524R	1	QCP				0.22		3.6		0.59
231	2015	19655R	1	QCP	0.70	0.70	0.64	0.10	3.4	3.7	0.92	1.01
232	2016	19522R	1	QCP	0.80	0.57	0.67		3.8	4.2	0.60	0.78
233	2015	19522R	1	QCP					4.8		0.00	
234	2015	19522R	1	QCP					4.0		0.00	
235	2017	19524R	1	QCP	1.00	0.44			4.1	4.4	0.35	0.99
236	2017	19524R	1	QCP	1.00				3.4	2.5	0.00	0.00
237	2017	19524R	1	QCP	0.67				3.7	4.7	0.14	0.00
238	2017	19524R	1	QCP	1.00				3.7	3.2	0.00	0.00

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239	2017	19524R	1	PFP	0.29	0.72	0.28		3.5	3.8	0.28	0.28
240	2017	19524R	1	QCP	1.00				3.3	2.0	0.00	0.00
241	2017	19524R	1	QCP	0.33	0.60			4.7	6.0	0.28	0.56
242	2017	19514R	1	QCP	1.00				4.3	4.6	0.00	0.00
243	2015	19514R	1	QCP	0.37	0.23	0.43	0.16	4.0	4.6	0.89	1.94
244	2017	19524R	1	QCP	0.46	0.18	0.56	0.09	3.9	4.7	0.41	1.01
245	2017	19524R	1	QCP	0.17	0.63	0.58	0.21	4.5	5.4	0.67	0.50
246	2015	19525R	1	QCP	0.63	0.19	0.73	0.27	3.8	3.6	0.29	0.70
247	2017	19525R	1	QCP	1.00		0.84		3.8	4.0	0.35	0.00
248	2017	19525R	1	QCP	1.00				3.3	3.4	0.00	0.00
249	2017	19525R	1	QCP	0.86	0.27	0.58		4.2	4.5	0.35	0.65
250	2015	19525R	1	QCP	0.82	0.36	0.15	1.00	3.8	3.6	0.45	0.20
251	2017	19525R	1	QCP	1.00				4.6	4.7	0.00	0.00
252	2017	19525R	1	QCP	1.00				4.5	4.2	0.57	0.00
253	2016	19510R	1	QCP	1.00				2.6	2.7	0.00	0.00
254	2016	19510R	1	QCP					2.6		0.14	
255	2016	19510R	1	QCP	1.00				3.8	4.7	0.00	0.00
256	2016	19510R	1	QCP	0.80	0.65	0.33		3.1	3.2	0.59	0.28
257	2017	19510R	1	QCP	1.00				3.1	2.8	0.35	0.00
258	2017	19510R	1	QCP	1.00				3.7	3.7	0.42	0.00
259	2017	19510R	1	QCP	0.33	0.66			2.9	3.8	0.28	0.49
260	2017	19510R	1	QCP	0.67				2.9	3.3	0.21	0.00
261	2017	19525R	1	QCP	0.28	0.22	0.39	0.64	4.1	4.8	0.52	0.92
262	2017	19536R	1	QCP	0.67				3.4	3.7	0.07	0.00
263	2015	19536R	1	QCP	1.00		0.41		3.0	3.1	0.47	0.00
264	2017	19524R	1	QCP	1.00		0.84		4.7	5.1	0.70	0.00
265	2017	19524R	1	QCP	0.50	0.63	0.25	0.70	3.2	3.5	0.38	0.56
266	2017	19524R	1	QCP	1.00		0.94		4.0	3.6	1.07	0.00
267	2015	19665R	1	QCP	0.12	0.67	0.75	0.78	3.9	4.3	0.38	0.25
268	2015	19525R	1	QCP	0.22	0.29	0.89		3.6	4.2	0.34	0.57
269	2015	19510R	1	QCP	0.03	0.96	0.01	0.33	3.3	5.1	1.07	0.97
270	2015	19524R	1	PFP	0.00	0.64	0.10	0.04	3.4	4.6	0.90	0.77
271	2015	19510R	1	QCP	0.67	0.86	0.61	0.30	3.2	3.0	0.45	0.51
272	2016	19514R	1	QCP	0.11	0.28	0.02	0.70	4.9	5.7	0.46	0.74
273	2016	19514R	1	QCP	0.06	0.90	0.10	0.00	4.1	4.6	0.77	0.79

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274	2017	19510R	1	QCP	0.93	0.22	0.34		3.7	3.5	0.69	1.56
275	2017	19510R	1	QCP	0.79	0.05	0.02	0.18	2.9	3.0	0.65	1.15
276	2017	19510R	1	QCP	1.00		0.41		2.8	2.8	0.47	0.00
277	2016	19512R	1	QCP	0.02	0.76	0.80	0.58	4.1	4.8	0.40	0.43
278	2017	19524R	1	QCP	0.11	0.57	0.19		3.6	4.4	0.56	0.21
279	2017	19524R	1	QCP	0.20	0.37	0.36		3.6	4.2	0.26	0.07
280	2017	19525R	1	PFP	0.00	0.25	0.12	0.81	3.5	4.1	0.74	0.95
281	2017	19525R	1	QCP	0.89	0.90	0.18	0.69	3.9	3.9	0.75	0.80
282	2015	19510R	1	QCP	0.80	0.58		0.38	3.5	3.3	0.42	1.03
283	2015	19524R	1	QCP	0.71	0.95	0.54	0.39	4.1	3.9	0.36	0.41
284	2015	19522R	1	QCP						5.0		0.00
285	2016	19522R	1	QCP					5.1		0.00	
286	2016	19522R	1	QCP			0.00		3.0		0.06	
287	2015	19522R	1	QCP	0.67				2.8	2.3	0.00	0.07
288	2016	19532R	1	QCP	0.40	0.77	0.88		3.6	4.1	0.45	0.49
289	2017	19510R	1	QCP	1.00				3.8	3.2	0.00	0.00
290	2016	19510R	1	QCP						3.1		0.78
291	2017	19510R	1	QCP	0.39	0.21	0.13	0.84	2.9	2.4	0.34	0.70
292	2015	19524R	1	QCP	1.00	0.27	0.23		3.9	4.0	0.56	1.13
293	2016	19524R	1	QCP						5.1		0.00
294	2016	19524R	1	QCP	1.00				4.4	4.2	0.00	0.00
295	2015	19510R	1	QCP	0.54	0.42	0.13	0.49	4.0	4.3	0.77	0.57
296	2015	19665R	1	PFP	0.02	0.61	0.37	0.54	3.4	2.8	0.71	0.80
297	2017	19510R	1	QCP	1.00		0.16		3.1	3.0	0.32	0.00
298	2016	19510R	1	QCP	1.00				2.9	2.9	0.21	0.00
299	2016	19524R	1	QCP	1.00		1.00		3.2	3.2	0.30	0.00
300	2016	19524R	1	QCP	1.00				3.3	3.0	0.35	0.00
301	2015	19536R	1	PFP					4.0		0.00	
302	2015	19536R	1	QCP	0.33	0.13			4.0	3.1	0.07	0.71
303	2015	19536R	1	PFP	0.07	0.15	0.08	0.09	3.4	2.8	1.24	0.79
304	2015	19536R	1	QCP			0.52		4.5		0.91	
305	2015	19512R	1	QCP	0.18	0.25	0.90	0.64	2.9	2.4	0.24	0.46
306	2017	19525R	1	QCP	0.33		0.72		3.5	4.6	0.33	0.00
307	2017	19525R	1	QCP	1.00				4.3	4.2	0.00	0.00
308	2016	19525R	1	QCP	0.57		0.04		4.5	4.9	0.43	0.00

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
309	2017	19525R	1	PFP	0.64	0.22	0.12	0.00	3.6	3.7	0.62	1.04
310	2017	19512R	1	QCP					4.5		0.07	
311	2017	19512R	1	QCP					4.4		0.00	
312	2017	19536R	1	QCP	0.33	0.31			4.6	5.5	0.21	0.85
313	2016	19536R	1	QCP			0.78		3.7		0.25	
314	2017	19510R	1	QCP	0.33	0.58			3.1	2.1	0.42	0.21
315	2017	19510R	1	QCP	0.50		0.46		3.2	2.6	0.21	0.00
316	2017	19510R	1	QCP	0.74	0.38	0.61	1.00	3.0	2.7	0.57	1.00
317	2017	19510R	1	QCP					2.9		0.00	
318	2017	19665R	1	QCP	1.00				4.2	6.4	0.00	0.00
319	2017	19665R	1	PFP	0.23	0.14	0.00	0.73	3.9	3.1	1.50	0.40
320	2017	19525R	1	QCP	1.00				4.8	5.2	0.00	0.00
321	2017	19522R	1	QCP			0.07		3.8		0.66	
322	2017	19522R	1	QCP					3.4		0.00	
323	2017	19653R	1	PFP	0.52	0.67	0.16	0.46	3.6	3.5	0.64	0.60
324	2017	19655	1	PFP	0.79	0.11	0.09	0.20	3.6	3.6	0.59	0.47
325	2015	19532R	1	QCP	0.70	0.07	1.00	0.27	3.6	3.7	0.20	1.08
326	2017	19532R	1	QCP					3.6		0.28	
327	2017	19532R	1	QCP	0.67				4.4	4.2	0.07	0.00
328	2017	19524R	1	QCP	0.73		0.28		3.8	3.3	0.63	0.00
329	2017	19524R	1	QCP	0.20	0.15	0.41	0.69	3.9	3.1	0.46	0.85
330	2017	19524R	1	QCP	0.07	0.78	0.15	0.59	3.8	4.3	0.48	0.51
331	2017	19522R	1	QCP	0.62	0.58	0.48	0.10	3.9	4.0	0.52	0.43
332	2015	19522R	1	QCP	0.57		0.04		3.9	4.5	0.63	0.00
333	2015	19522R	1	QCP					3.9		0.00	
334	2015	19524R	1	PFP	0.13	0.31	0.02	0.65	3.6	3.0	0.50	0.73
335	2015	19524R	1	QCP	0.69	0.87	0.23	0.75	4.3	4.2	0.64	0.68
336	2015	19524R	1	QCP	1.00				4.9	4.9	0.07	0.00
337	2015	19522R	1	QCP	0.14	0.14	0.03	0.09	3.7	2.8	0.61	1.02
338	2015	19524R	1	QCP	0.09	0.99	0.01	0.60	4.3	3.8	0.53	0.49
339	2015	19522R	1	QCP					3.4		0.42	
340	2015	19524R	1	QCP	0.05	0.43	0.07	0.41	3.4	4.1	0.33	0.47
341	2015	19524R	1	PFP					3.0		0.14	
342	2015	19510R	1	QCP	0.80		0.44		3.7	3.6	0.94	0.00
343	2015	19510R	1	PFP	0.06	0.55	0.14	0.33	2.8	2.4	0.39	0.46

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
344	2015	19510R	1	QCP	0.21	0.20	0.37	0.90	2.9	2.0	0.39	0.82
345	2015	19510R	1	PFP	0.65	0.57	0.55	0.61	3.4	3.2	0.67	0.92
346	2015	19510R	1	QCP						3.4		0.00
347	2015	19510R	1	QCP	0.80		0.40		3.1	3.4	0.45	0.00
348	2015	19510R	1	PFP	0.27	0.17	0.08	0.00	3.2	3.4	0.45	0.72
349	2015	19510R	1	QCP			0.14		3.4		0.67	
350	2015	19510R	1	QCP	0.50		0.00		3.6	2.4	0.64	0.00
351	2015	19510R	1	QCP	1.00	0.59			3.6	3.5	0.71	0.35
352	2015	19510R	1	QCP	0.67				3.4	3.9	0.07	0.00
353	2015	19522R	1	QCP						3.0		0.00
354	2015	19536R	1	QCP	0.68	0.01	0.56	0.39	4.4	4.8	0.34	2.05
355	2015	19536R	1	QCP	1.00	0.97	0.80	0.27	4.4	4.2	0.62	0.67
356	2015	19536R	1	PFP	0.05	0.04	0.74	0.11	3.8	4.2	0.51	0.89
357	2016	19524R	1	QCP	1.00				3.5	3.4	0.00	0.00
358	2017	19524R	1	QCP	0.97	0.65	0.17	0.33	3.9	3.8	0.74	0.58
359	2015	19665R	1	QCP	0.57	0.03	0.77	0.19	3.2	3.1	0.67	2.03
360	2015	19665R	1	PFP			0.43		3.3		0.75	
361	2017	19510R	1	QCP	0.86	0.67	0.25	0.00	3.0	3.1	0.68	0.87
362	2015	19655R	1	PFP			0.77		3.5		0.55	
363	2016	19522R	1	QCP	0.75	0.14	0.89	0.60	4.0	4.0	0.36	0.67
364	2016	19524R	1	QCP					3.8		0.00	
365	2016	19514R	1	QCP	1.00				3.5	3.5	0.00	0.00
366	2016	19536R	1	QCP	1.00				3.4	3.4	0.28	0.00
367	2016	19532R	1	QCP	0.10	0.50	1.00	0.00	4.6	4.1	0.30	0.17
368	2017	19522R	1	QCP	1.00		0.60		4.3	3.8	0.64	0.00
369	2017	19522R	1	QCP	0.20		0.12		3.7	5.2	0.62	0.00
370	2017	19524R	1	QCP	0.20	0.21	0.20	0.41	4.2	5.0	0.65	1.14
371	2017	19524R	1	PFP	0.11	0.91	0.84	0.04	4.2	4.9	0.73	0.65
372	2017	19510R	1	QCP	0.57		0.01		2.9	3.1	0.28	0.00
373	2017	19510R	1	QCP	1.00	0.51	0.44		4.2	4.4	0.61	0.22
374	2017	19510R	1	QCP	1.00				3.1	2.4	0.00	0.00
375	2017	19525R	1	QCP	0.40	0.51	0.09	0.08	4.3	5.2	1.01	1.77
376	2017	19510R	1	QCP	0.63	0.17	0.40	0.00	3.2	2.8	0.40	0.98
377	2017	19510R	1	QCP	1.00	0.57	0.97	0.54	2.9	2.9	0.26	0.36
378	2017	19653R	1	QCP					3.7		0.00	

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
379	2017	19653R	1	PFP	0.77	0.06	0.02	0.49	3.5	3.6	0.70	1.09
380	2017	19525R	1	PFP						4.1		1.20
381	2017	19525R	1	PFP	0.25	0.21	0.45	0.94	4.6	5.2	0.74	1.33
382	2017	19655R	1	PFP	0.81	0.13	0.05	0.09	3.4	3.5	0.80	1.35
383	2017	19510R	1	QCP	0.09	0.53	0.82	0.87	3.2	2.8	0.51	0.61
384	2017	19665R	1	PFP	0.30	0.49	0.00	0.20	4.4	5.0	1.94	2.37
385	2017	19665R	1	QCP	0.80	0.34	0.77	0.82	3.7	3.6	0.66	0.98
386	2015	19512R	1	QCP	0.73	0.58	0.22		3.3	3.6	1.06	1.20
387	2015	19514R	1	QCP	0.67				4.1	4.5	0.35	0.00
388	2015	19522R	1	QCP	0.67				3.7	3.4	0.00	0.00
389	2016	19606F	2	PFP	0.60	0.34	0.00	0.01	3.7	3.8	0.63	0.76
390	2014	19514R	2	QCP	0.13	0.60	0.18	0.55	3.5	3.1	0.62	0.72
391	2015	19514R	2	QCP					4.2		0.00	
392	2015	19604FR	2	QCP	0.73	0.72	0.82	0.57	2.8	2.7	0.91	1.10
393	2015	19514R	2	QCP	0.41	0.56	0.36	0.18	4.3	4.8	1.14	0.89
394	2016	19512R	4	QCP					3.5		0.00	
395	2016	19535R	2	QCP	0.44	0.53	0.38	0.07	4.9	5.4	1.29	1.00
396	2015	19534R	2	PFP	0.18	0.38	0.14	0.58	4.2	4.0	0.57	0.65
397	2015	19532R	2	PFP	0.06	0.91	0.27	0.47	4.1	3.9	0.59	0.58
398	2015	19514R	2	QCP	0.25	0.39	0.20	0.48	4.1	3.8	0.63	0.77
399	2017	19514R	2	QCP	0.80		0.03		4.0	4.4	0.70	0.00
400	2015	19524R	2	QCP	0.27	0.72	0.01	0.27	3.7	3.3	0.97	1.08
401	2015	19514R	2	QCP	0.01	0.25	0.99	0.62	3.8	2.9	0.63	0.42
402	2015	19604FR	2	QCP	0.69	0.81	0.99	0.96	3.9	3.6	0.79	0.93
403	2015	19604FR	2	QCP	0.69	0.99	0.53	1.00	3.9	3.5	0.92	0.92
404	2015	19514R	2	QCP	0.46	0.77	0.60	0.50	4.7	4.2	1.13	1.29
405	2016	19604FR	2	QCP	0.58	0.49	0.87	0.07	3.9	3.8	0.67	0.54
406	2016	19514R	2	QCP	0.37	0.73	0.00	0.00	4.6	4.4	0.97	0.90
407	2016	19516R	2	QCP	1.00	0.33			4.4	4.9	0.28	1.06
408	2017	19514R	2	QCP	0.70	0.72	0.46	0.83	3.7	3.6	0.89	0.95
409	2017	19512R	2	QCP	0.12	0.91	0.70	0.94	3.3	2.5	0.93	0.84
410	2017	19512R	2	QCP	0.94	0.16	0.17	0.60	4.1	4.2	1.36	0.54
411	2017	19514R	2	QCP	0.05	0.36	0.04	0.02	4.4	3.5	0.88	0.58
412	2016	19516R	2	QCP	1.00	0.33			4.4	4.9	0.28	1.06
413	2016	19513R	2	QCP	0.33	1.00			3.6	3.1	0.07	0.07

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414	2017	19514R	2	QCP	1.00		0.07		4.7	4.7	1.09	0.00
415	2015	19514R	2	QCP	0.42	0.39	0.55	0.23	4.6	4.2	0.81	1.07
416	2017	19513R	2	QCP					3.6		0.00	
417	2015	19514R	2	QCP	0.83	0.28	0.02	0.57	3.9	3.7	0.53	0.83
418	2016	19514R	2	QCP	0.13	0.41	0.37	0.49	4.4	4.0	0.86	0.71
419	2017	19512R	2	QCP	0.02	0.36	0.54	0.00	3.8	4.7	0.51	0.23
420	2015	19512R	2	QCP	0.10	0.66	0.35	0.54	4.3	4.1	0.78	0.84
421	2015	19512R	2	QCP	0.90	0.22	0.99	0.34	3.6	3.6	1.00	1.38
422	2015	19534R	2	PFP	0.80	0.11	0.00	0.01	3.8	3.8	0.59	0.76
423	2015	19534R	2	PFP	0.26	0.62	0.26	0.12	3.8	3.9	0.46	0.51
424	2016	19534R	2	PFP	0.77	0.17	0.60	0.72	4.0	3.9	0.54	0.77
425	2017	19532R	2	PFP	0.94	0.80	0.19	0.99	4.1	4.0	0.80	0.87
426	2015	19532R	2	PFP	0.74	0.18	0.13	0.25	2.9	3.5	1.21	0.38
427	2017	19535R	2	PFP	0.34	0.49	0.31	0.73	4.6	4.9	0.85	0.66
428	2015	19535R	2	PFP	0.78	0.52	0.09	0.04	4.3	4.3	0.65	0.49
429	2016	19512R	2	QCP	0.44	0.40	0.13	0.14	4.3	4.1	1.13	1.36
430	2015	19654R	2	PFP	0.72	0.60	0.12	0.24	4.1	4.0	0.89	0.81
431	2015	19514R	2	QCP	1.00	0.78			4.6	4.4	1.20	0.85
432	2015	19514R	2	QCP	0.96	0.67	0.61	0.80	4.7	4.6	1.34	1.58
433	2015	19514R	2	QCP	0.71	0.45	0.56	0.24	4.5	4.6	0.70	0.95
434	2016	19532R	2	PFP	0.24	0.52	0.01	0.25	3.8	3.6	0.58	0.63
435	2015	19512R	2	QCP	0.73	0.64	0.45	0.78	4.8	4.6	0.77	0.87
436	2016	19654R	2	PFP	0.30	0.62	0.12	0.51	4.0	4.1	0.94	1.01
437	2016	19654R	2	QCP	0.29	0.00	0.15		3.9	4.0	0.12	0.00
438	2016	19524R	2	QCP	1.00	0.64	0.08	0.19	4.1	4.2	0.82	0.99
439	2017	19524R	4	QCP					3.2		0.00	
440	2016	19534R	2	PFP	0.18	0.96	0.01	0.14	4.0	4.1	0.51	0.50
441	2016	19524R	2	PFP	0.17	0.57	0.94	0.96	4.6	5.2	0.77	0.93
442	2016	19534R	2	PFP	0.61	0.77	0.16	0.13	3.7	3.7	0.58	0.61
443	2015	19524R	2	QCP	0.13	0.02	0.06	0.14	3.9	3.7	0.58	0.90
444	2015	19525R	2	QCP	0.67	0.50		0.04	4.7	4.3	0.99	0.78
445	2015	19532R	2	PFP	0.00	0.90	0.06	0.02	3.9	4.4	0.65	0.66
446	2015	19605FR	2	QCP	0.95	0.55	0.34	0.66	4.0	3.9	0.62	0.51
447	2015	19532R	2	QCP	1.00	0.48			4.9	5.0	0.28	0.71
448	2015	19654R	2	PFP	0.00	0.01	0.71	0.00	3.8	4.5	0.56	0.86

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449	2015	19524R	2	QCP	1.00	0.03	0.98	0.37	3.9	4.0	0.56	1.06
450	2015	19515R	2	QCP				0.63		5.5		0.53
451	2016	19515R	2	QCP	0.01	0.79	0.63	0.55	4.3	5.0	0.69	0.73
452	2014	19604FR	2	QCP	0.54	0.12	0.73	0.04	3.9	4.0	0.58	0.91
453	2015	19605FR	2	QCP	0.50	0.84	0.24	0.71	3.8	4.2	0.81	0.96
454	2015	19525R	2	QCP	0.49	0.60	0.92	0.81	4.7	5.5	0.89	1.24
455	2015	19515R	2	QCP	0.01	0.00	0.02	0.23	3.7	4.4	0.63	1.11
456	2016	19525R	2	QCP	0.28	0.32	0.13	0.38	4.0	4.6	0.63	1.00
457	2015	19525R	2	QCP	0.40	0.76	0.90	1.00	4.3	4.9	0.55	0.70
458	2015	19532R	2	PFP	0.00	0.03	0.01	0.50	3.5	3.9	0.51	0.70
459	2015	19532R	2	QCP	0.80		0.04		3.9	3.5	0.61	0.00
460	2015	19654R	2	PFP	0.62	0.00	0.02	0.00	3.9	4.1	0.65	1.31
461	2015	19526R	2	QCP	1.00				4.7	5.9	0.00	0.00
462	2017	19515R	2	QCP	0.39	0.03	0.01	0.01	4.6	4.9	0.72	0.22
463	2017	19604FR	2	QCP	0.56	0.11	0.09		4.1	3.9	0.21	0.49
464	2017	19532	2	PFP	0.90	0.91	0.55	0.95	4.0	4.0	0.95	0.91
465	2017	19513R	2	QCP	0.62	0.80	0.56		4.7	4.2	1.29	0.71
466	2017	19535R	2	PFP	0.86	0.81	0.28	0.73	4.8	4.8	0.56	0.62
467	2015	19524R	3	QCP	0.08	0.59	0.09	0.11	4.3	3.5	1.05	0.83
468	2017	19524R	1	QCP	0.67				4.1	3.5	0.03	0.00
469	2017	19524R	3	PFP					5.2		0.00	
470	2017	19524R	1	PFP			0.02		4.8		0.41	
471	2016	19524R	3	QCP	0.40		0.37		4.0	4.9	0.26	0.00
472	2017	19522R	3	QCP	0.50		0.72		5.2	4.6	0.06	0.00
473	2015	19535R	3	PFP				0.14		4.5		1.12
474	2017	19510R	1	QCP	0.56	0.65	0.92		3.6	3.1	0.66	0.71
475	2017	19510R	1	QCP	0.05	0.78	0.40	0.90	3.8	3.1	0.52	0.42
476	2016	19524R	3	QCP	1.00	0.84			4.2	4.3	0.64	0.49
477	2017	19525R	1	PFP	0.05	0.79	0.76	0.41	4.3	3.4	0.66	0.47
478	2017	19534R	3	QCP	0.20	0.00	0.00		4.7	3.5	0.23	0.00
479	2016	19524R	3	QCP	0.67				5.0	5.2	0.21	0.00
480	2017	19524R	1	PFP	0.39	0.27	0.75		4.1	3.5	0.64	0.99
481	2017	19524R	3	QCP			0.07		3.6		0.41	
482	2015	19522R	3	QCP	0.40	0.85		0.30	3.5	4.1	0.42	0.64
483	2015	19522R	3	QCP	1.00			0.76	2.9	2.8	0.00	0.91

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
484	2015	19536R	1	QCP			0.00		3.6		0.35	
485	2015	19536R	1	QCP	0.67	0.69			3.8	3.2	0.71	0.42
486	2016	19512R	1	QCP	0.71	0.30	0.03	0.38	3.5	3.5	0.46	0.64
487	2016	19514R	3	QCP	0.20	0.37	0.36		3.5	4.1	0.26	0.07
488	2015	19534R	3	PFP				0.79		4.6		1.01
489	2015	19534R	3	PFP				0.87		4.1		0.50
490	2017	19524R	1	QCP	0.01	0.82	0.05	0.86	4.0	5.4	0.50	0.53
491	2016	19512R	1	QCP	0.01	0.63	0.82	0.73	3.8	4.8	0.68	0.55
492	2017	19534R	3	PFP				0.53		4.2		0.58
493	2017	19532R	3	PFP	0.34			0.22	3.6	4.0	0.00	0.43
494	2017	19510R	1	QCP	0.14	0.26	0.52	0.78	3.7	4.3	0.66	0.25
495	2017	19654R	3	QCP	0.54	0.25	0.03	0.40	3.3	3.3	0.70	0.41
496	2017	19510R	4	PFP	0.68	0.53	0.32	0.26	3.7	3.6	0.46	0.54
497	2015	19515R	4	QCP	1.00		0.79		3.8	3.9	1.02	0.00
498	2016	19515R	4	QCP			0.16		4.0		1.12	
499	2016	19522R	4	PFP					4.7		0.21	
500	2016	19522R	4	PFP	0.12	0.53	0.00	0.14	4.4	4.1	0.75	0.81
501	2016	19532R	3	PFP	0.67	0.64	0.25	0.30	4.1	4.2	0.47	0.43
502	2015	19653R	4	PFP				0.18		4.7		0.91
503	2016	19654R	4	PFP			0.17		4.2		0.52	
504	2017	19654R	4	PFP	0.18	0.89	0.04	0.08	3.9	4.2	0.93	0.96
505	2016	19654R	4	PFP	0.08	0.01	0.46	0.27	4.1	3.8	0.36	0.65
506	2017	19510R	4	QCP					2.4		0.00	
507	2015	19515R	4	QCP					5.6		3.32	
508	2016	19524R	4	PFP	0.10	0.34	0.01	0.99	4.4	4.0	0.50	0.68
509	2016	19525R	4	PFP					4.5		0.00	
510	2015	19525R	4	PFP	0.02	0.17	0.55	0.75	4.8	4.0	0.56	0.88
511	2015	19535R	3	PFP				0.07		4.2		0.55
512	2016	19510R	4	PFP	0.50	0.51	0.54	0.84	3.9	3.8	0.69	0.87
513	2016	19510R	4	PFP	0.43	0.71	0.93	0.63	3.8	3.6	0.45	0.38
514	2017	19510R	4	QCP	0.06	0.68	0.33	0.11	3.3	2.8	0.41	0.46
515	2017	19515R	4	QCP	1.00				4.2	4.4	0.00	0.00
516	2017	19514R	4	PFP			0.64		3.8		0.70	
517	2015	19515R	4	QCP					4.2		0.35	
518	2015	19524R	4	PFP	0.01	0.56	0.10	0.38	5.1	4.4	0.45	0.56

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
519	2016	19512R	4	PFP					4.2		0.00	
520	2017	19522R	4	QCP			0.41		3.6		0.25	
521	2015	19524R	4	PFP	0.00	0.23	0.66	0.28	5.2	3.9	0.28	0.52
522	2016	19512R	4	PFP					3.9		0.00	
523	2015	19514R	4	QCP			0.06		5.2		0.74	
524	2016	19514R	4	PFP	0.84	0.62	0.82	0.38	4.1	4.0	0.79	0.66
525	2015	19514R	4	PFP	0.02	0.75	0.09	0.09	5.2	3.9	0.65	0.82
526	2015	19524R	5	QCP	0.14	0.61	0.92		4.1	3.5	0.43	0.49
527	2015	19514R	5	QCP	0.80		0.01		4.0	3.8	0.34	0.00
528	2016	19514R	5	QCP			0.22		4.6		0.44	
529	2015	19514R	5	QCP	0.84	0.00	0.09		4.4	4.5	0.49	0.00
530	2016	19514R	5	QCP			0.00		4.4		0.29	
531	2016	19524R	5	QCP			0.33		4.4		0.44	
532	2017	19605FR	5	QCP	0.06	0.79	0.41	0.07	4.1	3.4	0.62	0.66
533	2015	19605FR	5	QCP	0.45	0.76	0.94	0.00	3.9	3.5	0.64	0.73
534	2015	19524R	5	QCP	0.34	0.50	0.36	1.00	4.2	4.5	0.55	0.30
535	2016	19514R	5	QCP	0.29		0.11		4.5	3.5	0.55	0.00
536	2017	19524R	5	QCP	0.90	0.08	0.33		4.4	4.5	0.52	1.20
537	2015	19534R	5	QCP	0.29		0.42		3.5	4.7	0.24	0.00
538	2015	19534R	5	PFP	0.28	0.68	0.12	0.69	3.9	4.3	0.46	0.53
539	2017	19535R	5	QCP	0.15	0.21	0.00		4.0	5.1	0.52	0.07
540	2017	19512R	6	QCP					4.3		0.00	
541	2017	19513R	5	QCP						4.3		0.78
542	2017	19532R	5	PFP				0.30		3.8		0.32
543	2016	19534R	5	QCP						3.0		0.00
544	2017	19534R	5	PFP				0.76		4.6		1.16
545	2017	19523R	5	QCP	0.91	0.42	0.65	0.00	3.8	3.9	0.63	0.87
546	2015	19534R	5	PFP	0.13	0.34	0.82	0.68	4.1	4.5	0.34	0.50
547	2016	19513R	5	QCP	0.22		0.85		4.0	5.1	0.61	0.00
548	2016	19514R	5	QCP			0.14		4.0		0.55	
549	2015	19532R	5	PFP	0.85	0.36	0.76	0.35	4.1	4.1	0.41	0.56
550	2015	19535R	5	PFP	0.24	0.78	0.43		3.2	4.0	0.68	0.35
551	2015	19523R	5	QCP	0.36	0.29	0.24	0.13	3.8	3.3	0.55	0.77
552	2015	19505R	5	QCP			0.63		4.2		0.64	
553	2015	19534R	5	PFP	0.15	0.92	0.39	0.36	3.8	4.4	0.66	0.53

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
554	2017	19534R	5	PFP	0.34	0.15	0.21	0.34	4.0	4.3	0.30	0.47
555	2016	19513R	5	QCP					4.8		0.00	
556	2016	19513R	5	QCP	1.00				4.8	4.8	0.21	0.00
557	2015	19532R	5	PFP	0.91	0.58	0.65	0.73	4.3	4.3	0.43	0.29
558	2016	19532R	5	PFP	0.52	0.96	0.40	0.73	4.1	4.0	0.38	0.35
559	2016	19535R	5	PFP	0.31	0.33	0.76	0.33	3.8	4.1	0.41	0.59
560	2017	19535R	5	QCP			1.00		4.0		0.10	
561	2015	19524R	5	QCP	0.80		0.75		3.8	4.0	0.55	0.00
562	2015	19524R	5	QCP	0.66	0.31	0.68		3.8	4.0	0.57	0.85
563	2017	19532R	5	PFP	0.00	0.97	0.00	0.89	4.2	3.6	0.37	0.35
564	2015	19523R	6	QCP	0.64	0.26	0.17	0.95	3.7	3.7	0.52	0.36
565	2015	19513R	6	QCP	0.05	0.73	0.51	0.74	3.6	4.5	0.69	0.74
566	2016	19524R	6	PFP	0.12			0.14	3.0	4.2	0.00	0.63
567	2016	19513R	6	PFP						3.9		0.00
568	2015	19513R	6	QCP	0.10	0.80	0.04	0.22	3.9	3.5	0.44	0.44
569	2015	19522R	6	PFP	0.18	0.93	0.05	0.26	5.0	4.3	0.90	0.94
570	2015	19522R	6	PFP	0.01	0.04	0.02	0.99	4.0	4.5	0.68	0.95
571	2015	19513R	6	QCP	0.25	0.83	0.10	0.85	4.0	4.3	0.48	0.41
572	2015	19513R	6	QCP	0.33	0.65	0.16	0.39	4.3	4.6	0.68	0.74
573	2015	19523R	6	PFP	0.47	0.80	0.00	0.87	4.9	4.4	1.08	1.18
574	2015	19513R	6	QCP	0.00	0.86	0.57	0.12	4.0	4.6	0.44	0.39
575	2015	19523R	6	QCP	0.06	0.92	0.99	0.09	3.6	4.2	0.70	0.68
576	2015	19523R	6	QCP			0.41		4.3		0.39	
577	2017	19523R	8	QCP	0.05	0.19	0.50	0.54	3.9	4.6	0.38	0.62
578	2015	19534R	6	PFP	0.03	0.43	0.27	0.81	3.9	4.3	0.60	0.72
579	2016	19534R	6	PFP	0.78	0.28	0.35	0.57	4.6	4.6	0.29	0.59
580	2015	19522R	6	PFP	0.00	0.03	0.06	0.22	4.7	4.1	0.45	0.68
581	2015	19513R	6	QCP	0.14	0.79	0.49	0.34	4.2	3.9	0.42	0.35
582	2017	19522R	6	QCP	0.17		0.36		3.5	4.1	0.25	0.00
583	2015	19535R	6	PFP	0.64	0.87	0.07	0.32	4.3	4.5	1.03	1.00
584	2015	19535R	6	QCP	1.00		0.30		3.5	3.8	0.40	0.00
585	2015	19535R	6	PFP	0.24	0.04	0.39	0.27	4.5	4.9	0.26	0.67
586	2016	19514R	6	QCP	0.99	0.20	0.11	0.64	4.4	4.4	0.62	1.07
587	2015	19513R	6	QCP	0.86	0.30	0.67	0.14	3.8	3.6	0.42	0.61
588	2015	19522R	6	QCP	0.77	0.06	0.17	0.98	4.1	4.1	0.68	1.21

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589	2016	19532R	6	PFP				0.06		4.5		0.67
590	2015	19532R	6	PFP	0.32	0.29	0.77	0.69	4.1	4.0	0.44	0.53
591	2016	19532R	6	QCP	0.29		0.30		3.8	3.1	0.60	0.00
592	2015	19524R	6	QCP	0.55	0.23	0.69		3.9	3.7	0.48	0.07
593	2015	19512R	6	QCP	0.24	0.10	0.98	0.11	4.1	4.4	0.37	0.57
594	2015	19535R	6	PFP	0.68	0.03	0.47	0.12	4.1	4.1	0.46	0.73
595	2017	19535R	6	PFP	0.05	0.63	0.54	0.15	3.3	3.7	0.37	0.43
596	2016	19535R	6	QCP	1.00		0.95		4.1	4.1	0.68	0.00
597	2017	19513R	6	QCP	0.37	0.90	0.86	0.88	4.0	4.3	0.57	0.45
598	2017	19513R	6	QCP	0.27	0.77	0.20	0.05	4.2	4.0	0.36	0.29
599	2017	19513R	6	QCP	0.84	0.85	0.23		4.6	4.8	0.59	0.49
600	2016	19513R	6	QCP					5.5		0.00	
601	2016	19513R	6	PFP						4.1		0.21
602	2016	19513R	6	QCP	0.00	0.88	0.00	0.20	3.7	4.5	0.70	0.67
603	2016	19513R	6	QCP	0.12	0.23	0.06	0.41	4.0	4.6	0.55	0.25
604	2016	19514R	6	QCP	1.00		0.64		4.6	4.6	0.15	0.00
605	2015	19512R	6	QCP	0.52	0.56	0.41	0.62	3.5	3.9	0.59	0.69
606	2016	19524R	6	QCP	0.32	0.99	0.42	0.09	3.9	4.3	0.76	0.70
607	2015	19513R	6	QCP	1.00		0.02		4.0	3.6	0.84	0.00
608	2017	19513R	6	QCP	0.18	0.94	0.07	0.54	4.3	4.5	0.40	0.36
609	2016	19513R	6	QCP	0.00	0.68	0.79	0.04	3.8	4.7	0.56	0.61
610	2017	19513R	6	QCP	0.02	0.15	0.10	0.04	3.7	4.7	0.54	0.83
611	2016	19513R	6	QCP	0.49	0.24	0.51		3.9	4.4	0.52	0.92
612	2017	19532R	6	PFP	0.00	0.08	0.51	0.28	3.8	4.2	0.29	0.44
613	2016	19524R	6	PFP	0.02	0.06	0.65	0.82	4.7	4.1	0.42	0.72
614	2016	19513R	6	QCP	0.10	0.40	0.50	0.87	4.2	4.9	0.82	0.52
615	2016	19514R	6	QCP	0.01	0.88	0.58	0.01	3.7	4.4	0.49	0.45
616	2016	19534R	7	PFP	0.45	0.01	0.73	0.73	4.6	4.5	0.28	0.78
617	2016	19524R	6	QCP	0.26	0.93	0.58	0.37	3.9	4.1	0.54	0.50
618	2016	19532R	6	PFP	0.24	0.14	0.14	0.21	3.6	3.8	0.48	0.65
619	2016	19523R	6	QCP	0.29		0.71		3.5	4.1	0.39	0.00
620	2016	19524R	6	QCP	0.37	0.42	0.65	0.11	3.9	4.6	1.05	1.38
621	2016	19534R	6	PFP	0.76	0.13	0.66	0.08	3.6	3.6	0.42	0.63
622	2016	19513R	6	QCP	0.80	0.34	0.57	0.13	4.3	4.3	0.50	0.72
623	2016	19512R	6	QCP	0.75	0.30	0.43	0.19	4.1	4.0	0.51	0.32

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624	2017	19514R	6	QCP	0.21	0.11	0.25	0.02	4.3	5.0	0.84	0.29
625	2017	19522R	6	PFP					3.6		0.00	
626	2017	19514R	6	QCP	1.00	0.08	0.01	0.02	4.6	4.2	0.60	1.15
627	2017	19513R	6	QCP	0.11	0.02	0.06	0.00	3.7	4.0	0.52	0.06
628	2015	19524	7	PFP	0.93	0.17	0.10	0.94	4.2	4.6	0.79	1.68
629	2016	19532R	7	QCP	1.00		0.46		4.1	4.0	0.42	0.00
630	2015	19532R	7	PFP			0.76		3.7		0.74	
631	2016	19523R	7	QCP	0.70	0.70	0.32	0.58	4.5	4.8	0.91	0.67
632	2016	19532R	7	QCP	0.14	0.52	0.06		3.6	3.9	0.22	0.28
633	2017	19532R	7	PFP	0.56	0.18	0.28	0.90	4.6	4.3	0.90	0.48
634	2017	19524R	7	PFP						5.1		0.00
635	2016	19523	7	QCP	0.95	0.55	0.80		3.8	3.6	0.67	0.85
636	2017	19523	7	QCP						4.6		0.00
637	2016	19523	7	QCP	0.67	0.08			4.9	4.1	0.07	1.06
638	2017	19523	7	QCP	1.00		0.16		4.4	4.6	0.62	0.00
639	2017	19534R	7	QCP				0.99		4.0		0.89
640	2016	19534R	7	PFP				0.02		4.1		0.78
641	2016	19534R	7	QCP	0.01	0.70	0.40	0.20	3.5	4.3	0.46	0.51
642	2016	19524R	7	QCP	0.45	0.77	0.28	0.01	3.1	3.5	1.22	1.09
643	2016	19523R	7	QCP	0.93	0.12	0.98		3.7	3.7	0.32	0.78
644	2015	19534R	7	PFP						4.0		0.00
645	2015	19534R	7	PFP				1.00		4.1		0.91
646	2016	19534R	7	QCP					3.9		0.35	
647	2015	19534R	7	QCP	1.00	0.79		0.74	3.1	3.1	0.71	1.22
648	2016	19523R	9	QCP	0.00	0.24	0.11	0.19	4.2	3.4	0.57	0.33
649	2016	19605FR	9	QCP	0.05	0.01	0.50	0.01	4.0	3.5	0.48	0.11
650	2015	19534R	7	PFP	0.94	0.89	0.84	0.14	3.5	3.5	0.49	0.52
651	2015	19523R	7	PFP	0.30	0.85	0.69	0.12	3.8	4.1	0.49	0.56
652	2015	19523R	7	QCP	0.74	0.66	0.98	0.28	4.3	3.8	1.41	1.17
653	2016	19524R	7	QCP	0.57	0.48	0.73	0.48	4.2	4.8	0.86	1.20
654	2016	19534R	7	QCP	1.00				3.4	3.7	0.92	0.00
655	2015	19534R	7	PFP	0.09	0.45	0.79	0.09	4.6	4.1	0.58	0.77
656	2016	19654R	7	PFP						3.4		0.00
657	2016	19654R	7	PFP						4.2		0.00
658	2015	19654R	7	PFP	0.60	0.98	0.74	0.50	3.9	4.0	0.77	0.79

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene’s P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
659	2016	19654R	7	PFP	0.63	0.50	0.51	0.78	4.4	4.0	0.33	0.50
660	2016	19654R	7	PFP	0.40	0.99	0.87	0.37	4.1	3.9	0.76	0.77
661	2017	19654R	7	PFP	0.71	0.85	0.64	0.27	4.5	4.4	0.64	0.69
662	2016	19532R	7	PFP	0.60	0.63	0.27	0.93	4.1	4.2	0.71	0.64
663	2017	19532R	7	PFP	1.00				5.5	5.7	0.00	0.00
664	2017	19523R	7	QCP	0.40	0.62	0.64		4.0	4.4	0.31	0.14
665	2015	19505R	7	PFP			0.10		3.7		0.32	
666	2015	19532R	7	PFP	0.45	0.53	0.67	0.40	4.3	4.2	0.81	0.74
667	2016	19532R	7	PFP	0.26	0.76	0.37	0.12	4.1	4.3	0.70	0.74
668	2015	19532R	7	PFP				0.87		4.1		0.69
669	2016	19654R	7	PFP	0.60	0.75	0.93	0.98	4.0	4.1	0.71	0.76
670	2015	19654R	7	PFP	0.97	0.51	0.02	0.54	4.0	3.9	0.59	0.74
671	2016	19532R	7	PFP	0.99	0.64	0.04	0.42	4.1	4.2	0.76	0.84
672	2017	19533R	7	PFP	0.63	0.90	0.74	0.98	4.1	3.9	0.66	0.65
673	2017	19532R	7	PFP	0.75	0.91	0.06	0.43	4.1	4.3	0.88	0.88
674	2017	19532R	7	PFP	0.59	0.80	0.50	0.25	4.4	4.5	0.62	0.70
675	2017	19532R	7	PFP						3.9		0.00
676	2017	19532R	7	PFP	0.78	0.07	0.33	0.67	4.3	4.0	0.88	0.31
677	2016	19523R	8	QCP						4.3		0.00
678	2016	19523R	8	QCP	0.67	0.75			4.0	3.7	0.57	0.85
679	2016	19523R	8	QCP	0.40		0.80		4.1	3.3	0.40	0.00
680	2016	19523R	8	QCP	0.05	0.73	0.93	0.39	4.2	5.1	0.84	0.90
681	2016	19534R	8	QCP	0.01	0.18	0.06	0.30	4.1	3.3	0.65	0.32
682	2015	19534R	8	QCP	0.14		0.31		4.0	3.6	0.35	0.00
683	2015	19534R	8	QCP	0.11	0.09	0.05	0.98	4.2	3.8	0.35	0.58
684	2015	19534R	8	QCP	0.53	0.29	0.11	0.26	4.3	4.4	0.59	0.83
685	2015	19524R	8	QCP	0.58	0.58	0.74	0.42	4.1	4.2	0.47	0.34
686	2017	19524R	8	QCP	0.63	0.76	0.18	0.06	4.3	4.4	1.02	1.14
687	2015	19535R	8	QCP	0.05	0.13	0.03	0.28	4.8	4.2	0.70	0.97
688	2017	19505R	8	QCP	0.43	0.59	0.01	0.21	4.5	4.3	0.84	1.04
689	2015	19505R	8	QCP	0.53	0.11	0.51		3.3	3.2	0.94	0.07
690	2015	19606R	8	QCP	0.29	0.57	0.21		4.4	3.9	0.51	0.57
691	2015	19654R	8	PFP	0.29	0.38	0.11	0.66	4.1	3.8	0.93	0.80
692	2015	19654R	8	PFP	0.32	0.90	0.28	0.86	4.6	4.3	0.90	0.93
693	2015	19534R	8	QCP	0.25	0.10	0.45	0.46	3.7	4.6	0.93	0.21

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene’s P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
694	2015	19654R	8	PFP	0.08	0.24	0.88	0.41	4.0	3.5	0.97	0.72
695	2015	19654R	8	PFP	0.02	0.65	0.43	0.66	4.1	3.7	0.69	0.63
696	2015	19654R	8	PFP	0.13	0.47	0.37	0.28	4.0	3.6	0.69	0.79
697	2015	19535R	8	QCP	0.83	0.80	0.81	0.88	4.0	3.9	0.51	0.41
698	2015	19601R	8	QCP					1.7		0.00	
699	2016	19523R	8	QCP	0.02	0.17	0.42	0.00	4.6	3.7	0.57	0.17
700	2016	19523R	8	QCP						2.9		0.21
701	2016	19532R	8	PFP	1.00	0.80	0.67	0.24	3.3	3.3	0.52	0.56
702	2016	19524R	8	QCP	0.51	0.72	0.06	0.86	3.4	3.2	0.42	0.46
703	2017	19524R	8	QCP	0.67				3.5	3.1	0.42	0.00
704	2016	19524R	8	QCP			0.33		3.5		0.59	
705	2016	19524R	8	QCP	1.00				5.2	5.2	0.00	0.00
706	2016	19524R	8	QCP	0.67				3.8	4.0	0.14	0.00
707	2016	19533R	8	QCP	0.52	0.03	0.00	0.09	4.1	3.9	0.44	1.01
708	2016	19534R	8	PFP	0.94	0.77	0.46	0.75	4.0	3.9	1.02	0.93
709	2016	19534R	8	QCP	0.31	0.18	0.11	0.01	4.0	4.2	0.73	1.20
710	2016	19504R	8	QCP	0.80	0.49	0.88		3.9	4.1	0.82	0.28
711	2016	19523R	8	QCP	1.00	0.73	0.64		3.6	3.6	0.31	0.35
712	2016	19605R	8	QCP	0.67				4.4	3.6	0.64	0.00
713	2016	19534R	8	QCP	0.06	0.50	0.82		4.2	3.0	0.58	0.71
714	2017	19654R	8	PFP						2.2		0.00
715	2017	19654R	8	PFP	0.12	0.07	0.15	0.65	4.3	4.1	0.68	0.86
716	2017	19523R	8	QCP	0.54	0.35	0.32	0.92	3.9	3.7	0.59	0.82
717	2017	19523R	8	QCP	0.62	0.93	0.01	0.48	4.7	4.6	0.86	0.83
718	2017	19524R	8	QCP	0.50		0.85		5.0	4.5	0.37	0.00
719	2017	19524R	8	QCP	0.93	0.58	0.03		4.7	4.6	0.55	0.21
720	2017	19605R	8	QCP	0.93	0.56	0.58		3.9	3.9	0.43	0.57
721	2015	19533R	9	QCP	0.15	0.91	0.75	0.50	3.6	2.9	0.99	0.92
722	2016	19606FR	9	QCP	0.27	0.82	0.27	0.40	4.3	3.6	1.23	1.36
723	2015	19605FR	9	QCP	0.40	0.95	0.36	0.70	3.5	3.1	0.53	0.56
724	2017	19513R	9	PFP						4.1		0.00
725	2016	19532R	9	QCP	0.67				4.6	4.1	0.14	0.00
726	2016	19534R	9	QCP	0.31	0.16	0.08	0.05	4.1	3.7	0.68	1.07
727	2016	19534R	9	QCP	0.54	0.91	0.63	0.62	3.9	3.7	0.71	0.69
728	2017	19524R	8	QCP	0.81	1.00	0.70	0.87	3.3	2.9	1.52	1.45

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene’s P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
729	2017	19524R	8	QCP	0.39	0.56	0.04	0.14	3.6	3.3	0.91	1.20
730	2017	19535R	8	QCP	0.54	0.31	0.44	0.26	4.4	3.5	0.83	1.46
731	2017	19532R	8	QCP	0.11	0.89	0.07	0.01	3.7	4.2	1.01	1.06
732	2017	19532R	9	QCP	0.25		0.00		5.4	4.1	0.44	0.00
733	2015	19532R	9	QCP	0.97	0.13	0.95	0.78	4.2	4.4	0.68	1.26
734	2015	19532R	9	PFP	0.16	0.63	0.65	0.99	4.0	4.3	0.57	0.63
735	2016	19532R	9	PFP	0.00	0.59	0.14	0.94	4.3	3.8	0.63	0.57
736	2016	19532R	9	QCP					3.8		0.00	
737	2017	19532R	9	QCP					3.7		0.00	
738	2015	19532R	9	PFP	0.17	0.52	0.98	0.29	4.5	5.0	0.78	0.58
739	2016	19532R	9	PFP	0.15	0.56	0.00	0.55	4.4	4.3	0.73	0.68
740	2016	19606FR	9	QCP	0.50		0.50		3.1	3.8	0.78	0.00
741	2016	19606FR	9	QCP	1.00				4.5	4.5	0.49	0.00
742	2016	19606FR	9	QCP	0.37	0.80	0.55	0.21	2.8	3.0	0.47	0.51
743	2016	19605FR	9	QCP	0.94	0.73	0.96	0.97	4.2	4.2	0.61	0.65
744	2017	19534R	9	QCP	0.33				3.0	2.5	0.00	0.00
745	2016	19534R	9	QCP	0.67				4.2	3.6	0.14	0.00
746	2016	19534R	9	QCP	0.67		0.86		2.9	3.3	0.32	0.00
747	2016	19534R	9	QCP	0.61	0.30	0.60		3.6	3.3	0.47	0.78
748	2016	19534R	9	QCP	0.89	0.13	0.39	1.00	3.9	3.8	0.38	0.10
749	2015	19523R	9	QCP	1.00		0.46		4.2	4.7	1.71	0.00
750	2015	19523R	9	QCP	0.90	0.50	0.49	0.38	3.5	3.4	0.77	1.00
751	2015	19534R	9	PFP	0.11	0.63	0.18		4.0	5.1	0.84	0.35
752	2015	19534R	9	QCP	1.00		0.18		3.9	3.0	1.04	0.00
753	2015	19534R	9	QCP	1.00		0.78		3.6	3.5	0.50	0.00
754	2017	19534R	9	QCP	0.57		0.31		3.9	3.5	0.79	0.00
755	2015	19606FR	9	QCP	1.00				5.9	4.8	2.19	0.00
756	2015	19606FR	9	QCP	1.00				3.8	3.9	0.00	0.00
757	2016	19535	9	PFP	0.00	0.45	0.32	0.63	3.8	3.4	0.64	0.71
758	2016	19522R	9	QCP	0.21	0.89	0.11	0.01	3.5	3.9	0.60	0.63
759	2017	19532R	9	PFP	0.00	0.31	0.60	0.35	4.2	3.8	0.66	0.73
760	2016	19523R	9	QCP					4.7		0.00	
761	2016	19523R	9	QCP					3.6		0.00	
762	2017	19523R	9	QCP	0.02	0.01	0.31	0.25	4.1	3.5	0.65	1.08
763	2017	19532R	9	PFP	0.41	0.16	0.80	0.25	3.9	3.6	0.53	0.85

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
764	2015	19534R	9	QCP	0.38	0.68	0.26		4.8	5.8	1.19	0.57
765	2015	19533R	9	QCP	1.00		0.54		4.2	4.3	0.72	0.00
766	2015	19533R	9	QCP	1.00	0.28	0.99	0.35	3.9	3.9	0.59	0.29
767	2015	19533R	9	QCP	0.44	0.14	0.32	0.17	3.3	3.2	0.30	0.55
768	2015	19533R	9	QCP	0.87	0.12	0.44	0.25	3.3	3.5	1.15	2.24
769	2015	19533R	9	QCP	0.86		0.41		4.1	4.2	0.88	0.00
770	2015	19533R	9	QCP	0.38	0.45	0.01	0.73	3.6	3.7	0.79	0.40
771	2015	19534R	9	QCP	0.87	0.45	0.03	1.00	3.1	3.2	0.94	1.34
772	2015	19606FR	9	QCP	0.67	0.89			4.2	4.6	1.48	1.77
773	2015	19606	9	QCP	0.80	0.60	0.51	0.62	4.2	4.7	1.14	1.73
774	2016	19606FR	9	QCP	0.10	0.67	0.84	0.19	3.1	2.4	0.35	0.49
775	2015	19606FR	9	QCP	0.93	0.53	0.32		4.1	4.1	0.56	0.71
776	2015	19606FR	9	QCP	0.64	0.68	0.43		3.6	3.9	0.47	0.49
777	2015	19606FR	9	QCP	0.97	0.30	0.45	0.16	3.9	3.9	1.01	1.61
778	2015	19606FR	9	QCP	1.00		0.46		3.7	3.5	0.42	0.00
779	2016	19606FR	9	QCP	0.55	1.00	0.32	0.58	4.7	4.3	1.01	1.00
780	2015	19606FR	9	QCP	0.86	0.52	0.23	0.86	3.5	3.5	0.45	0.32
781	2015	19606FR	9	QCP						3.7		0.00
782	2015	19534R	9	QCP	0.10	0.43	0.53	0.02	3.4	4.2	0.67	0.40
783	2016	19534R	9	QCP	0.28	0.86	0.31		3.7	3.1	0.73	0.42
784	2016	19533R	9	QCP	0.43	0.55	0.54		4.2	3.4	1.27	1.56
785	2016	19523R	9	QCP	1.00				3.9	3.8	0.99	0.00
786	2016	19523R	9	QCP	1.00		0.82		4.2	4.1	0.60	0.00
787	2017	19523R	9	QCP	0.13	0.29	0.02		3.5	2.6	0.72	0.14
788	2017	19523R	9	QCP	0.14	0.00	0.67	0.02	3.8	3.5	0.54	0.06
789	2016	19605FR	9	QCP	1.00	0.00			5.4	5.3	0.21	0.00
790	2016	19605FR	9	QCP	0.67				4.4	3.4	0.49	0.00
791	2017	19605FR	9	QCP	0.33	0.00			3.9	3.2	0.00	0.14
792	2017	19605FR	9	QCP	1.00		0.33		4.4	3.8	0.59	0.00
793	2015	HMA Binder	9	QCP	0.02	0.08	0.04	0.43	4.4	3.9	0.73	1.00
794	2015	HMA Binder	9	QCP	0.41	0.42	0.32	0.02	4.5	4.7	0.83	0.59
795	2015	HMA Binder	9	QCP	0.03	0.97	0.15	0.97	4.1	3.1	0.60	0.62

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
796	2015	HMA Binder	9	QCP	0.64	0.19	0.69		5.0	4.3	0.55	1.13
797	2016	19535	9	PFP	0.43	0.62	0.13	0.02	4.1	4.2	0.71	0.79
798	2016	19535	9	PFP	0.65	0.99	0.01	0.39	3.8	3.7	0.85	0.74
799	2016	19532R	9	PFP	0.46	0.19	0.05	0.03	4.0	4.3	0.83	1.05
800	2016	19532R	9	PFP	0.04	0.65	0.73	0.14	4.3	3.5	0.65	0.47
801	2017	19533R	9	QCP	0.43	0.20	0.06	0.22	3.9	4.0	0.54	0.24
802	2016	19533R	9	QCP	0.98	0.13	0.75	0.92	4.6	4.4	0.75	1.40
803	2017	19534R	9	PFP	0.40	0.18	0.00	0.38	3.9	4.2	0.78	1.02
804	2017	19532R	9	PFP	0.18	0.55	0.01	0.02	4.2	4.1	0.60	0.54
805	2015	19533R	9	QCP	0.58	0.42	0.11	0.64	3.9	4.2	0.62	0.31
806	2016	19534R	9	QCP	0.36	0.39	0.35		4.3	3.7	0.81	0.21
807	2015	19534R	9	QCP	0.80		0.58		3.7	3.1	0.49	0.00
808	2016	19534R	9	QCP	0.73	0.74	0.17	0.33	3.7	3.4	1.24	1.09
809	2016	19606FR	9	QCP	1.00				4.2	4.2	0.07	0.00
810	2016	19534R	9	QCP	0.67		0.35		5.0	4.9	0.29	0.00
811	2015	19605FR	9	QCP	0.33	1.00			3.6	3.2	0.14	0.14
812	2015	19605FR	9	QCP	0.53	0.59	0.86	0.21	3.4	3.2	1.12	0.92
813	2015	19605FR	9	QCP	0.50	0.25	0.64	0.00	2.9	3.0	0.15	0.06
814	2016	19606FR	9	QCP	0.86	0.88	0.07	0.71	2.0	2.0	0.59	0.55
815	2016	19533R	9	QCP	0.76	0.00	0.02		3.7	3.1	1.12	0.00
816	2015	19523R	9	QCP	0.60	0.79	0.85	0.66	3.6	3.5	0.84	0.77
817	2016	19523R	9	QCP	0.57		0.92		3.4	3.9	0.43	0.00
818	2015	19523R	9	QCP	1.00		0.79		3.1	3.5	0.93	0.00
819	2015	19523R	9	QCP	0.87	0.87	0.86	1.00	4.5	4.5	0.64	0.50
820	2015	19523R	9	QCP	0.28	0.67	0.95		3.2	3.5	0.31	0.14
821	2016	19532R	9	QCP	0.53	0.24	0.50	0.17	3.2	3.0	0.39	0.61
822	2016	19532R	9	QCP	0.57	0.00	0.08		3.2	2.9	0.72	0.00
823	2016	19522R	9	QCP	0.41	0.74	0.13	0.02	5.3	5.0	0.51	0.40
824	2016	19532R	9	QCP								
825	2016	19532R	9	QCP				0.57		2.6		0.36
826	2016	19606FR	9	QCP	0.50			0.46	4.1	5.0	0.00	0.62
827	2017	19605FR	9	QCP	0.33				2.5	2.1	0.00	0.00
828	2017	19532R	9	QCP	0.25	0.72	0.25	0.04	4.1	3.8	0.53	0.42
829	2017	19524R	9	QCP	0.57		0.92		4.3	4.9	0.43	0.00

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
830	2017	19534R	9	QCP	1.00	0.09	0.06	0.51	4.0	3.8	0.62	1.12
831	2016	19532R	9	PFP			0.64		4.4		0.15	
832	2016	19523R	9	QCP	0.40	0.83	0.47		3.9	3.4	0.58	0.35
833	2016	19535R	9	PFP					8.1		0.00	
834	2017	19523R	9	QCP	1.00	0.76	0.46	0.36	4.2	4.2	0.21	0.26
835	2017	19532R	9	PFP					3.8		0.00	
836	2017	19532R	9	PFP	0.57		0.63		3.9	4.4	0.33	0.00

C.2 VMA ANALYSIS RESULTS

Table C.2. VMA Analysis Results Summary

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
1	2015	19524R	1	QCP	0.33	0.86			15.4	14.2	0.35	0.28
2	2017	19524R	1	QCP	1.00				14.6	14.7	0.14	0.00
3	2017	19524R	1	QCP	1.00				15.3	15.0	1.06	0.00
4	2016	19524R	1	QCP	0.66	0.83	0.05	0.10	15.2	15.0	0.56	0.67
5	2015	19514R	1	QCP					15.3		0.00	
6	2015	19514R	1	QCP	0.67				15.0	14.6	0.00	0.00
7	2015	19524R	1	QCP	0.76	0.17	0.03	0.00	14.9	14.9	0.19	0.35
8	2015	19524R	1	QCP					15.0		0.14	
9	2015	19524R	1	PFP	0.04	0.57	0.07	0.60	15.1	14.7	0.26	0.32
10	2015	19512R	1	QCP	0.50		0.00		13.6	13.7	0.06	0.00
11	2015	19512R	1	QCP	0.67				12.8	13.0	0.00	0.00
12	2015	19522R	1	QCP	0.07	0.06	0.06	0.10	13.3	12.4	0.61	1.15
13	2017	19522R	1	QCP	0.33	0.00			13.4	14.0	0.00	0.64
14	2015	19510R	1	QCP	1.00		0.00		17.8	17.8	0.06	0.00
15	2015	19510R	1	QCP					17.8		0.00	
16	2015	19510R	1	QCP	0.01	0.05	0.00	0.56	17.9	17.4	0.16	0.42
17	2015	19512R	1	QCP	0.67				13.9	12.9	0.00	0.53
18	2015	19510R	1	QCP	0.13	0.77	0.41		18.1	17.6	0.13	0.07
19	2015	19536R	1	QCP				0.00		14.8		1.21
20	2017	19525R	1	QCP	0.13	0.40	0.71		15.4	16.4	0.39	0.64
21	2015	19524R	1	QCP	0.67				14.9	14.3	0.07	0.00
22	2015	19524R	1	QCP	1.00				15.1	15.4	0.64	0.00
23	2015	19512R	1	QCP	1.00		0.84		12.7	12.5	0.28	0.00
24	2016	19532R	1	QCP	0.33	0.25			12.9	12.2	0.14	0.71
25	2017	19532R	1	QCP	0.80		0.36		13.8	13.2	0.54	0.00
26	2017	19510R	1	QCP	1.00				18.1	18.4	0.00	0.00
27	2015	19510R	1	QCP	0.27	0.12	0.24	0.63	18.2	18.7	0.29	0.62
28	2017	19665R	1	QCP					16.9		0.14	
29	2015	19665R	1	QCP	0.23	0.59	0.91	0.05	17.1	16.9	0.22	0.30
30	2017	19524R	1	QCP	0.47	0.20	0.30	0.95	14.9	15.0	0.46	0.77
31	2017	19525R	1	QCP	0.67				15.2	15.7	0.07	0.00

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
32	2016	19510R	1	QCP	0.50		0.00		18.5	17.7	0.06	0.00
33	2015	19525R	1	QCP			0.79		16.0		0.25	
34	2016	19512R	1	QCP			0.82		13.7		0.29	
35	2015	19512R	1	QCP	0.67				14.5	13.6	0.21	0.00
36	2015	19522R	1	QCP	0.71		0.90		13.0	13.3	0.41	0.00
37	2015	19522R	1	QCP						13.8		0.00
38	2015	19524R	1	QCP	0.14	0.07	0.19	0.67	14.9	15.6	0.49	0.99
39	2015	19510R	1	QCP	0.27	0.54	0.57		18.8	19.5	0.74	0.28
40	2015	19510R	1	QCP					19.7		0.00	
41	2015	19510R	1	QCP	0.33				19.9	20.5	0.00	0.00
42	2015	19524R	1	QCP			0.69		15.4		0.25	
43	2015	19524R	1	QCP	0.26	0.61	0.46	0.11	15.3	14.9	0.52	0.64
44	2015	19510R	1	PFP	0.20	0.90	0.24	0.40	18.3	18.2	0.31	0.32
45	2015	19510R	1	PFP					18.0		0.00	
46	2015	19524R	1	QCP	0.94	0.24	0.65	0.39	16.1	16.0	0.32	0.68
47	2015	19655R	1	PFP	0.69	0.00	0.68	0.40	17.0	17.1	0.46	1.01
48	2015	19536R	1	PFP	0.34	0.07	0.25	0.78	15.3	15.0	0.57	0.96
49	2017	19510R	1	QCP	0.80		0.49		18.4	18.6	0.24	0.00
50	2017	19510R	1	QCP	0.89		0.64		18.5	18.6	0.43	0.00
51	2016	19510R	1	QCP	0.40	0.44		0.79	19.5	19.9	0.14	0.46
52	2017	19524R	1	QCP	0.67				15.1	15.6	0.42	0.00
53	2017	19525R	1	QCP	1.00		0.63		15.4	15.5	0.70	0.00
54	2017	19525R	1	PFP	0.26	0.63	0.17	0.01	15.4	15.7	0.39	0.45
55	2016	19525R	1	QCP	0.80	0.95	0.69	0.00	15.2	15.4	0.53	0.52
56	2016	19536R	1	QCP					16.0		0.28	
57	2015	19536R	1	PFP	0.98	0.15	0.16	0.01	15.4	15.4	0.64	0.97
58	2015	19524R	1	QCP	0.01	0.93	0.02	0.55	14.0	12.6	0.38	0.40
59	2017	19524R	1	QCP	0.10	0.05	0.00	0.54	14.3	13.3	0.06	0.36
60	2015	19522R	1	QCP	0.09	0.56	0.49	0.67	13.7	13.1	0.42	0.61
61	2015	19522R	1	QCP					13.0		0.21	
62	2015	19510R	1	QCP	0.67				19.4	18.9	0.00	0.00
63	2015	19510R	1	PFP	0.83	0.10	0.53	0.21	18.1	17.8	0.97	0.44
64	2017	19524R	1	QCP	1.00				16.0	16.8	0.00	0.00
65	2017	19524R	1	PFP	0.70	0.70	0.30	0.49	15.1	14.9	0.55	0.69
66	2017	19524R	1	QCP	0.67				15.0	15.7	0.42	0.00

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
67	2017	19510R	1	QCP	0.10	0.00		0.00	19.5	18.9	0.00	0.12
68	2015	19532R	1	QCP	1.00		0.78		12.8	13.0	0.50	0.00
69	2017	19510R	1	QCP	0.70	0.75	0.33	0.25	18.9	18.7	0.59	0.76
70	2016	19510R	1	QCP	0.67				18.5	18.8	0.28	0.00
71	2017	19524R	1	PFP					15.0		0.00	
72	2017	19510R	1	QCP	0.20	0.47		0.25	18.9	17.9	0.64	0.38
73	2017	19510R	1	QCP	0.20	0.18	0.64	0.19	18.8	18.1	0.15	0.49
74	2016	19525R	1	QCP	0.43	0.90	0.41		15.6	16.1	0.43	0.35
75	2017	19665R	1	QCP	1.00	0.14			17.0	16.6	0.07	0.64
76	2017	19655R	1	QCP	1.00	0.00			16.1	16.0	0.28	0.00
77	2017	19665R	1	QCP	1.00	0.31	0.30		16.6	16.5	0.32	0.07
78	2015	19512R	1	QCP	0.62	0.04	0.44	0.17	14.0	14.2	0.24	0.59
79	2015	19522R	1	PFP	1.00	0.70		0.22	13.5	13.4	0.35	0.73
80	2017	19522R	1	QCP	0.76	0.00	0.55		13.0	13.0	0.43	0.00
81	2015	19522R	1	QCP						15.7		0.00
82	2015	19514R	1	QCP								
83	2015	19524R	1	QCP	0.65	0.47	0.79	0.23	15.0	15.4	0.64	0.87
84	2015	19512R	1	QCP	1.00	0.36	0.40	0.57	13.4	13.4	0.46	0.62
85	2015	19512R	1	QCP	1.00		0.62		13.4	13.5	0.99	0.00
86	2015	19525R	1	PFP			0.03		15.2		0.63	
87	2015	19510R	1	QCP	1.00		0.63		19.0	19.0	0.34	0.00
88	2017	19510R	1	QCP	0.07	0.87	0.57	0.74	18.6	18.2	0.36	0.38
89	2017	19532R	1	QCP	0.67				13.5	13.9	0.35	0.00
90	2016	19524R	1	QCP	0.50		0.46		14.8	14.4	0.21	0.00
91	2016	19524R	1	QCP						14.5		0.35
92	2017	19536R	1	QCP	1.00				15.3	14.9	0.00	0.00
93	2015	19536R	1	QCP	0.10	0.15	0.15	0.93	14.7	14.2	0.72	0.20
94	2015	19524R	1	QCP	0.86	0.23	0.74	0.91	15.7	16.2	0.39	1.10
95	2015	19512R	1	QCP	0.93	0.73	0.91		13.1	13.3	0.71	0.70
96	2015	19512R	1	QCP	0.06	0.91	0.93	0.51	13.5	13.1	0.35	0.37
97	2015	19514R	1	QCP	0.39	0.39	0.43	0.07	15.5	15.2	0.56	0.83
98	2017	19522R	1	QCP	1.00				13.1	14.1	0.00	0.00
99	2017	19522R	1	QCP	0.29		0.46		14.2	13.4	0.40	0.00
100	2016	19522R	1	QCP	0.00	0.19	0.10	0.13	13.5	12.8	0.43	0.65
101	2015	19510R	1	QCP	1.00				18.4	18.0	0.49	0.00

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
102	2015	19510R	1	QCP			0.00		18.2		0.06	
103	2015	19510R	1	QCP	0.67	0.59			18.2	17.8	0.42	0.21
104	2015	19510R	1	QCP	1.00				18.3	18.4	0.42	0.00
105	2017	19510R	1	QCP	0.38	0.61	0.41	0.39	18.4	18.2	0.39	0.30
108	2017	19532R	1	QCP	0.80	0.96	0.00		13.8	13.3	0.58	0.49
107	2017	19532R	1	QCP	0.40	0.66	0.60	0.22	14.1	13.7	0.67	0.44
108	2017	19532R	1	QCP	0.73	0.50	0.29	0.89	14.3	14.4	0.57	0.76
109	2015	19536R	1	QCP	1.00		0.19		15.6	15.7	0.49	0.00
110	2015	19536R	1	QCP	1.00		0.84		14.9	15.2	0.35	0.00
111	2015	19524R	1	QCP	1.00		0.64		15.5	15.4	0.31	0.00
112	2015	19524R	1	QCP	0.67				15.8	15.2	0.49	0.00
113	2015	19524R	1	QCP	0.91	0.51	0.22	0.01	15.6	15.5	0.87	0.59
114	2017	19510R	1	QCP	1.00	0.00			18.0	17.8	0.00	0.64
115	2017	19510R	1	QCP			0.88		16.6		0.45	
116	2016	19510R	1	QCP						18.0		0.14
117	2017	19510R	1	QCP	0.06	0.15	0.00	0.16	18.0	17.2	0.06	0.21
118	2016	19510R	1	QCP	0.04	0.00		0.00	18.0	17.1	0.00	0.23
119	2017	19510R	1	QCP	0.80	0.00			17.8	18.1	0.00	0.42
120	2017	19510R	1	QCP	1.00	0.75			17.9	17.8	0.28	0.42
121	2017	19510R	1	QCP	0.33	0.59			18.1	17.8	0.07	0.14
122	2015	19522R	1	QCP	1.00				13.5	13.5	0.21	0.00
123	2015	19522R	1	QCP	1.00		0.82		13.3	13.1	0.69	0.00
124	2017	19524R	1	QCP	1.00				15.2	15.2	0.00	0.00
125	2017	19524R	1	QCP	0.30	0.09	0.00	0.00	14.6	14.0	0.12	0.52
126	2017	19524R	1	PFP			0.00		14.7		0.35	
127	2016	19524R	1	QCP	1.00				15.1	15.2	0.28	0.00
128	2017	19524R	1	QCP	0.33		0.11		15.1	15.6	0.44	0.00
129	2017	19524R	1	QCP	1.00	0.83	0.89		15.0	15.0	0.35	0.21
130	2017	19524R	1	QCP	1.00	0.66			16.3	16.4	0.28	0.49
131	2015	19510R	1	QCP	1.00				17.2	17.0	0.00	0.00
132	2015	19510R	1	QCP	0.32	0.70	0.12	0.33	18.5	18.2	0.48	0.42
133	2015	19536R	1	PFP	0.01	0.43	0.94	0.96	14.9	14.2	0.41	0.55
134	2015	19522R	1	PFP					13.5		0.78	
135	2015	19522R	1	QCP	0.67	0.40	1.00		14.1	14.4	0.44	0.73
136	2015	19536R	1	QCP	1.00				15.9	16.2	0.00	0.00

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
137	2015	19524R	1	QCP	0.69	0.45	0.95	0.70	14.3	14.4	0.20	0.33
138	2015	19510R	1	QCP	0.67	0.77			19.0	18.7	0.92	0.64
139	2015	19510R	1	QCP	1.00				19.7	19.7	0.00	0.00
140	2015	19524R	1	QCP	0.00	0.13	0.00	0.19	14.6	14.0	0.23	0.33
141	2015	19665R	1	QCP	0.38	0.39	0.24	0.64	15.8	15.6	0.90	0.68
142	2015	19524R	1	QCP	0.20	0.33		0.82	15.2	14.1	0.14	0.60
143	2015	19524R	1	QCP	0.18	0.24	0.41	0.10	14.4	14.0	0.39	0.83
144	2017	19510R	1	QCP	0.50	0.94	0.31		18.6	18.5	0.31	0.21
145	2017	19510R	1	QCP	0.67				18.9	18.8	0.00	0.00
146	2017	19510R	1	QCP	0.60	0.59	0.78		18.1	17.9	0.25	0.35
147	2015	19510R	1	QCP	0.67				18.1	18.2	0.07	0.00
148	2017	19522R	1	QCP	0.40		0.85		12.8	13.1	0.17	0.00
149	2015	19522R	1	QCP	1.00		0.22		13.2	13.2	0.44	0.00
150	2015	19536R	1	QCP	0.10	0.02	0.04	0.90	14.8	15.5	0.17	0.55
151	2017	19524R	1	QCP	0.33	0.00			15.5	16.1	0.07	0.00
152	2017	19524R	1	QCP				0.16		13.6		0.14
153	2017	19524R	1	QCP	0.67	0.82			14.9	15.5	0.64	0.85
154	2015	19525R	1	QCP	0.50		0.46		15.0	15.3	0.21	0.00
155	2017	19525R	1	QCP	0.67				14.7	14.9	0.07	0.00
156	2015	19525R	1	QCP	0.38	0.57	0.22		15.1	14.8	0.19	0.24
157	2015	19524R	1	QCP	0.80	0.96	0.30	0.53	15.4	15.4	0.22	0.22
158	2017	18436R	1	QCP	1.00	0.69			16.2	16.1	0.21	0.35
159	2016	19655R	1	QCP	0.67	0.11	0.86		16.5	16.9	0.32	0.85
160	2017	19655R	1	QCP	0.40		0.22		16.8	16.5	0.24	0.00
161	2015	19525R	1	QCP	0.04	0.58	0.50	0.06	15.3	15.9	0.16	0.21
162	2017	19653R	1	QCP	0.29	0.15	0.48	0.84	16.6	16.9	0.16	0.35
163	2016	19665R	1	PFP	0.28	0.84	0.48		17.3	17.6	0.24	0.14
164	2017	19665R	1	QCP	1.00		1.00		16.7	16.7	0.21	0.00
165	2015	19512R	1	QCP	0.23	0.99	0.12	0.37	13.4	12.9	0.53	0.50
166	2015	19512R	1	QCP	0.53	0.85		0.17	12.8	12.6	0.28	0.31
167	2017	19525R	1	QCP	0.40	0.47	0.54	0.92	14.8	14.3	0.36	0.65
168	2017	19525R	1	QCP	0.20	0.36		0.90	15.0	14.2	0.14	0.55
169	2017	19525R	1	QCP	1.00		0.78		15.3	15.1	0.25	0.00
170	2017	19525R	1	PFP	0.51	0.10	0.43	0.91	15.0	15.2	0.62	0.27
171	2017	19655R	1	PFP	0.24	0.02	0.32	0.81	16.8	17.5	0.24	0.85

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172	2015	19512R	1	QCP					13.5		0.00	
173	2015	19522R	1	QCP					12.9		0.00	
174	2015	19522R	1	QCP			0.43		13.2		0.27	
175	2015	19536R	1	QCP	1.00	0.39		0.27	14.2	14.1	0.21	0.80
176	2015	19510R	1	QCP	0.60	0.00	0.00		19.4	19.1	0.75	0.00
177	2015	19510R	1	QCP						19.9		0.00
178	2015	19510R	1	QCP	0.42	0.54	0.00	0.09	19.0	18.9	0.40	0.28
179	2015	19522R	1	QCP			0.58		12.9		0.14	
180	2015	19522R	1	QCP			0.14		13.0		0.49	
181	2015	19522R	1	QCP			0.06		12.8		0.34	
182	2015	19522R	1	QCP	0.14		0.38		12.8	11.8	0.31	0.00
183	2015	19524R	1	PFP	0.01	0.63	0.38	0.93	15.3	16.4	0.30	0.37
184	2015	19510R	1	QCP			0.18		19.2		0.18	
185	2015	19510R	1	QCP	0.03	0.02	0.73	0.02	18.7	18.1	0.29	0.06
186	2017	19510R	1	QCP	0.50		0.64		19.0	18.5	0.15	0.00
187	2015	19522R	1	QCP	0.50		0.04		13.3	13.8	0.57	0.00
188	2015	19524R	1	QCP	1.00		0.22		14.8	14.9	0.15	0.00
189	2015	19524R	1	QCP	0.13	0.00	0.02		15.1	13.8	0.06	0.85
190	2015	19510R	1	QCP	0.93	0.49	0.96		19.0	19.0	0.22	0.28
191	2015	19510R	1	QCP	0.67				19.0	18.6	0.14	0.00
192	2015	19510R	1	PFP	0.85	0.16	0.01	0.51	18.8	18.9	0.40	0.66
193	2015	19510R	1	QCP	1.00	0.06			18.9	19.3	0.07	1.56
194	2015	19510R	1	QCP	0.42	0.46	0.81		18.8	18.5	0.33	0.42
195	2015	19510R	1	QCP			0.83		18.9		0.27	
196	2017	19510R	1	QCP	1.00				18.6	18.0	0.00	0.00
197	2017	19510R	1	QCP	1.00				18.8	18.7	0.35	0.00
198	2017	19510R	1	QCP	1.00				19.0	19.0	0.28	0.00
199	2017	19510R	1	QCP	1.00			0.75	18.8	19.4	0.00	0.66
200	2017	19510R	1	QCP	1.00				18.9	19.1	0.57	0.00
201	2017	19510R	1	QCP	1.00		0.55		18.9	18.6	0.30	0.00
202	2017	19510R	1	QCP	0.40		0.49		19.2	18.7	0.24	0.00
203	2017	19510R	1	QCP	1.00				18.6	18.6	0.07	0.00
204	2015	19665R	1	PFP	0.03	0.05	0.08	0.23	17.1	16.8	0.17	0.33
205	2015	19665R	1	PFP	0.35	0.51	0.00	0.19	16.9	16.7	0.55	0.66
206	2015	19665R	1	PFP	0.49	0.81	0.04	0.05	16.6	16.3	0.51	0.47

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
207	2015	19522R	1	QCP	0.15	0.61	0.34	0.53	12.3	13.1	0.62	0.82
208	2015	19524R	1	QCP	0.17	0.00	0.45	0.23	14.9	14.1	0.32	1.06
209	2015	19524R	1	QCP	0.98	0.00	0.06	0.02	15.0	14.7	0.56	1.37
210	2015	19524R	1	QCP	0.50		0.00		14.9	15.8	0.52	0.00
211	2015	19524R	1	QCP	0.73	0.68	0.59	0.99	15.4	15.6	0.43	0.35
212	2015	19524R	1	QCP						16.0		0.00
213	2017	19522R	1	QCP			0.00		13.1		0.12	
214	2015	19536R	1	PFP	0.02	0.26	0.17	0.09	15.0	14.6	0.35	0.47
215	2015	19510R	1	QCP	1.00				18.2	18.3	0.00	0.00
216	2015	19510R	1	QCP	0.32	0.31	0.22	0.33	18.6	18.8	0.33	0.46
217	2015	19510R	1	QCP	0.67				18.8	19.2	0.00	0.00
218	2015	19510R	1	QCP	0.08	0.27	0.11	0.05	19.5	20.0	0.25	0.46
219	2015	19510R	1	QCP	0.67				18.4	18.7	0.07	0.00
220	2015	19510R	1	QCP	0.67				18.7	19.9	0.49	0.00
221	2015	19522R	1	QCP	1.00				12.3	12.1	0.00	0.00
222	2015	19522R	1	QCP	0.92	0.36	0.94	0.31	12.4	12.3	0.75	1.08
223	2015	19536R	1	QCP	0.03	0.83	0.25	0.85	15.2	15.9	0.31	0.34
224	2015	19536R	1	QCP	0.75		0.85		15.0	15.3	0.45	0.00
225	2015	19536R	1	QCP	0.03	0.37	0.42	0.06	14.6	15.3	0.26	0.45
226	2015	19536R	1	QCP					14.9		0.00	
227	2016	19536R	1	QCP					14.6		0.00	
228	2015	19524R	1	PFP	0.84	0.69	1.00	0.75	15.0	15.0	0.40	0.46
229	2016	19524R	1	QCP					14.8		0.85	
230	2016	19524R	1	QCP				0.68		14.4		0.58
231	2015	19655R	1	QCP	0.85	0.43	0.23	0.32	15.6	15.7	0.59	0.72
232	2016	19522R	1	QCP	0.53	0.36	0.86		13.3	12.9	0.53	0.92
233	2015	19522R	1	QCP					13.6		0.00	
234	2015	19522R	1	QCP					13.5		0.00	
235	2017	19524R	1	QCP	0.67	0.87			15.6	15.8	0.64	0.78
236	2017	19524R	1	QCP	1.00				15.0	14.6	0.00	0.00
237	2017	19524R	1	QCP	0.67				15.3	16.3	0.42	0.00
238	2017	19524R	1	QCP	1.00				15.5	14.8	0.00	0.00
239	2017	19524R	1	PFP	0.29	0.14	0.03		15.2	14.6	0.24	0.57
240	2017	19524R	1	QCP	1.00				15.0	13.8	0.00	0.00
241	2017	19524R	1	QCP	0.33	0.59			15.8	17.8	0.14	0.28

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene’s P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
242	2017	19514R	1	QCP	1.00				15.7	15.6	0.00	0.00
243	2015	19514R	1	QCP	0.40		0.48		15.7	12.8	0.84	0.00
244	2017	19524R	1	QCP	0.34	0.22	0.06	0.64	14.8	15.3	0.27	0.61
245	2017	19524R	1	QCP	0.11	0.50	0.57	0.27	15.7	16.3	0.51	0.34
246	2015	19525R	1	QCP	0.40	0.65	0.65	0.78	15.9	16.1	0.31	0.21
247	2017	19525R	1	QCP	0.50		0.25		15.4	15.9	0.38	0.00
248	2017	19525R	1	QCP	1.00				15.5	15.3	0.00	0.00
249	2017	19525R	1	QCP	0.10	0.02	0.00		15.9	16.6	0.04	0.21
250	2015	19525R	1	QCP	0.83	0.26	0.93	0.25	15.5	15.5	0.29	0.11
251	2017	19525R	1	QCP	1.00				15.1	15.8	0.00	0.00
252	2017	19525R	1	QCP	1.00				15.3	15.3	0.42	0.00
253	2016	19510R	1	QCP	1.00				17.8	17.7	0.00	0.00
254	2016	19510R	1	QCP					18.1		0.00	
255	2016	19510R	1	QCP	1.00				19.0	19.4	0.00	0.00
256	2016	19510R	1	QCP	0.60	0.79	0.00		18.6	18.7	0.35	0.21
257	2017	19510R	1	QCP	1.00				18.0	18.0	0.21	0.00
258	2017	19510R	1	QCP	0.67				18.8	19.1	0.21	0.00
259	2017	19510R	1	QCP	0.33	0.59			17.7	18.5	0.28	0.14
260	2017	19510R	1	QCP	0.67				17.6	18.0	0.00	0.00
261	2017	19525R	1	QCP	0.75	0.10	0.15	0.83	15.0	15.3	0.60	1.31
262	2017	19536R	1	QCP	1.00				14.8	14.8	0.07	0.00
263	2015	19536R	1	QCP	1.00		0.84		14.7	14.6	0.35	0.00
264	2017	19524R	1	QCP	0.50		0.70		15.6	16.4	0.56	0.00
265	2017	19524R	1	QCP	0.20	0.25	0.64	0.00	14.5	15.2	0.15	0.40
266	2017	19524R	1	QCP	1.00		0.93		15.0	14.8	0.94	0.00
267	2015	19665R	1	QCP	0.23	0.98	0.01	0.43	16.2	16.5	0.31	0.28
268	2015	19525R	1	QCP	0.50	0.51	0.63		15.1	15.3	0.22	0.08
269	2015	19510R	1	QCP	0.21	0.20	0.09	0.52	18.8	20.2	1.04	1.82
270	2015	19524R	1	PFP	0.00	0.36	0.07	0.31	14.2	15.0	0.60	0.44
271	2015	19510R	1	QCP	0.37	0.04	0.27	0.24	17.6	18.0	0.74	0.35
272	2016	19514R	1	QCP	0.03	0.34	0.03	0.03	15.8	16.8	0.42	0.63
273	2016	19514R	1	QCP	0.01	0.51	0.11	0.52	15.3	16.3	0.60	0.78
274	2017	19510R	1	QCP	0.80	0.49	0.37		18.9	18.9	0.73	1.06
275	2017	19510R	1	QCP	0.38	0.09	0.00	0.02	18.7	18.6	0.43	0.70
276	2017	19510R	1	QCP	1.00		0.25		18.4	18.5	0.38	0.00

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
277	2016	19512R	1	QCP	0.01	0.38	0.69	0.98	14.2	14.8	0.27	0.38
278	2017	19524R	1	QCP	0.18	0.59	0.80		14.5	14.9	0.36	0.14
279	2017	19524R	1	QCP	0.60	0.55	0.00		14.4	14.5	0.17	0.07
280	2017	19525R	1	PFP	0.09	0.18	0.07	0.43	15.2	15.6	0.54	0.72
281	2017	19525R	1	QCP	0.56	0.96	0.27	0.51	15.3	15.1	0.58	0.60
282	2015	19510R	1	QCP	0.27	0.27		0.35	18.1	17.4	0.14	0.76
283	2015	19524R	1	QCP	0.75	0.89	0.54	0.13	14.5	14.4	0.36	0.36
284	2015	19522R	1	QCP						13.5		0.00
285	2016	19522R	1	QCP					14.6		0.00	
286	2016	19522R	1	QCP			1.00		13.4		0.10	
287	2015	19522R	1	QCP	0.67				12.4	11.6	0.00	0.06
288	2016	19532R	1	QCP	1.00	0.59	0.30		13.6	13.6	0.32	0.14
289	2017	19510R	1	QCP	1.00				18.7	18.9	0.00	0.00
290	2016	19510R	1	QCP						18.3		0.00
291	2017	19510R	1	QCP	0.36	0.72	0.07	0.78	18.7	18.1	0.71	0.50
292	2015	19524R	1	QCP	0.53	0.48	0.62		15.4	15.1	0.56	0.82
293	2016	19524R	1	QCP						15.4		0.00
294	2016	19524R	1	QCP	1.00				15.3	14.9	0.00	0.00
295	2015	19510R	1	QCP	0.78	0.87	0.99	0.48	18.8	18.7	0.46	0.45
296	2015	19665R	1	PFP	0.00	0.95	0.92	0.07	17.0	16.3	0.60	0.60
297	2017	19510R	1	QCP	0.18		0.04		18.9	19.4	0.25	0.00
298	2016	19510R	1	QCP	1.00				18.7	18.6	0.07	0.00
299	2016	19524R	1	QCP	1.00		0.64		14.7	14.6	0.15	0.00
300	2016	19524R	1	QCP	0.67				14.8	14.6	0.14	0.00
301	2015	19536R	1	PFP					15.2		0.00	
302	2015	19536R	1	QCP	0.33	1.00			15.6	15.0	0.14	0.14
303	2015	19536R	1	PFP	0.05	0.20	0.00	0.00	14.5	14.0	1.13	0.76
304	2015	19536R	1	QCP			0.37		15.2		1.12	
305	2015	19512R	1	QCP	0.33		0.93		13.0	12.7	0.19	0.00
306	2017	19525R	1	QCP	0.33		0.03		15.5	15.8	0.19	0.00
307	2017	19525R	1	QCP	1.00				15.5	15.9	0.00	0.00
308	2016	19525R	1	QCP	0.86		0.14		15.6	16.0	0.56	0.00
309	2017	19525R	1	PFP	0.60	0.28	0.06	0.56	15.3	15.7	0.53	0.84
310	2017	19512R	1	QCP					15.5		0.28	
311	2017	19512R	1	QCP					14.8		0.00	

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
312	2017	19536R	1	QCP	0.67	0.59			15.9	16.2	0.35	0.71
313	2016	19536R	1	QCP			0.64		15.2		0.15	
314	2017	19510R	1	QCP	0.67	0.69			18.6	18.4	0.35	0.21
315	2017	19510R	1	QCP	0.50		0.78		18.5	19.1	0.25	0.00
316	2017	19510R	1	QCP	0.86	0.96	0.80	1.00	18.4	18.3	0.22	0.20
317	2017	19510R	1	QCP					18.3		0.00	
318	2017	19665R	1	QCP	1.00				17.7	18.8	0.00	0.00
319	2017	19665R	1	PFP	0.44	0.91	0.00	0.27	17.7	17.2	0.87	0.70
320	2017	19525R	1	QCP	1.00				15.9	16.4	0.00	0.00
321	2017	19522R	1	QCP			0.39		13.7		0.30	
322	2017	19522R	1	QCP					13.0		0.00	
323	2017	19653R	1	PFP	0.27	0.75	0.14	0.74	16.3	16.4	0.50	0.47
324	2017	19655	1	PFP	0.42	0.22	0.05	0.02	17.6	17.5	0.51	0.43
325	2015	19532R	1	QCP	0.70	0.26	0.88	0.06	13.4	13.7	0.42	1.10
326	2017	19532R	1	QCP					13.6		0.00	
327	2017	19532R	1	QCP	0.67				14.0	13.4	0.00	0.00
328	2017	19524R	1	QCP	1.00		0.10		15.2	15.3	0.46	0.00
329	2017	19524R	1	QCP	0.08	0.59	0.03	0.90	15.1	14.8	0.27	0.33
330	2017	19524R	1	QCP	0.10	0.90	0.96	0.08	15.2	15.4	0.32	0.33
331	2017	19522R	1	QCP	0.32	0.36	0.34	0.00	13.5	13.6	0.48	0.34
332	2015	19522R	1	QCP	0.86		0.38		13.2	13.4	0.49	0.00
333	2015	19522R	1	QCP					13.6		0.00	
334	2015	19524R	1	PFP	0.00	0.29	0.84	0.53	15.1	14.4	0.31	0.47
335	2015	19524R	1	QCP	0.18	0.48	0.38	0.14	15.7	15.3	0.55	0.38
336	2015	19524R	1	QCP	0.67				16.1	15.9	0.00	0.00
337	2015	19522R	1	QCP	0.12	0.97	0.24	0.65	12.9	12.5	0.41	0.37
338	2015	19524R	1	QCP	0.46	0.92	0.83	0.38	14.9	14.8	0.35	0.31
339	2015	19522R	1	QCP					12.7		0.00	
340	2015	19524R	1	QCP	0.45	0.27	0.02	0.00	14.4	14.4	0.10	0.17
341	2015	19524R	1	PFP					14.8		0.57	
342	2015	19510R	1	QCP	0.40		0.01		15.8	14.3	1.66	0.00
343	2015	19510R	1	PFP	0.00	0.18	0.02	0.11	18.4	17.5	0.32	0.48
344	2015	19510R	1	QCP	0.04	0.00	0.93		18.6	18.1	0.19	0.00
345	2015	19510R	1	PFP	0.19	0.65	0.66	0.99	18.8	18.6	0.28	0.36
346	2015	19510R	1	QCP						18.2		0.00

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
347	2015	19510R	1	QCP	1.00		0.71		18.3	18.2	0.39	0.00
348	2015	19510R	1	PFP	0.47	0.00	0.05	0.00	18.5	12.4	0.14	7.99
349	2015	19510R	1	QCP			0.41		18.4		0.47	
350	2015	19510R	1	QCP	0.50		0.78		18.5	18.2	0.25	0.00
351	2015	19510R	1	QCP	1.00	0.54			18.3	18.3	0.35	0.78
352	2015	19510R	1	QCP	0.67				18.6	19.2	0.35	0.00
353	2015	19522R	1	QCP						13.0		0.00
354	2015	19536R	1	QCP	0.70	0.03	0.28	0.53	15.4	15.6	0.30	1.32
355	2015	19536R	1	QCP	0.64	0.41	0.98	0.09	15.1	14.9	0.56	0.37
356	2015	19536R	1	PFP	0.88	0.01	0.60	0.15	14.8	14.8	0.33	0.71
357	2016	19524R	1	QCP	1.00				14.3	14.0	0.00	0.00
358	2017	19524R	1	QCP	0.58	0.36	0.25	0.49	15.1	14.8	0.54	0.33
359	2015	19665R	1	QCP	0.98	0.12	0.54	0.14	17.5	17.3	0.65	1.39
360	2015	19665R	1	PFP			0.56		17.7		0.70	
361	2017	19510R	1	QCP	0.46	0.48	0.31	0.13	18.1	18.0	0.35	0.54
362	2015	19655R	1	PFP			0.13		17.3		0.26	
363	2016	19522R	1	QCP	0.52	0.96	0.47	0.80	13.8	13.5	0.51	0.50
364	2016	19524R	1	QCP					14.8		0.00	
365	2016	19514R	1	QCP	1.00				14.8	14.4	0.00	0.00
366	2016	19536R	1	QCP	0.67				14.7	14.4	0.14	0.00
367	2016	19532R	1	QCP	1.00	0.44	0.98	0.03	14.3	14.1	0.33	0.62
368	2017	19522R	1	QCP	0.33		0.17		13.7	13.4	0.13	0.00
369	2017	19522R	1	QCP	0.80		0.33		13.3	13.6	0.49	0.00
370	2017	19524R	1	QCP	0.65	0.23	0.33	0.34	15.1	15.1	0.31	0.53
371	2017	19524R	1	PFP	0.31	0.84	0.01	0.30	15.0	15.2	0.57	0.49
372	2017	19510R	1	QCP	0.57		0.21		18.0	17.8	0.18	0.00
373	2017	19510R	1	QCP	0.93	0.41	0.33		18.7	18.8	0.50	0.14
374	2017	19510R	1	QCP	1.00				18.0	17.5	0.00	0.00
375	2017	19525R	1	QCP	0.63	0.20	0.04	0.27	15.5	16.1	0.37	1.12
376	2017	19510R	1	QCP	0.51	0.19	0.27	0.42	18.4	17.9	0.29	0.68
377	2017	19510R	1	QCP	0.63	0.71	0.58	0.36	18.2	18.0	0.22	0.26
378	2017	19653R	1	QCP					15.4		0.00	
379	2017	19653R	1	PFP	0.13	0.16	0.34	0.84	16.1	15.7	0.51	0.72
380	2017	19525R	1	PFP						15.2		0.57
381	2017	19525R	1	PFP	0.22	0.11	0.38	0.10	15.1	15.4	0.34	0.74

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
382	2017	19655R	1	PFP	0.12	0.07	0.71	0.27	16.5	16.1	0.41	0.76
383	2017	19510R	1	QCP	0.00	0.10	0.17	0.32	18.5	18.1	0.30	0.15
384	2017	19665R	1	PFP	0.32	0.61	0.00	0.02	17.0	17.4	1.59	1.83
385	2017	19665R	1	QCP	0.64	0.96	0.05	0.99	16.3	16.1	0.34	0.34
386	2015	19512R	1	QCP	0.95	0.21	0.20		13.5	13.4	0.61	1.13
387	2015	19514R	1	QCP	0.67				15.2	14.6	0.07	0.00
388	2015	19522R	1	QCP	0.67				13.2	12.9	0.07	0.00
389	2016	19606F	2	PFP	0.41	0.45	0.56	0.27	14.9	15.0	0.53	0.61
390	2014	19514R	2	QCP								
391	2015	19514R	2	QCP					15.8		0.00	
392	2015	19604FR	2	QCP	0.85	0.50	0.86	0.86	13.5	13.8	1.40	0.97
393	2015	19514R	2	QCP	0.63	0.36	0.65	0.52	15.1	15.3	0.79	0.54
394	2016	19512R	4	QCP					13.1		0.00	
395	2016	19535R	2	QCP	0.32	0.39	0.12	0.01	15.9	16.3	1.00	0.71
396	2015	19534R	2	PFP	0.30	0.30	0.07	0.30	15.4	15.3	0.49	0.57
397	2015	19532R	2	PFP	0.27	0.99	0.18	0.27	13.4	13.3	0.43	0.43
398	2015	19514R	2	QCP	0.33	0.42	0.37	0.21	15.7	15.5	0.46	0.35
399	2017	19514R	2	QCP	0.80		0.11		15.6	16.0	0.63	0.00
400	2015	19524R	2	QCP	0.50	0.80	0.17	0.36	15.4	15.1	0.71	0.53
401	2015	19514R	2	QCP	0.01	0.11	0.75	0.21	14.1	13.7	0.44	0.25
402	2015	19604FR	2	QCP	0.31	0.84	0.07	0.98	14.6	14.2	0.43	0.38
403	2015	19604FR	2	QCP	0.40	0.77	0.41	0.53	14.3	14.0	0.39	0.47
404	2015	19514R	2	QCP	0.76	0.56	0.67	0.26	15.0	14.8	0.62	0.82
405	2016	19604FR	2	QCP	0.03	0.01	0.12	0.15	14.8	14.5	0.43	0.19
406	2016	19514R	2	QCP	0.00	0.16	0.01	0.00	15.6	15.2	0.59	0.44
407	2016	19516R	2	QCP	0.67	0.66			15.0	14.5	0.28	0.49
408	2017	19514R	2	QCP	0.28	0.58	0.99	0.47	15.5	15.0	0.65	0.78
409	2017	19512R	2	QCP	0.02	0.59	0.66	0.61	13.4	12.7	0.60	0.46
410	2017	19512R	2	QCP	0.59	0.02	0.88	0.65	13.8	13.4	0.68	0.13
411	2017	19514R	2	QCP	0.03	0.02	0.27	0.23	15.8	15.3	0.77	0.24
412	2016	19516R	2	QCP	0.67	0.66			15.0	14.5	0.28	0.49
413	2016	19513R	2	QCP	0.33	0.00			14.0	13.6	0.00	0.21
414	2017	19514R	2	QCP	0.80		0.72		15.9	15.7	0.79	0.00
415	2015	19514R	2	QCP	0.33	0.70	0.47	0.13	15.4	15.1	0.50	0.56
416	2017	19513R	2	QCP					14.4		0.20	

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
417	2015	19514R	2	QCP	0.80	0.86	0.45	0.87	14.9	14.8	0.43	0.44
418	2016	19514R	2	QCP	0.06	0.31	0.51	0.39	14.8	14.4	0.69	0.54
419	2017	19512R	2	QCP	0.15	0.22	0.02	0.00	13.8	14.2	0.51	0.17
420	2015	19512R	2	QCP	0.34	0.66	0.33	0.84	13.6	13.4	0.76	0.82
421	2015	19512R	2	QCP	0.81	0.11	0.02	0.00	12.9	12.6	0.73	1.12
422	2015	19534R	2	PFP	0.50	0.20	0.62	0.59	15.0	15.1	0.45	0.55
423	2015	19534R	2	PFP	0.21	0.09	0.10	0.62	14.4	14.5	0.31	0.44
424	2016	19534R	2	PFP	0.04	0.24	0.17	0.37	15.0	14.7	0.44	0.60
425	2017	19532R	2	PFP	0.24	0.94	0.67	0.57	14.5	13.9	1.17	1.19
426	2015	19532R	2	PFP	0.80	0.59	0.00	1.00	12.6	12.9	0.64	0.40
427	2017	19535R	2	PFP	0.67	0.28	0.71	0.24	15.8	15.8	0.61	0.41
428	2015	19535R	2	PFP	0.57	0.85	0.27	0.69	15.4	15.5	0.38	0.37
429	2016	19512R	2	QCP	0.58	0.44	0.23	0.85	14.8	14.6	1.22	1.45
430	2015	19654R	2	PFP	0.92	0.30	0.52	0.11	17.9	17.9	0.61	0.50
431	2015	19514R	2	QCP	0.67	0.85			15.6	15.3	0.99	0.78
432	2015	19514R	2	QCP	1.00	0.62	0.94	0.83	15.2	15.3	1.12	1.36
433	2015	19514R	2	QCP	0.27	0.67	0.09	0.46	15.6	15.3	0.50	0.59
434	2016	19532R	2	PFP	0.96	0.47	0.00	0.07	13.4	13.4	0.48	0.53
435	2015	19512R	2	QCP	0.57	0.38	0.97	0.65	14.1	14.3	0.68	0.50
436	2016	19654R	2	PFP	0.91	0.53	0.64	0.38	17.7	17.6	0.51	0.56
437	2016	19654R	2	QCP	0.29	0.00	0.14		17.7	17.5	0.12	0.00
438	2016	19524R	2	QCP	0.43	0.69	0.32	0.46	15.0	14.6	0.61	0.42
439	2017	19524R	4	QCP					15.9		0.00	
440	2016	19534R	2	PFP	0.08	0.67	0.03	0.01	15.1	15.0	0.35	0.38
441	2016	19524R	2	PFP	0.83	0.40	0.73	0.74	16.0	16.1	0.69	0.92
442	2016	19534R	2	PFP	0.77	0.39	0.85	0.88	14.9	14.9	0.46	0.52
443	2015	19524R	2	QCP	0.06	0.08	0.18	0.11	14.4	14.1	0.70	0.99
444	2015	19525R	2	QCP	0.78	0.52		0.34	15.3	15.0	0.99	0.80
445	2015	19532R	2	PFP	0.00	0.47	0.47	0.11	13.5	13.8	0.50	0.55
446	2015	19605FR	2	QCP	0.06	0.02	0.06	0.01	14.9	14.5	0.31	0.71
447	2015	19532R	2	QCP	1.00	0.31			13.4	13.3	0.07	0.28
448	2015	19654R	2	PFP	0.00	0.00	0.02	0.00	16.6	17.0	0.40	0.67
449	2015	19524R	2	QCP	0.26	0.08	0.51	0.67	15.1	14.8	0.54	0.89
450	2015	19515R	2	QCP				0.75		15.6		0.37
451	2016	19515R	2	QCP	0.24	0.45	0.43	0.66	15.1	15.4	0.56	0.46

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452	2014	19604FR	2	QCP	0.26	0.23	0.82	0.01	15.0	15.1	0.65	0.92
453	2015	19605FR	2	QCP	0.80	0.52	0.64	0.50	14.9	15.1	0.46	0.78
454	2015	19525R	2	QCP	0.97	0.45	0.63	0.48	15.5	15.8	0.69	1.12
455	2015	19515R	2	QCP	0.04	0.00	0.14	0.36	14.8	15.3	0.44	0.86
456	2016	19525R	2	QCP	0.08	0.41	0.68	0.27	15.2	16.2	0.49	0.70
457	2015	19525R	2	QCP	1.00	0.72	0.51	0.25	15.4	15.3	0.57	0.76
458	2015	19532R	2	PFP	0.07	0.02	0.05	0.00	13.6	13.7	0.48	0.68
459	2015	19532R	2	QCP	0.40		0.27		13.5	12.7	0.69	0.00
460	2015	19654R	2	PFP	0.62	0.00	0.13	0.25	16.4	16.6	0.42	0.78
461	2015	19526R	2	QCP	1.00				15.9	15.5	0.00	0.00
462	2017	19515R	2	QCP	0.02	0.01	0.60	0.20	15.0	15.7	0.60	0.13
463	2017	19604FR	2	QCP	1.00	0.23	0.91		14.8	14.8	0.23	0.42
464	2017	19532	2	PFP	0.34	0.86	0.50	0.62	14.6	13.8	1.34	1.25
465	2017	19513R	2	QCP	0.40	1.00	0.60		15.8	15.3	0.90	0.64
466	2017	19535R	2	PFP	0.17	0.60	0.13	0.04	15.9	15.7	0.39	0.32
467	2015	19524R	3	QCP	0.03	0.28	0.57	0.28	15.3	14.5	0.88	0.56
468	2017	19524R	1	QCP	0.67				15.6	14.8	0.00	0.00
469	2017	19524R	3	PFP					15.4		0.00	
470	2017	19524R	1	PFP			0.03		15.5		0.22	
471	2016	19524R	3	QCP	1.00		0.26		14.2	14.3	0.24	0.00
472	2017	19522R	3	QCP	0.50		0.00		14.2	13.7	0.17	0.00
473	2015	19535R	3	PFP				0.18		14.9		0.66
474	2017	19510R	1	QCP	0.78	0.42	0.62		19.1	18.9	0.40	0.57
475	2017	19510R	1	QCP	0.04	0.49	0.07	0.43	18.9	18.4	0.29	0.40
476	2016	19524R	3	QCP	0.67	0.92			15.5	15.1	0.49	0.57
477	2017	19525R	1	PFP	0.02	0.55	0.83	1.00	15.3	14.5	0.52	0.30
478	2017	19534R	3	QCP	0.20	0.69	0.00		15.3	14.8	0.12	0.14
479	2016	19524R	3	QCP	1.00				15.9	16.0	0.21	0.00
480	2017	19524R	1	PFP	0.15	0.42	0.06		14.9	14.3	0.44	0.57
481	2017	19524R	3	QCP			0.57		14.7		0.32	
482	2015	19522R	3	QCP	0.20	0.12		0.31	13.6	14.0	0.02	0.28
483	2015	19522R	3	QCP	0.50			0.96	13.5	12.5	0.00	0.28
484	2015	19536R	1	QCP			0.00		14.1		0.23	
485	2015	19536R	1	QCP	0.67	0.48			14.4	14.2	0.14	0.35
486	2016	19512R	1	QCP	0.65	0.37	0.55	0.80	13.7	13.7	0.22	0.15

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487	2016	19514R	3	QCP	1.00	0.71	0.36		15.4	15.4	0.26	0.14
488	2015	19534R	3	PFP				0.12		15.0		0.61
489	2015	19534R	3	PFP				0.56		14.6		0.40
490	2017	19524R	1	QCP	0.01	0.56	0.00	0.28	14.6	15.7	0.44	0.30
491	2016	19512R	1	QCP			0.14		13.6		0.68	
492	2017	19534R	3	PFP				0.85		15.2		0.49
493	2017	19532R	3	PFP	0.42			0.02	14.0	14.1	0.00	0.35
494	2017	19510R	1	QCP	0.11	0.93	0.15	0.00	19.4	19.8	0.27	0.23
495	2017	19654R	3	QCP	0.83	0.83	0.30	0.66	16.9	16.7	0.67	0.59
496	2017	19510R	4	PFP	0.34	0.54	0.21	0.85	18.3	18.1	0.46	0.39
497	2015	19515R	4	QCP	0.75		0.99		15.5	15.1	0.60	0.00
498	2016	19515R	4	QCP			0.43		15.6		0.54	
499	2016	19522R	4	PFP					14.1		0.07	
500	2016	19522R	4	PFP	0.00	0.99	0.00	0.15	14.2	13.6	0.64	0.64
501	2016	19532R	3	PFP	0.27	0.13	0.68	0.02	13.6	13.4	0.47	0.33
502	2015	19653R	4	PFP				0.71		17.4		0.57
503	2016	19654R	4	PFP			0.86		17.5		0.46	
504	2017	19654R	4	PFP	0.32	0.59	0.11	0.06	17.3	17.5	0.54	0.60
505	2016	19654R	4	PFP	0.00	0.41	0.15	0.13	17.5	17.0	0.34	0.42
506	2017	19510R	4	QCP					18.7		0.00	
507	2015	19515R	4	QCP					16.3		2.33	
508	2016	19524R	4	PFP	0.02	0.95	0.11	0.52	15.5	15.1	0.42	0.41
509	2016	19525R	4	PFP					15.5		0.00	
510	2015	19525R	4	PFP	0.00	0.67	0.09	0.35	16.1	15.1	0.70	0.62
511	2015	19535R	3	PFP				0.17		15.0		0.48
512	2016	19510R	4	PFP	0.10	0.90	0.19	0.24	18.7	18.6	0.32	0.34
513	2016	19510R	4	PFP	0.55	0.51	0.28	0.27	18.6	18.6	0.45	0.34
514	2017	19510R	4	QCP	0.29	0.31	0.49	0.00	18.0	17.9	0.22	0.31
515	2017	19515R	4	QCP	1.00				15.9	15.6	0.00	0.00
516	2017	19514R	4	PFP			0.35		15.2		0.46	
517	2015	19515R	4	QCP					15.2		0.14	
518	2015	19524R	4	PFP	0.00	0.36	0.50	0.27	16.3	15.3	0.42	0.59
519	2016	19512R	4	PFP					14.2		0.00	
520	2017	19522R	4	QCP			0.71		13.9		0.39	
521	2015	19524R	4	PFP	0.00	0.56	0.55	0.79	16.4	15.3	0.30	0.42

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
522	2016	19512R	4	PFP					14.8		0.00	
523	2015	19514R	4	QCP			0.05		15.7		0.90	
524	2016	19514R	4	PFP	0.83	0.70	0.37	0.96	15.1	15.0	0.39	0.34
525	2015	19514R	4	PFP	0.01	0.07	0.85	0.03	16.3	14.9	0.17	0.57
526	2015	19524R	5	QCP	0.14	0.87	0.12		15.7	15.3	0.36	0.30
527	2015	19514R	5	QCP	0.80		0.65		15.1	14.8	0.40	0.00
528	2016	19514R	5	QCP			0.78		16.3		0.25	
529	2015	19514R	5	QCP			0.05		15.6		0.18	
530	2016	19514R	5	QCP			1.00		15.4		0.10	
531	2016	19524R	5	QCP			0.52		16.2		0.46	
532	2017	19605FR	5	QCP	0.04	0.82	0.13	0.94	14.1	13.7	0.33	0.35
533	2015	19605FR	5	QCP	0.43	0.47	0.68	0.12	13.8	13.4	0.63	0.89
534	2015	19524R	5	QCP	0.50		0.42		16.3	15.9	0.33	0.00
535	2016	19514R	5	QCP	0.29		0.83		15.7	14.7	0.50	0.00
536	2017	19524R	5	QCP	0.86	0.05	0.00		15.4	15.0	0.38	0.99
537	2015	19534R	5	QCP	0.57		0.92		15.3	15.5	0.18	0.00
538	2015	19534R	5	PFP	0.63	0.79	0.16	0.91	15.8	15.9	0.31	0.25
539	2017	19535R	5	QCP	0.15	0.47	0.01		15.8	16.5	0.38	0.12
540	2017	19512R	6	QCP					14.1		0.00	
541	2017	19513R	5	QCP						15.3		0.35
542	2017	19532R	5	PFP				0.23		13.7		0.33
543	2016	19534R	5	QCP						15.2		0.00
544	2017	19534R	5	PFP				0.94		15.7		0.95
545	2017	19523R	5	QCP	0.69	0.40	0.81	0.90	15.1	15.1	0.30	0.42
546	2015	19534R	5	PFP	0.50	0.24	0.60	0.44	15.9	15.7	0.38	0.20
547	2016	19513R	5	QCP	0.67		0.52		15.6	16.1	0.41	0.00
548	2016	19514R	5	QCP			0.01		15.5		0.13	
549	2015	19532R	5	PFP	0.01	0.85	0.10	0.66	14.2	13.6	0.49	0.43
550	2015	19535R	5	PFP	0.04	0.29	0.47		14.7	15.3	0.38	0.07
551	2015	19523R	5	QCP	0.01	0.14	0.53	0.11	15.3	14.5	0.35	0.58
552	2015	19505R	5	QCP			0.31		15.8		0.77	
553	2015	19534R	5	PFP	0.29	0.77	0.69	0.25	15.6	15.3	0.53	0.38
554	2017	19534R	5	PFP	0.13	0.37	0.32	0.01	15.9	15.7	0.24	0.31
555	2016	19513R	5	QCP					15.7		0.00	
556	2016	19513R	5	QCP	0.67				16.1	15.8	0.00	0.00

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557	2015	19532R	5	PFP	0.12	0.46	0.53	0.57	14.1	13.8	0.33	0.21
558	2016	19532R	5	PFP	0.14	0.14	0.02	0.02	14.1	13.9	0.28	0.45
559	2016	19535R	5	PFP	0.41	0.25	0.05	0.99	15.8	15.6	0.22	0.34
560	2017	19535R	5	QCP			0.78		16.0		0.25	
561	2015	19524R	5	QCP	0.80		0.58		15.4	15.1	0.34	0.00
562	2015	19524R	5	QCP	0.44	0.85	0.62		15.8	15.6	0.34	0.28
563	2017	19532R	5	PFP	0.00	0.08	0.39	0.48	14.4	13.8	0.21	0.34
564	2015	19523R	6	QCP	0.12	0.86	0.25	0.41	14.7	14.8	0.37	0.34
565	2015	19513R	6	QCP	0.36	0.26	0.35	0.15	14.6	14.7	0.33	0.50
566	2016	19524R	6	PFP	0.30			0.43	14.3	14.8	0.00	0.46
567	2016	19513R	6	PFP						14.5		0.00
568	2015	19513R	6	QCP	0.72	0.15	0.75	0.84	14.6	14.5	0.35	0.61
569	2015	19522R	6	PFP	0.04	0.64	0.08	0.04	14.1	13.5	0.51	0.67
570	2015	19522R	6	PFP	0.00	0.06	0.32	0.89	13.5	14.0	0.42	0.56
571	2015	19513R	6	QCP	0.93	0.05	0.62	0.99	15.1	15.1	0.27	0.50
572	2015	19513R	6	QCP	0.86	0.68	0.12	0.84	15.5	15.4	0.54	0.35
573	2015	19523R	6	PFP	0.23	0.95	0.11	0.74	15.8	15.3	0.91	0.94
574	2015	19513R	6	QCP	0.77	0.97	0.97	0.48	14.8	14.8	0.64	0.61
575	2015	19523R	6	QCP	0.05	0.77	0.51	0.56	14.7	15.1	0.38	0.32
576	2015	19523R	6	QCP			0.22		15.0		0.15	
577	2017	19523R	8	QCP	0.80	0.06	0.06	0.72	14.6	14.6	0.18	0.36
578	2015	19534R	6	PFP	0.57	0.27	0.46	0.08	15.2	15.2	0.43	0.55
579	2016	19534R	6	PFP	0.38	0.83	0.58	0.37	15.5	15.2	0.43	0.50
580	2015	19522R	6	PFP	0.00	0.16	0.91	0.12	14.3	14.0	0.39	0.51
581	2015	19513R	6	QCP	0.08	0.38	0.16	0.77	15.1	14.8	0.31	0.19
582	2017	19522R	6	QCP	0.67		0.42		13.2	13.4	0.28	0.00
583	2015	19535R	6	PFP	0.69	0.26	0.02	0.64	15.5	15.5	0.96	0.67
584	2015	19535R	6	QCP	1.00		0.91		15.1	15.3	0.35	0.00
585	2015	19535R	6	PFP	0.80	0.80	0.03	0.31	15.4	15.3	0.37	0.33
586	2016	19514R	6	QCP	0.45	0.23	0.85	0.59	15.2	15.6	0.49	0.82
587	2015	19513R	6	QCP	0.31	0.94	0.87	0.46	14.4	14.1	0.43	0.40
588	2015	19522R	6	QCP	0.22	0.58	0.00	0.00	14.3	13.9	0.58	0.35
589	2016	19532R	6	PFP				0.51		14.5		0.55
590	2015	19532R	6	PFP	0.03	0.16	0.03	0.66	14.2	13.8	0.61	0.49
591	2016	19532R	6	QCP	0.67				13.6	13.3	0.07	0.00

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592	2015	19524R	6	QCP	0.44	0.00	0.98		15.3	15.1	0.30	0.00
593	2015	19512R	6	QCP	0.76	0.11	0.03		14.0	13.9	0.24	0.57
594	2015	19535R	6	PFP	0.05	0.13	0.42	0.05	15.7	15.5	0.38	0.52
595	2017	19535R	6	PFP				0.69		15.6		0.28
596	2016	19535R	6	QCP	1.00		0.22		15.2	15.3	0.44	0.00
597	2017	19513R	6	QCP						14.7		0.00
598	2017	19513R	6	QCP	0.27	0.07	1.00	0.00	15.3	15.1	0.31	0.06
599	2017	19513R	6	QCP	1.00	0.66			15.7	15.8	0.49	0.28
600	2016	19513R	6	QCP					15.7		0.00	
601	2016	19513R	6	PFP						15.3		0.07
602	2016	19513R	6	QCP	0.06	0.72	0.12	0.07	14.6	15.0	0.51	0.57
603	2016	19513R	6	QCP	0.67				14.5	15.3	0.28	0.00
604	2016	19514R	6	QCP	0.67				16.3	15.9	0.35	0.00
605	2015	19512R	6	QCP	0.67		0.01		13.2	13.2	0.29	0.00
606	2016	19524R	6	QCP	0.07	0.94	0.07	0.46	15.5	15.9	0.25	0.21
607	2015	19513R	6	QCP	0.67				14.7	15.2	0.35	0.00
608	2017	19513R	6	QCP	0.06	0.71	0.30		15.3	16.1	0.29	0.14
609	2016	19513R	6	QCP	0.03	0.17	0.91	0.70	14.8	15.4	0.32	0.55
610	2017	19513R	6	QCP	0.01	0.48	0.60	0.12	14.7	15.4	0.27	0.37
611	2016	19513R	6	QCP	0.22		0.48		15.1	15.4	0.18	0.00
612	2017	19532R	6	PFP	0.04	0.44	0.35	0.14	13.8	14.0	0.35	0.42
613	2016	19524R	6	PFP	0.00	0.06	0.98	0.59	16.4	15.7	0.33	0.56
614	2016	19513R	6	QCP	0.04	0.93	0.01	0.64	15.0	15.9	0.71	0.65
615	2016	19514R	6	QCP	0.00	0.64	0.21	0.15	15.0	15.5	0.26	0.30
616	2016	19534R	7	PFP	0.01	0.15	0.69	0.44	16.6	16.0	0.33	0.55
617	2016	19524R	6	QCP	0.97	0.62	0.08	0.47	15.3	15.3	0.60	0.48
618	2016	19532R	6	PFP	0.11	0.45	0.77	0.96	13.9	13.7	0.41	0.48
619	2016	19523R	6	QCP	0.86		0.52		15.0	14.7	0.34	0.00
620	2016	19524R	6	QCP	0.89	0.63	0.93	0.43	15.1	15.0	0.58	0.66
621	2016	19534R	6	PFP	0.00	0.66	0.01	0.31	15.4	14.7	0.51	0.57
622	2016	19513R	6	QCP	0.22	0.78	0.23	0.23	15.6	15.3	0.37	0.38
623	2016	19512R	6	QCP	0.31	0.31	0.76		14.0	13.7	0.35	0.07
624	2017	19514R	6	QCP	0.33	0.00			15.9	16.1	0.14	0.00
625	2017	19522R	6	PFP					13.5		0.00	
626	2017	19514R	6	QCP	1.00	0.17	0.03		16.4	16.1	0.43	0.92

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene’s P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
627	2017	19513R	6	QCP						15.9		0.07
628	2015	19524	7	PFP	1.00	0.14	0.43	0.88	15.9	15.9	0.54	1.22
629	2016	19532R	7	QCP	1.00		0.70		13.9	13.6	0.56	0.00
630	2015	19532R	7	PFP			0.93		13.4		0.67	
631	2016	19523R	7	QCP	0.50	0.83	0.30	0.64	15.7	16.0	0.64	0.76
632	2016	19532R	7	QCP	0.36	0.32	0.32		13.7	14.0	0.30	0.49
633	2017	19532R	7	PFP	0.88	0.01	0.04	0.96	14.5	14.1	0.90	0.22
634	2017	19524R	7	PFP						14.9		0.00
635	2016	19523	7	QCP	0.57	0.54	0.99		15.5	15.1	0.61	0.78
636	2017	19523	7	QCP						15.7		0.00
637	2016	19523	7	QCP	0.33	0.94			16.6	15.2	0.78	0.85
638	2017	19523	7	QCP	0.80		0.09		16.3	15.7	0.65	0.00
639	2017	19534R	7	QCP				0.01		14.8		0.49
640	2016	19534R	7	PFP				0.44		15.1		0.40
641	2016	19534R	7	QCP	0.06	0.14	0.65	0.25	15.4	16.0	0.26	0.47
642	2016	19524R	7	QCP	0.06	0.62	0.04	0.00	15.1	15.9	1.21	0.97
643	2016	19523R	7	QCP	0.64	0.34	0.08		15.3	15.1	0.44	0.71
644	2015	19534R	7	PFP						14.9		0.00
645	2015	19534R	7	PFP				0.35		15.5		0.91
646	2016	19534R	7	QCP					15.2		0.21	
647	2015	19534R	7	QCP	0.53	0.69		0.24	14.8	14.0	0.49	0.99
648	2016	19523R	9	QCP	0.00	0.00	0.07	0.00	15.6	14.7	0.56	0.05
649	2016	19605FR	9	QCP	0.17	0.25	0.02	0.00	15.7	15.3	0.31	0.12
650	2015	19534R	7	PFP	0.76	0.11	0.83	0.56	15.3	15.4	0.29	0.53
651	2015	19523R	7	PFP	0.13	0.87	0.75	0.46	15.1	14.8	0.40	0.46
652	2015	19523R	7	QCP	0.31	0.90	0.90	0.78	15.5	14.9	0.99	0.97
653	2016	19524R	7	QCP	0.18	0.43	0.16	0.39	15.4	15.0	0.40	0.58
654	2016	19534R	7	QCP	0.67				15.8	15.2	0.64	0.00
655	2015	19534R	7	PFP	0.15	0.23	0.94	0.17	15.8	15.5	0.36	0.57
656	2016	19654R	7	PFP						16.5		0.00
657	2016	19654R	7	PFP						16.4		0.00
658	2015	19654R	7	PFP	0.52	0.34	0.11	0.06	16.9	16.7	0.87	0.69
659	2016	19654R	7	PFP	0.46	0.37	0.24	0.90	17.5	17.1	0.31	0.55
660	2016	19654R	7	PFP	0.26	0.93	0.06	0.20	17.8	17.7	0.59	0.59
661	2017	19654R	7	PFP	0.39	0.85	0.83	0.25	18.1	17.8	0.63	0.68

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene’s P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
662	2016	19532R	7	PFP	0.41	0.58	0.44	0.40	14.5	14.4	0.59	0.52
663	2017	19532R	7	PFP	1.00				15.8	15.6	0.00	0.00
664	2017	19523R	7	QCP	0.40	0.62	0.64		15.3	15.5	0.15	0.07
665	2015	19505R	7	PFP			0.86		15.7		0.57	
666	2015	19532R	7	PFP	0.01	0.47	0.64	0.15	13.9	13.6	0.66	0.60
667	2016	19532R	7	PFP	0.58	0.94	0.59	0.09	13.8	13.7	0.61	0.61
668	2015	19532R	7	PFP				0.33		13.8		0.60
669	2016	19654R	7	PFP	0.77	0.88	0.44	0.37	17.7	17.8	0.62	0.64
670	2015	19654R	7	PFP	0.76	0.24	0.05	0.07	17.7	17.9	0.38	0.57
671	2016	19532R	7	PFP	0.68	0.93	0.14	0.34	14.2	14.1	0.66	0.67
672	2017	19533R	7	PFP	0.05	0.91	0.63	0.92	16.1	15.6	0.47	0.47
673	2017	19532R	7	PFP	0.56	0.46	0.87	0.71	13.8	13.5	0.95	0.78
674	2017	19532R	7	PFP	0.48	0.82	0.53	0.34	14.2	14.0	0.48	0.54
675	2017	19532R	7	PFP						13.7		0.00
676	2017	19532R	7	PFP	0.83	0.23	0.23	0.14	14.7	14.4	0.74	0.39
677	2016	19523R	8	QCP						14.9		0.00
678	2016	19523R	8	QCP	1.00	0.84			14.5	14.5	0.49	0.64
679	2016	19523R	8	QCP	0.40		0.27		15.7	15.1	0.29	0.00
680	2016	19523R	8	QCP	0.32	0.12	0.12	0.89	15.7	16.0	0.48	0.75
681	2016	19534R	8	QCP	0.02	0.52	0.67	0.21	15.4	14.6	0.61	0.43
682	2015	19534R	8	QCP	0.14		0.31		15.2	14.3	0.20	0.00
683	2015	19534R	8	QCP	0.00	0.03	0.04	0.22	15.7	14.9	0.31	0.59
684	2015	19534R	8	QCP	0.50	0.49	0.37	0.21	15.5	15.7	0.58	0.72
685	2015	19524R	8	QCP	0.18	0.25	0.54	0.79	15.2	14.9	0.44	0.24
686	2017	19524R	8	QCP	0.89	0.74	0.27	0.14	15.2	15.1	0.78	0.89
687	2015	19535R	8	QCP	0.45	0.00	0.09	0.01	15.2	14.8	0.56	1.30
688	2017	19505R	8	QCP	0.63	0.50	0.13	0.32	15.3	15.2	0.62	0.81
689	2015	19505R	8	QCP	0.53	0.18	0.22		14.0	13.4	0.59	0.07
690	2015	19606R	8	QCP	0.84	0.16	0.49		15.4	15.2	0.55	1.06
691	2015	19654R	8	PFP	0.05	0.45	0.02	0.16	17.9	17.6	0.64	0.56
692	2015	19654R	8	PFP	0.10	0.80	0.44	0.69	18.2	17.7	0.56	0.61
693	2015	19534R	8	QCP	0.71	0.63	0.46	0.78	15.1	15.4	0.78	0.50
694	2015	19654R	8	PFP	0.63	0.67	0.43	0.35	17.8	17.6	0.74	0.66
695	2015	19654R	8	PFP	0.04	0.36	0.54	0.68	18.0	17.7	0.57	0.49
696	2015	19654R	8	PFP	0.01	0.73	0.17	0.70	18.0	17.4	0.60	0.64

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
697	2015	19535R	8	QCP	0.40	0.86	0.61	0.49	15.8	15.5	0.48	0.40
698	2015	19601R	8	QCP					11.2		0.00	
699	2016	19523R	8	QCP	0.62	0.24	0.40	0.42	15.4	15.2	0.42	0.68
700	2016	19523R	8	QCP						14.6		0.21
701	2016	19532R	8	PFP	0.15	0.75	0.24	0.59	13.5	13.0	0.53	0.47
702	2016	19524R	8	QCP	0.84	0.85	0.83	0.92	15.4	15.3	0.34	0.35
703	2017	19524R	8	QCP	1.00				14.7	14.7	0.35	0.00
704	2016	19524R	8	QCP			0.30		15.1		0.32	
705	2016	19524R	8	QCP	0.67				16.2	16.0	0.07	0.00
706	2016	19524R	8	QCP	1.00				15.2	15.1	0.07	0.00
707	2016	19533R	8	QCP			0.04		15.6		0.22	
708	2016	19534R	8	PFP	0.11	0.99	0.27	0.13	16.0	15.6	0.77	0.76
709	2016	19534R	8	QCP	1.00	0.33	0.21	0.03	15.3	15.1	0.72	1.03
710	2016	19504R	8	QCP	0.67	0.40	0.13		13.3	13.2	0.47	0.78
711	2016	19523R	8	QCP	1.00	0.42	0.00		15.7	15.7	0.12	0.21
712	2016	19605R	8	QCP	0.67				15.6	14.8	0.35	0.00
713	2016	19534R	8	QCP	0.76	0.14	0.53		15.6	15.3	0.53	1.08
714	2017	19654R	8	PFP						16.5		0.00
715	2017	19654R	8	PFP	0.82	0.24	0.30	0.11	18.1	18.0	0.49	0.57
716	2017	19523R	8	QCP	0.75	0.63	0.85	0.52	16.0	15.9	0.57	0.66
717	2017	19523R	8	QCP	0.89	0.93	0.00	0.07	16.0	15.8	0.49	0.46
718	2017	19524R	8	QCP	0.25		0.89		15.6	15.0	0.32	0.00
719	2017	19524R	8	QCP	0.93	0.51	0.61		16.0	16.0	0.49	0.17
720	2017	19605R	8	QCP	0.93	0.00	0.52		14.9	14.7	0.46	0.00
721	2015	19533R	9	QCP	0.06	0.82	0.82	0.08	14.6	13.8	0.70	0.61
722	2016	19606FR	9	QCP	0.20	0.79	0.28	0.32	15.2	14.6	1.09	1.22
723	2015	19605FR	9	QCP	0.30	0.80	0.25	0.00	14.5	13.8	0.38	0.46
724	2017	19513R	9	PFP						15.5		0.00
725	2016	19532R	9	QCP	0.67				13.8	13.1	0.85	0.00
726	2016	19534R	9	QCP	0.25	0.42	0.01	0.15	15.3	14.9	0.56	0.72
727	2016	19534R	9	QCP	0.64	0.80	0.99	0.25	15.3	15.1	0.53	0.43
728	2017	19524R	8	QCP	0.29	0.77	0.27	0.83	16.2	15.0	1.08	1.42
729	2017	19524R	8	QCP	0.26	0.65	0.03	0.18	15.1	14.8	0.74	0.91
730	2017	19535R	8	QCP	0.61	0.02	0.97	0.07	15.0	13.4	0.65	2.82
731	2017	19532R	8	QCP	0.77	0.69	0.17	0.00	13.3	13.4	0.93	0.79

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732	2017	19532R	9	QCP	0.25		0.02		14.6	13.1	0.69	0.00
733	2015	19532R	9	QCP	0.65	0.29	0.80	0.19	13.6	13.4	0.33	0.50
734	2015	19532R	9	PFP	0.92	1.00	0.00	0.02	13.8	13.8	0.51	0.50
735	2016	19532R	9	PFP	0.00	0.64	0.00	0.16	13.9	13.6	0.56	0.51
736	2016	19532R	9	QCP					13.9		0.00	
737	2017	19532R	9	QCP					13.9		0.00	
738	2015	19532R	9	PFP	0.82	0.74	0.95	0.08	14.2	14.5	0.81	0.68
739	2016	19532R	9	PFP	0.00	0.57	0.04	0.08	14.0	13.7	0.57	0.62
740	2016	19606FR	9	QCP	1.00		0.88		14.8	14.9	0.45	0.00
741	2016	19606FR	9	QCP	0.67				15.5	15.2	0.28	0.00
742	2016	19606FR	9	QCP	0.61	0.79	0.88	0.53	14.7	14.8	0.45	0.39
743	2016	19605FR	9	QCP	0.69	0.46	0.46	0.39	15.7	15.6	0.59	0.75
744	2017	19534R	9	QCP	0.33				14.3	13.7	0.00	0.00
745	2016	19534R	9	QCP	0.67				15.6	14.9	0.21	0.00
746	2016	19534R	9	QCP	1.00		0.98		15.1	15.1	0.29	0.00
747	2016	19534R	9	QCP	0.11	0.93	0.40		15.3	14.8	0.32	0.21
748	2016	19534R	9	QCP	0.10	0.60	0.19	0.46	15.6	15.3	0.34	0.21
749	2015	19523R	9	QCP	1.00		0.91		15.4	15.3	0.88	0.00
750	2015	19523R	9	QCP	0.47	0.46	0.37	0.58	14.5	14.2	0.49	0.67
751	2015	19534R	9	PFP	0.80	0.84	0.51		15.7	15.7	0.41	0.35
752	2015	19534R	9	QCP	1.00		0.22		15.5	14.5	0.87	0.00
753	2015	19534R	9	QCP	0.50		0.46		15.6	15.1	0.42	0.00
754	2017	19534R	9	QCP	0.29		0.20		15.6	14.8	0.27	0.00
755	2015	19606FR	9	QCP	1.00				16.8	15.8	1.41	0.00
756	2015	19606FR	9	QCP	1.00				15.5	15.3	0.00	0.00
757	2016	19535	9	PFP	0.01	0.31	0.01	0.29	15.5	15.3	0.53	0.60
758	2016	19522R	9	QCP	0.80	0.89	0.27		12.8	13.1	0.70	0.49
759	2017	19532R	9	PFP	0.00	0.89	0.00	0.00	13.8	13.5	0.62	0.61
760	2016	19523R	9	QCP					16.2		0.00	
761	2016	19523R	9	QCP					15.5		0.00	
762	2017	19523R	9	QCP	0.01	0.42	0.02	0.01	15.4	14.7	0.82	0.96
763	2017	19532R	9	PFP	0.66	0.43	0.26	0.30	13.6	13.5	0.58	0.74
764	2015	19534R	9	QCP	1.00	0.72	0.57		15.9	16.1	0.89	0.92
765	2015	19533R	9	QCP	1.00		0.13		15.5	15.9	0.72	0.00
766	2015	19533R	9	QCP	0.74	0.99	0.68	0.49	15.2	15.1	0.44	0.40

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767	2015	19533R	9	QCP	0.39	0.30	0.60	0.46	14.9	14.7	0.28	0.42
768	2015	19533R	9	QCP	0.83	0.19	0.37	0.53	14.5	14.2	1.25	2.18
769	2015	19533R	9	QCP	0.57		0.01		15.4	15.1	0.46	0.00
770	2015	19533R	9	QCP	0.79	0.91	0.09	0.19	14.9	15.0	0.53	0.49
771	2015	19534R	9	QCP	0.96	0.86	0.46	0.82	15.2	15.2	0.77	0.81
772	2015	19606FR	9	QCP	1.00	0.87			15.0	14.9	1.56	1.91
773	2015	19606	9	QCP	0.80	0.78	1.00	0.60	15.7	15.4	0.90	1.12
774	2016	19606FR	9	QCP	0.10	0.32	0.64	0.84	14.9	14.2	0.15	0.35
775	2015	19606FR	9	QCP	0.43	0.82	0.65		15.3	15.0	0.31	0.28
776	2015	19606FR	9	QCP	0.71	0.56	0.02		14.8	14.6	0.56	0.21
777	2015	19606FR	9	QCP	0.68	0.30	0.98	0.55	15.4	15.1	0.62	0.99
778	2015	19606FR	9	QCP	0.50		0.64		14.9	14.4	0.31	0.00
779	2016	19606FR	9	QCP	0.39	0.68	0.12	0.93	15.6	15.3	0.51	0.63
780	2015	19606FR	9	QCP	0.27	0.71	0.49	0.88	14.9	14.5	0.45	0.37
781	2015	19606FR	9	QCP						15.1		0.00
782	2015	19534R	9	QCP	0.68	0.94	0.33	0.52	15.3	15.4	0.53	0.46
783	2016	19534R	9	QCP	0.69	0.35	0.67		15.7	15.4	0.48	0.71
784	2016	19533R	9	QCP	0.43	0.77	0.45		15.4	14.8	0.74	0.71
785	2016	19523R	9	QCP	1.00				15.6	15.2	0.49	0.00
786	2016	19523R	9	QCP	1.00		0.25		15.4	15.4	0.38	0.00
787	2017	19523R	9	QCP	0.13	0.00	0.72		14.9	14.1	0.58	0.00
788	2017	19523R	9	QCP	0.11	0.02	0.99	0.02	15.2	14.9	0.31	0.06
789	2016	19605FR	9	QCP	1.00	0.00			16.4	16.4	0.35	0.00
790	2016	19605FR	9	QCP	0.67				15.9	15.1	0.78	0.00
791	2017	19605FR	9	QCP	0.33	0.00			14.8	14.4	0.14	0.00
792	2017	19605FR	9	QCP	0.50		1.00		15.6	14.9	0.10	0.00
793	2015	HMA Binder	9	QCP	0.04	0.06	0.64	0.47	14.0	13.6	0.61	0.86
794	2015	HMA Binder	9	QCP	0.16	0.06	0.95	0.53	13.7	14.2	0.65	0.29
795	2015	HMA Binder	9	QCP	0.01	0.60	0.53	0.68	14.8	13.9	0.41	0.52
796	2015	HMA Binder	9	QCP	0.36	0.21	0.35		16.2	15.4	0.64	1.27
797	2016	19535	9	PFP	0.70	0.51	0.09	0.10	16.4	16.4	0.52	0.60

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
798	2016	19535	9	PFP	0.78	0.78	0.01	0.19	16.0	16.1	0.69	0.49
799	2016	19532R	9	PFP	0.92	0.23	0.40	0.03	14.7	14.8	0.61	0.76
800	2016	19532R	9	PFP	0.19	0.97	0.08	0.76	14.7	14.3	0.49	0.43
801	2017	19533R	9	QCP	0.63	0.14	0.04	0.41	15.4	15.5	0.33	0.13
802	2016	19533R	9	QCP	0.86	0.09	0.45	0.96	15.8	16.0	0.71	1.45
803	2017	19534R	9	PFP	0.82	0.16	0.28	0.62	15.9	15.9	0.68	0.89
804	2017	19532R	9	PFP	0.04	0.20	0.05	0.03	14.6	14.4	0.43	0.34
805	2015	19533R	9	QCP	0.66	0.54	0.13		15.4	15.1	0.61	0.71
806	2016	19534R	9	QCP	0.36	0.44	0.35		15.9	15.5	0.48	0.14
807	2015	19534R	9	QCP	0.40		0.90		15.4	14.6	0.42	0.00
808	2016	19534R	9	QCP	0.53	0.70	0.14	0.29	15.3	15.0	0.86	0.73
809	2016	19606FR	9	QCP	1.00				14.4	14.3	0.28	0.00
810	2016	19534R	9	QCP	0.33		0.49		16.3	16.0	0.16	0.00
811	2015	19605FR	9	QCP	0.33	0.82			14.6	14.0	0.21	0.28
812	2015	19605FR	9	QCP	0.03	0.80	0.41	0.06	14.3	13.7	0.61	0.56
813	2015	19605FR	9	QCP	0.70	0.25	0.64	0.00	14.0	13.9	0.15	0.06
814	2016	19606FR	9	QCP	0.29	0.64	0.16	0.66	13.2	12.8	0.80	0.64
815	2016	19533R	9	QCP	0.50		0.27		14.8	14.2	0.70	0.00
816	2015	19523R	9	QCP	0.04	0.58	0.25	0.35	15.2	14.8	0.55	0.62
817	2016	19523R	9	QCP	1.00		0.21		14.8	14.9	0.40	0.00
818	2015	19523R	9	QCP	1.00		0.91		14.7	14.4	0.69	0.00
819	2015	19523R	9	QCP	0.57	0.40	0.73	0.00	15.7	15.6	0.48	0.23
820	2015	19523R	9	QCP	0.06	0.58	0.65		14.8	14.4	0.18	0.07
821	2016	19532R	9	QCP	0.42	0.02	0.00	0.05	13.0	12.8	0.22	0.55
822	2016	19532R	9	QCP	0.42	0.00	0.62		13.0	13.4	0.57	0.00
823	2016	19522R	9	QCP	0.50		0.64		14.6	14.2	0.15	0.00
824	2016	19532R	9	QCP								
825	2016	19532R	9	QCP				0.56		12.8		0.35
826	2016	19606FR	9	QCP	0.50			1.00	15.4	15.8	0.00	0.30
827	2017	19605FR	9	QCP	0.67	0.82			14.7	14.6	0.28	0.21
828	2017	19532R	9	QCP	0.49	0.98	0.01	0.28	13.8	13.7	0.37	0.35
829	2017	19524R	9	QCP	0.29		0.49		15.6	16.1	0.31	0.00
830	2017	19534R	9	QCP	0.81	0.15	0.71	0.30	15.3	15.1	0.49	0.81
831	2016	19532R	9	PFP			0.22		14.3		0.87	
832	2016	19523R	9	QCP	0.27	0.84	0.52		15.1	14.3	0.45	0.28

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
833	2016	19535R	9	PFP					18.6		0.00	
834	2017	19523R	9	QCP	0.30	0.60	0.64	1.00	15.8	15.5	0.31	0.20
835	2017	19532R	9	PFP					13.8		0.00	
836	2017	19532R	9	PFP	0.86		0.57		13.9	14.1	0.27	0.00

C.3 DENSITY ANALYSIS RESULTS

Table C.3. Density Analysis Results Summary

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
2	2015	19524R	1	QCP				0.55		95.4		1.46
3	2017	19524R	1	QCP	0.58	0.37		0.20	92.3	92.7	1.98	1.34
4	2017	19524R	1	QCP				0.02		94.2		1.56
5	2016	19524R	1	QCP				0.44		93.4		1.54
6	2015	19514R	1	QCP				0.99		92.7		1.68
7	2015	19524R	1	QCP				0.47		94.1		1.39
8	2015	19524R	1	QCP				0.39		91.2		1.42
9	2015	19524R	1	PFP	0.83	0.28	0.02	0.28	91.8	92.0	2.46	2.17
10	2015	19512R	1	QCP				0.36		93.6		1.02
11	2015	19512R	1	QCP				0.01		91.9		1.51
12	2015	19522R	1	QCP				0.51		93.8		1.20
13	2017	19522R	1	QCP				0.00		92.9		3.19
14	2015	19510R	1	QCP				0.04		93.4		1.62
15	2015	19510R	1	QCP				0.00		92.5		2.47
16	2015	19512R	1	QCP				0.55		94.9		1.00
17	2015	19510R	1	QCP				0.03		93.6		2.30
18	2015	19536R	1	QCP				0.01		91.9		1.51
20	2017	19525R	1	QCP	0.44	0.74	0.48	0.11	92.6	93.2	2.09	1.98
21	2015	19524R	1	QCP				0.38		94.6		1.51
22	2015	19512R	1	QCP	0.67				92.2	94.6	1.34	0.00
23	2016	19532R	1	QCP				0.99		93.6		1.06
24	2017	19532R	1	QCP	0.88	0.48	0.04	0.35	93.3	93.3	1.17	1.55
25	2017	19510R	1	QCP			0.04		93.5		3.08	
26	2015	19510R	1	QCP				0.22		93.3		1.62
27	2015	19665R	1	QCP	0.54	0.31		0.53	94.7	95.2	0.49	2.49
28	2017	19524R	1	QCP				0.82		93.5		1.55
29	2017	19525R	1	QCP				0.10		93.6		0.55
30	2016	19512R	1	QCP			0.73		95.0		1.42	
31	2015	19512R	1	QCP				0.08		95.8		1.24
32	2015	19522R	1	QCP	1.00				95.1	94.9	0.57	0.00
33	2015	19522R	1	QCP	0.80	0.93		0.10	95.2	95.0	0.71	0.95

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
34	2015	19524R	1	QCP				0.00		93.8		2.58
35	2015	19510R	1	QCP	0.96	0.48	0.56	0.00	92.7	92.6	2.00	2.50
36	2015	19510R	1	QCP				0.85		91.5		1.74
37	2015	19510R	1	QCP				0.37		92.4		1.66
38	2015	19524R	1	QCP	0.67				94.2	95.5	0.00	1.27
39	2015	19524R	1	QCP	0.01	0.91	0.00	0.05	96.0	95.0	1.43	1.41
40	2015	19510R	1	PFP	0.04	0.94	0.00	0.00	93.9	93.5	2.02	2.01
41	2015	19510R	1	PFP					95.7		0.28	
42	2015	19524R	1	QCP				0.00		93.5		1.70
43	2015	19655R	1	PFP	0.01	0.00	0.00	0.00	94.8	94.1	1.50	2.13
44	2015	19536R	1	PFP	0.01	0.29	0.00	0.00	92.1	91.5	2.24	2.05
45	2017	19510R	1	QCP	0.06	0.37	0.44	0.18	94.7	93.2	1.80	2.33
46	2017	19510R	1	QCP				0.00		93.8		1.82
47	2016	19510R	1	QCP	1.00	0.43	0.36	0.55	92.1	92.0	1.24	2.07
48	2017	19524R	1	QCP	0.67		0.23		94.5	94.5	1.24	0.00
49	2017	19525R	1	QCP				0.00		93.9		1.44
50	2017	19525R	1	PFP	0.35	0.95	0.00	0.00	93.8	94.0	2.13	2.14
51	2016	19525R	1	QCP	0.23	0.37		0.00	94.8	93.5	0.49	2.07
52	2016	19536R	1	QCP			0.14		93.1		0.67	
53	2015	19536R	1	PFP	0.20	0.00	0.01	0.02	93.7	93.2	1.35	2.20
54	2015	19524R	1	QCP				0.02		94.5		2.10
55	2017	19524R	1	QCP				0.07		95.1		1.29
56	2015	19522R	1	QCP	0.48	0.84	0.81	0.64	95.4	95.6	0.85	0.91
57	2015	19522R	1	QCP	0.62			0.00	96.2	95.3	0.00	1.23
58	2015	19510R	1	QCP	0.35	0.23	1.00	0.04	94.5	93.1	0.70	1.99
59	2015	19510R	1	PFP	0.03	0.75	0.00	0.36	94.2	93.3	1.98	1.87
60	2017	19524R	1	QCP	0.89	0.79	0.07	0.47	93.1	93.2	0.63	0.73
61	2017	19524R	1	PFP	0.74	0.21	0.00	0.00	93.4	93.3	0.85	1.04
62	2017	19524R	1	QCP				0.70		93.8		1.08
63	2017	19510R	1	QCP				0.12		94.4		1.26
64	2015	19532R	1	QCP			0.45		94.2		1.61	
65	2017	19510R	1	QCP	0.01	0.66	0.02	0.11	94.7	93.6	1.13	1.00
66	2017	19510R	1	QCP				0.16		94.3		1.88
67	2016	19510R	1	QCP	0.95	0.35	0.02	0.00	93.1	93.0	1.78	2.08
69	2017	19524R	1	PFP	0.68	0.07	0.01	0.00	91.3	91.2	2.78	3.41

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
70	2017	19655R	1	QCP				0.80		94.9		1.66
71	2017	19665R	1	QCP				0.29		94.4		1.51
72	2017	19665R	1	QCP	0.23	0.96	0.02	0.04	95.1	94.1	2.64	2.68
73	2015	19512R	1	QCP	0.09	0.45	0.01	0.43	93.8	95.3	1.37	1.75
74	2015	19522R	1	PFP	0.20	0.23		0.00	94.3	92.3	0.35	2.49
75	2017	19522R	1	QCP				0.02		94.7		2.00
76	2015	19522R	1	QCP	0.40	0.00	0.06	0.00	94.1	92.0	0.63	6.36
78	2015	19514R	1	QCP	0.27	0.84	0.00	0.11	93.7	94.0	0.94	0.97
79	2015	19524R	1	QCP				0.06		93.8		1.75
80	2015	19512R	1	QCP	0.67			0.02	94.7	95.2	0.00	1.50
81	2015	19512R	1	QCP	0.18	0.08	0.22	0.01	95.1	94.4	1.15	1.78
83	2015	19525R	1	PFP	0.30	0.92	0.44	0.13	93.3	93.0	1.74	1.76
84	2017	19510R	1	QCP				0.00		93.2		4.89
85	2015	19510R	1	QCP	0.24	0.44	0.44	0.13	94.3	92.8	1.10	2.17
86	2017	19532R	1	QCP				0.32		93.5		2.03
87	2017	19536R	1	QCP	0.86			0.25	93.4	93.0	0.00	1.26
88	2015	19536R	1	QCP	0.37	0.18		0.28	92.0	92.9	2.05	1.20
89	2015	19512R	1	QCP	0.67				95.3	97.3	0.00	0.14
90	2015	19512R	1	QCP	0.13	0.13		0.96	97.4	96.1	0.07	0.83
91	2015	19514R	1	QCP				0.93		95.5		0.82
92	2017	19522R	1	QCP	0.72	0.60	0.00	0.93	95.8	95.6	0.58	0.94
93	2017	19522R	1	QCP				0.00		94.8		1.76
94	2016	19522R	1	QCP				0.00		94.2		1.97
95	2015	19510R	1	QCP				0.31		94.9		2.10
96	2015	19510R	1	QCP				0.41		93.2		1.40
97	2015	19510R	1	QCP	0.43			0.19	94.9	93.8	0.00	1.51
98	2015	19510R	1	QCP				0.06		94.7		1.38
99	2017	19510R	1	QCP				0.08		94.5		1.78
101	2017	19532R	1	QCP				0.07		93.4		1.48
102	2017	19532R	1	QCP				0.77		93.7		1.30
103	2015	19536R	1	QCP				0.08		93.3		1.36
104	2015	19536R	1	QCP	0.82	0.53		0.05	93.2	93.5	2.69	2.26
105	2015	19524R	1	QCP	0.01	0.33	0.25	0.42	95.7	92.3	0.76	1.76
106	2015	19524R	1	QCP				0.48		91.9		2.00
107	2015	19524R	1	QCP				0.68		93.3		1.88

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
108	2017	19510R	1	QCP				0.14		93.0		1.96
109	2017	19510R	1	QCP	0.28			0.00	95.1	93.2	0.00	2.31
110	2016	19510R	1	QCP			0.82		93.1		1.81	
111	2017	19510R	1	QCP				0.13		93.7		1.77
112	2016	19510R	1	QCP	0.00	0.00	0.88	0.00	94.0	92.9	1.36	2.18
113	2017	19510R	1	QCP				0.03		94.8		1.81
114	2017	19510R	1	QCP				0.08		94.5		1.97
115	2017	19510R	1	QCP				0.02		92.8		2.26
116	2015	19522R	1	QCP				0.58		92.1		2.39
117	2015	19522R	1	QCP				0.30		93.5		1.59
118	2017	19524R	1	PFP	0.00	0.93	0.00	0.00	94.8	95.5	1.37	1.38
119	2017	19524R	1	QCP				0.02		95.1		1.75
120	2017	19524R	1	QCP				0.69		94.8		1.38
121	2017	19524R	1	QCP				0.63		94.4		0.82
122	2017	19524R	1	QCP				0.94		96.1		1.27
123	2016	19524R	1	QCP	0.19	0.27	0.16	0.07	94.6	93.6	1.77	2.40
124	2017	19524R	1	QCP				0.08		94.2		1.62
125	2015	19510R	1	QCP				0.39		92.9		1.14
126	2015	19510R	1	QCP	0.01	0.08	0.27	0.00	93.8	93.1	1.55	1.81
127	2015	19536R	1	PFP	0.22	0.01	0.00	0.54	92.8	92.5	1.33	1.75
128	2015	19522R	1	QCP	1.00	0.51	0.31	0.40	94.1	93.7	1.55	2.81
129	2015	19522R	1	PFP			0.19		94.3		1.08	
130	2015	19536R	1	QCP				0.00		91.0		1.94
131	2015	19524R	1	QCP	0.23	0.64	0.95	0.83	92.3	93.5	1.97	1.76
132	2015	19510R	1	QCP	0.73	0.37	0.17	0.03	92.5	92.6	1.09	1.65
133	2015	19510R	1	QCP				0.31		91.5		2.22
134	2015	19524R	1	QCP	0.00	0.95	0.34	0.38	92.8	91.9	2.02	2.00
135	2015	19665R	1	QCP				0.04		93.4		1.44
136	2015	19524R	1	QCP				0.34		94.1		1.72
137	2015	19524R	1	QCP				0.04		94.5		1.82
139	2017	19510R	1	QCP				0.00		92.7		1.80
140	2017	19510R	1	QCP				0.49		91.9		1.41
141	2017	19510R	1	QCP				0.69		94.7		1.12
142	2015	19510R	1	QCP				0.01		93.3		2.01
144	2017	19522R	1	QCP				1.00		93.3		0.65

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
145	2015	19522R	1	QCP	0.51	0.73	0.13	0.19	94.9	94.7	1.54	1.41
146	2015	19536R	1	QCP	0.29	0.45		0.24	93.9	93.0	0.49	1.72
147	2017	19524R	1	QCP				0.48		92.7		2.07
148	2017	19524R	1	QCP				0.41		92.8		2.04
149	2017	19524R	1	QCP				0.54		92.6		1.67
150	2015	19525R	1	QCP	1.00				94.8	94.8	0.00	0.00
151	2015	19525R	1	QCP				0.00		94.1		1.60
152	2017	19525R	1	QCP				0.16		93.9		3.28
153	2017	18436R	1	QCP				0.42		94.7		1.49
154	2017	19655R	1	QCP				0.49		94.9		1.45
155	2016	19655R	1	QCP	0.37	0.32	1.00	0.10	94.7	95.0	1.24	1.66
156	2015	19525R	1	QCP	0.03	0.27	0.20	0.01	92.3	93.9	2.00	1.51
157	2017	19653R	1	QCP	0.10	0.37	0.48	0.60	94.0	95.8	2.17	1.71
158	2016	19665R	1	PFP	0.90	0.61	0.56	0.32	93.8	93.8	1.43	1.53
159	2017	19665R	1	QCP	0.87			0.39	95.0	95.2	0.00	0.98
160	2015	19512R	1	QCP	0.25			0.00	97.4	95.8	0.00	0.70
161	2015	19512R	1	QCP				0.05		93.8		1.37
162	2017	19525R	1	QCP	0.80			0.90	93.8	94.5	0.00	1.39
163	2017	19525R	1	PFP			0.20		94.8		1.46	
164	2017	19525R	1	QCP				0.11		94.3		0.65
165	2017	19525R	1	QCP				0.02		94.0		1.68
166	2017	19655R	1	PFP	0.01	0.94	0.44	0.06	94.5	95.1	1.66	1.65
167	2015	19512R	1	QCP	0.01	0.02	0.65	0.60	94.1	91.8	0.62	1.86
168	2015	19522R	1	QCP	0.30	0.11	0.39	0.00	94.6	93.1	0.86	2.47
169	2015	19522R	1	QCP	0.27	0.56	0.36	0.07	94.8	93.2	1.32	2.30
170	2015	19536R	1	QCP				0.63		94.0		1.40
171	2015	19510R	1	QCP				0.10		93.8		1.73
172	2015	19510R	1	QCP				0.17		93.4		2.22
173	2015	19510R	1	QCP	0.00	0.05	0.73	0.43	96.0	93.3	1.08	1.92
178	2015	19522R	1	QCP	0.26	0.25	0.71	0.36	95.9	95.4	0.72	0.26
179	2015	19522R	1	QCP	0.60	0.00		0.63	96.4	96.8	0.00	1.32
180	2015	19522R	1	QCP	0.21	0.08		0.59	94.9	95.8	0.07	1.35
181	2015	19522R	1	QCP	0.56			0.41	96.2	95.1	0.00	1.54
183	2015	19524R	1	PFP	0.47	0.00	0.50	0.00	92.9	92.5	1.82	2.53
184	2015	19510R	1	QCP	0.55	0.44	0.21	0.18	93.6	93.8	1.76	1.98

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
185	2015	19510R	1	QCP	0.64	0.63	0.00	0.00	94.4	94.1	1.95	2.16
186	2017	19510R	1	QCP	0.15	0.21	0.08	0.00	92.6	93.0	1.37	1.77
187	2015	19522R	1	QCP	0.51	0.45	0.57	0.01	93.7	93.5	1.20	1.03
188	2015	19524R	1	QCP	0.12	0.58	0.64	0.76	94.3	93.6	0.80	0.93
189	2015	19524R	1	QCP				0.58		95.3		1.66
190	2015	19510R	1	QCP	0.34	0.41	0.00	0.00	94.7	94.5	1.56	1.72
191	2015	19510R	1	PFP	0.87	0.07	0.00	0.00	93.7	93.7	1.68	1.92
192	2015	19510R	1	QCP				0.00		94.1		1.94
193	2015	19510R	1	QCP				0.24		93.1		1.46
194	2015	19510R	1	QCP				0.02		95.3		1.12
195	2017	19510R	1	QCP	0.11	0.39	0.32	0.35	95.0	94.2	1.00	1.30
196	2017	19510R	1	QCP				0.33		94.7		1.26
197	2017	19510R	1	QCP	0.16	0.08	0.05	0.49	94.2	93.7	1.14	1.56
198	2017	19510R	1	QCP				0.00		93.3		1.55
199	2017	19510R	1	QCP	0.77	0.79	0.62	0.20	94.0	93.9	1.26	1.34
200	2017	19510R	1	QCP				0.57		93.6		1.61
201	2017	19510R	1	QCP				0.70		93.8		1.80
202	2017	19510R	1	QCP				0.03		93.9		2.21
203	2015	19665R	1	PFP	0.94	0.00	0.00	0.00	94.8	94.7	1.25	1.67
204	2015	19665R	1	PFP	0.61	0.83	0.15	0.61	94.6	94.6	0.96	0.94
205	2015	19665R	1	PFP	0.89	0.07	0.00	0.00	94.5	94.5	1.39	1.58
206	2015	19522R	1	QCP				0.17		93.7		2.09
316	2015	19524R	1	QCP				0.01		93.4		1.49
317	2015	19524R	1	QCP	0.39	0.04	0.45	0.34	94.5	94.2	1.36	0.64
318	2017	19522R	1	QCP	0.51		0.19		94.6	95.1	1.16	0.00
319	2015	19536R	1	PFP	0.46	0.99	0.00	0.00	93.5	93.4	1.41	1.41
320	2015	19510R	1	QCP	0.80			0.20	95.4	94.5	0.00	1.60
321	2015	19510R	1	QCP				0.00		93.7		1.62
322	2015	19510R	1	QCP				0.20		93.7		1.45
323	2015	19510R	1	QCP	0.33			0.00	95.3	93.4	0.00	3.41
324	2015	19510R	1	QCP				0.01		92.6		2.60
325	2015	19510R	1	QCP				0.02		93.5		1.94
326	2015	19522R	1	QCP	0.02	0.57	0.36	0.14	96.2	94.1	1.22	1.81
327	2015	19536R	1	QCP	0.87	0.79	0.13	0.02	93.8	93.7	1.17	1.37
328	2015	19536R	1	QCP				0.00		93.1		1.23

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
329	2015	19536R	1	QCP				0.02		93.2		1.91
330	2016	19536R	1	QCP	1.00	1.00			93.0	93.0	0.28	0.28
373	2015	19524R	1	PFP	0.84	0.83	0.57	0.91	92.8	92.8	1.86	1.91
374	2016	19524R	1	QCP				0.70		93.4		1.10
375	2016	19524R	1	QCP				0.06		92.1		2.61
376	2015	19655R	1	QCP				0.51		94.6		1.60
377	2015	19522R	1	QCP	0.40			0.18	94.0	91.9	0.00	0.78
378	2016	19522R	1	QCP	0.11			0.94	96.4	93.0	0.00	1.69
379	2015	19522R	1	QCP	0.03	0.54	0.36	0.50	96.2	94.0	1.22	1.85
380	2017	19524R	1	PFP	0.16	0.55	0.01	0.28	94.0	94.5	2.10	2.24
381	2017	19524R	1	QCP	0.47	0.12	0.11	0.09	94.4	95.3	2.28	1.20
382	2017	19524R	1	QCP	0.22	0.64	0.09	0.32	93.3	93.8	1.15	0.94
383	2017	19524R	1	QCP				0.43		93.4		1.21
384	2017	19524R	1	QCP	0.62	0.58	0.90	0.67	93.7	93.3	1.29	1.68
385	2017	19524R	1	QCP	0.88	0.73	0.03	0.30	94.2	94.2	1.75	2.13
386	2017	19524R	1	QCP				0.45		94.1		1.02
387	2015	19514R	1	QCP	0.32	0.66	0.14	0.01	93.6	93.9	1.49	1.38
388	2017	19514R	1	QCP	0.04	0.56	0.76	0.04	95.0	94.2	0.64	0.84
389	2017	19524R	1	QCP	0.13	0.83	0.12	0.32	91.7	93.1	1.62	1.70
391	2017	19524R	1	QCP	0.79	0.29		0.84	94.8	94.2	0.28	1.54
392	2015	19525R	1	QCP	0.47	0.61	0.30	0.08	94.5	94.8	1.24	1.10
393	2017	19525R	1	QCP				0.92		94.7		1.29
394	2017	19525R	1	QCP				0.14		94.1		1.31
395	2015	19525R	1	QCP				0.12		94.6		1.51
396	2017	19525R	1	QCP			0.62		94.9		1.44	
397	2017	19525R	1	QCP				0.79		93.9		1.58
398	2017	19525R	1	QCP				0.71		93.2		1.19
399	2017	19510R	1	QCP				0.00		93.4		2.43
400	2016	19510R	1	QCP	0.36	0.62	0.04	0.08	92.0	90.7	1.76	2.13
401	2016	19510R	1	QCP				0.04		94.8		1.82
402	2016	19510R	1	QCP				0.00		92.7		2.97
403	2017	19510R	1	QCP				0.01		94.6		1.26
404	2016	19510R	1	QCP				0.14		94.6		1.28
405	2017	19510R	1	QCP				0.54		93.2		1.32
406	2017	19510R	1	QCP	0.69			0.34	93.5	92.5	0.00	1.66

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
407	2017	19525R	1	QCP	0.15	0.94	0.13	0.00	93.9	93.4	1.21	1.25
408	2015	19536R	1	QCP	0.69	0.48	0.21	0.32	94.1	94.3	1.44	1.17
409	2017	19536R	1	QCP	0.74	0.66	0.06	0.01	93.8	93.9	1.13	1.01
410	2017	19524R	1	QCP				0.20		93.0		2.71
411	2017	19524R	1	QCP	0.48	0.59	0.86	0.59	94.6	95.1	1.32	1.14
412	2017	19524R	1	QCP	0.16	0.00		0.91	92.7	94.0	0.00	1.51
414	2015	19665R	1	QCP	0.98	0.86	0.12	0.02	94.9	94.9	1.04	1.01
415	2015	19525R	1	QCP	0.29	0.54	0.31	0.14	94.7	95.1	1.34	1.49
416	2015	19510R	1	QCP				0.00		92.8		2.35
417	2015	19524R	1	PFP	0.51	0.72	0.01	0.00	93.6	93.8	2.09	2.17
418	2015	19510R	1	QCP	0.29	0.24		0.03	94.6	93.2	0.35	2.35
419	2016	19514R	1	QCP				0.00		95.0		1.72
420	2016	19514R	1	QCP	0.04	0.62		0.00	96.7	94.1	0.85	2.11
421	2017	19510R	1	QCP				0.02		92.9		2.18
422	2017	19510R	1	QCP				0.00		94.2		1.90
423	2017	19510R	1	QCP				0.84		94.5		1.57
424	2016	19512R	1	QCP				0.78		94.3		0.71
425	2017	19524R	1	QCP				0.12		93.9		1.95
426	2017	19524R	1	QCP				0.79		94.3		1.54
427	2017	19525R	1	PFP	0.00	0.26	0.00	0.00	93.3	93.9	1.88	2.01
428	2017	19525R	1	QCP				0.00		94.8		1.93
429	2015	19510R	1	QCP	0.00	0.02	0.29	0.11	95.3	91.5	1.02	3.05
430	2015	19524R	1	QCP	0.00	0.11	0.81	0.12	95.9	93.5	0.69	1.46
431	2015	19522R	1	QCP						95.4		0.00
432	2016	19522R	1	QCP	0.08	0.75	0.48	0.57	95.4	94.2	1.12	0.88
433	2016	19522R	1	QCP				0.08		94.2		1.61
434	2015	19522R	1	QCP	0.29			0.11	96.1	93.6	0.00	1.01
435	2016	19532R	1	QCP				0.85		93.3		1.66
436	2017	19510R	1	QCP				0.74		95.2		1.90
437	2016	19510R	1	QCP				0.99		92.2		1.73
438	2017	19510R	1	QCP	0.63			0.01	93.9	92.4	0.00	2.86
439	2015	19524R	1	QCP	0.23	0.89	0.05	0.41	94.6	95.1	0.56	0.47
440	2016	19524R	1	QCP	0.67		0.07		93.8	96.2	1.65	0.00
442	2015	19510R	1	QCP	0.01	0.02	0.85	0.07	95.6	93.2	0.86	2.48
443	2015	19665R	1	PFP	0.09	0.00	0.01	0.00	94.7	94.8	1.44	1.78

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
444	2016	19510R	1	QCP				0.44		93.7		2.46
445	2015	19536R	1	PFP	0.91	0.59	0.00	0.09	93.6	93.5	1.33	1.40
446	2015	19536R	1	PFP	0.80	0.02	0.27		93.6	93.9	0.10	0.57
447	2015	19536R	1	QCP				0.07		91.8		1.87
448	2015	19512R	1	QCP	1.00	0.49	1.00		97.3	97.4	0.20	0.07
449	2016	19525R	1	QCP				0.88		94.3		1.76
450	2017	19525R	1	PFP	0.13	0.38	0.12	0.04	94.1	94.5	1.53	1.69
451	2017	19525R	1	QCP	0.53	0.25		0.58	93.0	94.1	2.90	1.81
452	2017	19525R	1	QCP				0.34		94.6		1.26
454	2017	19512R	1	QCP	1.00	0.49	1.00		97.3	97.4	0.20	0.07
455	2017	19512R	1	QCP				0.17		94.2		1.65
456	2017	19536R	1	QCP				0.18		93.7		1.66
457	2016	19536R	1	QCP				0.91		93.1		2.14
458	2017	19510R	1	QCP	0.38	0.24	0.52	0.02	94.8	94.6	1.41	1.97
459	2017	19510R	1	QCP				0.63		93.9		1.99
460	2017	19510R	1	QCP				0.01		94.5		2.33
461	2017	19665R	1	PFP	0.81	0.22	0.61	0.09	94.6	94.6	1.33	1.57
462	2017	19665R	1	QCP	0.40	0.64	0.22	0.60	95.7	95.1	1.31	1.11
463	2017	19525R	1	QCP	0.53	0.91	0.52		95.2	96.0	1.03	0.71
464	2017	19522R	1	QCP	0.77	0.00	0.21	0.07	95.1	95.3	0.90	2.22
465	2017	19522R	1	QCP	0.01	0.66	0.00	0.28	94.4	95.2	0.98	1.05
466	2017	19653R	1	PFP	0.20	0.12	0.05	0.54	94.5	94.6	1.21	1.32
467	2017	19655	1	PFP	0.00	0.56	0.00	0.00	95.2	95.5	1.22	1.26
468	2015	19532R	1	QCP	0.59	0.68	0.52	0.52	94.4	94.5	0.98	1.15
469	2017	19532R	1	QCP	0.67		0.04		94.4	94.2	1.31	0.00
470	2017	19532R	1	QCP				0.11		95.7		1.26
471	2017	19524R	1	QCP	0.00	0.00	0.08	0.13	94.7	93.5	0.64	1.42
472	2017	19524R	1	QCP	0.75	0.75	0.89	0.27	94.2	94.4	1.15	1.37
473	2017	19522R	1	QCP				0.16		95.4		1.07
474	2015	19522R	1	QCP	1.00	0.24	0.27		95.5	96.1	1.29	0.21
475	2015	19522R	1	QCP				0.07		92.4		1.40
476	2015	19524R	1	QCP	0.84			0.31	94.5	94.2	0.00	1.98
477	2015	19524R	1	PFP	0.00	0.27	0.00	0.09	93.1	94.1	2.07	1.80
478	2015	19524R	1	QCP				0.68		92.3		1.58
479	2015	19522R	1	QCP	0.59	0.87	0.06	0.01	94.5	94.6	1.54	1.58

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
480	2015	19522R	1	QCP				0.05		94.8		1.21
481	2015	19524R	1	QCP	0.72	0.40	0.00	0.00	93.6	93.4	2.00	2.17
483	2015	19510R	1	QCP	0.09	0.84	0.06	0.24	94.3	93.7	1.52	1.57
484	2015	19510R	1	PFP	0.97	0.00	0.00	0.00	93.8	93.5	2.26	2.94
485	2015	19510R	1	QCP	0.17	0.00	0.00	0.00	93.6	92.8	2.15	3.69
486	2015	19510R	1	PFP	0.44	0.51	0.00	0.00	94.3	94.1	2.34	2.46
487	2015	19510R	1	QCP				0.18		92.0		1.84
488	2015	19510R	1	PFP	0.19	0.62	0.18	0.14	93.5	92.9	2.25	2.41
489	2015	19510R	1	QCP				0.58		91.4		2.12
490	2015	19510R	1	QCP	0.55	0.47	0.13	0.67	94.6	94.7	1.49	1.73
491	2015	19510R	1	QCP				0.15		93.8		1.98
492	2015	19510R	1	QCP	0.70			0.53	94.2	93.4	0.00	1.61
493	2015	19522R	1	QCP	0.45	0.67	0.06	0.18	94.5	94.7	1.54	1.63
494	2015	19536R	1	QCP				0.87		94.1		1.30
495	2015	19536R	1	QCP	0.86	0.39	0.71	0.27	93.9	93.8	0.98	1.55
496	2015	19536R	1	PFP	0.15	0.49	0.02	0.30	93.0	92.7	1.91	2.02
497	2016	19524R	1	QCP			0.46		94.2		1.49	
498	2017	19524R	1	QCP				0.14		93.3		1.00
499	2015	19665R	1	QCP	0.47	0.43	0.12	0.26	95.0	94.8	1.06	1.22
500	2015	19665R	1	PFP	0.53	0.87	0.01	0.10	94.1	94.2	1.42	1.43
501	2017	19510R	1	QCP				0.01		93.6		1.71
502	2015	19655R	1	PFP	0.80	0.79	0.00	0.00	95.1	95.1	1.57	1.60
503	2016	19522R	1	QCP	0.02	0.62	0.46	0.61	96.0	94.3	1.26	1.13
504	2016	19524R	1	QCP				0.58		94.0		2.08
505	2016	19514R	1	QCP	0.33	0.18	0.98	0.09	92.9	91.1	1.84	3.53
506	2016	19536R	1	QCP				0.78		93.1		1.71
507	2016	19532R	1	QCP	0.75			0.62	94.0	93.0	0.00	1.02
508	2017	19522R	1	QCP	0.22	0.74	0.51	0.01	94.1	93.6	1.31	1.23
511	2017	19524R	1	QCP				0.00		93.3		1.11
512	2017	19524R	1	PFP	0.45	0.13	0.15	0.04	93.7	93.4	1.97	2.40
513	2017	19510R	1	QCP				0.05		94.3		1.47
514	2017	19510R	1	QCP				0.00		93.4		1.80
515	2017	19510R	1	QCP	0.48	0.82	0.59	0.13	95.5	94.9	0.97	1.06
516	2017	19525R	1	QCP	0.13	0.53	0.73	0.85	92.9	92.1	1.08	1.34
517	2017	19510R	1	QCP	0.51	0.28	0.01	0.13	94.2	94.0	1.50	1.73

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518	2017	19510R	1	QCP	0.17	0.99	0.23	0.06	94.3	93.8	1.75	1.74
519	2017	19653R	1	PFP	0.10	0.49	0.07	0.04	93.3	93.7	1.91	2.07
520	2017	19525R	1	PFP	0.52	0.50	0.00	0.00	94.0	93.9	1.59	1.51
521	2017	19525R	1	PFP	0.80	0.84	0.27		93.6	93.7	0.92	0.57
522	2017	19655R	1	PFP	0.15	0.31	0.00	0.88	95.3	96.1	1.37	0.98
523	2017	19510R	1	QCP	0.93			0.01	94.6	94.5	0.00	1.24
524	2017	19665R	1	PFP	0.80	0.73	0.05	0.00	94.3	94.3	2.09	2.17
525	2017	19665R	1	QCP				0.01		95.3		1.70
526	2015	19512R	1	QCP				0.21		91.1		1.44
527	2015	19514R	1	QCP				1.00		90.9		1.53
529	2016	19606F	2	PFP	0.51	0.75	0.52	0.07	92.1	92.2	1.95	1.99
530	2015	19514R	2	QCP	0.75	0.51	0.21	0.02	94.0	93.8	2.10	2.35
531	2014	19514R	2	QCP				0.12		93.2		1.86
532	2015	19604FR	2	QCP	0.17	0.03	0.20	0.05	94.1	92.9	2.00	3.08
533	2015	19514R	2	QCP				0.12		94.0		2.00
534	2016	19535R	2	QCP	0.95	0.59	0.28	0.64	97.7	97.6	2.12	2.39
535	2015	19534R	2	PFP	0.87	0.63	0.00	0.00	92.0	92.0	1.70	1.67
536	2015	19532R	2	PFP	0.04	0.12	0.00	0.00	92.9	93.1	1.29	1.18
537	2015	19514R	2	QCP	0.00	0.10	0.84	0.73	92.4	93.3	1.82	1.54
538	2017	19514R	2	QCP	0.22	0.82	0.46	0.31	96.2	95.5	1.85	1.93
539	2015	19524R	2	QCP	0.04	0.00	0.05		93.5	92.6	0.56	0.00
540	2015	19514R	2	QCP	0.14	0.98	0.02	0.06	93.9	93.6	1.44	1.44
541	2015	19604FR	2	QCP	0.58	0.31	0.23	0.45	91.8	91.7	0.53	0.66
542	2015	19604FR	2	QCP	0.82	0.12	0.02	0.02	92.1	91.8	0.89	1.44
543	2015	19514R	2	QCP	0.13	0.77	0.36	0.78	93.0	92.6	1.20	1.25
544	2016	19604FR	2	QCP	0.00	0.97	0.20	0.01	92.7	91.3	0.96	0.96
545	2016	19514R	2	QCP	0.00	0.59	0.32	0.00	91.6	94.0	2.12	2.27
546	2016	19516R	2	QCP	0.78	0.58	0.85	0.01	94.8	94.2	1.85	1.50
547	2017	19514R	2	QCP	0.14	0.13	0.95	0.00	94.8	95.7	2.74	1.97
548	2017	19512R	2	QCP	0.91	0.88	0.00	0.00	94.7	94.4	1.60	1.57
549	2017	19512R	2	QCP	0.67	0.84	0.00	0.00	94.7	94.3	1.60	1.55
553	2017	19514R	2	QCP	0.63	0.34	0.76	0.65	94.4	94.2	0.69	0.96
554	2015	19514R	2	QCP	0.98	0.29	0.27	0.07	92.8	92.8	1.98	1.83
555	2017	19514R	2	QCP	0.75	0.91	0.35	0.18	93.5	93.6	1.74	1.76
556	2015	19514R	2	QCP	0.24	0.77	0.80	0.80	93.1	93.3	1.55	1.59

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
557	2016	19514R	2	QCP	0.23	0.14	0.00	0.00	93.0	92.7	1.86	2.05
558	2015	19512R	2	QCP	0.54	0.63	0.02	0.03	93.7	93.6	1.68	1.62
559	2017	19512R	2	QCP	0.10	0.95	0.02	0.04	94.3	93.6	2.07	2.10
560	2015	19512R	2	QCP	0.83	0.62	0.62	0.80	92.8	92.8	1.88	1.97
561	2015	19534R	2	PFP	1.00	0.56	0.00	0.00	92.2	92.2	2.06	2.11
562	2015	19534R	2	PFP	0.24	0.04	0.02	0.00	92.7	92.3	1.81	2.13
563	2016	19534R	2	PFP	0.33	0.29	0.54	0.50	93.0	93.1	1.30	1.38
564	2017	19532R	2	PFP	0.62	0.29	0.09	0.02	92.1	91.9	2.06	2.32
565	2015	19535R	2	PFP	0.46	0.28	0.78	0.67	92.4	92.8	1.63	1.29
566	2017	19535R	2	PFP	0.68	0.97	0.17	0.18	92.4	92.5	2.04	2.05
567	2016	19512R	2	QCP				0.12		92.6		1.93
568	2015	19654R	2	PFP	0.32	0.91	0.03	0.01	93.5	93.6	1.42	1.43
569	2016	19532R	2	PFP	0.11	0.50	0.00	0.00	92.9	93.1	1.95	2.04
570	2016	19654R	2	PFP	0.15	0.74	0.00	0.00	93.1	93.3	1.95	1.93
571	2016	19654R	2	QCP	0.02	0.33	0.23	0.03	92.3	94.6	1.43	2.18
572	2016	19524R	2	QCP	0.20	0.66	0.64	0.12	91.4	92.2	2.76	2.58
573	2017	19524R	4	QCP	0.68	0.12	0.01	0.38	94.1	94.7	1.81	0.88
574	2016	19534R	2	PFP	0.26	0.33	0.34	0.46	93.0	93.1	1.29	1.36
575	2016	19534R	2	PFP	0.71	0.79	0.07	0.71	93.2	93.3	1.50	1.47
576	2015	19524R	2	QCP				0.29		94.2		1.50
577	2015	19525R	2	QCP	0.45	0.89	0.14	0.00	92.3	92.5	2.41	2.45
578	2015	19532R	2	PFP	0.06	0.00	0.01	0.00	94.5	94.3	1.28	1.46
579	2015	19605FR	2	QCP				0.50		91.1		2.15
580	2015	19654R	2	PFP	0.12	0.87	0.60	0.65	94.7	94.5	1.31	1.29
581	2015	19515R	2	QCP	0.00	0.84	0.00	0.00	93.1	93.8	1.79	1.76
582	2016	19515R	2	QCP				0.00		94.1		1.55
583	2014	19604FR	2	QCP				0.00		92.8		1.54
584	2015	19605FR	2	QCP	0.01	0.20	0.77	0.00	92.2	89.4	1.24	0.40
585	2015	19525R	2	QCP	0.53	0.59	0.03	0.15	92.1	91.9	2.03	1.83
586	2015	19515R	2	QCP				0.00		93.4		1.72
587	2016	19525R	2	QCP				0.10		93.9		2.03
588	2015	19532R	2	PFP	0.98	0.68	0.44	0.14	94.7	94.7	1.28	1.32
589	2015	19532R	2	QCP	0.12	0.03	0.19	0.00	94.6	94.4	1.27	1.45
590	2015	19654R	2	PFP	0.32	0.04	0.00	0.00	93.9	93.7	1.82	1.99
591	2015	19526R	2	QCP						92.2		0.92

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
595	2017	19515R	2	QCP	0.65	0.51	0.64	0.98	93.3	93.2	1.12	1.30
596	2017	19604FR	2	QCP	0.17	0.12	0.06	0.85	92.6	92.2	0.66	0.92
597	2017	19532	2	PFP	0.94	0.60	0.69	0.58	92.7	92.7	1.59	1.72
598	2017	19513R	2	QCP				0.09		93.5		1.84
599	2017	19535R	2	PFP	0.98	0.63	0.79	0.16	93.2	93.1	1.66	1.79
600	2017	19524R	1	QCP				0.86		92.5		1.54
601	2017	19524R	1	PFP	0.98	0.06	0.00	0.00	91.9	91.7	2.68	3.13
602	2016	19524R	3	QCP				0.36		92.3		1.80
603	2017	19522R	3	QCP				0.00		94.1		1.10
604	2015	19535R	3	PFP	0.03	0.00	0.17	0.33	92.3	91.8	1.17	1.66
605	2017	19510R	1	QCP				0.01		93.0		1.48
606	2017	19510R	1	QCP	0.43	0.20	0.06	0.00	93.9	94.0	1.84	1.69
607	2016	19524R	3	QCP	0.11	0.20	0.10	0.20	94.2	93.2	1.04	1.66
608	2017	19534R	3	QCP	0.12	0.73		0.04	91.5	93.0	0.78	1.62
609	2017	19524R	1	PFP	0.99	0.35	0.12	0.19	92.8	92.8	1.53	1.63
610	2017	19524R	3	QCP	0.32	0.30	0.73	0.01	94.0	94.2	1.12	1.52
613	2015	19522R	3	QCP				0.00		93.9		2.24
614	2015	19522R	3	QCP				0.63		94.0		1.40
615	2016	19512R	1	QCP				0.00		93.3		0.92
616	2016	19514R	3	QCP				0.00		93.6		1.31
617	2015	19534R	3	PFP	0.01	0.51	0.24	0.01	93.8	93.0	1.35	1.55
618	2015	19534R	3	PFP	0.18	0.02	0.83	0.00	93.1	93.3	0.96	1.47
619	2017	19524R	1	QCP				0.05		93.2		1.61
620	2016	19512R	1	QCP				0.00		93.9		1.11
621	2017	19534R	3	PFP	0.79	0.45	0.08	0.01	93.8	93.9	0.83	1.10
622	2017	19532R	3	PFP	0.42	0.55	0.15	0.00	93.0	93.4	1.11	1.47
623	2017	19510R	1	QCP				0.00		93.1		0.91
624	2017	19654R	3	QCP	0.01	0.88	0.23	0.17	91.5	94.1	1.61	1.86
625	2017	19510R	4	PFP	0.00	0.03	0.00	0.00	94.6	94.8	1.06	1.21
626	2015	19515R	4	QCP	0.02	0.33	0.17	0.32	93.8	94.8	0.66	1.03
627	2016	19515R	4	QCP	0.04	0.18	0.08	0.57	92.3	91.6	1.33	1.68
628	2016	19522R	4	PFP	0.65	0.68	0.01	0.06	94.3	94.4	1.93	2.07
629	2016	19522R	4	PFP	0.37	0.28	0.00	0.00	93.5	93.6	1.81	1.90
630	2016	19532R	3	PFP	0.42			0.00	93.1	93.7	0.00	1.26
631	2015	19653R	4	PFP			0.01		94.4		1.68	

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
632	2016	19654R	4	PFP	0.19	0.26	0.00	0.00	94.0	94.3	1.98	2.16
633	2017	19654R	4	PFP	0.38	0.92	0.36	0.02	95.1	95.3	1.32	1.33
634	2016	19654R	4	PFP	0.37			0.17	93.5	94.6	0.00	1.77
635	2017	19510R	4	QCP	0.05	0.00	0.00	0.00	94.1	94.5	0.92	1.58
636	2015	19515R	4	QCP	0.32	0.48	0.02	0.01	94.4	94.2	1.24	1.36
637	2016	19524R	4	PFP	0.10	0.73	0.00	0.82	93.1	93.8	1.44	1.34
638	2016	19525R	4	PFP	0.05	0.98	0.37	0.11	93.6	94.7	2.03	2.01
639	2015	19525R	4	PFP	0.00	0.00	0.00	0.00	93.5	92.9	1.23	1.77
640	2015	19535R	3	PFP	0.00	0.63	0.00	0.00	93.3	92.9	1.26	1.31
641	2016	19510R	4	PFP	0.01	0.14	0.02	0.00	94.2	94.6	1.22	1.37
642	2016	19510R	4	PFP	0.84	0.37	0.00	0.10	93.8	93.7	1.71	1.55
643	2017	19515R	4	QCP	0.95	0.90	0.92	0.80	94.0	94.1	1.20	1.16
644	2017	19514R	4	PFP	0.92	0.22	0.12	0.92	94.0	93.9	1.28	1.42
645	2015	19515R	4	QCP	0.05	0.96	0.00	0.61	94.3	92.8	1.97	1.89
646	2015	19524R	4	PFP	0.76	0.00	0.20	0.00	94.4	94.2	0.90	1.43
647	2016	19512R	4	PFP	0.00	0.00	0.15	0.00	95.0	96.1	1.03	1.55
648	2017	19522R	4	QCP	0.38	0.03	0.85	0.76	94.8	94.4	1.52	0.81
649	2015	19514R	4	QCP	0.80	0.45	0.11	0.20	94.5	94.5	1.09	1.22
650	2016	19514R	4	PFP	0.37	0.21	0.00	0.62	96.0	95.6	2.23	1.99
651	2015	19514R	4	PFP	0.30	0.00	0.78	0.00	94.1	93.7	0.89	1.59
652	2015	19524R	5	QCP	0.84	0.05	0.18	0.93	94.5	94.6	0.88	1.82
653	2015	19514R	5	QCP	0.01	0.06	0.00	0.26	93.7	93.0	1.29	1.64
654	2016	19514R	5	QCP					93.1		0.00	
655	2016	19514R	5	QCP			0.85		93.6		0.71	
656	2015	19514R	5	QCP				0.82		93.1		1.68
658	2015	19605FR	5	QCP	0.05	0.50	0.54	0.13	93.5	91.3	1.08	2.02
659	2015	19524R	5	QCP						89.6		0.00
734	2015	19534R	5	QCP				0.05		93.5		1.28
735	2015	19534R	5	PFP	0.45	0.62	0.02	0.01	93.6	93.5	1.53	1.47
745	2017	19535R	5	QCP			0.70		93.6		0.56	
746	2017	19512R	6	QCP	0.15	0.34	0.16	0.05	94.1	94.6	0.78	1.13
749	2015	19534R	5	PFP	0.00	0.03	0.02	0.37	97.7	93.2	2.82	1.57
750	2016	19513R	5	QCP			0.11		99.5		0.63	
751	2015	19532R	5	PFP	0.55	0.00	0.39	0.02	94.5	94.3	0.66	1.37
752	2015	19535R	5	PFP	0.14	0.29		0.55	94.6	93.1	0.28	1.56

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753	2015	19523R	5	QCP	0.04	0.05	0.15	0.95	95.0	94.1	0.97	1.59
754	2015	19505R	5	QCP	0.13			0.04	96.8	93.9	0.00	2.04
756	2015	19534R	5	PFP	0.85	0.74		0.08	93.5	93.5	0.85	1.75
757	2016	19513R	5	QCP	0.33	0.08	0.23	0.97	94.3	94.8	0.85	1.43
758	2016	19513R	5	QCP			0.15		94.7		0.76	
759	2015	19532R	5	PFP	1.00	0.37	0.14	0.78	94.4	94.4	0.70	0.97
760	2016	19535R	5	PFP					93.5		1.34	
761	2017	19532R	5	PFP					94.6		0.14	
762	2015	19523R	6	QCP	0.05	0.00	0.06	0.36	93.2	93.9	0.63	1.48
763	2015	19513R	6	QCP	0.02	0.00	0.42	0.14	94.3	92.9	0.58	1.91
765	2015	19513R	6	QCP	0.29	0.00	0.52	0.20	93.9	93.7	0.70	1.61
766	2016	19513R	6	PFP	0.13	0.18	0.01	0.06	93.8	93.9	1.06	1.27
767	2015	19522R	6	PFP	0.38	0.42	0.00	0.00	94.1	94.0	1.64	1.52
768	2015	19522R	6	PFP	0.19	0.00	0.01	0.47	94.3	94.0	0.82	1.48
769	2015	19513R	6	QCP	0.01	0.00	0.30	0.01	94.9	94.2	0.96	1.46
770	2015	19513R	6	QCP	0.12	0.04	0.20	0.26	94.4	93.6	0.99	1.76
771	2015	19523R	6	PFP	0.00	0.00	0.00	0.00	93.9	94.6	1.70	1.21
772	2015	19513R	6	QCP	0.14	0.00	0.02	0.00	93.4	93.8	0.27	1.42
773	2015	19523R	6	QCP	0.97	0.01	0.02	0.40	93.7	93.6	0.98	1.39
774	2015	19523R	6	QCP	0.41	0.79	0.00	0.18	92.3	92.2	1.26	1.29
775	2016	19534R	6	PFP				0.06		93.2		1.61
776	2015	19534R	6	PFP				0.00		93.7		1.32
780	2015	19522R	6	PFP	0.39	0.43	0.00	0.00	94.5	94.7	1.60	1.54
781	2015	19513R	6	QCP	0.61	0.78	0.05	0.27	94.5	94.0	1.22	1.49
782	2017	19522R	6	QCP	0.00	0.03	0.00	0.03	94.1	93.5	1.01	1.32
783	2015	19535R	6	PFP				0.03		93.7		1.68
784	2015	19535R	6	QCP				0.60		94.0		1.72
785	2015	19535R	6	PFP				0.01		93.2		1.49
786	2016	19514R	6	QCP	0.92	0.00	0.06	0.02	93.2	93.4	0.54	2.21
787	2015	19513R	6	QCP	0.08	0.00	0.02	0.01	93.2	91.7	0.06	1.97
788	2015	19522R	6	QCP				0.27		94.2		1.50
789	2015	19532R	6	PFP	0.17	0.08		0.00	93.2	94.0	0.07	1.41
790	2016	19532R	6	QCP				0.28		94.7		1.01
791	2015	19524R	6	QCP				0.12		93.7		1.18
792	2015	19512R	6	QCP	0.50	0.00	0.02	0.74	93.5	93.4	0.44	1.10

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793	2015	19535R	6	PFP	0.22	0.29	0.02	0.00	94.4	93.4	0.87	1.70
794	2017	19535R	6	PFP				0.54		93.7		1.40
795	2016	19535R	6	QCP				0.69		93.6		1.04
796	2017	19513R	6	QCP	0.29	0.00	0.01	0.00	93.9	94.0	0.85	1.60
797	2017	19513R	6	QCP				0.48		94.1		1.21
798	2017	19513R	6	QCP	0.58	0.18		0.07	94.4	94.0	0.14	1.22
799	2016	19513R	6	PFP	0.12	0.47	0.23	0.10	94.3	94.0	0.78	0.86
801	2016	19513R	6	QCP	0.25	0.02	0.29	0.04	93.5	93.8	0.47	1.10
802	2016	19513R	6	QCP				0.61		92.3		2.10
803	2016	19514R	6	QCP				0.37		93.7		1.52
804	2015	19512R	6	QCP	0.36	0.01	0.81	0.14	94.7	94.5	0.72	1.36
805	2016	19524R	6	QCP	0.03	0.00	0.00	0.03	93.7	94.0	0.83	1.29
807	2017	19513R	6	QCP	0.86	0.28	0.19	0.00	95.0	94.9	0.86	1.31
808	2015	19513R	6	QCP	0.89	0.68		0.75	95.3	95.4	0.71	1.54
809	2017	19513R	6	QCP	0.08	0.03	0.07	0.09	94.6	93.7	0.47	1.28
810	2016	19513R	6	QCP	0.18	0.04	0.00	0.02	93.6	93.7	0.98	1.47
811	2016	19513R	6	QCP	0.00	0.38	0.02	0.56	95.9	93.8	1.04	1.44
812	2017	19532R	6	PFP				0.01		94.6		1.12
813	2016	19514R	6	QCP	0.93	0.55	0.83	0.73	94.2	94.1	0.93	1.13
814	2016	19534R	7	PFP	0.34	0.48	0.03	0.19	93.9	94.1	1.28	1.37
815	2016	19524R	6	QCP	0.00	0.31	0.04	0.00	93.7	94.7	1.21	1.50
817	2016	19532R	6	PFP	0.38	0.25		0.32	93.5	94.1	0.21	1.37
818	2016	19524R	6	QCP				0.66		92.7		1.57
819	2016	19534R	6	PFP				0.06		93.2		1.61
820	2016	19513R	6	QCP	0.00	0.38	0.02	0.56	95.9	93.8	1.04	1.44
821	2016	19512R	6	QCP	0.08	0.00	0.78	0.00	93.6	93.7	0.33	1.52
822	2017	19514R	6	QCP	0.77	0.06		0.02	94.2	94.1	0.07	1.95
823	2017	19522R	6	PFP	0.10	0.37	0.00	0.04	93.5	92.6	2.03	2.34
824	2017	19514R	6	QCP				0.82		92.9		1.47
825	2017	19513R	6	QCP	0.39	0.04	0.22	0.02	94.9	95.0	1.16	1.66
826	2015	19524	7	PFP	0.36	0.17	0.51	0.26	93.2	93.8	0.67	1.36
827	2015	19532R	7	PFP	0.84	0.94	0.04	0.83	94.1	94.0	1.31	1.17
828	2016	19523R	7	QCP	0.26	0.92	0.07	0.86	93.5	93.9	1.43	1.45
829	2016	19532R	7	QCP	0.24	0.25	0.85	0.16	93.5	93.8	1.14	1.28
830	2016	19523	7	QCP				0.98		93.8		1.34

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
831	2016	19523	7	QCP				0.26		93.0		1.21
832	2017	19523	7	QCP	0.88	0.07	0.00	0.48	92.1	92.3	2.34	1.29
833	2016	19534R	7	QCP	0.37	0.01	0.07	0.84	93.7	93.5	0.78	1.52
834	2015	19534R	7	PFP	0.50	0.10	0.78	0.79	93.6	93.2	0.97	1.50
835	2015	19534R	7	PFP	0.45	0.25	0.92	0.00	93.0	93.2	1.14	1.58
836	2016	19534R	7	QCP	0.00	0.00	0.59	0.04	94.1	93.2	0.77	1.52
837	2015	19534R	7	QCP	0.10	0.82	0.85	0.34	93.5	94.4	1.44	1.37
838	2016	19523R	9	QCP				0.67		93.4		0.70
839	2016	19605FR	9	QCP				0.10		93.3		0.75
840	2015	19534R	7	PFP	0.93	0.46	0.08	0.01	93.7	93.6	1.66	1.79
841	2015	19523R	7	QCP	0.65	0.51	0.70	0.18	94.0	94.1	1.35	1.20
842	2015	19523R	7	PFP	0.84	0.32	0.33	0.02	92.9	92.9	1.78	1.91
843	2016	19534R	7	QCP	0.02	0.01	0.51	0.01	93.0	94.2	0.47	1.65
844	2015	19534R	7	PFP	0.88	0.91	0.17	0.03	93.1	93.1	1.60	1.58
845	2016	19654R	7	PFP	0.94	0.07	0.00	0.00	94.3	94.3	1.63	1.83
846	2015	19654R	7	PFP	0.98	0.32	0.03	0.00	93.9	93.9	1.75	1.89
847	2016	19654R	7	PFP	0.94	0.25	0.02	0.03	95.2	95.1	1.11	1.33
848	2016	19654R	7	PFP	0.01	0.37	0.34	0.30	94.6	93.2	1.22	1.51
849	2017	19654R	7	PFP	0.15	0.47	0.01	0.00	94.9	95.1	1.25	1.31
850	2016	19532R	7	PFP	0.78	0.48	0.00	0.02	93.6	93.7	1.69	1.75
851	2017	19532R	7	PFP	0.01	0.01	0.00	0.03	93.9	94.1	0.96	1.09
852	2017	19523R	7	QCP	0.39	0.49	0.73	0.61	93.5	93.2	1.42	1.59
853	2015	19505R	7	PFP	0.04	0.98	0.43	0.26	94.4	94.1	0.61	0.60
854	2015	19532R	7	PFP	0.02	0.00	0.06	0.00	93.2	93.6	0.66	1.22
855	2016	19532R	7	PFP	0.27	0.00	0.00	0.00	93.8	93.9	1.09	1.51
856	2015	19654R	7	PFP	0.65	0.06	1.00	0.00	95.2	94.5	0.30	1.75
857	2016	19654R	7	PFP	0.35	0.34	0.00	0.00	93.9	94.0	1.68	1.79
858	2017	19533R	7	PFP	0.37	0.18	0.01	0.18	93.5	93.3	1.27	1.45
859	2017	19532R	7	PFP	0.06	0.06	0.85	0.90	95.1	94.5	0.54	0.91
861	2016	19523R	8	QCP	0.47		0.51		93.6	94.4	1.15	0.00
862	2016	19523R	8	QCP			0.02		94.2		1.16	
863	2016	19534R	8	QCP	0.03	0.00	0.99	0.95	93.3	93.9	0.61	1.32
864	2015	19534R	8	QCP			0.42		93.7		0.59	
865	2015	19534R	8	QCP	0.05	0.23	0.47	1.00	93.9	93.2	0.57	0.20
866	2015	19534R	8	QCP	1.00				92.0	92.7	0.00	0.00

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
869	2015	19535R	8	QCP	0.00	0.39	0.67	0.46	92.5	95.7	1.19	0.81
870	2015	19654R	8	PFP	0.01	0.13	0.00	0.52	95.2	94.2	1.55	1.04
871	2015	19534R	8	QCP			0.09		92.2		1.67	
873	2015	19654R	8	PFP	0.34	0.08	0.00	0.27	94.7	94.4	1.65	0.74
874	2015	19535R	8	QCP			0.31		94.1		1.11	
875	2015	19601R	8	QCP	0.07	0.20	0.00	0.06	95.6	95.3	0.96	1.16
876	2016	19532R	8	PFP	0.52	0.39	0.01		93.2	93.9	1.41	0.35
877	2016	19533R	8	QCP	0.60	0.20	0.58	0.36	93.6	93.3	0.95	1.29
878	2016	19534R	8	PFP			0.20		92.8		0.69	
879	2016	19504R	8	QCP					93.5		0.00	
881	2017	19654R	8	PFP			0.04		95.2		0.76	
882	2017	19523R	8	QCP	0.44	0.40	0.01	0.52	93.9	93.7	1.06	1.21
883	2017	19523R	8	QCP				0.57		94.0		1.12
884	2015	19533R	9	QCP				0.68		92.8		2.13
885	2016	19606FR	9	QCP				0.17		92.0		1.47
886	2015	19605FR	9	QCP				0.63		91.8		1.09
887	2016	19534R	9	QCP				0.68		94.3		1.08
888	2016	19534R	9	QCP	0.11		0.24		93.7	91.1	1.08	0.00
889	2016	19532R	9	QCP	0.09		0.00		94.7	93.1	0.86	0.00
890	2017	19532R	9	QCP			0.64		94.4		0.83	
891	2015	19532R	9	QCP	0.00	0.09	0.88	0.38	94.6	92.7	0.71	1.16
892	2015	19532R	9	PFP				0.48		92.3		0.80
893	2016	19532R	9	PFP	0.04	0.61	0.66	0.20	94.3	93.9	0.98	0.89
894	2016	19606FR	9	QCP				0.28		90.9		0.78
895	2016	19606FR	9	QCP				0.55		91.3		0.78
896	2016	19606FR	9	QCP				0.41		90.8		1.14
898	2016	19534R	9	QCP	0.80	0.65		0.37	93.6	93.5	0.71	0.54
899	2017	19534R	9	QCP						93.8		0.00
900	2016	19534R	9	QCP				0.45		93.3		0.84
901	2016	19534R	9	QCP				0.87		92.6		0.75
902	2016	19534R	9	QCP					93.2		0.00	
903	2017	19534R	9	QCP				0.46		94.2		0.72
904	2015	19534R	9	QCP				0.80		92.2		0.65
905	2015	19534R	9	QCP				0.35		93.0		1.05
906	2015	19606FR	9	QCP				0.08		90.9		1.98

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
907	2015	19606FR	9	QCP						91.4		0.96
908	2016	19522R	9	QCP	0.00	0.00	0.00	0.02	94.2	93.1	1.07	0.12
909	2017	19523R	9	QCP				0.54		94.2		1.21
910	2016	19523R	9	QCP			0.48		94.2		1.44	
911	2016	19523R	9	QCP					93.8		0.00	
912	2015	19534R	9	QCP				0.18		90.5		1.92
913	2015	19533R	9	QCP				0.06		92.5		0.65
914	2015	19533R	9	QCP	0.01	0.96	0.90	0.37	92.5	91.1	0.55	0.66
915	2015	19533R	9	QCP				0.69		92.9		0.89
916	2015	19533R	9	QCP				0.97		92.2		1.36
917	2015	19533R	9	QCP				0.69		91.7		1.02
918	2015	19533R	9	QCP				0.23		91.6		0.87
919	2015	19534R	9	QCP				0.29		89.5		1.83
921	2015	19606	9	QCP				0.62		89.7		1.45
922	2015	19606FR	9	QCP				0.17		90.9		0.89
923	2016	19606FR	9	QCP				0.23		91.9		1.23
924	2015	19606FR	9	QCP				0.56		90.4		1.18
925	2016	19606FR	9	QCP				0.47		91.5		0.84
926	2015	19534R	9	QCP				0.12		92.4		0.93
927	2016	19534R	9	QCP				0.13		94.3		0.87
928	2016	19533R	9	QCP				0.25		94.0		0.96
929	2016	19523R	9	QCP	0.96	0.46	0.00	0.23	92.7	92.2	1.38	1.85
930	2016	19523R	9	QCP				0.69		94.0		0.90
931	2017	19523R	9	QCP				0.11		93.2		0.53
932	2017	19523R	9	QCP				0.58		93.6		0.72
933	2016	19605FR	9	QCP				0.63		92.3		0.86
934	2017	19605FR	9	QCP				0.67		91.9		1.01
935	2016	19605FR	9	QCP				0.58		92.8		1.52
936	2015	HMA Binder	9	QCP				0.97		93.5		1.07
937	2015	HMA Binder	9	QCP				0.28		92.2		0.97
938	2015	HMA Binder	9	QCP				0.46		94.1		0.96
939	2016	19535	9	PFP				0.11		95.4		0.90

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
940	2016	19535	9	PFP			0.78		91.8		2.26	
941	2016	19532R	9	PFP	0.48	0.45	0.32	0.20	94.4	94.2	1.39	1.54
942	2016	19532R	9	PFP	0.88	0.81	0.87	0.03	94.5	94.5	1.62	1.58
943	2017	19533R	9	QCP			0.75		94.5		1.10	
944	2016	19533R	9	QCP				0.60		92.8		1.40
945	2017	19534R	9	PFP					93.4		0.00	
946	2015	19533R	9	QCP				0.40		92.4		0.97
947	2016	19534R	9	QCP				0.88		93.1		0.51
948	2016	19534R	9	QCP				0.45		93.8		1.05
949	2015	19534R	9	QCP				0.62		93.3		0.77
950	2016	19606FR	9	QCP						93.0		0.66
951	2016	19534R	9	QCP				0.35		92.9		1.50
952	2015	19605FR	9	QCP				0.00		91.6		1.04
953	2015	19605FR	9	QCP				0.57		92.0		1.14
954	2015	19605FR	9	QCP				0.17		92.0		0.57
955	2016	19606FR	9	QCP				0.85		91.2		1.24
957	2015	19523R	9	QCP				0.45		93.1		0.74
958	2015	19523R	9	QCP				0.04		93.6		0.66
959	2016	19523R	9	QCP			0.97		94.6		1.10	
960	2015	19523R	9	QCP				0.59		94.6		1.18
961	2015	19523R	9	QCP				0.97		94.0		0.89
962	2016	19532R	9	QCP				0.42		93.5		1.15
963	2016	19606FR	9	QCP				0.65		91.7		0.62
964	2017	19605FR	9	QCP						93.7		0.14
965	2017	19532R	9	QCP	0.00	0.07	0.38	0.81	94.5	92.0	0.77	1.56
966	2017	19524R	9	QCP				0.30		94.9		0.65
967	2017	19534R	9	QCP				0.35		92.9		1.50

C.4 G_{MM} ANALYSIS RESULTS

Table C.4. G_{mm} Analysis Results Summary

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
1	2015	19524R	1	QCP	1.00	0.22			2.526	2.520	0.002	0.012
2	2017	19524R	1	QCP	0.67				2.516	2.511	0.001	0.000
3	2017	19524R	1	QCP	0.67				2.519	2.524	0.003	0.000
4	2016	19524R	1	QCP	0.79	0.82	0.89	0.59	2.519	2.517	0.007	0.007
5	2015	19514R	1	QCP					2.503		0.000	
6	2015	19514R	1	QCP	0.67				2.505	2.502	0.003	0.000
7	2015	19524R	1	QCP	0.74	0.38	0.33	0.00	2.492	2.490	0.008	0.011
8	2015	19524R	1	QCP					2.493		0.001	
9	2015	19524R	1	PFP	0.53	0.42	0.79	0.30	2.491	2.494	0.007	0.009
10	2015	19512R	1	QCP	0.50		1.00		2.514	2.526	0.006	0.000
11	2015	19512R	1	QCP	1.00				2.530	2.528	0.004	0.000
12	2015	19522R	1	QCP	0.07	0.34	0.08	0.03	2.519	2.526	0.009	0.006
13	2017	19522R	1	QCP	0.33	0.59			2.548	2.571	0.007	0.004
14	2015	19510R	1	QCP	0.50		0.00		2.440	2.452	0.002	0.000
15	2015	19510R	1	QCP					2.455		0.011	
16	2015	19510R	1	QCP	0.17	0.03	0.86	0.40	2.447	2.452	0.006	0.002
17	2015	19512R	1	QCP	0.67				2.530	2.547	0.000	0.010
18	2015	19510R	1	QCP	1.00	0.46	0.18		2.425	2.426	0.007	0.002
19	2015	19536R	1	QCP				0.54		2.493		0.004
20	2017	19525R	1	QCP	0.80	0.53	0.97		2.501	2.502	0.012	0.004
21	2015	19524R	1	QCP	0.67				2.499	2.503	0.001	0.000
22	2015	19524R	1	QCP	1.00				2.501	2.500	0.002	0.000
23	2015	19512R	1	QCP	0.50		0.54		2.518	2.525	0.004	0.000
24	2016	19532R	1	QCP	0.33	0.88			2.509	2.519	0.004	0.004
25	2017	19532R	1	QCP	1.00		0.84		2.514	2.512	0.006	0.000
26	2017	19510R	1	QCP	1.00				2.439	2.448	0.000	0.000
27	2015	19510R	1	QCP	0.72	0.56	0.12	0.17	2.434	2.437	0.009	0.006
28	2017	19665R	1	QCP					2.424		0.001	
29	2015	19665R	1	QCP	0.06	0.26	0.27	1.00	2.424	2.428	0.001	0.002
30	2017	19524R	1	QCP	0.93	0.78	0.05	0.59	2.504	2.505	0.008	0.007
31	2017	19525R	1	QCP	1.00				2.502	2.499	0.006	0.000

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
32	2016	19510R	1	QCP	0.50		0.00		2.413	2.422	0.001	0.000
33	2015	19525R	1	QCP			0.42		2.505		0.010	
34	2016	19512R	1	QCP			0.57		2.507		0.006	
35	2015	19512R	1	QCP	0.67				2.505	2.490	0.002	0.000
36	2015	19522R	1	QCP	0.14		0.35		2.531	2.540	0.006	0.000
37	2015	19522R	1	QCP						2.539		0.000
38	2015	19524R	1	QCP	0.85	0.01	0.57	0.54	2.518	2.520	0.004	0.012
39	2015	19510R	1	QCP	1.00	0.54	0.08		2.423	2.418	0.017	0.006
40	2015	19510R	1	QCP					2.425		0.000	
41	2015	19510R	1	QCP	1.00	0.67			2.401	2.400	0.013	0.023
42	2015	19524R	1	QCP			0.60		2.492		0.008	
43	2015	19524R	1	QCP	0.00	0.03	0.78	0.97	2.480	2.494	0.006	0.002
44	2015	19510R	1	PFP	0.61	0.00	0.10	0.22	2.431	2.431	0.004	0.011
45	2015	19510R	1	PFP					2.426		0.000	
46	2015	19524R	1	QCP	0.06	0.56	0.53	0.34	2.498	2.520	0.011	0.008
47	2015	19655R	1	PFP	0.00	0.00	0.53	0.00	2.609	2.618	0.006	0.025
48	2015	19536R	1	PFP	0.23	0.20	0.10	0.15	2.704	2.716	0.020	0.029
49	2017	19510R	1	QCP	0.40		0.40		2.437	2.450	0.008	0.000
50	2017	19510R	1	QCP	0.22		0.25		2.437	2.456	0.010	0.000
51	2016	19510R	1	QCP	0.27	1.00		0.98	2.435	2.447	0.009	0.012
52	2017	19524R	1	QCP	0.67				2.512	2.522	0.006	0.000
53	2017	19525R	1	QCP	0.33		0.48		2.491	2.504	0.006	0.000
54	2017	19525R	1	PFP	0.36	0.51	0.91	0.32	2.502	2.505	0.008	0.006
55	2016	19525R	1	QCP	1.00	0.24	0.77	0.19	2.508	2.512	0.007	0.015
56	2016	19536R	1	QCP					2.500		0.001	
57	2015	19536R	1	PFP	0.65	0.13	0.00	0.75	2.507	2.506	0.009	0.014
58	2015	19524R	1	QCP	0.49	0.12	0.00	0.24	2.515	2.516	0.004	0.009
59	2017	19524R	1	QCP	1.00	0.35	0.25	0.00	2.507	2.506	0.004	0.002
60	2015	19522R	1	QCP	0.37	0.80	0.26	0.30	2.540	2.544	0.006	0.007
61	2015	19522R	1	QCP	0.30	0.18	0.46	0.74	2.546	2.550	0.008	0.014
62	2015	19510R	1	QCP	1.00				2.421	2.425	0.006	0.000
63	2015	19510R	1	PFP	0.98	0.85	0.01	0.41	2.449	2.448	0.009	0.009
64	2017	19524R	1	QCP	1.00				2.502	2.506	0.000	0.000
65	2017	19524R	1	PFP	0.74	0.36	0.17	0.83	2.509	2.512	0.006	0.004
66	2017	19524R	1	QCP	1.00				2.505	2.503	0.012	0.000

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
67	2017	19510R	1	QCP	0.10	1.00	0.00	0.00	2.419	2.414	0.001	0.001
68	2015	19532R	1	QCP	0.28	0.33	0.70	0.39	2.537	2.532	0.005	0.007
69	2017	19510R	1	QCP	1.00	0.41	0.36	0.24	2.449	2.452	0.008	0.016
70	2016	19510R	1	QCP	0.67				2.443	2.448	0.004	0.000
71	2017	19524R	1	PFP					2.519		0.000	
72	2017	19510R	1	QCP	0.20	0.70		1.00	2.442	2.458	0.004	0.008
73	2017	19510R	1	QCP	0.10	0.05	0.00	0.54	2.447	2.454	0.001	0.004
74	2016	19525R	1	QCP	0.29	0.51	0.20		2.492	2.504	0.012	0.004
75	2017	19665R	1	QCP	0.67	0.69			2.452	2.458	0.008	0.014
76	2017	19655R	1	QCP	0.33	0.00			2.450	2.457	0.004	0.000
77	2017	19665R	1	QCP	0.20	0.69	0.00		2.453	2.458	0.001	0.001
78	2015	19512R	1	QCP	0.30	0.39	0.41	0.02	2.516	2.522	0.013	0.008
79	2015	19522R	1	PFP	0.71	0.32		0.06	2.527	2.531	0.001	0.007
80	2017	19522R	1	QCP	0.36	0.89	0.17		2.526	2.529	0.006	0.004
81	2015	19522R	1	QCP						2.531		0.000
82	2015	19514R	1	QCP	0.10	0.92	0.10	0.36	2.504	2.513	0.010	0.009
83	2015	19524R	1	QCP	0.50	0.51	0.18	0.58	2.501	2.499	0.003	0.004
84	2015	19512R	1	QCP	0.10	0.71	0.72	0.50	2.526	2.532	0.007	0.007
85	2015	19512R	1	QCP	1.00		0.00		2.525	2.524	0.008	0.000
86	2015	19525R	1	PFP			0.37		2.552		0.007	
87	2015	19510R	1	QCP	0.40		0.97		2.453	2.460	0.003	0.000
88	2017	19510R	1	QCP	0.43	0.90	0.39	0.37	2.447	2.451	0.009	0.010
89	2017	19532R	1	QCP	1.00				2.538	2.534	0.006	0.000
90	2016	19524R	1	QCP	0.50		0.12		2.501	2.508	0.008	0.000
91	2016	19524R	1	QCP						2.504		0.010
92	2017	19536R	1	QCP	1.00				2.553	2.555	0.000	0.000
93	2015	19536R	1	QCP	0.52	0.48	0.12	0.30	2.740	2.744	0.012	0.006
94	2015	19524R	1	QCP	0.46	0.09	0.64	0.41	2.520	2.515	0.002	0.007
95	2015	19512R	1	QCP	0.21	0.45	0.93		2.543	2.549	0.004	0.006
96	2015	19512R	1	QCP	0.36	0.84	0.23	0.93	2.533	2.537	0.007	0.006
97	2015	19514R	1	QCP	0.51	0.71	0.31	0.08	2.513	2.516	0.007	0.008
98	2017	19522R	1	QCP	1.00				2.553	2.544	0.000	0.000
99	2017	19522R	1	QCP	0.57		0.55		2.543	2.536	0.006	0.000
100	2016	19522R	1	QCP	0.20	0.22	0.72	0.13	2.541	2.538	0.006	0.009
101	2015	19510R	1	QCP	0.67				2.442	2.432	0.003	0.000

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
102	2015	19510R	1	QCP			1.00		2.445		0.010	
103	2015	19510R	1	QCP	0.67	0.29			2.437	2.422	0.018	0.004
104	2015	19510R	1	QCP	0.67				2.450	2.431	0.008	0.000
105	2017	19510R	1	QCP	0.05	0.66	0.42	0.01	2.429	2.419	0.005	0.004
108	2017	19532R	1	QCP	0.20	0.55	0.84		2.529	2.517	0.004	0.001
107	2017	19532R	1	QCP	0.31	0.14	0.36	0.11	2.533	2.528	0.005	0.009
108	2017	19532R	1	QCP	0.73	0.85	0.34	0.82	2.535	2.532	0.010	0.008
109	2015	19536R	1	QCP	0.50		0.54		2.741	2.703	0.030	0.000
110	2015	19536R	1	QCP	1.00		0.13		2.742	2.750	0.007	0.000
111	2015	19524R	1	QCP	0.50				2.501	2.514	0.000	0.000
112	2015	19524R	1	QCP	0.67				2.504	2.513	0.005	0.000
113	2015	19524R	1	QCP	0.34	0.30	0.46	0.25	2.510	2.515	0.008	0.004
114	2017	19510R	1	QCP	0.33	1.00			2.438	2.445	0.003	0.003
115	2017	19510R	1	QCP			0.00		2.454		0.002	
116	2016	19510R	1	QCP						2.435		0.004
117	2017	19510R	1	QCP	0.06	0.34	0.84	0.27	2.441	2.451	0.004	0.002
118	2016	19510R	1	QCP	0.04	0.54	0.78	0.00	2.423	2.433	0.003	0.004
119	2017	19510R	1	QCP	0.60	0.70	0.22		2.436	2.440	0.009	0.011
120	2017	19510R	1	QCP	0.33	0.00			2.442	2.447	0.000	0.004
121	2017	19510R	1	QCP	0.67	0.75			2.442	2.447	0.004	0.003
122	2015	19522R	1	QCP	0.67				2.526	2.538	0.008	0.000
123	2015	19522R	1	QCP	0.50		0.25		2.523	2.533	0.004	0.000
124	2017	19524R	1	QCP	1.00				2.487	2.474	0.000	0.000
125	2017	19524R	1	QCP	0.80	0.76	0.88	0.84	2.501	2.502	0.005	0.004
126	2017	19524R	1	PFP			0.45		2.493		0.006	
127	2016	19524R	1	QCP	0.67				2.499	2.523	0.008	0.000
128	2017	19524R	1	QCP	0.67		0.55		2.497	2.500	0.004	0.000
129	2017	19524R	1	QCP	0.80	0.43	0.06		2.493	2.494	0.003	0.004
130	2017	19524R	1	QCP	1.00	0.35			2.501	2.502	0.015	0.004
131	2015	19510R	1	QCP	1.00				2.437	2.449	0.000	0.000
132	2015	19510R	1	QCP	0.30	0.01	0.40	0.01	2.422	2.435	0.011	0.028
133	2015	19536R	1	PFP	0.53	0.27	0.17	0.14	2.702	2.705	0.011	0.016
134	2015	19522R	1	PFP					2.532		0.001	
135	2015	19522R	1	QCP	1.00	0.72	0.36		2.526	2.527	0.008	0.004
136	2015	19536R	1	QCP	1.00				2.738	2.730	0.000	0.000

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137	2015	19524R	1	QCP	0.17	0.37	0.10	0.09	2.512	2.506	0.003	0.006
138	2015	19510R	1	QCP	1.00	0.56			2.409	2.416	0.011	0.024
139	2015	19510R	1	QCP	1.00				2.409	2.417	0.000	0.000
140	2015	19524R	1	QCP	0.89	0.75	0.32	0.59	2.503	2.503	0.006	0.006
141	2015	19665R	1	QCP	0.64	0.01	0.03	0.21	2.796	2.797	0.024	0.010
142	2015	19524R	1	QCP	0.40	0.83		0.13	2.585	2.574	0.023	0.023
143	2015	19524R	1	QCP	0.50	0.48	0.69	0.69	2.611	2.605	0.012	0.009
144	2017	19510R	1	QCP	0.43	0.13	0.55		2.418	2.412	0.004	0.009
145	2017	19510R	1	QCP	1.00				2.412	2.412	0.001	0.000
146	2017	19510R	1	QCP	0.20	0.00	0.54		2.426	2.413	0.004	0.000
147	2015	19510R	1	QCP	0.67				2.437	2.433	0.000	0.000
148	2017	19522R	1	QCP	0.80		0.18		2.523	2.535	0.009	0.000
149	2015	19522R	1	QCP	0.97	0.56	0.82	0.80	2.523	2.523	0.009	0.006
150	2015	19536R	1	QCP	0.18	0.80	0.44	0.12	2.741	2.749	0.010	0.008
151	2017	19524R	1	QCP	0.33	0.90			2.495	2.514	0.004	0.005
152	2017	19524R	1	QCP				0.02		2.510		0.012
153	2017	19524R	1	QCP	0.67	0.86			2.524	2.516	0.011	0.008
154	2015	19525R	1	QCP	0.50		0.92		2.538	2.548	0.007	0.000
155	2017	19525R	1	QCP	1.00				2.540	2.538	0.007	0.000
156	2015	19525R	1	QCP	0.38	0.12	0.46		2.552	2.559	0.009	0.001
157	2015	19524R	1	QCP	1.00	0.24	0.25	0.28	2.512	2.515	0.004	0.010
158	2017	18436R	1	QCP	0.67	0.21			2.586	2.576	0.013	0.002
159	2016	19655R	1	QCP	0.38	0.78	0.55		2.583	2.570	0.009	0.009
160	2017	19655R	1	QCP	0.40		0.74		2.564	2.582	0.008	0.000
161	2015	19525R	1	QCP	0.46	0.87	0.16	0.41	2.613	2.607	0.012	0.009
162	2017	19653R	1	QCP	0.19	0.47	0.12	0.17	2.471	2.484	0.012	0.017
163	2016	19665R	1	PFP	0.17	0.87	0.95		2.809	2.823	0.012	0.007
164	2017	19665R	1	QCP	0.80		0.65		2.811	2.817	0.015	0.000
165	2015	19512R	1	QCP	0.51	0.56	0.55	0.18	2.539	2.534	0.009	0.012
166	2015	19512R	1	QCP	0.67	0.36		0.26	2.538	2.537	0.008	0.005
167	2017	19525R	1	QCP	0.40	0.95	0.36	0.78	2.667	2.663	0.005	0.005
168	2017	19525R	1	QCP	0.80	0.24		0.34	2.660	2.671	0.029	0.011
169	2017	19525R	1	QCP	0.50		0.00		2.648	2.661	0.006	0.000
170	2017	19525R	1	PFP	0.03	0.08	0.68	0.77	2.657	2.646	0.009	0.004
171	2017	19655R	1	PFP	0.88	0.11	0.16	0.36	2.952	2.952	0.015	0.035

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172	2015	19512R	1	QCP					2.521		0.000	
173	2015	19522R	1	QCP					2.532		0.000	
174	2015	19522R	1	QCP			0.07		2.539		0.009	
175	2015	19536R	1	QCP	0.53	0.41		0.39	2.694	2.662	0.010	0.035
176	2015	19510R	1	QCP	0.20	0.00	0.00		2.432	2.446	0.012	0.000
177	2015	19510R	1	QCP						2.440		0.000
178	2015	19510R	1	QCP	0.12	0.08	0.36	0.71	2.429	2.438	0.006	0.012
179	2015	19522R	1	QCP			0.65		2.523		0.005	
180	2015	19522R	1	QCP			0.09		2.527		0.007	
181	2015	19522R	1	QCP			0.35		2.531		0.006	
182	2015	19522R	1	QCP	0.86		0.49		2.529	2.532	0.007	0.000
183	2015	19524R	1	PFP	0.15	0.31	0.79	0.54	2.507	2.502	0.006	0.003
184	2015	19510R	1	QCP			0.29		2.426		0.006	
185	2015	19510R	1	QCP	0.63	0.32	0.71	0.27	2.426	2.425	0.002	0.001
186	2017	19510R	1	QCP	1.00		1.00		2.430	2.434	0.005	0.000
187	2015	19522R	1	QCP	1.00		0.44		2.525	2.526	0.007	0.000
188	2015	19524R	1	QCP	1.00		0.47		2.482	2.483	0.010	0.000
189	2015	19524R	1	QCP	0.80	0.34	0.95		2.480	2.481	0.009	0.017
190	2015	19510R	1	QCP	0.14	0.54	0.82		2.404	2.416	0.005	0.006
191	2015	19510R	1	QCP	0.67				2.409	2.425	0.006	0.000
192	2015	19510R	1	PFP	0.01	0.47	0.33	0.12	2.408	2.417	0.007	0.009
193	2015	19510R	1	QCP	0.33	0.28			2.407	2.427	0.003	0.013
194	2015	19510R	1	QCP	0.03	0.76	0.98		2.404	2.416	0.003	0.003
195	2015	19510R	1	QCP			0.86		2.407		0.005	
196	2017	19510R	1	QCP	1.00				2.411	2.424	0.000	0.000
197	2017	19510R	1	QCP	0.67				2.409	2.420	0.010	0.000
198	2017	19510R	1	QCP	1.00				2.415	2.417	0.003	0.000
199	2017	19510R	1	QCP	0.50			0.84	2.411	2.422	0.000	0.007
200	2017	19510R	1	QCP	0.67				2.407	2.414	0.002	0.000
201	2017	19510R	1	QCP	0.33		0.34		2.407	2.418	0.006	0.000
202	2017	19510R	1	QCP	0.40		0.42		2.410	2.417	0.005	0.000
203	2017	19510R	1	QCP	0.67				2.410	2.422	0.002	0.000
204	2015	19665R	1	PFP			0.71		2.432		0.001	
205	2015	19665R	1	PFP	0.02	0.03	0.05	0.18	2.434	2.445	0.006	0.011
206	2015	19665R	1	PFP	0.35	0.52	0.13	0.86	2.434	2.436	0.006	0.007

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207	2015	19522R	1	QCP	1.00	0.87	0.26	0.28	2.546	2.547	0.008	0.009
208	2015	19524R	1	QCP	0.36	0.67	0.72	0.54	2.504	2.507	0.007	0.005
209	2015	19524R	1	QCP	0.58	0.00	0.05	0.00	2.490	2.541	0.010	0.154
210	2015	19524R	1	QCP	1.00		0.00		2.491	2.488	0.003	0.000
211	2015	19524R	1	QCP	0.34	0.13	0.83	0.35	2.486	2.483	0.003	0.006
212	2015	19524R	1	QCP						2.498		0.000
213	2017	19522R	1	QCP			0.36		2.512		0.003	
214	2015	19536R	1	PFP	0.00	0.64	0.49	0.88	2.471	2.481	0.005	0.006
215	2015	19510R	1	QCP	1.00				2.456	2.458	0.000	0.000
216	2015	19510R	1	QCP	0.30	0.89	0.14	0.39	2.427	2.429	0.005	0.005
217	2015	19510R	1	QCP	0.67				2.425	2.411	0.004	0.000
218	2015	19510R	1	QCP	0.55	0.00	0.26	0.42	2.427	2.429	0.002	0.015
219	2015	19510R	1	QCP	0.67				2.427	2.424	0.001	0.000
220	2015	19510R	1	QCP	1.00				2.425	2.426	0.004	0.000
221	2015	19522R	1	QCP	1.00				2.521	2.520	0.000	0.000
222	2015	19522R	1	QCP	0.18	0.72	0.16	0.94	2.536	2.531	0.007	0.006
223	2015	19536R	1	QCP	0.08	0.84	0.54	0.16	2.496	2.491	0.003	0.003
224	2015	19536R	1	QCP	1.00		0.82		2.490	2.490	0.004	0.000
225	2015	19536R	1	QCP	0.29	0.08	0.40	0.09	2.488	2.493	0.006	0.002
226	2015	19536R	1	QCP					2.500		0.000	
227	2016	19536R	1	QCP					2.492		0.000	
228	2015	19524R	1	PFP	0.24	0.04	0.03	0.18	2.502	2.504	0.004	0.008
229	2016	19524R	1	QCP					2.502		0.013	
230	2016	19524R	1	QCP				0.58		2.508		0.002
231	2015	19655R	1	QCP	0.98	0.34	0.37	0.43	2.470	2.470	0.005	0.007
232	2016	19522R	1	QCP	0.13	0.13	0.06		2.535	2.553	0.003	0.008
233	2015	19522R	1	QCP					2.548		0.000	
234	2015	19522R	1	QCP					2.545		0.000	
235	2017	19524R	1	QCP	0.33	0.16			2.485	2.495	0.006	0.001
236	2017	19524R	1	QCP	1.00				2.484	2.472	0.000	0.000
237	2017	19524R	1	QCP	0.67				2.484	2.494	0.010	0.000
238	2017	19524R	1	QCP	1.00				2.481	2.485	0.000	0.000
239	2017	19524R	1	PFP	0.07	0.10	0.51		2.480	2.498	0.004	0.011
240	2017	19524R	1	QCP	1.00				2.483	2.484	0.000	0.000
241	2017	19524R	1	QCP	1.00	0.13			2.491	2.475	0.003	0.028

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242	2017	19514R	1	QCP	1.00				2.486	2.502	0.000	0.000
243	2015	19514R	1	QCP	0.03	0.00	0.41	0.93	2.482	2.498	0.001	0.012
244	2017	19524R	1	QCP	0.40	0.19	0.98	1.00	2.518	2.524	0.004	0.009
245	2017	19524R	1	QCP	0.29	0.08	0.30	0.09	2.506	2.501	0.006	0.002
246	2015	19525R	1	QCP	0.63	0.11	0.59	0.64	2.475	2.464	0.005	0.015
247	2017	19525R	1	QCP	1.00		0.54		2.489	2.490	0.004	0.000
248	2017	19525R	1	QCP	1.00				2.476	2.486	0.000	0.000
249	2017	19525R	1	QCP	0.10	0.29	0.40		2.488	2.499	0.004	0.001
250	2015	19525R	1	QCP	0.77	0.54	0.42	0.82	2.488	2.489	0.005	0.006
251	2017	19525R	1	QCP	1.00				2.497	2.485	0.000	0.000
252	2017	19525R	1	QCP	0.67				2.491	2.484	0.001	0.000
253	2016	19510R	1	QCP	1.00				2.436	2.440	0.000	0.000
254	2016	19510R	1	QCP					2.426		0.005	
255	2016	19510R	1	QCP	1.00				2.432	2.440	0.000	0.000
256	2016	19510R	1	QCP	0.20	0.13	0.00		2.427	2.436	0.002	0.008
257	2017	19510R	1	QCP	0.67				2.442	2.438	0.001	0.000
258	2017	19510R	1	QCP	1.00				2.434	2.433	0.001	0.000
259	2017	19510R	1	QCP	1.00	0.41			2.441	2.441	0.002	0.001
260	2017	19510R	1	QCP	1.00				2.443	2.444	0.006	0.000
261	2017	19525R	1	QCP	1.00	0.83	0.25	0.27	2.515	2.516	0.011	0.011
262	2017	19536R	1	QCP	0.67				2.480	2.488	0.004	0.000
263	2015	19536R	1	QCP	1.00		1.00		2.477	2.478	0.001	0.000
264	2017	19524R	1	QCP	0.50		0.00		2.509	2.502	0.005	0.000
265	2017	19524R	1	QCP	0.40	0.89	0.16	0.42	2.501	2.494	0.006	0.007
266	2017	19524R	1	QCP	0.40		0.35		2.507	2.503	0.003	0.000
267	2015	19665R	1	QCP	0.68	0.86	0.84	0.46	2.460	2.461	0.003	0.002
268	2015	19525R	1	QCP	0.22	0.22	0.43		2.485	2.499	0.006	0.012
269	2015	19510R	1	QCP	0.39	0.51	0.12	0.46	2.395	2.406	0.016	0.021
270	2015	19524R	1	PFP	0.07	0.53	0.01	0.00	2.490	2.496	0.010	0.008
271	2015	19510R	1	QCP	0.66	0.37	0.72	0.00	2.429	2.425	0.009	0.013
272	2016	19514R	1	QCP	0.31	0.44	0.24	0.86	2.481	2.477	0.006	0.008
273	2016	19514R	1	QCP	0.10	0.92	0.10	0.11	2.479	2.469	0.009	0.008
274	2017	19510R	1	QCP	0.67	0.30	0.33		2.418	2.408	0.007	0.013
275	2017	19510R	1	QCP	0.53	0.38	0.34	0.04	2.412	2.409	0.007	0.009
276	2017	19510R	1	QCP	1.00		0.24		2.413	2.412	0.008	0.000

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
277	2016	19512R	1	QCP	0.56	0.49	0.03	0.42	2.493	2.494	0.008	0.005
278	2017	19524R	1	QCP	0.98	0.44	0.35		2.480	2.482	0.010	0.013
279	2017	19524R	1	QCP	0.20	0.00	0.64		2.485	2.493	0.003	0.000
280	2017	19525R	1	PFP	0.00	0.78	0.14	0.67	2.525	2.531	0.006	0.007
281	2017	19525R	1	QCP	0.22	0.65	0.77	0.82	2.529	2.533	0.005	0.007
282	2015	19510R	1	QCP	0.67	0.10		0.48	2.444	2.448	0.001	0.011
283	2015	19524R	1	QCP	0.86	0.33	0.17	0.51	2.513	2.509	0.006	0.013
284	2015	19522R	1	QCP						2.534		0.000
285	2016	19522R	1	QCP					2.523		0.000	
286	2016	19522R	1	QCP			0.88		2.506		0.005	
287	2015	19522R	1	QCP	0.67				2.524	2.531	0.000	0.003
288	2016	19532R	1	QCP	0.40	0.94	0.08		2.505	2.515	0.011	0.008
289	2017	19510R	1	QCP	1.00				2.429	2.415	0.000	0.000
290	2016	19510R	1	QCP						2.420		0.013
291	2017	19510R	1	QCP	0.04	0.81	0.23	0.00	2.426	2.411	0.004	0.003
292	2015	19524R	1	QCP	0.27	0.25	0.79		2.488	2.496	0.005	0.010
293	2016	19524R	1	QCP						2.517		0.000
294	2016	19524R	1	QCP	1.00				2.499	2.501	0.000	0.000
295	2015	19510R	1	QCP	1.00	0.04	0.32	0.64	2.428	2.431	0.010	0.004
296	2015	19665R	1	PFP	0.32	0.30	0.26	0.30	2.565	2.561	0.009	0.007
297	2017	19510R	1	QCP	0.18		0.27		2.416	2.401	0.004	0.000
298	2016	19510R	1	QCP	1.00				2.416	2.415	0.008	0.000
299	2016	19524R	1	QCP	0.50				2.492	2.497	0.000	0.000
300	2016	19524R	1	QCP	0.67				2.490	2.495	0.004	0.000
301	2015	19536R	1	PFP					2.671		0.000	
302	2015	19536R	1	QCP	0.67	0.37			2.660	2.648	0.006	0.021
303	2015	19536R	1	PFP	0.98	0.12	0.44	0.94	2.677	2.676	0.008	0.014
304	2015	19536R	1	QCP			0.51		2.554		0.013	
305	2015	19512R	1	QCP	0.25	0.89	0.44	0.94	2.518	2.510	0.010	0.010
306	2017	19525R	1	QCP	0.33		0.04		2.502	2.518	0.004	0.000
307	2017	19525R	1	QCP	1.00				2.515	2.505	0.000	0.000
308	2016	19525R	1	QCP	1.00		0.83		2.513	2.514	0.010	0.000
309	2017	19525R	1	PFP	0.05	0.61	0.06	0.49	2.508	2.501	0.006	0.007
310	2017	19512R	1	QCP					2.489		0.004	
311	2017	19512R	1	QCP					2.507		0.000	

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312	2017	19536R	1	QCP	0.33	0.00			2.537	2.554	0.013	0.000
313	2016	19536R	1	QCP			0.00		2.527		0.001	
314	2017	19510R	1	QCP	0.33	0.59			2.418	2.407	0.001	0.001
315	2017	19510R	1	QCP	0.50		0.78		2.418	2.409	0.003	0.000
316	2017	19510R	1	QCP	0.69	0.08	0.33	0.71	2.415	2.413	0.004	0.015
317	2017	19510R	1	QCP					2.416		0.000	
318	2017	19665R	1	QCP	1.00				2.557	2.565	0.000	0.000
319	2017	19665R	1	PFP	0.59	0.35	0.15	0.97	2.551	2.545	0.012	0.018
320	2017	19525R	1	QCP	1.00				2.510	2.502	0.000	0.000
321	2017	19522R	1	QCP			0.77		2.517		0.009	
322	2017	19522R	1	QCP					2.522		0.000	
323	2017	19653R	1	PFP	0.01	0.10	0.41	0.00	2.473	2.468	0.008	0.006
324	2017	19655	1	PFP	0.08	0.73	0.13	0.10	2.582	2.584	0.007	0.007
325	2015	19532R	1	QCP	1.00	0.82	0.70	0.14	2.515	2.513	0.006	0.007
326	2017	19532R	1	QCP					2.516		0.006	
327	2017	19532R	1	QCP	0.67				2.519	2.530	0.005	0.000
328	2017	19524R	1	QCP	0.18		0.96		2.492	2.477	0.004	0.000
329	2017	19524R	1	QCP	0.98	0.90	0.02	0.24	2.492	2.490	0.007	0.007
330	2017	19524R	1	QCP	0.44	0.77	0.82	0.51	2.494	2.497	0.005	0.006
331	2017	19522R	1	QCP	0.13	0.20	0.90	0.31	2.522	2.518	0.006	0.009
332	2015	19522R	1	QCP	0.86		0.94		2.543	2.553	0.012	0.000
333	2015	19522R	1	QCP					2.533		0.000	
334	2015	19524R	1	PFP	0.03	0.39	0.97	0.65	2.503	2.510	0.005	0.003
335	2015	19524R	1	QCP	0.03	0.90	0.13	1.00	2.503	2.512	0.005	0.005
336	2015	19524R	1	QCP	0.67				2.508	2.509	0.001	0.000
337	2015	19522R	1	QCP	1.00	0.01	0.26	0.36	2.537	2.533	0.008	0.019
338	2015	19524R	1	QCP	0.23	0.00	0.59	0.74	2.491	2.484	0.003	0.012
339	2015	19522R	1	QCP					2.527		0.004	
340	2015	19524R	1	QCP	0.26	0.39	0.98	0.67	2.502	2.511	0.007	0.010
341	2015	19524R	1	PFP					2.485		0.007	
342	2015	19510R	1	QCP	0.60		0.00		2.478	2.460	0.031	0.000
343	2015	19510R	1	PFP	0.51	0.39	0.06		2.421	2.424	0.006	0.001
344	2015	19510R	1	QCP	0.54	0.31	0.47	0.75	2.420	2.416	0.008	0.013
345	2015	19510R	1	PFP	0.75	0.48	0.76	0.61	2.433	2.429	0.010	0.015
346	2015	19510R	1	QCP						2.447		0.000

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347	2015	19510R	1	QCP	0.40		0.72		2.433	2.447	0.006	0.000
348	2015	19510R	1	PFP	0.13	0.00	0.31	0.01	2.435	2.443	0.010	0.002
349	2015	19510R	1	QCP			0.21		2.438		0.009	
350	2015	19510R	1	QCP	0.50		0.70		2.440	2.418	0.006	0.000
351	2015	19510R	1	QCP	1.00	0.56			2.447	2.445	0.006	0.013
352	2015	19510R	1	QCP	1.00				2.433	2.434	0.013	0.000
353	2015	19522R	1	QCP						2.522		0.000
354	2015	19536R	1	QCP	0.38	0.25	0.68	0.39	2.482	2.486	0.004	0.009
355	2015	19536R	1	QCP	0.90	0.71	0.10	0.10	2.488	2.489	0.004	0.006
356	2015	19536R	1	PFP	0.02	0.14	0.92	0.11	2.485	2.491	0.006	0.008
357	2016	19524R	1	QCP	1.00				2.493	2.501	0.000	0.000
358	2017	19524R	1	QCP	0.01	0.24	0.17	0.76	2.482	2.493	0.003	0.005
359	2015	19665R	1	QCP	0.03	0.39	0.23	0.55	2.587	2.604	0.006	0.009
360	2015	19665R	1	PFP			0.38		2.585		0.005	
361	2017	19510R	1	QCP	0.11	0.91	0.97	0.33	2.413	2.423	0.007	0.006
362	2015	19655R	1	PFP			0.04		2.594		0.010	
363	2016	19522R	1	QCP	0.16	0.52	0.54	0.27	2.506	2.512	0.009	0.007
364	2016	19524R	1	QCP					2.486		0.000	
365	2016	19514R	1	QCP	1.00				2.488	2.499	0.000	0.000
366	2016	19536R	1	QCP	0.67				2.469	2.477	0.001	0.000
367	2016	19532R	1	QCP	1.00	0.59	0.51	0.39	2.497	2.499	0.011	0.007
368	2017	19522R	1	QCP	1.00		0.64		2.523	2.518	0.011	0.000
369	2017	19522R	1	QCP	0.20		0.43		2.518	2.547	0.008	0.000
370	2017	19524R	1	QCP	0.02	0.95	0.10	0.47	2.494	2.510	0.011	0.011
371	2017	19524R	1	PFP	0.86	0.23	0.41	0.37	2.501	2.499	0.009	0.014
372	2017	19510R	1	QCP	1.00		0.52		2.419	2.420	0.007	0.000
373	2017	19510R	1	QCP	0.80	0.81	0.08		2.429	2.431	0.007	0.007
374	2017	19510R	1	QCP	1.00				2.421	2.423	0.000	0.000
375	2017	19525R	1	QCP	0.80	0.44	0.00	0.35	2.475	2.479	0.006	0.011
376	2017	19510R	1	QCP	0.51	0.05	0.10	0.76	2.433	2.439	0.002	0.009
377	2017	19510R	1	QCP	0.40	0.78	0.24	0.69	2.433	2.440	0.006	0.007
378	2017	19653R	1	QCP					2.480		0.000	
379	2017	19653R	1	PFP	0.00	0.07	0.21	0.20	2.464	2.476	0.008	0.012
380	2017	19525R	1	PFP						2.479		0.008
381	2017	19525R	1	PFP	0.86	0.43	0.05	0.01	2.491	2.493	0.009	0.013

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382	2017	19655R	1	PFP	0.05	0.37	0.16	0.32	2.427	2.435	0.007	0.009
383	2017	19510R	1	QCP	0.25	0.60	0.15	0.30	2.423	2.418	0.010	0.011
384	2017	19665R	1	PFP	0.53	0.36	0.28	0.22	2.437	2.438	0.006	0.008
385	2017	19665R	1	QCP	0.69	0.04	0.66	0.88	2.445	2.442	0.005	0.011
386	2015	19512R	1	QCP	0.55	0.10	0.89		2.513	2.517	0.011	0.001
387	2015	19514R	1	QCP	0.67				2.500	2.517	0.008	0.000
388	2015	19522R	1	QCP	0.67				2.532	2.522	0.011	0.000
390	2014	19514R	2	QCP	0.92	0.62	0.67	0.10	2.498	2.497	0.009	0.010
391	2015	19514R	2	QCP					2.499		0.000	
392	2015	19604FR	2	QCP	0.75	0.00	0.01	0.11	2.506	2.523	0.040	0.003
393	2015	19514R	2	QCP	0.22	0.15	0.18	0.29	2.522	2.526	0.007	0.013
394	2016	19512R	4	QCP					2.547		0.000	
395	2016	19535R	2	QCP	0.04	0.28	0.02	0.00	2.662	2.673	0.009	0.006
396	2015	19534R	2	PFP	0.16	0.34	0.38	0.07	2.508	2.510	0.008	0.010
397	2015	19532R	2	PFP	0.10	0.86	0.12	0.00	2.542	2.540	0.006	0.007
398	2015	19514R	2	QCP	0.09	0.12	0.15	0.91	2.500	2.495	0.005	0.008
399	2017	19514R	2	QCP	1.00		0.73		2.501	2.500	0.003	0.000
400	2015	19524R	2	QCP	0.42	0.45	0.05	0.27	2.502	2.504	0.005	0.007
401	2015	19514R	2	QCP	0.80	0.59	0.35	0.35	2.498	2.499	0.008	0.006
402	2015	19604FR	2	QCP	0.31	0.77	0.02	0.87	2.486	2.492	0.009	0.011
404	2015	19514R	2	QCP	0.81	0.04	0.24	0.98	2.489	2.487	0.006	0.018
405	2016	19604FR	2	QCP	0.01	0.55	0.56	0.22	2.482	2.492	0.009	0.007
406	2016	19514R	2	QCP	0.00	0.64	0.61	0.50	2.476	2.490	0.008	0.009
407	2016	19516R	2	QCP	0.33	0.22			2.699	2.729	0.002	0.012
408	2017	19514R	2	QCP	0.06	0.36	0.20	0.84	2.489	2.500	0.008	0.004
409	2017	19512R	2	QCP	0.67	0.68	0.23	0.61	2.522	2.524	0.010	0.011
410	2017	19512R	2	QCP	0.13	0.40	0.01	0.67	2.521	2.533	0.016	0.009
411	2017	19514R	2	QCP	0.08	0.42	0.22	0.16	2.466	2.473	0.010	0.007
412	2016	19516R	2	QCP	0.33	0.22			2.699	2.729	0.002	0.012
413	2016	19513R	2	QCP	0.33	0.41			2.562	2.559	0.002	0.001
414	2017	19514R	2	QCP	0.80		0.40		2.510	2.517	0.013	0.000
415	2015	19514R	2	QCP	0.98	0.04	0.65	0.01	2.522	2.525	0.007	0.014
416	2017	19513R	2	QCP					2.526		0.006	
417	2015	19514R	2	QCP	0.65	0.21	0.31	0.32	2.523	2.523	0.006	0.010
418	2016	19514R	2	QCP	0.37	0.24	0.00	0.00	2.531	2.534	0.011	0.014

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419	2017	19512R	2	QCP	0.64	0.00	0.38	0.01	2.532	1.525	0.012	1.392
420	2015	19512R	2	QCP	0.62	0.52	0.00	0.00	2.547	2.547	0.014	0.013
421	2015	19512R	2	QCP	0.32	0.31	0.12	0.95	2.552	2.556	0.008	0.011
422	2015	19534R	2	PFP	0.45	0.01	0.19	0.04	2.520	2.521	0.006	0.004
423	2015	19534R	2	PFP	0.47	0.85	0.39	0.07	2.532	2.533	0.006	0.006
424	2016	19534R	2	PFP	0.01	0.06	0.05	0.34	2.523	2.527	0.003	0.005
425	2017	19532R	2	PFP	0.12	0.73	0.04	0.01	2.530	2.537	0.017	0.015
426	2015	19532R	2	PFP	1.00	0.59	0.88	0.73	2.552	2.555	0.013	0.008
427	2017	19535R	2	PFP	0.21	0.35	0.40	0.04	2.679	2.686	0.009	0.013
428	2015	19535R	2	PFP	0.19	0.74	0.09	0.34	2.677	2.673	0.007	0.006
429	2016	19512R	2	QCP	1.00	1.00	0.07	0.00	2.529	2.530	0.013	0.013
430	2015	19654R	2	PFP	0.15	0.78	0.16	0.42	3.101	3.096	0.013	0.012
431	2015	19514R	2	QCP	1.00	0.00			2.523	2.524	0.000	0.001
432	2015	19514R	2	QCP	0.13	0.11	0.25	0.76	2.531	2.526	0.007	0.004
433	2015	19514R	2	QCP	0.08	0.44	0.50	0.19	2.517	2.525	0.008	0.005
434	2016	19532R	2	PFP	0.34	0.80	0.20	0.18	2.544	2.545	0.007	0.007
435	2015	19512R	2	QCP	0.59	0.57	0.74	0.41	2.544	2.545	0.006	0.007
436	2016	19654R	2	PFP	0.06	0.10	0.01	0.48	3.141	3.146	0.016	0.019
437	2016	19654R	2	QCP	0.82	0.00	0.00	0.00	3.138	2.099	0.006	1.817
438	2016	19524R	2	QCP	0.33	0.96	0.02	0.00	2.530	2.534	0.008	0.007
439	2017	19524R	4	QCP					2.493		0.000	
440	2016	19534R	2	PFP	0.00	0.01	0.34	0.05	2.520	2.525	0.003	0.005
441	2016	19524R	2	PFP	0.48	0.04	0.41	0.78	2.500	2.503	0.008	0.003
442	2016	19534R	2	PFP	0.74	0.26	0.64	0.87	2.516	2.516	0.006	0.004
443	2015	19524R	2	QCP	0.33	0.12	0.01	0.00	2.498	2.502	0.014	0.010
444	2015	19525R	2	QCP	0.22	0.28		0.35	2.501	2.505	0.001	0.004
445	2015	19532R	2	PFP				0.89		2.521		0.006
446	2015	19605FR	2	QCP	0.58	0.85	0.12	0.42	2.502	2.504	0.013	0.014
447	2015	19532R	2	QCP	0.67	0.92			2.539	2.542	0.011	0.010
448	2015	19654R	2	PFP	0.70			0.21	2.474	2.477	0.000	0.008
449	2015	19524R	2	QCP	0.00	0.14	0.58	0.06	2.482	2.492	0.007	0.004
450	2015	19515R	2	QCP				0.17		2.500		0.005
451	2016	19515R	2	QCP	0.00	0.01	0.10	0.01	2.494	2.502	0.010	0.005
452	2014	19604FR	2	QCP	0.68	0.37	0.20	0.00	2.502	2.501	0.010	0.008
453	2015	19605FR	2	QCP	0.10	0.18	0.90	0.00	2.493	2.503	0.006	0.002

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454	2015	19525R	2	QCP	0.03	0.77	0.08	0.80	2.496	2.509	0.004	0.005
455	2015	19515R	2	QCP	0.00	0.11	0.02	0.05	2.495	2.503	0.007	0.009
456	2016	19525R	2	QCP	0.92	0.21	0.82	1.00	2.498	2.497	0.009	0.003
457	2015	19525R	2	QCP	0.10	0.70	0.00	0.90	2.495	2.509	0.004	0.006
458	2015	19532R	2	PFP	0.07	0.12	0.58	0.01	2.512	2.516	0.007	0.008
459	2015	19532R	2	QCP	0.40		0.57		2.510	2.518	0.006	0.000
460	2015	19654R	2	PFP	0.91	0.03	0.07	0.00	2.486	2.486	0.008	0.012
461	2015	19526R	2	QCP	1.00				2.490	2.512	0.000	0.000
462	2017	19515R	2	QCP	0.84	0.83	0.01	0.09	2.504	2.501	0.006	0.006
463	2017	19604FR	2	QCP	0.11	0.56	0.80		2.500	2.493	0.004	0.004
464	2017	19532	2	PFP								
465	2017	19513R	2	QCP	0.40	0.00	0.00	0.00	2.555	1.680	0.071	1.455
466	2017	19535R	2	PFP								
467	2015	19524R	3	QCP	0.11	0.13	0.14	0.74	2.459	2.464	0.010	0.005
468	2017	19524R	1	QCP	0.67				2.517	2.518	0.000	0.000
469	2017	19524R	3	PFP					2.524		0.000	
470	2017	19524R	1	PFP			0.06		2.517		0.007	
471	2016	19524R	3	QCP	0.80		0.68		2.523	2.525	0.002	0.000
472	2017	19522R	3	QCP	0.50		0.00		2.537	2.533	0.003	0.000
473	2015	19535R	3	PFP				0.22		2.507		0.009
474	2017	19510R	1	QCP	0.11	0.26	0.02		2.428	2.418	0.013	0.002
475	2017	19510R	1	QCP	0.31	0.56	0.23	0.18	2.438	2.431	0.010	0.013
476	2016	19524R	3	QCP	0.33	0.75			2.473	2.478	0.001	0.002
477	2017	19525R	1	PFP	0.63	0.32	0.28	0.81	2.662	2.660	0.010	0.015
478	2017	19534R	3	QCP	0.20	0.53	0.46		2.517	2.509	0.004	0.006
479	2016	19524R	3	QCP	0.67				2.477	2.481	0.005	0.000
480	2017	19524R	1	PFP	0.73	0.44	0.82		2.490	2.493	0.006	0.008
481	2017	19524R	3	QCP			0.34		2.485		0.008	
482	2015	19522R	3	QCP	0.60	0.39		0.70	2.534	2.527	0.011	0.006
483	2015	19522R	3	QCP	1.00			0.64	2.522	2.535	0.000	0.015
484	2015	19536R	1	QCP			0.42		2.706		0.014	
485	2015	19536R	1	QCP	0.33	0.20			2.703	2.681	0.013	0.002
486	2016	19512R	1	QCP	0.74	0.29	0.16	0.95	2.504	2.506	0.006	0.009
487	2016	19514R	3	QCP	0.20	0.70	0.84		2.478	2.486	0.004	0.004
488	2015	19534R	3	PFP				0.24		2.499		0.007

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene’s P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
489	2015	19534R	3	PFP				0.07		2.498		0.009
490	2017	19524R	1	QCP	0.44	0.77	0.51	0.14	2.493	2.496	0.007	0.005
491	2016	19512R	1	QCP	0.63	0.13	0.40	0.20	2.496	2.494	0.010	0.005
492	2017	19534R	3	PFP				0.88		2.486		0.003
493	2017	19532R	3	PFP	0.21			0.27	2.489	2.497	0.000	0.006
494	2017	19510R	1	QCP	1.00	0.89	0.80	0.16	2.408	2.410	0.015	0.012
495	2017	19654R	3	QCP	0.94	0.74	0.53	0.92	2.477	2.478	0.007	0.007
496	2017	19510R	4	PFP	0.61	0.48	0.08	0.41	2.390	2.392	0.008	0.006
497	2015	19515R	4	QCP	0.50		0.77		2.465	2.473	0.007	0.000
498	2016	19515R	4	QCP			0.61		2.630		0.011	
499	2016	19522R	4	PFP					2.535		0.007	
500	2016	19522R	4	PFP	0.00	0.00	0.67	0.53	2.529	2.535	0.008	0.011
501	2016	19532R	3	PFP	0.00	0.41	0.09	0.67	2.473	2.481	0.004	0.006
502	2015	19653R	4	PFP				0.49		2.453		0.010
503	2016	19654R	4	PFP			0.54		2.442		0.004	
504	2017	19654R	4	PFP	0.29	0.08	0.11	0.68	2.434	2.437	0.009	0.006
505	2016	19654R	4	PFP	0.42	0.20	0.40	0.04	2.441	2.443	0.005	0.007
506	2017	19510R	4	QCP					2.445		0.000	
507	2015	19515R	4	QCP					2.476		0.008	
508	2016	19524R	4	PFP	0.62	0.14	0.35	0.14	2.483	2.485	0.005	0.008
509	2016	19525R	4	PFP					2.470		0.000	
510	2015	19525R	4	PFP	0.02	0.08	0.10	0.13	2.462	2.469	0.011	0.007
511	2015	19535R	3	PFP				0.12		2.459		0.006
512	2016	19510R	4	PFP	0.62	0.68	0.51	0.36	2.453	2.454	0.012	0.011
513	2016	19510R	4	PFP	0.50	0.70	0.14	0.02	2.448	2.449	0.007	0.006
514	2017	19510R	4	QCP	0.00	0.97	0.67	0.98	2.584	2.574	0.004	0.004
515	2017	19515R	4	QCP	1.00				2.452	2.456	0.000	0.000
516	2017	19514R	4	PFP			0.60		2.516		0.005	
517	2015	19515R	4	QCP					2.473		0.005	
518	2015	19524R	4	PFP	0.01	0.64	0.36	0.96	2.488	2.500	0.007	0.009
519	2016	19512R	4	PFP					2.501		0.000	
520	2017	19522R	4	QCP			0.06		2.582		0.005	
521	2015	19524R	4	PFP	0.78	0.31	0.20	0.13	2.480	2.482	0.005	0.008
522	2016	19512R	4	PFP					2.532		0.000	
523	2015	19514R	4	QCP			0.61		2.491		0.008	

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524	2016	19514R	4	PFP	0.98	0.46	0.33	0.01	2.488	2.490	0.012	0.009
525	2015	19514R	4	PFP	0.11	0.41	0.98	0.52	2.473	2.479	0.006	0.004
526	2015	19524R	5	QCP	0.14	0.90	0.76		2.445	2.452	0.003	0.002
527	2015	19514R	5	QCP	0.60		0.10		2.455	2.460	0.007	0.000
528	2016	19514R	5	QCP			0.73		2.443		0.004	
529	2015	19514R	5	QCP	0.67	0.00	0.48		2.486	2.485	0.011	0.000
530	2016	19514R	5	QCP			0.64		2.486		0.003	
531	2016	19524R	5	QCP			0.65		2.484		0.004	
532	2017	19605FR	5	QCP	0.20	0.85	0.19	0.25	2.474	2.467	0.009	0.008
533	2015	19605FR	5	QCP	0.97	0.85	0.77	0.34	2.481	2.481	0.008	0.007
534	2015	19524R	5	QCP	0.35	0.71	0.01	0.11	2.477	2.482	0.008	0.009
535	2016	19514R	5	QCP	0.29		0.33		2.476	2.484	0.003	0.000
536	2017	19524R	5	QCP	0.08	0.62	0.49		2.474	2.488	0.007	0.008
537	2015	19534R	5	QCP	0.29		0.05		2.428	2.447	0.004	0.000
538	2015	19534R	5	PFP	0.01	0.44	0.57	0.91	2.424	2.437	0.005	0.006
539	2017	19535R	5	QCP	0.04	0.73	0.72		2.417	2.430	0.004	0.002
540	2017	19512R	6	QCP					2.470		0.000	
541	2017	19513R	5	QCP						2.451		0.008
542	2017	19532R	5	PFP				0.47		2.462		0.005
543	2016	19534R	5	QCP						2.424		0.000
544	2017	19534R	5	PFP				0.00		2.442		0.001
545	2017	19523R	5	QCP	0.67	0.82	0.82	1.00	2.445	2.449	0.008	0.008
546	2015	19534R	5	PFP	0.01	0.63	0.18	0.83	2.440	2.459	0.008	0.006
547	2016	19513R	5	QCP	0.22		0.01		2.445	2.462	0.012	0.000
548	2016	19514R	5	QCP			0.96		2.450		0.010	
549	2015	19532R	5	PFP	0.00	0.48	0.90	0.06	2.468	2.482	0.007	0.005
550	2015	19535R	5	PFP	0.29	0.22	0.95		2.458	2.463	0.010	0.001
551	2015	19523R	5	QCP	0.02	0.09	0.23	0.04	2.450	2.462	0.008	0.003
552	2015	19505R	5	QCP			0.71		2.449		0.010	
553	2015	19534R	5	PFP	0.11	0.77	0.01	0.21	2.439	2.462	0.018	0.019
554	2017	19534R	5	PFP	0.00	0.23	0.86	0.96	2.434	2.454	0.006	0.009
555	2016	19513R	5	QCP					2.463		0.000	
556	2016	19513R	5	QCP	0.67				2.454	2.466	0.003	0.000
557	2015	19532R	5	PFP	0.00	0.38	0.02	0.91	2.457	2.468	0.004	0.003
558	2016	19532R	5	PFP	0.02	0.83	0.32	0.03	2.451	2.456	0.005	0.004

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559	2016	19535R	5	PFP	0.01	0.37	0.23	0.91	2.444	2.456	0.006	0.009
560	2017	19535R	5	QCP			0.11		2.444		0.008	
561	2015	19524R	5	QCP	0.20		0.53		2.443	2.464	0.010	0.000
562	2015	19524R	5	QCP	0.09	0.40	0.19		2.430	2.451	0.010	0.013
563	2017	19532R	5	PFP	0.02	0.73	0.00	0.64	2.466	2.472	0.006	0.005
564	2015	19523R	6	QCP	0.70	0.21	0.38	0.91	2.446	2.445	0.006	0.008
565	2015	19513R	6	QCP	0.40	0.08	0.06	0.51	2.452	2.463	0.016	0.005
566	2016	19524R	6	PFP	0.12			0.45	2.422	2.432	0.000	0.004
567	2016	19513R	6	PFP						2.456		0.000
568	2015	19513R	6	QCP	0.45	0.75	0.09	0.51	2.453	2.448	0.008	0.006
569	2015	19522R	6	PFP	0.88	0.47	0.94	0.92	2.485	2.484	0.011	0.009
570	2015	19522R	6	PFP	0.53	0.83	0.05	0.81	2.477	2.478	0.009	0.009
571	2015	19513R	6	QCP	0.21	0.11	0.49	0.29	2.439	2.447	0.011	0.019
572	2015	19513R	6	QCP	0.18	0.90	0.32	0.86	2.434	2.442	0.010	0.008
573	2015	19523R	6	PFP	0.77	0.90	0.03	0.99	2.450	2.449	0.007	0.006
574	2015	19513R	6	QCP	0.05	0.13	0.46	0.44	2.444	2.455	0.013	0.007
575	2015	19523R	6	QCP	0.06	0.42	0.14	0.12	2.441	2.448	0.008	0.006
576	2015	19523R	6	QCP			0.98		2.447		0.007	
577	2017	19523R	8	QCP	0.23	0.82	0.68	0.06	2.454	2.460	0.006	0.005
578	2015	19534R	6	PFP	0.02	0.33	0.88	0.10	2.451	2.458	0.010	0.008
579	2016	19534R	6	PFP	0.06	0.41	0.91	0.85	2.460	2.469	0.006	0.004
580	2015	19522R	6	PFP	0.10	0.25	0.20	0.74	2.482	2.478	0.006	0.008
581	2015	19513R	6	QCP	0.47	0.50	0.34	0.46	2.453	2.451	0.005	0.006
582	2017	19522R	6	QCP	0.50		0.44		2.462	2.468	0.007	0.000
583	2015	19535R	6	PFP	0.80	0.51	0.81	0.77	2.422	2.421	0.007	0.010
584	2015	19535R	6	QCP	1.00		0.83		2.415	2.416	0.004	0.000
585	2015	19535R	6	PFP	0.27	0.15	0.80	0.07	2.430	2.437	0.005	0.010
586	2016	19514R	6	QCP	0.16	0.23	0.37	1.00	2.435	2.429	0.006	0.002
587	2015	19513R	6	QCP	0.37	0.38	0.01	0.01	2.465	2.465	0.004	0.006
588	2015	19522R	6	QCP	0.70	0.11	0.00	0.79	2.470	2.467	0.005	0.009
589	2016	19532R	6	PFP				0.09		2.464		0.002
590	2015	19532R	6	PFP	0.00	0.00	0.61	0.58	2.454	2.463	0.010	0.005
591	2016	19532R	6	QCP	1.00		0.32		2.459	2.462	0.006	0.000
592	2015	19524R	6	QCP	0.65	0.73	0.54		2.427	2.426	0.004	0.002
593	2015	19512R	6	QCP	0.03	0.10	0.06	0.05	2.472	2.480	0.009	0.004

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594	2015	19535R	6	PFP	0.01	0.22	0.95	0.49	2.428	2.434	0.009	0.007
595	2017	19535R	6	PFP	0.07	0.37	0.12	0.84	2.423	2.427	0.005	0.007
596	2016	19535R	6	QCP	1.00		0.36		2.442	2.446	0.008	0.000
597	2017	19513R	6	QCP	0.96	0.43	0.34	0.51	2.458	2.460	0.011	0.006
598	2017	19513R	6	QCP	0.45	0.84	0.89	0.57	2.449	2.452	0.006	0.006
599	2017	19513R	6	QCP	0.95	0.27	0.04		2.451	2.455	0.008	0.001
600	2016	19513R	6	QCP					2.469		0.000	
601	2016	19513R	6	PFP						2.462		0.002
602	2016	19513R	6	QCP	0.00	0.65	0.25	0.01	2.461	2.468	0.009	0.008
603	2016	19513R	6	QCP	0.35	0.92	0.95	0.28	2.459	2.464	0.008	0.008
604	2016	19514R	6	QCP	1.00		0.78		2.484	2.489	0.010	0.000
605	2015	19512R	6	QCP	0.10	0.79	0.36	0.79	2.421	2.431	0.012	0.012
606	2016	19524R	6	QCP	0.75	0.78	0.12	0.42	2.443	2.443	0.015	0.015
607	2015	19513R	6	QCP	1.00		0.07		2.446	2.443	0.005	0.000
608	2017	19513R	6	QCP	0.39	0.63	0.27	0.36	2.450	2.448	0.004	0.003
609	2016	19513R	6	QCP	0.26	0.01	0.05	0.01	2.443	2.446	0.010	0.004
610	2017	19513R	6	QCP	0.39	0.93	0.35	0.00	2.447	2.449	0.008	0.008
611	2016	19513R	6	QCP	0.53	0.66	0.53		2.440	2.447	0.011	0.011
612	2017	19532R	6	PFP	0.00	0.64	0.01	1.00	2.456	2.463	0.005	0.006
613	2016	19524R	6	PFP	0.83	0.31	0.64	0.23	2.438	2.438	0.004	0.003
614	2016	19513R	6	QCP	0.79	0.43	0.10	0.65	2.449	2.451	0.010	0.007
615	2016	19514R	6	QCP	0.56	0.81	0.16	0.60	2.414	2.416	0.006	0.005
616	2016	19534R	7	PFP	0.02	0.94	0.91	0.21	2.436	2.441	0.004	0.004
617	2016	19524R	6	QCP	0.60	0.56	0.06	0.85	2.431	2.433	0.009	0.007
618	2016	19532R	6	PFP	0.00	0.00	0.16	0.27	2.452	2.461	0.009	0.004
619	2016	19523R	6	QCP	0.29		0.10		2.416	2.431	0.009	0.000
620	2016	19524R	6	QCP	0.03	0.94	0.18	0.06	2.421	2.436	0.012	0.011
621	2016	19534R	6	PFP	0.00	0.00	0.31	0.41	2.406	2.417	0.010	0.003
622	2016	19513R	6	QCP	0.72	0.38	0.13	0.68	2.432	2.433	0.006	0.009
623	2016	19512R	6	QCP	0.24	0.71	0.22	0.02	2.454	2.459	0.009	0.007
624	2017	19514R	6	QCP	0.32	0.19	0.24	0.02	2.443	2.449	0.008	0.003
625	2017	19522R	6	PFP					2.471		0.000	
626	2017	19514R	6	QCP	0.05	0.15	0.15	0.02	2.440	2.436	0.002	0.004
627	2017	19513R	6	QCP	1.00	0.23	0.13	0.00	2.435	2.436	0.010	0.003
628	2015	19524	7	PFP	0.33	0.20	0.85	0.11	2.440	2.445	0.003	0.006

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629	2016	19532R	7	QCP	1.00		0.46		2.481	2.481	0.002	0.000
630	2015	19532R	7	PFP			0.15		2.486		0.006	
631	2016	19523R	7	QCP	0.30	0.91	0.36	0.00	2.457	2.454	0.003	0.003
632	2016	19532R	7	QCP	1.00	0.93	0.00		2.477	2.478	0.005	0.004
633	2017	19532R	7	PFP	0.22	0.93	0.02	0.41	2.478	2.483	0.006	0.006
634	2017	19524R	7	PFP						2.483		0.000
635	2016	19523	7	QCP	0.86	0.53	0.82		2.429	2.431	0.008	0.003
636	2017	19523	7	QCP						2.442		0.000
637	2016	19523	7	QCP	0.33	0.34			2.425	2.439	0.013	0.004
638	2017	19523	7	QCP	0.40		0.66		2.426	2.442	0.014	0.000
639	2017	19534R	7	QCP				0.51		2.445		0.011
640	2016	19534R	7	PFP				0.02		2.442		0.007
641	2016	19534R	7	QCP	0.43	0.60	0.72	0.61	2.429	2.424	0.009	0.006
642	2016	19524R	7	QCP	0.12	0.51	0.16	0.49	2.433	2.426	0.006	0.005
643	2016	19523R	7	QCP	0.71	0.32	0.11		2.425	2.425	0.007	0.001
644	2015	19534R	7	PFP						2.451		0.000
645	2015	19534R	7	PFP				0.71		2.446		0.007
646	2016	19534R	7	QCP					2.448		0.001	
647	2015	19534R	7	QCP	0.13	0.36		0.23	2.435	2.455	0.001	0.006
648	2016	19523R	9	QCP	0.67				2.443	2.459	0.000	0.002
649	2016	19605FR	9	QCP	0.87	0.27	0.41	0.00	2.440	2.440	0.005	0.002
650	2015	19534R	7	PFP	0.83	0.32	0.58	0.67	2.441	2.441	0.005	0.003
651	2015	19523R	7	PFP	0.12	0.30	0.17	0.51	2.465	2.468	0.002	0.004
652	2015	19523R	7	QCP	0.35	0.23	0.48	0.29	2.466	2.458	0.006	0.012
653	2016	19524R	7	QCP	0.02	0.72	0.01	0.38	2.455	2.472	0.011	0.009
654	2016	19534R	7	QCP	0.67				2.447	2.452	0.006	0.000
655	2015	19534R	7	PFP	0.76	0.85	0.64	0.40	2.442	2.440	0.006	0.006
656	2016	19654R	7	PFP						2.380		0.000
657	2016	19654R	7	PFP						2.409		0.000
658	2015	19654R	7	PFP	0.41	0.88	0.88	0.79	2.387	2.389	0.008	0.008
659	2016	19654R	7	PFP	0.40	0.09	0.99	0.64	2.378	2.382	0.007	0.002
660	2016	19654R	7	PFP	0.63	0.66	0.30	0.80	2.409	2.410	0.005	0.004
661	2017	19654R	7	PFP	0.04	0.25	0.07	0.04	2.414	2.417	0.003	0.005
662	2016	19532R	7	PFP	0.08	0.13	0.43	0.79	2.475	2.479	0.005	0.004
663	2017	19532R	7	PFP	1.00				2.475	2.475	0.000	0.000

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
664	2017	19523R	7	QCP	0.20	0.50	0.00		2.456	2.465	0.006	0.002
665	2015	19505R	7	PFP			0.69		2.429		0.014	
666	2015	19532R	7	PFP	0.31	0.22	0.71	0.03	2.486	2.485	0.005	0.006
667	2016	19532R	7	PFP	0.03	0.20	0.24	0.23	2.473	2.477	0.006	0.005
668	2015	19532R	7	PFP				0.57		2.472		0.006
669	2016	19654R	7	PFP	0.09	0.00	0.16	0.09	2.407	2.410	0.007	0.003
670	2015	19654R	7	PFP	0.65	0.78	0.02	0.64	2.409	2.408	0.004	0.004
671	2016	19532R	7	PFP	0.12	0.84	0.24	0.02	2.476	2.478	0.005	0.005
672	2017	19533R	7	PFP	0.01	0.71	0.02	0.56	2.445	2.452	0.005	0.006
673	2017	19532R	7	PFP	0.02	0.44	0.90	0.28	2.482	2.488	0.007	0.006
674	2017	19532R	7	PFP	0.00	0.68	0.76	0.23	2.475	2.484	0.004	0.003
675	2017	19532R	7	PFP						2.482		0.000
676	2017	19532R	7	PFP	0.52	0.05	0.42	0.46	2.472	2.471	0.003	0.007
677	2016	19523R	8	QCP						2.462		0.000
678	2016	19523R	8	QCP	0.67	0.75			2.459	2.461	0.001	0.002
679	2016	19523R	8	QCP	0.80		0.03		2.439	2.439	0.004	0.000
680	2016	19523R	8	QCP	0.00	0.29	0.12	0.79	2.435	2.449	0.008	0.005
681	2016	19534R	8	QCP	0.39	0.97	0.35	0.97	2.427	2.430	0.007	0.007
682	2015	19534R	8	QCP	0.29		0.32		2.427	2.436	0.005	0.000
683	2015	19534R	8	QCP	0.09	0.77	0.59	0.35	2.418	2.424	0.008	0.007
684	2015	19534R	8	QCP	0.78	0.96	0.68	0.18	2.398	2.399	0.005	0.005
685	2015	19524R	8	QCP	0.17	0.62	0.97	0.36	2.429	2.434	0.005	0.006
686	2017	19524R	8	QCP	0.35	0.94	0.16	0.10	2.431	2.433	0.004	0.004
687	2015	19535R	8	QCP	0.00	0.00	0.17	0.00	2.380	2.378	0.005	0.026
688	2017	19505R	8	QCP	0.17	0.98	0.19	0.89	2.450	2.447	0.004	0.004
689	2015	19505R	8	QCP	0.40	0.14	0.41		2.444	2.449	0.008	0.001
690	2015	19606R	8	QCP	0.07	0.13	0.07		2.422	2.413	0.004	0.008
691	2015	19654R	8	PFP	0.68	0.16	0.62	0.69	2.352	2.352	0.006	0.005
692	2015	19654R	8	PFP	0.53	1.00	0.23	0.48	2.355	2.354	0.007	0.007
693	2015	19534R	8	QCP	0.04	0.23	0.95	0.57	2.388	2.396	0.003	0.005
694	2015	19654R	8	PFP	0.00	0.53	0.52	0.72	2.378	2.366	0.007	0.006
695	2015	19654R	8	PFP	0.01	0.05	0.69	0.29	2.372	2.369	0.007	0.005
696	2015	19654R	8	PFP	0.88	0.75	0.07	0.18	2.372	2.372	0.005	0.005
697	2015	19535R	8	QCP	0.98	0.31	0.80	0.91	2.389	2.389	0.005	0.002
698	2015	19601R	8	QCP					2.481		0.000	

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
699	2016	19523R	8	QCP	0.02	0.17	0.96	0.92	2.459	2.448	0.004	0.007
700	2016	19523R	8	QCP						2.445		0.002
701	2016	19532R	8	PFP	0.06	0.43	0.36	0.95	2.463	2.471	0.009	0.007
702	2016	19524R	8	QCP	0.40	0.22	0.76	0.42	2.443	2.441	0.004	0.002
703	2017	19524R	8	QCP	0.67				2.463	2.446	0.002	0.000
704	2016	19524R	8	QCP			0.30		2.431		0.006	
705	2016	19524R	8	QCP	0.67				2.442	2.444	0.002	0.000
706	2016	19524R	8	QCP	1.00				2.440	2.443	0.005	0.000
707	2016	19533R	8	QCP	0.67	0.05	0.01	0.92	2.441	2.446	0.006	0.013
708	2016	19534R	8	PFP	0.18	0.81	0.16	0.54	2.426	2.429	0.008	0.007
709	2016	19534R	8	QCP	0.02	0.18	0.40	0.45	2.440	2.444	0.004	0.002
710	2016	19504R	8	QCP	0.67	0.88	0.05		2.472	2.482	0.011	0.010
711	2016	19523R	8	QCP	1.00	0.91	0.33		2.433	2.432	0.006	0.004
712	2016	19605R	8	QCP	0.67				2.436	2.432	0.004	0.000
713	2016	19534R	8	QCP	0.06	0.47	0.01		2.452	2.438	0.005	0.006
714	2017	19654R	8	PFP						2.399		0.000
715	2017	19654R	8	PFP	0.00	0.27	0.00	0.18	2.407	2.403	0.007	0.008
716	2017	19523R	8	QCP	0.83	0.36	0.57	0.54	2.427	2.427	0.004	0.006
717	2017	19523R	8	QCP	0.87	0.44	0.56	0.92	2.444	2.445	0.008	0.011
718	2017	19524R	8	QCP	1.00		0.12		2.414	2.419	0.005	0.000
719	2017	19524R	8	QCP	0.22	0.14	0.25		2.432	2.424	0.004	0.008
720	2017	19605R	8	QCP	0.80	0.97	0.24		2.443	2.441	0.005	0.004
721	2015	19533R	9	QCP	0.07	0.75	0.67	0.86	2.470	2.477	0.007	0.006
724	2017	19513R	9	PFP						2.459		0.000
725	2016	19532R	9	QCP	1.00				2.487	2.490	0.006	0.000
726	2016	19534R	9	QCP	0.92	0.44	0.70	0.00	2.433	2.434	0.006	0.008
727	2016	19534R	9	QCP	0.54	0.88	0.68	1.00	2.430	2.429	0.004	0.003
728	2017	19524R	8	QCP	0.98	0.19	0.74	0.20	2.418	2.420	0.004	0.008
729	2017	19524R	8	QCP	0.56	0.19	0.67	0.80	2.429	2.431	0.003	0.006
730	2017	19535R	8	QCP	0.14	0.01	0.79	0.13	2.432	2.454	0.005	0.029
731	2017	19532R	8	QCP	0.03	0.72	0.72	0.05	2.488	2.495	0.005	0.005
732	2017	19532R	9	QCP			0.11		2.490		0.008	
733	2015	19532R	9	QCP	0.36	0.61	0.49	0.66	2.490	2.498	0.012	0.013
734	2015	19532R	9	PFP	0.02	0.86	0.37	0.54	2.476	2.483	0.008	0.007
735	2016	19532R	9	PFP	0.21	0.49	0.36	0.33	2.483	2.481	0.008	0.009

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
736	2016	19532R	9	QCP					2.468		0.000	
737	2017	19532R	9	QCP					2.474		0.000	
738	2015	19532R	9	PFP	0.03	0.38	0.09	0.31	2.480	2.486	0.006	0.004
739	2016	19532R	9	PFP	0.36	0.45	0.23	0.02	2.486	2.489	0.009	0.007
744	2017	19534R	9	QCP	1.00				2.440	2.439	0.000	0.000
745	2016	19534R	9	QCP	0.67				2.431	2.436	0.000	0.000
746	2016	19534R	9	QCP	0.33		0.33		2.418	2.425	0.003	0.000
747	2016	19534R	9	QCP	1.00	0.02	0.13		2.427	2.427	0.002	0.009
748	2016	19534R	9	QCP	0.11	0.74	0.88	0.64	2.423	2.428	0.004	0.003
749	2015	19523R	9	QCP	0.50		0.35		2.451	2.464	0.012	0.000
750	2015	19523R	9	QCP	0.22	0.86	0.63	0.30	2.456	2.465	0.008	0.006
751	2015	19534R	9	PFP	0.04	0.00	0.82		2.431	2.451	0.008	0.000
752	2015	19534R	9	QCP	1.00		0.33		2.429	2.436	0.006	0.000
753	2015	19534R	9	QCP	0.50		0.36		2.425	2.432	0.003	0.000
754	2017	19534R	9	QCP	1.00		0.13		2.432	2.435	0.010	0.000
757	2016	19535	9	PFP	0.05	0.51	0.73	0.62	2.414	2.407	0.009	0.007
758	2016	19522R	9	QCP	0.01	0.73	0.01	0.09	2.492	2.501	0.005	0.004
760	2016	19523R	9	QCP					2.443		0.000	
761	2016	19523R	9	QCP					2.435		0.000	
762	2017	19523R	9	QCP	0.60	0.98	0.03		2.451	2.450	0.018	0.012
763	2017	19532R	9	PFP	0.25	0.27	0.46	0.24	2.484	2.482	0.006	0.003
764	2015	19534R	9	QCP	0.19	0.37	0.74		2.456	2.470	0.006	0.009
765	2015	19533R	9	QCP	1.00		0.30		2.458	2.460	0.003	0.000
766	2015	19533R	9	QCP	0.07	0.60	0.09	0.03	2.457	2.463	0.005	0.006
767	2015	19533R	9	QCP	0.01	0.71	0.57	1.00	2.452	2.457	0.003	0.002
768	2015	19533R	9	QCP	0.02	0.89	0.04	0.15	2.459	2.471	0.008	0.007
769	2015	19533R	9	QCP	0.29		0.77		2.455	2.467	0.004	0.000
770	2015	19533R	9	QCP	0.01	0.54	0.63	0.46	2.455	2.463	0.004	0.002
771	2015	19534R	9	QCP	0.17	0.92	0.33	0.64	2.441	2.449	0.006	0.005
782	2015	19534R	9	QCP	0.00	0.47	0.89	0.85	2.436	2.446	0.003	0.003
783	2016	19534R	9	QCP	0.28	0.31	0.75		2.432	2.423	0.006	0.009
784	2016	19533R	9	QCP	0.50	0.27	0.12		2.456	2.450	0.008	0.014
785	2016	19523R	9	QCP	1.00				2.448	2.447	0.006	0.000
786	2016	19523R	9	QCP	1.00		0.25		2.456	2.452	0.004	0.000
787	2017	19523R	9	QCP	0.40	0.85	0.02		2.455	2.452	0.003	0.002

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
797	2016	19535	9	PFP	0.42	0.59	0.48		2.412	2.407	0.005	0.006
798	2016	19535	9	PFP	0.08	0.57	0.14	0.78	2.415	2.410	0.004	0.003
799	2016	19532R	9	PFP	0.30	0.44	1.00	0.58	2.462	2.465	0.006	0.004
800	2016	19532R	9	PFP	0.06	0.48	0.60	0.68	2.466	2.459	0.007	0.004
801	2017	19533R	9	QCP	1.00		0.47		2.449	2.449	0.006	0.000
802	2016	19533R	9	QCP	0.05	0.49	0.90	0.69	2.453	2.444	0.006	0.007
803	2017	19534R	9	PFP	0.10	0.95	0.41	0.43	2.436	2.443	0.006	0.006
804	2017	19532R	9	PFP	0.95	0.49	0.48	0.96	2.470	2.470	0.006	0.007
805	2015	19533R	9	QCP	0.09	0.05	0.18	0.60	2.459	2.470	0.005	0.011
806	2016	19534R	9	QCP	0.36	0.16	0.59		2.434	2.431	0.007	0.001
807	2015	19534R	9	QCP	0.40		0.54		2.434	2.444	0.003	0.000
808	2016	19534R	9	QCP	0.64	0.54	0.11	0.92	2.438	2.436	0.005	0.007
809	2016	19606FR	9	QCP								
810	2016	19534R	9	QCP	1.00		0.25		2.442	2.443	0.005	0.000
815	2016	19533R	9	QCP	0.29	0.00	0.06		2.457	2.461	0.005	0.000
816	2015	19523R	9	QCP	0.00	0.44	0.99	0.70	2.451	2.461	0.006	0.004
817	2016	19523R	9	QCP	0.86		0.33		2.463	2.465	0.005	0.000
818	2015	19523R	9	QCP	0.33		0.60		2.452	2.463	0.006	0.000
819	2015	19523R	9	QCP	0.17	0.78	0.95	1.00	2.463	2.471	0.008	0.006
820	2015	19523R	9	QCP	0.06	0.90	0.35		2.451	2.467	0.005	0.004
821	2016	19532R	9	QCP	0.77	0.96	0.12	0.68	2.484	2.485	0.005	0.005
822	2016	19532R	9	QCP	0.50		0.00		2.490	2.473	0.011	0.000
823	2016	19522R	9	QCP	0.79	0.18	0.01	0.02	2.491	2.491	0.008	0.003
828	2017	19532R	9	QCP	0.24	0.53	0.44	0.40	2.491	2.486	0.008	0.009
829	2017	19524R	9	QCP	1.00		0.54		2.442	2.443	0.005	0.000
830	2017	19534R	9	QCP	0.11	1.00	0.45	0.16	2.446	2.442	0.005	0.004
831	2016	19532R	9	PFP			0.57		2.477		0.015	
832	2016	19523R	9	QCP	0.27	0.85	0.56		2.453	2.459	0.003	0.002
833	2016	19535R	9	PFP					2.430		0.000	
834	2017	19523R	9	QCP	0.40	0.62	0.38	0.94	2.439	2.448	0.013	0.009
835	2017	19532R	9	PFP					2.474		0.000	
836	2017	19532R	9	PFP	0.29		0.52		2.470	2.475	0.003	0.000

C.5 G_{MB} ANALYSIS RESULTS

Table C.5. G_{mb} Analysis Results Summary

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
1	2015	19524R	1	QCP	0.33	0.00			2.422	2.447	0.008	0.000
2	2017	19524R	1	QCP	0.67				2.444	2.439	0.004	0.000
3	2017	19524R	1	QCP	1.00				2.421	2.423	0.029	0.000
4	2016	19524R	1	QCP	0.32	0.43	0.68	0.44	2.419	2.428	0.012	0.019
5	2015	19514R	1	QCP					2.374		0.000	
6	2015	19514R	1	QCP	0.67				2.390	2.397	0.004	0.000
7	2015	19524R	1	QCP	0.64	0.63	0.47	0.00	2.383	2.388	0.006	0.006
8	2015	19524R	1	QCP					2.383		0.001	
9	2015	19524R	1	PFP	0.17	0.31	0.18	0.39	2.382	2.392	0.009	0.013
10	2015	19512R	1	QCP	0.50		0.46		2.414	2.404	0.004	0.000
11	2015	19512R	1	QCP	0.67				2.434	2.425	0.009	0.000
12	2015	19522R	1	QCP	0.03	0.04	0.04	0.02	2.421	2.448	0.017	0.033
13	2017	19522R	1	QCP	0.33	0.38			2.438	2.421	0.003	0.009
14	2015	19510R	1	QCP	1.00		0.41		2.345	2.341	0.005	0.000
15	2015	19510R	1	QCP					2.352		0.006	
16	2015	19510R	1	QCP	0.35	0.02	0.00	0.47	2.346	2.351	0.004	0.013
17	2015	19512R	1	QCP	0.67				2.424	2.449	0.000	0.028
18	2015	19510R	1	QCP	0.13	0.19	0.22		2.351	2.372	0.002	0.006
19	2015	19536R	1	QCP				0.19		2.388		0.035
20	2017	19525R	1	QCP	0.53	0.44	0.42		2.401	2.384	0.013	0.020
21	2015	19524R	1	QCP	0.67				2.406	2.423	0.000	0.000
22	2015	19524R	1	QCP	1.00				2.401	2.392	0.018	0.000
23	2015	19512R	1	QCP	1.00		0.19		2.450	2.445	0.005	0.000
24	2016	19532R	1	QCP	0.33	0.20			2.434	2.451	0.003	0.018
25	2017	19532R	1	QCP	0.40		0.51		2.410	2.430	0.016	0.000
26	2017	19510R	1	QCP	1.00				2.342	2.343	0.000	0.000
27	2015	19510R	1	QCP	0.57	0.63	0.91	0.89	2.346	2.340	0.008	0.010
28	2017	19665R	1	QCP					2.359		0.001	
29	2015	19665R	1	QCP	0.63	0.13	0.85	0.27	2.356	2.357	0.004	0.011
30	2017	19524R	1	QCP	0.89	0.33	0.88	0.75	2.399	2.398	0.013	0.019
31	2017	19525R	1	QCP	0.67				2.393	2.384	0.000	0.000

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
32	2016	19510R	1	QCP	0.50		0.30		2.336	2.356	0.003	0.000
33	2015	19525R	1	QCP			0.99		2.402		0.011	
34	2016	19512R	1	QCP			0.83		2.426		0.008	
35	2015	19512R	1	QCP	0.67				2.412	2.432	0.008	0.000
36	2015	19522R	1	QCP	0.43		0.30		2.431	2.415	0.016	0.000
37	2015	19522R	1	QCP						2.410		0.000
38	2015	19524R	1	QCP	0.10	0.15	0.29	0.95	2.411	2.387	0.017	0.029
39	2015	19510R	1	QCP	0.80	0.92	0.02		2.355	2.346	0.018	0.015
40	2015	19510R	1	QCP					2.321		0.000	
41	2015	19510R	1	QCP	1.00	1.00			2.326	2.326	0.013	0.013
42	2015	19524R	1	QCP			0.11		2.380		0.006	
43	2015	19524R	1	QCP	0.30	0.74	0.47	0.57	2.386	2.394	0.017	0.019
44	2015	19510R	1	PFP	0.87	0.44	0.88	0.21	2.338	2.337	0.010	0.012
45	2015	19510R	1	PFP					2.352		0.000	
46	2015	19524R	1	QCP	0.74	0.24	0.63	0.29	2.383	2.375	0.008	0.018
47	2015	19655R	1	PFP	0.07	0.00	0.50	0.80	2.520	2.506	0.014	0.033
48	2015	19536R	1	PFP	0.55	0.14	0.43	0.46	2.571	2.576	0.019	0.029
49	2017	19510R	1	QCP	1.00		0.16		2.361	2.359	0.008	0.000
50	2017	19510R	1	QCP	0.44		0.19		2.360	2.353	0.008	0.000
51	2016	19510R	1	QCP	0.67	0.73		0.66	2.332	2.323	0.008	0.015
52	2017	19524R	1	QCP	0.67				2.409	2.389	0.018	0.000
53	2017	19525R	1	QCP	1.00		0.56		2.401	2.395	0.021	0.000
54	2017	19525R	1	PFP	0.16	0.39	0.14	0.25	2.399	2.391	0.011	0.008
55	2016	19525R	1	QCP	0.17	0.88	0.43	0.38	2.400	2.387	0.012	0.010
56	2016	19536R	1	QCP					2.375		0.006	
57	2015	19536R	1	PFP	0.75	0.14	0.03	0.01	2.394	2.395	0.021	0.033
58	2015	19524R	1	QCP	0.01	0.59	0.34	0.23	2.438	2.476	0.012	0.009
59	2017	19524R	1	QCP	0.10	0.73	0.46	0.17	2.421	2.457	0.004	0.006
60	2015	19522R	1	QCP	0.34	0.69	0.60	0.71	2.427	2.439	0.014	0.018
61	2015	19522R	1	QCP	0.02	0.46	0.01	0.04	2.448	2.481	0.012	0.017
62	2015	19510R	1	QCP	0.67				2.356	2.370	0.005	0.000
63	2015	19510R	1	PFP	0.98	0.16	0.24	0.20	2.371	2.375	0.031	0.016
64	2017	19524R	1	QCP	1.00				2.384	2.367	0.000	0.000
65	2017	19524R	1	PFP	0.43	0.63	0.46	0.33	2.410	2.414	0.013	0.016
66	2017	19524R	1	QCP	0.67				2.415	2.394	0.012	0.000

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
67	2017	19510R	1	QCP	0.10	0.17	0.00	0.00	2.353	2.371	0.002	0.006
68	2015	19532R	1	QCP	0.70	0.84	0.36	0.40	2.443	2.441	0.016	0.012
69	2017	19510R	1	QCP	0.70	0.47	0.12	0.55	2.355	2.350	0.016	0.028
70	2016	19510R	1	QCP	1.00				2.356	2.349	0.009	0.000
71	2017	19524R	1	PFP					2.413		0.000	
72	2017	19510R	1	QCP	0.20	0.66		0.50	2.355	2.371	0.010	0.008
73	2017	19510R	1	QCP	0.50	0.06	0.36	0.39	2.353	2.368	0.003	0.015
74	2016	19525R	1	QCP	0.07	0.80	0.46		2.383	2.365	0.010	0.006
75	2017	19665R	1	QCP	1.00	0.15			2.349	2.350	0.003	0.024
76	2017	19655R	1	QCP	1.00	0.00			2.375	2.369	0.009	0.000
77	2017	19665R	1	QCP	0.60	0.22	0.00		2.356	2.355	0.009	0.001
78	2015	19512R	1	QCP	0.65	0.00	0.32	0.89	2.424	2.415	0.007	0.024
79	2015	19522R	1	PFP	0.71	0.85		0.06	2.428	2.426	0.013	0.021
80	2017	19522R	1	QCP	0.33	0.17	0.54		2.445	2.453	0.013	0.001
81	2015	19522R	1	QCP						2.357		0.000
82	2015	19514R	1	QCP	0.86	0.06	0.16	0.68	2.408	2.404	0.007	0.016
83	2015	19524R	1	QCP	0.53	0.99	0.74	0.37	2.400	2.389	0.021	0.020
84	2015	19512R	1	QCP	0.48	0.12	0.42	0.20	2.426	2.433	0.011	0.018
85	2015	19512R	1	QCP	1.00		0.24		2.424	2.421	0.024	0.000
86	2015	19525R	1	PFP			0.35		2.436		0.012	
87	2015	19510R	1	QCP	0.80		0.78		2.350	2.353	0.004	0.000
88	2017	19510R	1	QCP	0.20	0.45	0.56	0.89	2.352	2.364	0.012	0.017
89	2017	19532R	1	QCP	1.00				2.440	2.435	0.011	0.000
90	2016	19524R	1	QCP	1.00		0.93		2.411	2.413	0.008	0.000
91	2016	19524R	1	QCP						2.410		0.010
92	2017	19536R	1	QCP	1.00				2.465	2.467	0.000	0.000
93	2015	19536R	1	QCP	0.17	0.36	0.79	0.00	2.634	2.654	0.022	0.010
94	2015	19524R	1	QCP	0.63	0.19	0.14	0.82	2.395	2.382	0.007	0.021
95	2015	19512R	1	QCP	0.93	0.41	0.26		2.460	2.456	0.014	0.021
96	2015	19512R	1	QCP	0.03	0.61	0.51	0.41	2.455	2.469	0.007	0.008
97	2015	19514R	1	QCP	0.97	0.45	0.48	0.07	2.403	2.405	0.018	0.025
98	2017	19522R	1	QCP	1.00				2.463	2.435	0.000	0.000
99	2017	19522R	1	QCP	0.57		0.02		2.429	2.451	0.012	0.000
100	2016	19522R	1	QCP	0.02	0.12	0.18	0.14	2.450	2.468	0.013	0.021
101	2015	19510R	1	QCP	1.00				2.363	2.367	0.013	0.000

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102	2015	19510R	1	QCP			0.54		2.372		0.004	
103	2015	19510R	1	QCP	0.33	0.00			2.370	2.379	0.008	0.000
104	2015	19510R	1	QCP	1.00				2.367	2.366	0.007	0.000
105	2017	19510R	1	QCP	0.38	0.91	0.27	0.10	2.364	2.367	0.006	0.007
108	2017	19532R	1	QCP	0.80	0.90	0.33		2.444	2.458	0.014	0.013
107	2017	19532R	1	QCP	0.71	0.53	0.62	0.70	2.431	2.438	0.020	0.011
108	2017	19532R	1	QCP	0.76	0.52	0.99	0.54	2.428	2.426	0.016	0.021
109	2015	19536R	1	QCP	1.00		0.10		2.591	2.605	0.027	0.000
110	2015	19536R	1	QCP	0.50		0.54		2.625	2.615	0.007	0.000
111	2015	19524R	1	QCP	1.00		0.09		2.394	2.391	0.010	0.000
112	2015	19524R	1	QCP	1.00				2.388	2.394	0.013	0.000
113	2015	19524R	1	QCP	0.51	0.66	0.04	0.00	2.385	2.385	0.023	0.018
114	2017	19510R	1	QCP	1.00	0.19			2.349	2.350	0.003	0.018
115	2017	19510R	1	QCP			0.95		2.386		0.012	
116	2016	19510R	1	QCP						2.355		0.001
117	2017	19510R	1	QCP	0.06	0.29	0.64	0.20	2.349	2.364	0.002	0.004
118	2016	19510R	1	QCP	0.04	0.08	0.75	0.00	2.359	2.377	0.002	0.006
119	2017	19510R	1	QCP	1.00	0.04	0.46		2.355	2.352	0.002	0.014
120	2017	19510R	1	QCP	1.00	0.73			2.353	2.352	0.008	0.012
121	2017	19510R	1	QCP	1.00	0.46			2.345	2.347	0.006	0.002
122	2015	19522R	1	QCP	0.67				2.423	2.416	0.008	0.000
123	2015	19522R	1	QCP	1.00		0.84		2.429	2.432	0.014	0.000
124	2017	19524R	1	QCP	1.00				2.404	2.403	0.000	0.000
125	2017	19524R	1	QCP	0.60	0.27	0.36	0.00	2.418	2.430	0.008	0.020
126	2017	19524R	1	PFP			0.08		2.416		0.010	
127	2016	19524R	1	QCP	1.00				2.402	2.401	0.006	0.000
128	2017	19524R	1	QCP	0.67		0.75		2.399	2.386	0.014	0.000
129	2017	19524R	1	QCP	1.00	0.84	0.91		2.405	2.406	0.009	0.006
130	2017	19524R	1	QCP	1.00	0.36			2.364	2.360	0.005	0.017
131	2015	19510R	1	QCP	1.00				2.371	2.372	0.000	0.000
132	2015	19510R	1	QCP	0.01	0.15	0.01	0.52	2.365	2.380	0.008	0.013
133	2015	19536R	1	PFP	0.05	0.49	0.87	0.86	2.603	2.623	0.016	0.020
134	2015	19522R	1	PFP					2.437		0.026	
135	2015	19522R	1	QCP	0.67	0.44	0.99		2.420	2.412	0.009	0.014
136	2015	19536R	1	QCP	1.00				2.588	2.574	0.000	0.000

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137	2015	19524R	1	QCP	0.49	0.58	0.77	0.95	2.424	2.420	0.007	0.009
138	2015	19510R	1	QCP	0.67	0.93			2.328	2.335	0.035	0.032
139	2015	19510R	1	QCP	1.00				2.300	2.299	0.000	0.000
140	2015	19524R	1	QCP	0.00	0.46	0.01	0.37	2.404	2.417	0.008	0.010
141	2015	19665R	1	QCP	0.92	0.15	0.07	0.29	2.714	2.711	0.031	0.020
142	2015	19524R	1	QCP	0.20	0.11		1.00	2.507	2.528	0.001	0.018
143	2015	19524R	1	QCP	0.52	0.40	0.37	0.54	2.516	2.522	0.011	0.019
144	2017	19510R	1	QCP	0.43	0.76	0.45		2.341	2.334	0.009	0.008
145	2017	19510R	1	QCP	0.67				2.332	2.335	0.003	0.000
146	2017	19510R	1	QCP	0.40	0.97	0.58		2.355	2.361	0.007	0.006
147	2015	19510R	1	QCP	0.67				2.363	2.347	0.002	0.000
148	2017	19522R	1	QCP	0.40		0.20		2.439	2.427	0.008	0.000
149	2015	19522R	1	QCP	0.37	0.84	0.49	0.45	2.418	2.405	0.022	0.023
150	2015	19536R	1	QCP	0.05	0.02	0.34	0.61	2.625	2.603	0.005	0.016
151	2017	19524R	1	QCP	0.33	0.52			2.394	2.370	0.002	0.005
152	2017	19524R	1	QCP				0.02		2.433		0.002
153	2017	19524R	1	QCP	0.67	0.81			2.408	2.380	0.018	0.024
154	2015	19525R	1	QCP	1.00		0.78		2.431	2.426	0.008	0.000
155	2017	19525R	1	QCP	0.67				2.448	2.438	0.001	0.000
156	2015	19525R	1	QCP	0.38	0.16	0.94		2.431	2.436	0.003	0.007
157	2015	19524R	1	QCP	0.80	0.59	1.00	0.54	2.401	2.397	0.007	0.011
158	2017	18436R	1	QCP	0.67	0.91			2.509	2.513	0.013	0.016
159	2016	19655R	1	QCP	1.00	0.18	0.64		2.491	2.488	0.016	0.035
160	2017	19655R	1	QCP	1.00		0.65		2.492	2.495	0.009	0.000
161	2015	19525R	1	QCP	0.07	0.48	0.42	0.28	2.504	2.488	0.007	0.010
162	2017	19653R	1	QCP	0.52	0.01	0.29	0.00	2.354	2.342	0.004	0.016
163	2016	19665R	1	PFP	0.28	0.86	0.74		2.705	2.693	0.011	0.006
164	2017	19665R	1	QCP	0.80		0.67		2.738	2.732	0.007	0.000
165	2015	19512R	1	QCP	0.71	0.78	0.08	0.34	2.449	2.462	0.015	0.017
166	2015	19512R	1	QCP	0.53	0.34		0.22	2.472	2.480	0.013	0.007
167	2017	19525R	1	QCP	0.70	0.66	0.84	0.67	2.559	2.574	0.018	0.025
168	2017	19525R	1	QCP	0.20	0.34		0.05	2.555	2.580	0.005	0.021
169	2017	19525R	1	QCP	1.00		0.54		2.551	2.554	0.004	0.000
170	2017	19525R	1	PFP	0.51	0.04	0.65	0.86	2.557	2.551	0.018	0.006
171	2017	19655R	1	PFP	0.55	0.01	0.99	0.92	2.859	2.841	0.009	0.041

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172	2015	19512R	1	QCP					2.445		0.000	
173	2015	19522R	1	QCP					2.455		0.000	
174	2015	19522R	1	QCP			0.30		2.446		0.010	
175	2015	19536R	1	QCP	0.53	0.67		0.08	2.626	2.620	0.010	0.021
176	2015	19510R	1	QCP	0.60	0.00	0.00		2.325	2.322	0.015	0.000
177	2015	19510R	1	QCP						2.297		0.000
178	2015	19510R	1	QCP	0.97	0.85	0.02	0.82	2.351	2.350	0.009	0.008
179	2015	19522R	1	QCP			0.92		2.432		0.006	
180	2015	19522R	1	QCP			0.50		2.427		0.014	
181	2015	19522R	1	QCP			0.57		2.434		0.009	
182	2015	19522R	1	QCP	0.14		0.98		2.435	2.449	0.007	0.000
183	2015	19524R	1	PFP	0.01	0.66	0.45	0.79	2.393	2.363	0.009	0.007
184	2015	19510R	1	QCP			0.34		2.338		0.005	
185	2015	19510R	1	QCP	0.03	0.75	0.85	0.02	2.353	2.376	0.005	0.004
186	2017	19510R	1	QCP	1.00		0.82		2.352	2.353	0.006	0.000
187	2015	19522R	1	QCP	0.50		0.06		2.429	2.414	0.016	0.000
188	2015	19524R	1	QCP	0.80		0.80		2.395	2.398	0.004	0.000
189	2015	19524R	1	QCP	0.13	0.01	0.02		2.392	2.430	0.002	0.019
190	2015	19510R	1	QCP	0.64	0.93	0.77		2.326	2.328	0.003	0.002
191	2015	19510R	1	QCP	1.00				2.328	2.332	0.006	0.000
192	2015	19510R	1	PFP	0.89	0.10	0.04	0.76	2.332	2.332	0.011	0.020
193	2015	19510R	1	QCP	0.33	0.00			2.337	2.351	0.000	0.002
194	2015	19510R	1	QCP	0.21	0.43	0.19		2.335	2.345	0.008	0.011
195	2015	19510R	1	QCP			0.58		2.332		0.007	
196	2017	19510R	1	QCP	1.00				2.337	2.342	0.000	0.000
197	2017	19510R	1	QCP	0.67				2.334	2.349	0.008	0.000
198	2017	19510R	1	QCP	1.00				2.327	2.323	0.009	0.000
199	2017	19510R	1	QCP	0.50			0.64	2.334	2.311	0.000	0.005
200	2017	19510R	1	QCP	1.00				2.332	2.320	0.017	0.000
201	2017	19510R	1	QCP	1.00		0.81		2.331	2.334	0.008	0.000
202	2017	19510R	1	QCP	0.40		0.61		2.323	2.337	0.006	0.000
203	2017	19510R	1	QCP	0.67				2.336	2.349	0.001	0.000
204	2015	19665R	1	PFP			0.99		2.345		0.006	
205	2015	19665R	1	PFP	0.90	0.32	0.00	0.30	2.353	2.357	0.014	0.019
206	2015	19665R	1	PFP	0.49	0.94	0.26	0.10	2.362	2.368	0.013	0.013

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207	2015	19522R	1	QCP	0.13	0.68	0.45	0.65	2.466	2.442	0.019	0.024
208	2015	19524R	1	QCP	0.34	0.00	0.51	0.25	2.417	2.439	0.009	0.031
209	2015	19524R	1	QCP	0.53	0.00	0.20	0.01	2.390	2.392	0.016	0.038
210	2015	19524R	1	QCP	0.50		0.28		2.392	2.360	0.017	0.000
211	2015	19524R	1	QCP	0.01	0.73	0.40	0.87	2.379	2.361	0.008	0.007
212	2015	19524R	1	QCP						2.360		0.000
213	2017	19522R	1	QCP			0.78		2.434		0.003	
214	2015	19536R	1	PFP	0.01	0.14	0.29	0.22	2.382	2.397	0.010	0.015
215	2015	19510R	1	QCP	1.00				2.374	2.366	0.000	0.000
216	2015	19510R	1	QCP	0.91	0.02	0.56	0.69	2.346	2.353	0.010	0.022
217	2015	19510R	1	QCP	0.67				2.343	2.326	0.002	0.000
218	2015	19510R	1	QCP	0.55	0.64	0.79	0.33	2.322	2.317	0.009	0.011
219	2015	19510R	1	QCP	1.00				2.356	2.352	0.010	0.000
220	2015	19510R	1	QCP	0.67				2.341	2.322	0.014	0.000
221	2015	19522R	1	QCP	1.00				2.467	2.464	0.000	0.000
222	2015	19522R	1	QCP	0.72	0.64	0.86	0.81	2.454	2.459	0.023	0.027
223	2015	19536R	1	QCP	0.08	0.68	0.73	0.37	2.378	2.363	0.009	0.011
224	2015	19536R	1	QCP	0.75		0.38		2.378	2.374	0.012	0.000
225	2015	19536R	1	QCP	0.06	0.14	0.13	0.28	2.398	2.383	0.008	0.003
226	2015	19536R	1	QCP					2.392		0.000	
227	2016	19536R	1	QCP					2.400		0.000	
228	2015	19524R	1	PFP	0.38	0.90	1.00	0.98	2.411	2.406	0.010	0.011
229	2016	19524R	1	QCP					2.419		0.030	
230	2016	19524R	1	QCP				0.34		2.419		0.014
231	2015	19655R	1	QCP	0.66	0.61	0.52	0.10	2.385	2.379	0.020	0.023
232	2016	19522R	1	QCP	0.80	0.41	0.71		2.438	2.446	0.017	0.027
233	2015	19522R	1	QCP					2.425		0.000	
234	2015	19522R	1	QCP					2.442		0.000	
235	2017	19524R	1	QCP	1.00	0.68			2.385	2.384	0.014	0.024
236	2017	19524R	1	QCP	1.00				2.399	2.409	0.000	0.000
237	2017	19524R	1	QCP	0.67				2.393	2.376	0.013	0.000
238	2017	19524R	1	QCP	1.00				2.390	2.406	0.000	0.000
239	2017	19524R	1	PFP	0.14	0.72	0.87		2.394	2.404	0.007	0.004
240	2017	19524R	1	QCP	1.00				2.402	2.434	0.000	0.000
241	2017	19524R	1	QCP	0.33	0.34			2.374	2.326	0.004	0.013

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene’s P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
242	2017	19514R	1	QCP	1.00				2.380	2.386	0.000	0.000
243	2015	19514R	1	QCP	0.69	0.18	0.38	0.38	2.384	2.383	0.021	0.051
244	2017	19524R	1	QCP	0.29	0.11	0.44	0.54	2.420	2.405	0.006	0.020
245	2017	19524R	1	QCP	0.06	0.86	0.08	0.27	2.393	2.367	0.012	0.012
246	2015	19525R	1	QCP	0.40	0.58	0.03	0.22	2.382	2.376	0.007	0.004
247	2017	19525R	1	QCP	1.00		0.51		2.395	2.390	0.011	0.000
248	2017	19525R	1	QCP	1.00				2.394	2.401	0.000	0.000
249	2017	19525R	1	QCP	1.00	0.08	0.30		2.382	2.385	0.006	0.017
250	2015	19525R	1	QCP	0.52	0.70	0.42	0.95	2.393	2.400	0.009	0.011
251	2017	19525R	1	QCP	1.00				2.381	2.367	0.000	0.000
252	2017	19525R	1	QCP	1.00				2.379	2.381	0.011	0.000
253	2016	19510R	1	QCP	1.00				2.372	2.374	0.000	0.000
254	2016	19510R	1	QCP					2.363		0.001	
255	2016	19510R	1	QCP	1.00				2.339	2.325	0.000	0.000
256	2016	19510R	1	QCP	0.80	0.23	0.00		2.351	2.358	0.013	0.002
257	2017	19510R	1	QCP	1.00				2.368	2.370	0.009	0.000
258	2017	19510R	1	QCP	1.00				2.344	2.343	0.010	0.000
259	2017	19510R	1	QCP	0.33	0.73			2.370	2.349	0.008	0.012
260	2017	19510R	1	QCP	0.67				2.374	2.363	0.001	0.000
261	2017	19525R	1	QCP	0.36	0.17	0.41	0.59	2.412	2.396	0.017	0.033
262	2017	19536R	1	QCP	0.67				2.398	2.395	0.002	0.000
263	2015	19536R	1	QCP	1.00		0.34		2.402	2.400	0.011	0.000
264	2017	19524R	1	QCP	0.50		0.93		2.392	2.374	0.015	0.000
265	2017	19524R	1	QCP	0.10	0.28	0.84	0.68	2.422	2.407	0.004	0.009
266	2017	19524R	1	QCP	1.00		0.88		2.408	2.413	0.029	0.000
267	2015	19665R	1	QCP	0.05	0.43	0.26	0.88	2.364	2.353	0.009	0.005
268	2015	19525R	1	QCP	0.83	0.38	0.46		2.396	2.394	0.009	0.002
269	2015	19510R	1	QCP	0.11	0.46	0.02	0.65	2.316	2.283	0.027	0.036
270	2015	19524R	1	PFP	0.00	0.46	0.24	0.40	2.406	2.382	0.017	0.013
271	2015	19510R	1	QCP	0.43	0.58	0.04	0.18	2.353	2.351	0.009	0.008
272	2016	19514R	1	QCP	0.03	0.42	0.01	0.59	2.359	2.335	0.012	0.017
273	2016	19514R	1	QCP	0.03	0.79	0.31	0.16	2.378	2.355	0.019	0.021
274	2017	19510R	1	QCP	1.00	0.62	0.82		2.330	2.324	0.020	0.024
275	2017	19510R	1	QCP	0.83	0.08	0.00	0.01	2.341	2.338	0.013	0.022
276	2017	19510R	1	QCP	1.00		1.00		2.347	2.344	0.009	0.000

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277	2016	19512R	1	QCP	0.01	0.31	0.92	0.80	2.390	2.373	0.007	0.011
278	2017	19524R	1	QCP	0.15	0.89	0.89		2.391	2.375	0.012	0.007
279	2017	19524R	1	QCP	0.60	0.19	0.36		2.395	2.390	0.005	0.001
280	2017	19525R	1	PFP	0.07	0.30	0.36	0.48	2.437	2.426	0.017	0.021
281	2017	19525R	1	QCP	0.78	0.87	0.26	0.73	2.431	2.434	0.018	0.017
282	2015	19510R	1	QCP	0.80	0.76		0.93	2.358	2.368	0.012	0.022
283	2015	19524R	1	QCP	0.86	0.77	0.52	0.11	2.409	2.410	0.009	0.008
284	2015	19522R	1	QCP						2.408		0.000
285	2016	19522R	1	QCP					2.395		0.000	
286	2016	19522R	1	QCP			0.46		2.430		0.004	
287	2015	19522R	1	QCP	0.67				2.453	2.475	0.000	0.002
288	2016	19532R	1	QCP	1.00	0.89	0.78		2.414	2.413	0.005	0.004
289	2017	19510R	1	QCP	1.00				2.336	2.337	0.000	0.000
290	2016	19510R	1	QCP						2.347		0.006
291	2017	19510R	1	QCP	0.64	0.11	0.12	0.37	2.355	2.353	0.007	0.018
292	2015	19524R	1	QCP	0.53	0.65	0.08		2.391	2.397	0.015	0.018
293	2016	19524R	1	QCP						2.388		0.000
294	2016	19524R	1	QCP	1.00				2.389	2.396	0.000	0.000
295	2015	19510R	1	QCP	0.41	0.64	0.74	0.49	2.331	2.326	0.014	0.012
296	2015	19665R	1	PFP	0.05	0.95	0.92	0.26	2.477	2.491	0.019	0.019
297	2017	19510R	1	QCP	0.18		0.13		2.342	2.328	0.007	0.000
298	2016	19510R	1	QCP	1.00				2.348	2.346	0.004	0.000
299	2016	19524R	1	QCP	1.00		0.86		2.412	2.416	0.008	0.000
300	2016	19524R	1	QCP	0.67				2.409	2.419	0.005	0.000
301	2015	19536R	1	PFP					2.564		0.000	
302	2015	19536R	1	QCP	0.33	0.25			2.555	2.565	0.007	0.001
303	2015	19536R	1	PFP	0.06	0.22	0.01	0.01	2.586	2.601	0.034	0.023
304	2015	19536R	1	QCP			0.49		2.439		0.034	
305	2015	19512R	1	QCP	0.39	0.25	1.00	0.78	2.445	2.451	0.007	0.003
306	2017	19525R	1	QCP	0.33		0.04		2.413	2.401	0.006	0.000
307	2017	19525R	1	QCP	1.00				2.407	2.401	0.000	0.000
308	2016	19525R	1	QCP	0.86		0.33		2.399	2.390	0.015	0.000
309	2017	19525R	1	PFP	0.70	0.15	0.04	0.06	2.417	2.408	0.015	0.028
310	2017	19512R	1	QCP					2.379		0.003	
311	2017	19512R	1	QCP					2.396		0.000	

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312	2017	19536R	1	QCP	0.67	0.84			2.421	2.415	0.017	0.022
313	2016	19536R	1	QCP			0.75		2.435		0.007	
314	2017	19510R	1	QCP	0.67	0.62			2.343	2.356	0.012	0.006
315	2017	19510R	1	QCP	1.00		0.46		2.342	2.345	0.006	0.000
316	2017	19510R	1	QCP	0.74	0.98	0.45	0.64	2.342	2.348	0.010	0.009
317	2017	19510R	1	QCP					2.347		0.000	
318	2017	19665R	1	QCP	1.00				2.450	2.402	0.000	0.000
319	2017	19665R	1	PFP	0.36	0.52	0.00	0.28	2.452	2.467	0.031	0.017
320	2017	19525R	1	QCP	1.00				2.390	2.371	0.000	0.000
321	2017	19522R	1	QCP			0.84		2.421		0.010	
322	2017	19522R	1	QCP					2.436		0.000	
323	2017	19653R	1	PFP	0.46	0.45	0.02	0.60	2.383	2.382	0.016	0.014
324	2017	19655	1	PFP	0.26	0.47	0.25	0.01	2.490	2.492	0.015	0.014
325	2015	19532R	1	QCP	0.70	0.23	0.74	0.06	2.425	2.419	0.011	0.029
326	2017	19532R	1	QCP					2.425		0.001	
327	2017	19532R	1	QCP	0.67				2.410	2.425	0.006	0.000
328	2017	19524R	1	QCP	1.00		0.27		2.397	2.395	0.014	0.000
329	2017	19524R	1	QCP	0.03	0.14	0.48	0.66	2.396	2.414	0.008	0.015
330	2017	19524R	1	QCP	0.07	0.79	0.86	0.04	2.400	2.390	0.010	0.010
331	2017	19522R	1	QCP	0.05	0.09	0.11	0.08	2.425	2.417	0.014	0.008
332	2015	19522R	1	QCP	0.86		0.08		2.443	2.438	0.015	0.000
333	2015	19522R	1	QCP					2.434		0.000	
334	2015	19524R	1	PFP	0.01	0.24	0.57	0.37	2.412	2.435	0.010	0.016
335	2015	19524R	1	QCP	0.33	0.76	0.06	0.16	2.395	2.406	0.017	0.014
336	2015	19524R	1	QCP	1.00				2.386	2.386	0.001	0.000
337	2015	19522R	1	QCP	0.03	0.43	0.27	0.34	2.442	2.461	0.013	0.008
338	2015	19524R	1	QCP	0.73	0.15	0.18	0.56	2.385	2.391	0.014	0.005
339	2015	19522R	1	QCP					2.441		0.007	
340	2015	19524R	1	QCP	0.05	0.82	0.50	0.84	2.417	2.407	0.003	0.004
341	2015	19524R	1	PFP					2.412		0.011	
342	2015	19510R	1	QCP	0.80		0.92		2.385	2.371	0.028	0.000
343	2015	19510R	1	PFP	0.09	0.34	0.49		2.354	2.371	0.009	0.013
344	2015	19510R	1	QCP	0.04	0.03	0.22	0.84	2.350	2.367	0.002	0.007
345	2015	19510R	1	PFP	0.65	0.60	0.26	0.08	2.349	2.352	0.010	0.013
346	2015	19510R	1	QCP						2.363		0.000

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347	2015	19510R	1	QCP	0.80		0.91		2.358	2.363	0.013	0.000
348	2015	19510R	1	PFP	0.18	0.39	0.27	0.02	2.357	2.354	0.006	0.009
349	2015	19510R	1	QCP			0.80		2.354		0.014	
350	2015	19510R	1	QCP	1.00		0.44		2.353	2.359	0.011	0.000
351	2015	19510R	1	QCP	1.00	0.61			2.359	2.361	0.011	0.021
352	2015	19510R	1	QCP	0.67				2.351	2.338	0.011	0.000
353	2015	19522R	1	QCP						2.446		0.000
354	2015	19536R	1	QCP	0.73	0.04	0.33	0.51	2.372	2.369	0.010	0.043
355	2015	19536R	1	QCP	0.76	0.95	0.55	0.36	2.380	2.385	0.012	0.013
356	2015	19536R	1	PFP	0.53	0.01	0.79	0.07	2.389	2.386	0.011	0.022
357	2016	19524R	1	QCP	1.00				2.406	2.416	0.000	0.000
358	2017	19524R	1	QCP	0.34	0.52	0.45	0.97	2.386	2.398	0.017	0.012
359	2015	19665R	1	QCP	0.67	0.10	0.34	0.28	2.505	2.522	0.020	0.045
360	2015	19665R	1	PFP			0.41		2.499		0.022	
361	2017	19510R	1	QCP	0.40	0.50	0.26	0.17	2.340	2.349	0.011	0.017
362	2015	19655R	1	PFP			0.22		2.503		0.009	
363	2016	19522R	1	QCP	0.52	0.74	0.33	0.69	2.407	2.412	0.013	0.015
364	2016	19524R	1	QCP					2.391		0.000	
365	2016	19514R	1	QCP	1.00				2.402	2.411	0.000	0.000
366	2016	19536R	1	QCP	0.67				2.385	2.392	0.007	0.000
367	2016	19532R	1	QCP	0.20	0.75	0.11	0.27	2.383	2.396	0.008	0.011
368	2017	19522R	1	QCP	0.33		0.26		2.415	2.422	0.006	0.000
369	2017	19522R	1	QCP	0.60		0.98		2.426	2.414	0.013	0.000
370	2017	19524R	1	QCP	0.50	0.12	0.08	0.33	2.390	2.384	0.009	0.018
371	2017	19524R	1	PFP	0.06	0.57	0.13	0.03	2.397	2.378	0.018	0.013
372	2017	19510R	1	QCP	0.86		0.56		2.350	2.346	0.006	0.000
373	2017	19510R	1	QCP	1.00	0.14	0.12		2.328	2.323	0.015	0.001
374	2017	19510R	1	QCP	1.00				2.345	2.364	0.000	0.000
375	2017	19525R	1	QCP	0.40	0.48	0.15	0.27	2.368	2.350	0.019	0.035
376	2017	19510R	1	QCP	0.34	0.41	0.24	0.64	2.356	2.370	0.011	0.018
377	2017	19510R	1	QCP	0.29	0.43	0.91	0.94	2.363	2.369	0.005	0.009
378	2017	19653R	1	QCP					2.388		0.000	
379	2017	19653R	1	PFP	0.18	0.08	0.14	0.13	2.379	2.386	0.016	0.025
380	2017	19525R	1	PFP						2.380		0.022
381	2017	19525R	1	PFP	0.11	0.20	0.06	0.54	2.376	2.363	0.013	0.024

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382	2017	19655R	1	PFP	0.27	0.14	0.27	0.20	2.345	2.351	0.015	0.026
383	2017	19510R	1	QCP	0.04	0.49	0.01	0.23	2.344	2.351	0.009	0.007
384	2017	19665R	1	PFP	0.23	0.57	0.00	0.06	2.330	2.316	0.046	0.055
385	2017	19665R	1	QCP	1.00	0.90	0.50	0.95	2.356	2.355	0.013	0.014
386	2015	19512R	1	QCP	0.76	0.27	0.05		2.429	2.427	0.019	0.031
387	2015	19514R	1	QCP	0.67				2.398	2.403	0.000	0.000
388	2015	19522R	1	QCP	1.00				2.439	2.436	0.011	0.000
389	2016	19606F	2	PFP								
390	2014	19514R	2	QCP	0.12	0.72	0.15	0.74	2.413	2.420	0.013	0.015
391	2015	19514R	2	QCP					2.395		0.000	
392	2015	19604FR	2	QCP	0.55	0.56	0.89	0.71	2.470	2.454	0.038	0.028
393	2015	19514R	2	QCP	0.46	0.28	0.55	0.65	2.413	2.404	0.023	0.014
394	2016	19512R	4	QCP					2.457		0.000	
395	2016	19535R	2	QCP	0.92	0.62	0.18	0.01	2.532	2.529	0.028	0.024
396	2015	19534R	2	PFP	0.04	0.84	0.50	0.13	2.403	2.409	0.014	0.015
397	2015	19532R	2	PFP	0.18	0.74	0.33	0.40	2.438	2.441	0.013	0.013
398	2015	19514R	2	QCP	0.46	0.70	0.06	0.30	2.397	2.402	0.014	0.012
399	2017	19514R	2	QCP	0.80		0.08		2.402	2.390	0.019	0.000
400	2015	19524R	2	QCP	0.27	0.84	0.05	0.28	2.410	2.422	0.020	0.020
401	2015	19514R	2	QCP	0.00	0.13	0.92	0.96	2.404	2.425	0.012	0.007
402	2015	19604FR	2	QCP	0.40	0.83	0.21	0.82	2.389	2.402	0.015	0.013
403	2015	19604FR	2	QCP	0.63	0.96	0.78	0.57	2.400	2.413	0.015	0.017
404	2015	19514R	2	QCP	0.66	0.96	0.58	0.28	2.372	2.382	0.023	0.023
405	2016	19604FR	2	QCP	0.01	0.59	0.19	0.87	2.385	2.397	0.010	0.009
406	2016	19514R	2	QCP	0.00	0.72	0.00	0.00	2.363	2.380	0.018	0.017
407	2016	19516R	2	QCP	0.67	0.66			2.581	2.597	0.009	0.016
408	2017	19514R	2	QCP	0.40	0.84	0.83	0.78	2.397	2.409	0.020	0.020
409	2017	19512R	2	QCP	0.01	0.70	0.73	0.57	2.438	2.460	0.017	0.014
410	2017	19512R	2	QCP	0.27	0.04	0.60	0.67	2.419	2.428	0.021	0.005
411	2017	19514R	2	QCP	0.01	0.05	0.05	0.03	2.357	2.386	0.023	0.009
412	2016	19516R	2	QCP	0.67	0.66			2.581	2.597	0.009	0.016
413	2016	19513R	2	QCP	0.33	0.75			2.471	2.480	0.001	0.002
414	2017	19514R	2	QCP	0.80		0.73		2.393	2.399	0.025	0.000
415	2015	19514R	2	QCP	0.14	0.84	0.63	0.10	2.406	2.419	0.018	0.016
416	2017	19513R	2	QCP					2.434		0.006	

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417	2015	19514R	2	QCP	0.62	0.51	0.93	0.17	2.424	2.429	0.011	0.015
418	2016	19514R	2	QCP	0.03	0.05	0.77	0.63	2.419	2.431	0.020	0.013
419	2017	19512R	2	QCP	0.02	0.00	0.00	0.01	2.435	1.454	0.012	1.327
420	2015	19512R	2	QCP	0.07	0.93	0.05	0.20	2.436	2.443	0.018	0.018
421	2015	19512R	2	QCP	0.93	0.20	0.08	0.01	2.459	2.464	0.023	0.032
422	2015	19534R	2	PFP	0.69	0.24	0.33	0.10	2.424	2.425	0.014	0.017
423	2015	19534R	2	PFP	0.27	0.20	0.54	0.77	2.437	2.434	0.009	0.012
424	2016	19534R	2	PFP	0.23	0.30	0.36	0.54	2.422	2.429	0.013	0.017
425	2017	19532R	2	PFP	0.42	0.78	0.60	0.45	2.427	2.435	0.030	0.033
426	2015	19532R	2	PFP	0.23	0.11	0.01	0.64	2.478	2.465	0.019	0.005
427	2017	19535R	2	PFP	0.94	0.51	0.59	0.19	2.556	2.553	0.019	0.015
428	2015	19535R	2	PFP	0.51	0.62	0.17	0.56	2.563	2.557	0.014	0.011
429	2016	19512R	2	QCP	0.37	0.47	0.74	0.56	2.419	2.427	0.031	0.036
430	2015	19654R	2	PFP	0.78	0.37	0.27	0.12	2.973	2.972	0.022	0.018
431	2015	19514R	2	QCP	1.00	0.78			2.409	2.412	0.029	0.021
432	2015	19514R	2	QCP	0.94	0.61	0.87	0.87	2.411	2.409	0.031	0.038
433	2015	19514R	2	QCP	0.68	0.68	0.16	0.41	2.403	2.408	0.017	0.020
434	2016	19532R	2	PFP	0.06	0.86	0.00	0.07	2.446	2.452	0.014	0.015
435	2015	19512R	2	QCP	0.55	0.86	0.43	0.81	2.423	2.427	0.018	0.017
436	2016	19654R	2	PFP	0.94	0.63	0.89	0.29	3.016	3.016	0.021	0.022
437	2016	19654R	2	QCP	0.50	0.00	0.27	0.00	3.016	2.014	0.003	1.744
438	2016	19524R	2	QCP	0.90	0.81	0.52	0.26	2.426	2.429	0.018	0.018
439	2017	19524R	4	QCP					2.412		0.000	
440	2016	19534R	2	PFP	0.51	0.76	0.06	0.14	2.419	2.420	0.011	0.011
441	2016	19524R	2	PFP	0.29	0.53	0.80	0.75	2.386	2.373	0.020	0.025
442	2016	19534R	2	PFP	0.38	0.89	1.00	0.65	2.423	2.426	0.011	0.012
443	2015	19524R	2	QCP	0.05	0.01	0.67	0.10	2.400	2.409	0.017	0.027
444	2015	19525R	2	QCP	0.33	0.60		0.11	2.384	2.397	0.023	0.020
445	2015	19532R	2	PFP				0.19		2.411		0.015
446	2015	19605FR	2	QCP	0.11	0.04	0.74	0.01	2.401	2.405	0.009	0.017
447	2015	19532R	2	QCP	1.00	0.59			2.415	2.414	0.004	0.008
448	2015	19654R	2	PFP	0.83			0.00	2.369	2.366	0.000	0.019
449	2015	19524R	2	QCP	0.42	0.05	0.97	0.46	2.385	2.391	0.015	0.027
450	2015	19515R	2	QCP				0.52		2.364		0.010
451	2016	19515R	2	QCP	0.17	0.94	0.77	0.23	2.386	2.377	0.018	0.019

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene’s P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
452	2014	19604FR	2	QCP	0.52	0.35	0.21	0.15	2.404	2.402	0.019	0.024
453	2015	19605FR	2	QCP	1.00	0.71	0.57	0.64	2.398	2.396	0.017	0.023
454	2015	19525R	2	QCP	0.74	0.51	0.78	0.52	2.380	2.373	0.021	0.031
455	2015	19515R	2	QCP	0.06	0.00	0.39	0.14	2.402	2.394	0.014	0.024
456	2016	19525R	2	QCP	0.27	0.28	0.45	0.30	2.397	2.381	0.013	0.023
457	2015	19525R	2	QCP	0.80	0.81	0.64	0.46	2.389	2.387	0.014	0.017
458	2015	19532R	2	PFP	0.03	0.05	0.25	0.04	2.424	2.418	0.013	0.017
459	2015	19532R	2	QCP	0.40		0.24		2.413	2.430	0.017	0.000
460	2015	19654R	2	PFP	0.59	0.00	0.90	0.03	2.390	2.383	0.012	0.025
461	2015	19526R	2	QCP	1.00				2.372	2.365	0.000	0.000
462	2017	19515R	2	QCP	0.23	0.01	0.35	0.01	2.389	2.379	0.017	0.003
463	2017	19604FR	2	QCP	1.00	0.07	0.98		2.398	2.397	0.006	0.016
464	2017	19532	2	PFP								
465	2017	19513R	2	QCP	0.92	0.00	0.01	0.02	2.435	1.609	0.094	1.394
466	2017	19535R	2	PFP								
467	2015	19524R	3	QCP	0.02	0.35	0.40	0.46	2.354	2.378	0.025	0.017
468	2017	19524R	1	QCP	0.67				2.415	2.431	0.000	0.000
469	2017	19524R	3	PFP					2.392		0.000	
470	2017	19524R	1	PFP			0.04		2.397		0.008	
471	2016	19524R	3	QCP	0.40		0.33		2.422	2.402	0.005	0.000
472	2017	19522R	3	QCP	0.50		0.00		2.407	2.417	0.002	0.000
473	2015	19535R	3	PFP				0.22		2.395		0.022
474	2017	19510R	1	QCP	1.00	0.42	0.58		2.340	2.343	0.012	0.016
475	2017	19510R	1	QCP	0.08	0.93	0.10	0.95	2.346	2.356	0.008	0.008
476	2016	19524R	3	QCP	1.00	0.82			2.370	2.373	0.014	0.011
477	2017	19525R	1	PFP	0.02	0.28	0.79	0.90	2.549	2.568	0.014	0.006
478	2017	19534R	3	QCP	0.20	0.28	0.36		2.398	2.421	0.003	0.006
479	2016	19524R	3	QCP	1.00				2.354	2.351	0.010	0.000
480	2017	19524R	1	PFP	0.15	0.33	0.24		2.389	2.406	0.013	0.018
481	2017	19524R	3	QCP			0.36		2.395		0.010	
482	2015	19522R	3	QCP	0.20	0.09		0.00	2.445	2.423	0.001	0.012
483	2015	19522R	3	QCP	0.50			0.00	2.449	2.465	0.000	0.010
484	2015	19536R	1	QCP			0.88		2.608		0.005	
485	2015	19536R	1	QCP	0.67	0.65			2.600	2.594	0.007	0.013
486	2016	19512R	1	QCP	0.93	0.38	0.87	0.36	2.416	2.417	0.007	0.009

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487	2016	19514R	3	QCP	0.60	0.49	0.00		2.391	2.386	0.010	0.004
488	2015	19534R	3	PFP				0.20		2.385		0.020
489	2015	19534R	3	PFP				0.48		2.396		0.012
490	2017	19524R	1	QCP	0.01	0.67	0.01	0.96	2.394	2.361	0.011	0.008
491	2016	19512R	1	QCP	0.00	0.13	0.14	0.52	2.402	2.374	0.019	0.010
492	2017	19534R	3	PFP				0.88		2.381		0.014
493	2017	19532R	3	PFP	0.53			0.37	2.400	2.397	0.000	0.010
494	2017	19510R	1	QCP	0.14	0.82	0.34	0.27	2.320	2.306	0.009	0.007
495	2017	19654R	3	QCP	0.79	0.63	0.12	0.08	2.396	2.397	0.017	0.014
496	2017	19510R	4	PFP	0.28	0.69	0.21	0.29	2.301	2.305	0.011	0.010
497	2015	19515R	4	QCP	0.75		0.95		2.372	2.376	0.020	0.000
498	2016	19515R	4	QCP			0.68		2.524		0.021	
499	2016	19522R	4	PFP					2.417		0.003	
500	2016	19522R	4	PFP	0.00	0.42	0.00	0.11	2.419	2.431	0.017	0.019
501	2016	19532R	3	PFP	0.25	0.13	0.77	0.02	2.372	2.376	0.013	0.009
502	2015	19653R	4	PFP				0.12		2.337		0.018
503	2016	19654R	4	PFP			0.41		2.340		0.012	
504	2017	19654R	4	PFP	0.33	0.59	0.06	0.08	2.340	2.335	0.017	0.019
505	2016	19654R	4	PFP	0.03	0.33	0.17	0.29	2.342	2.350	0.010	0.012
506	2017	19510R	4	QCP					2.386		0.000	
507	2015	19515R	4	QCP					2.338		0.074	
508	2016	19524R	4	PFP	0.07	0.68	0.15	0.73	2.374	2.386	0.015	0.013
509	2016	19525R	4	PFP					2.358		0.000	
510	2015	19525R	4	PFP	0.00	0.98	0.10	0.53	2.344	2.370	0.019	0.019
511	2015	19535R	3	PFP				0.14		2.354		0.013
512	2016	19510R	4	PFP	0.23	0.38	0.83	0.23	2.357	2.362	0.010	0.013
513	2016	19510R	4	PFP	0.34	0.97	0.61	0.95	2.356	2.360	0.011	0.011
514	2017	19510R	4	QCP	0.22	0.59	0.36	0.25	2.499	2.503	0.008	0.009
515	2017	19515R	4	QCP	1.00				2.349	2.348	0.000	0.000
516	2017	19514R	4	PFP			0.24		2.420		0.015	
517	2015	19515R	4	QCP					2.370		0.004	
518	2015	19524R	4	PFP	0.00	0.66	0.28	0.40	2.361	2.391	0.011	0.014
519	2016	19512R	4	PFP					2.396		0.000	
520	2017	19522R	4	QCP			0.55		2.491		0.010	
521	2015	19524R	4	PFP	0.00	0.89	0.45	0.25	2.352	2.386	0.009	0.009

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522	2016	19512R	4	PFP					2.434		0.000	
523	2015	19514R	4	QCP			0.07		2.362		0.024	
524	2016	19514R	4	PFP	0.82	0.89	0.33	0.10	2.386	2.390	0.010	0.011
525	2015	19514R	4	PFP	0.01	0.54	0.41	0.13	2.346	2.383	0.012	0.017
526	2015	19524R	5	QCP	0.07	0.95	0.82		2.344	2.367	0.011	0.008
527	2015	19514R	5	QCP	0.60		0.43		2.357	2.367	0.011	0.000
528	2016	19514R	5	QCP			0.39		2.330		0.007	
529	2015	19514R	5	QCP	0.80	0.20	0.33		2.376	2.374	0.006	0.001
530	2016	19514R	5	QCP			0.09		2.376		0.011	
531	2016	19524R	5	QCP			0.39		2.374		0.014	
532	2017	19605FR	5	QCP	0.05	0.93	0.81	0.74	2.372	2.384	0.010	0.010
533	2015	19605FR	5	QCP	0.79	0.49	0.65	0.10	2.385	2.393	0.015	0.021
534	2015	19524R	5	QCP	0.87	0.35	0.24	0.19	2.374	2.371	0.011	0.005
535	2016	19514R	5	QCP	0.29		0.24		2.366	2.397	0.014	0.000
536	2017	19524R	5	QCP	0.78	0.13	0.01		2.366	2.377	0.012	0.023
537	2015	19534R	5	QCP	0.29		0.57		2.342	2.332	0.004	0.000
538	2015	19534R	5	PFP	0.71	0.84	0.30	0.89	2.330	2.332	0.008	0.009
539	2017	19535R	5	QCP	0.15	0.00	0.00		2.320	2.307	0.012	0.000
540	2017	19512R	6	QCP					2.364		0.000	
541	2017	19513R	5	QCP						2.346		0.013
542	2017	19532R	5	PFP				0.39		2.368		0.008
543	2016	19534R	5	QCP						2.352		0.000
544	2017	19534R	5	PFP				0.76		2.328		0.030
545	2017	19523R	5	QCP	0.79	0.36	0.73	0.54	2.352	2.353	0.010	0.014
546	2015	19534R	5	PFP	0.17	0.53	0.67	0.34	2.339	2.347	0.010	0.007
547	2016	19513R	5	QCP	0.67		0.37		2.346	2.337	0.009	0.000
548	2016	19514R	5	QCP			0.17		2.352		0.006	
549	2015	19532R	5	PFP	0.04	0.87	0.24	0.68	2.367	2.381	0.012	0.012
550	2015	19535R	5	PFP	0.13	0.88	0.28		2.379	2.366	0.011	0.006
551	2015	19523R	5	QCP	0.00	0.09	0.87	0.07	2.357	2.381	0.010	0.017
552	2015	19505R	5	QCP			0.04		2.345		0.019	
553	2015	19534R	5	PFP	0.24	0.35	0.30	0.70	2.346	2.354	0.013	0.006
554	2017	19534R	5	PFP	0.00	0.10	0.79	0.14	2.336	2.349	0.005	0.008
555	2016	19513R	5	QCP					2.346		0.000	
556	2016	19513R	5	QCP	0.67				2.338	2.348	0.002	0.000

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557	2015	19532R	5	PFP	0.03	0.53	0.82	0.69	2.350	2.362	0.008	0.005
558	2016	19532R	5	PFP	0.08	0.51	0.33	0.89	2.350	2.359	0.008	0.010
559	2016	19535R	5	PFP	0.14	0.08	0.23	0.78	2.351	2.357	0.005	0.010
560	2017	19535R	5	QCP			0.58		2.345		0.007	
561	2015	19524R	5	QCP	0.40		0.11		2.352	2.365	0.009	0.000
562	2015	19524R	5	QCP	0.10	0.80	0.39		2.339	2.353	0.009	0.008
563	2017	19532R	5	PFP	0.00	0.51	0.83	0.95	2.361	2.382	0.005	0.006
564	2015	19523R	6	QCP	0.36	0.85	0.61	1.00	2.356	2.353	0.011	0.010
565	2015	19513R	6	QCP	0.36	0.07	0.11	0.70	2.362	2.352	0.009	0.018
566	2016	19524R	6	PFP	0.19			0.30	2.349	2.331	0.000	0.014
567	2016	19513R	6	PFP						2.360		0.000
568	2015	19513R	6	QCP	0.30	0.30	0.78	0.96	2.356	2.363	0.009	0.014
569	2015	19522R	6	PFP	0.06	0.67	0.02	0.03	2.361	2.377	0.015	0.020
570	2015	19522R	6	PFP	0.00	0.03	0.31	0.74	2.376	2.365	0.012	0.018
571	2015	19513R	6	QCP	0.93	0.21	0.17	0.89	2.341	2.342	0.008	0.012
572	2015	19513R	6	QCP	0.72	0.82	0.16	0.17	2.331	2.329	0.015	0.011
573	2015	19523R	6	PFP	0.46	0.95	0.01	0.87	2.330	2.341	0.026	0.027
574	2015	19513R	6	QCP	0.57	0.70	0.75	0.83	2.347	2.342	0.017	0.014
575	2015	19523R	6	QCP	0.29	0.81	0.39	0.18	2.354	2.345	0.013	0.014
576	2015	19523R	6	QCP			0.56		2.343		0.003	
577	2017	19523R	8	QCP	0.14	0.09	0.01	0.40	2.358	2.349	0.007	0.012
578	2015	19534R	6	PFP	0.26	0.37	0.92	0.06	2.355	2.351	0.013	0.015
579	2016	19534R	6	PFP	0.32	0.89	0.18	0.45	2.346	2.355	0.010	0.012
580	2015	19522R	6	PFP	0.00	0.08	0.67	0.48	2.365	2.377	0.010	0.013
581	2015	19513R	6	QCP	0.08	0.25	0.32	0.46	2.350	2.355	0.009	0.005
582	2017	19522R	6	QCP	0.33		0.44		2.376	2.367	0.008	0.000
583	2015	19535R	6	PFP	0.49	0.36	0.03	0.37	2.317	2.313	0.026	0.019
584	2015	19535R	6	QCP	0.67		0.51		2.330	2.324	0.009	0.000
585	2015	19535R	6	PFP	0.27	0.65	0.05	0.19	2.322	2.318	0.010	0.008
586	2016	19514R	6	QCP	0.81	0.22	0.81	0.71	2.328	2.321	0.015	0.025
587	2015	19513R	6	QCP	0.85	0.90	0.56	0.68	2.372	2.375	0.011	0.011
588	2015	19522R	6	QCP	0.87	0.04	0.06	0.17	2.370	2.366	0.015	0.028
589	2016	19532R	6	PFP				0.05		2.352		0.015
590	2015	19532R	6	PFP	0.00	0.57	0.31	0.68	2.353	2.364	0.013	0.012
591	2016	19532R	6	QCP	0.29		0.02		2.365	2.385	0.013	0.000

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592	2015	19524R	6	QCP	0.87	0.00	0.61		2.333	2.336	0.010	0.000
593	2015	19512R	6	QCP	0.97	0.67	0.41	0.08	2.371	2.372	0.010	0.011
594	2015	19535R	6	PFP	0.13	0.00	0.46	0.39	2.329	2.335	0.009	0.018
595	2017	19535R	6	PFP	0.19	0.57	0.83	0.99	2.342	2.336	0.012	0.010
596	2016	19535R	6	QCP	1.00		0.17		2.341	2.345	0.014	0.000
597	2017	19513R	6	QCP	0.22	0.87	0.74	0.25	2.360	2.355	0.008	0.008
598	2017	19513R	6	QCP	0.09	0.60	0.35	0.08	2.345	2.354	0.010	0.007
599	2017	19513R	6	QCP	1.00	0.76	0.47		2.339	2.338	0.014	0.013
600	2016	19513R	6	QCP					2.334		0.000	
601	2016	19513R	6	PFP						2.363		0.004
602	2016	19513R	6	QCP	0.00	0.58	0.00	0.01	2.370	2.358	0.015	0.016
603	2016	19513R	6	QCP	0.10	0.08	0.01	0.23	2.361	2.352	0.019	0.006
604	2016	19514R	6	QCP	1.00		0.75		2.370	2.375	0.007	0.000
605	2015	19512R	6	QCP	0.94	0.28	0.01	0.88	2.335	2.337	0.015	0.008
606	2016	19524R	6	QCP	0.19	0.19	0.19	0.99	2.348	2.338	0.012	0.005
607	2015	19513R	6	QCP	1.00		0.43		2.349	2.354	0.019	0.000
608	2017	19513R	6	QCP	0.15	0.86	0.59	0.11	2.346	2.338	0.010	0.009
609	2016	19513R	6	QCP	0.00	0.33	0.61	0.02	2.350	2.331	0.011	0.013
610	2017	19513R	6	QCP	0.00	0.06	0.19	0.02	2.356	2.335	0.008	0.014
611	2016	19513R	6	QCP	0.71	0.17	0.30		2.345	2.341	0.006	0.011
612	2017	19532R	6	PFP	0.07	0.20	0.01	0.18	2.364	2.359	0.009	0.012
613	2016	19524R	6	PFP	0.01	0.09	0.54	0.85	2.322	2.338	0.010	0.016
614	2016	19513R	6	QCP	0.16	0.95	0.02	0.59	2.345	2.331	0.020	0.018
615	2016	19514R	6	QCP	0.00	0.64	0.37	0.00	2.325	2.310	0.009	0.007
616	2016	19534R	7	PFP	0.08	0.05	0.23	0.48	2.322	2.332	0.008	0.017
617	2016	19524R	6	QCP	0.47	0.49	0.03	0.96	2.336	2.333	0.016	0.012
618	2016	19532R	6	PFP	0.17	0.16	0.63	0.54	2.364	2.369	0.010	0.014
619	2016	19523R	6	QCP	1.00		0.88		2.332	2.331	0.006	0.000
620	2016	19524R	6	QCP	0.59	0.34	0.22	0.25	2.326	2.323	0.017	0.024
621	2016	19534R	6	PFP	0.04	0.26	0.12	0.05	2.318	2.329	0.012	0.016
622	2016	19513R	6	QCP	0.55	0.39	0.15	0.78	2.327	2.329	0.009	0.013
623	2016	19512R	6	QCP	0.18	0.03	0.17	0.06	2.353	2.359	0.009	0.003
624	2017	19514R	6	QCP	0.38	0.03	0.50	0.02	2.338	2.328	0.016	0.003
625	2017	19522R	6	PFP					2.383		0.000	
626	2017	19514R	6	QCP	1.00	0.10	0.00	0.02	2.329	2.333	0.013	0.024

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
627	2017	19513R	6	QCP	0.14	0.02	0.84	0.00	2.346	2.338	0.012	0.001
628	2015	19524	7	PFP	1.00	0.17	0.30	0.92	2.338	2.334	0.017	0.036
629	2016	19532R	7	QCP	1.00		0.33		2.378	2.382	0.012	0.000
630	2015	19532R	7	PFP			0.99		2.394		0.018	
631	2016	19523R	7	QCP	0.40	0.95	0.23	0.54	2.345	2.335	0.021	0.020
632	2016	19532R	7	QCP	0.36	0.40	0.18		2.388	2.381	0.008	0.011
633	2017	19532R	7	PFP	0.36	0.02	0.07	0.65	2.364	2.377	0.024	0.007
634	2017	19524R	7	PFP						2.358		0.000
635	2016	19523	7	QCP	0.57	0.61	0.76		2.337	2.344	0.016	0.018
636	2017	19523	7	QCP						2.330		0.000
637	2016	19523	7	QCP	0.33	0.72			2.308	2.340	0.015	0.023
638	2017	19523	7	QCP	0.80		0.44		2.319	2.330	0.018	0.000
639	2017	19534R	7	QCP				0.17		2.348		0.014
640	2016	19534R	7	PFP				0.03		2.341		0.015
641	2016	19534R	7	QCP	0.00	0.33	0.58	0.82	2.345	2.319	0.008	0.012
642	2016	19524R	7	QCP	0.07	0.81	0.02	0.01	2.360	2.342	0.032	0.029
643	2016	19523R	7	QCP	0.86	0.19	0.46		2.335	2.337	0.009	0.019
644	2015	19534R	7	PFP						2.354		0.000
645	2015	19534R	7	PFP				0.56		2.347		0.022
646	2016	19534R	7	QCP					2.354		0.008	
647	2015	19534R	7	QCP	0.53	0.75		0.54	2.360	2.379	0.015	0.028
648	2016	19523R	9	QCP	0.67				2.351	2.374	0.000	0.005
649	2016	19605FR	9	QCP	0.18	0.21	0.79	0.00	2.342	2.355	0.014	0.005
650	2015	19534R	7	PFP	0.91	0.27	0.99	0.60	2.356	2.356	0.009	0.014
651	2015	19523R	7	PFP	0.51	0.84	0.73	0.79	2.372	2.368	0.011	0.013
652	2015	19523R	7	QCP	0.91	0.89	0.88	0.71	2.361	2.364	0.030	0.029
653	2016	19524R	7	QCP	0.54	0.50	0.02	0.41	2.351	2.353	0.015	0.021
654	2016	19534R	7	QCP	1.00				2.364	2.361	0.017	0.000
655	2015	19534R	7	PFP	0.07	0.28	0.79	0.12	2.331	2.340	0.010	0.015
656	2016	19654R	7	PFP						2.299		0.000
657	2016	19654R	7	PFP						2.307		0.000
658	2015	19654R	7	PFP	0.79	0.37	0.23	0.07	2.294	2.295	0.022	0.018
659	2016	19654R	7	PFP	0.29	0.48	0.57	0.80	2.274	2.286	0.009	0.014
660	2016	19654R	7	PFP	0.23	0.82	0.21	0.48	2.311	2.317	0.017	0.017
661	2017	19654R	7	PFP	0.40	0.86	0.49	0.25	2.306	2.312	0.017	0.018

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
662	2016	19532R	7	PFP	0.99	0.56	0.36	0.44	2.375	2.374	0.016	0.015
663	2017	19532R	7	PFP	1.00				2.338	2.335	0.000	0.000
664	2017	19523R	7	QCP	0.80	0.57	1.00		2.358	2.356	0.005	0.002
665	2015	19505R	7	PFP			0.19		2.340		0.013	
666	2015	19532R	7	PFP	0.47	0.37	0.76	0.37	2.379	2.381	0.019	0.017
667	2016	19532R	7	PFP	0.86	0.84	0.72	0.12	2.371	2.370	0.016	0.017
668	2015	19532R	7	PFP				0.53		2.369		0.017
669	2016	19654R	7	PFP	0.95	0.88	0.73	0.92	2.311	2.312	0.017	0.018
670	2015	19654R	7	PFP	0.84	0.28	0.01	0.68	2.315	2.313	0.011	0.016
671	2016	19532R	7	PFP	0.81	0.92	0.44	0.30	2.373	2.375	0.018	0.018
672	2017	19533R	7	PFP	0.19	0.97	0.94	0.62	2.344	2.355	0.013	0.014
673	2017	19532R	7	PFP	0.86	0.57	0.33	0.34	2.381	2.382	0.025	0.022
674	2017	19532R	7	PFP	0.48	0.93	0.42	0.12	2.367	2.372	0.014	0.015
675	2017	19532R	7	PFP						2.385		0.000
676	2017	19532R	7	PFP	0.78	0.11	0.25	0.65	2.365	2.373	0.021	0.009
677	2016	19523R	8	QCP						2.356		0.000
678	2016	19523R	8	QCP	0.67	0.83			2.361	2.369	0.014	0.018
679	2016	19523R	8	QCP	0.40		0.17		2.340	2.358	0.009	0.000
680	2016	19523R	8	QCP	0.29	0.32	0.54	0.64	2.332	2.324	0.015	0.020
681	2016	19534R	8	QCP	0.01	0.45	0.72	0.67	2.328	2.351	0.016	0.011
682	2015	19534R	8	QCP	0.14		0.80		2.329	2.349	0.006	0.000
683	2015	19534R	8	QCP	0.03	0.01	0.33	0.72	2.318	2.332	0.007	0.015
684	2015	19534R	8	QCP	0.53	0.25	0.20	0.11	2.295	2.293	0.014	0.021
685	2015	19524R	8	QCP	0.85	0.49	0.58	0.83	2.331	2.333	0.011	0.008
686	2017	19524R	8	QCP	1.00	0.86	0.17	0.04	2.326	2.326	0.023	0.024
687	2015	19535R	8	QCP	0.27	0.02	0.06	0.09	2.266	2.277	0.016	0.028
688	2017	19505R	8	QCP	0.78	0.61	0.04	0.32	2.341	2.341	0.019	0.023
689	2015	19505R	8	QCP	0.53	0.07	0.37		2.363	2.371	0.016	0.001
690	2015	19606R	8	QCP	1.00	0.27	1.00		2.316	2.319	0.014	0.022
691	2015	19654R	8	PFP	0.18	0.39	0.02	0.66	2.256	2.263	0.019	0.016
692	2015	19654R	8	PFP	0.46	0.90	0.62	0.79	2.246	2.252	0.017	0.018
693	2015	19534R	8	QCP	0.25	0.21	0.50	0.12	2.300	2.285	0.023	0.008
694	2015	19654R	8	PFP	1.00	0.53	0.90	0.41	2.283	2.284	0.022	0.019
695	2015	19654R	8	PFP	0.10	0.44	0.43	0.29	2.275	2.280	0.016	0.014
696	2015	19654R	8	PFP	0.12	0.62	0.11	0.19	2.277	2.287	0.017	0.019

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
697	2015	19535R	8	QCP	0.81	0.43	0.70	0.91	2.294	2.297	0.013	0.008
698	2015	19601R	8	QCP					2.440		0.000	
699	2016	19523R	8	QCP	0.27	0.91	0.38	0.51	2.347	2.357	0.012	0.011
700	2016	19523R	8	QCP						2.375		0.006
701	2016	19532R	8	PFP	0.15	0.69	0.52	0.15	2.382	2.391	0.012	0.011
702	2016	19524R	8	QCP	0.84	0.74	0.50	0.83	2.361	2.363	0.010	0.011
703	2017	19524R	8	QCP	1.00				2.377	2.371	0.009	0.000
704	2016	19524R	8	QCP			0.34		2.346		0.009	
705	2016	19524R	8	QCP	0.67				2.315	2.318	0.001	0.000
706	2016	19524R	8	QCP	1.00				2.347	2.346	0.001	0.000
707	2016	19533R	8	QCP	0.34	0.14	0.00	0.96	2.341	2.352	0.009	0.016
708	2016	19534R	8	PFP	0.42	0.91	0.20	0.39	2.328	2.333	0.022	0.021
709	2016	19534R	8	QCP	0.46	0.30	0.12	0.02	2.342	2.342	0.019	0.028
710	2016	19504R	8	QCP	0.80	0.59	0.05		2.377	2.381	0.013	0.017
711	2016	19523R	8	QCP	1.00	0.27	0.00		2.345	2.346	0.002	0.006
712	2016	19605R	8	QCP	0.67				2.330	2.345	0.011	0.000
713	2016	19534R	8	QCP	0.42	0.24	0.73		2.349	2.365	0.014	0.025
714	2017	19654R	8	PFP						2.347		0.000
715	2017	19654R	8	PFP	0.71	0.29	0.31	0.10	2.304	2.306	0.015	0.017
716	2017	19523R	8	QCP	0.54	0.74	0.54	0.81	2.332	2.337	0.017	0.019
717	2017	19523R	8	QCP	0.87	0.85	0.00	0.54	2.328	2.333	0.016	0.014
718	2017	19524R	8	QCP	0.25		0.48		2.294	2.309	0.008	0.000
719	2017	19524R	8	QCP	0.93	0.34	0.32		2.319	2.313	0.013	0.003
720	2017	19605R	8	QCP	0.80	0.95	0.67		2.349	2.346	0.012	0.010
721	2015	19533R	9	QCP	0.07	0.79	0.73	0.31	2.382	2.406	0.021	0.018
724	2017	19513R	9	PFP						2.358		0.000
725	2016	19532R	9	QCP	0.67				2.373	2.388	0.010	0.000
726	2016	19534R	9	QCP	0.55	0.34	0.21	0.70	2.336	2.345	0.015	0.022
727	2016	19534R	9	QCP	0.78	1.00	0.90	0.48	2.337	2.341	0.016	0.015
728	2017	19524R	8	QCP	0.61	0.91	0.53	0.97	2.339	2.351	0.037	0.037
729	2017	19524R	8	QCP	0.33	0.73	0.01	0.10	2.343	2.350	0.022	0.026
730	2017	19535R	8	QCP	0.57	0.04	0.69	0.08	2.326	2.368	0.018	0.063
731	2017	19532R	8	QCP	0.40	0.85	0.14	0.01	2.397	2.390	0.025	0.023
732	2017	19532R	9	QCP			0.70		2.351		0.011	
733	2015	19532R	9	QCP	0.61	0.11	0.99	0.38	2.385	2.389	0.010	0.020

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
734	2015	19532R	9	PFP	0.91	0.79	0.03	0.05	2.379	2.378	0.013	0.014
735	2016	19532R	9	PFP	0.00	0.19	0.01	0.40	2.376	2.386	0.016	0.012
736	2016	19532R	9	QCP					2.375		0.000	
737	2017	19532R	9	QCP					2.382		0.000	
738	2015	19532R	9	PFP	0.81	0.46	0.97	0.06	2.369	2.361	0.022	0.016
739	2016	19532R	9	PFP	0.30	0.43	0.10	0.91	2.376	2.383	0.018	0.021
744	2017	19534R	9	QCP	1.00				2.368	2.378	0.000	0.000
745	2016	19534R	9	QCP	0.67				2.329	2.348	0.004	0.000
746	2016	19534R	9	QCP	1.00		0.95		2.348	2.345	0.008	0.000
747	2016	19534R	9	QCP	0.33	0.73	0.76		2.338	2.348	0.010	0.010
748	2016	19534R	9	QCP	0.29	0.17	0.05	0.64	2.330	2.337	0.010	0.003
749	2015	19523R	9	QCP	1.00		0.85		2.348	2.348	0.031	0.000
750	2015	19523R	9	QCP	0.40	0.41	0.09	0.60	2.371	2.382	0.014	0.019
751	2015	19534R	9	PFP	0.80	0.87	0.12		2.332	2.327	0.014	0.008
752	2015	19534R	9	QCP	1.00		0.20		2.335	2.362	0.024	0.000
753	2015	19534R	9	QCP	1.00		0.80		2.337	2.347	0.014	0.000
754	2017	19534R	9	QCP	0.57		0.38		2.336	2.350	0.010	0.000
757	2016	19535	9	PFP	0.53	0.33	0.52	0.19	2.323	2.328	0.014	0.018
758	2016	19522R	9	QCP	0.66	0.83	0.05	0.00	2.404	2.404	0.014	0.012
759	2017	19532R	9	PFP								
760	2016	19523R	9	QCP					2.329		0.000	
761	2016	19523R	9	QCP					2.348		0.000	
762	2017	19523R	9	QCP	0.03	0.62	0.32		2.349	2.388	0.024	0.010
763	2017	19532R	9	PFP	0.66	0.20	0.54	0.43	2.388	2.393	0.014	0.022
764	2015	19534R	9	QCP	0.86	0.87	0.34		2.337	2.327	0.025	0.022
765	2015	19533R	9	QCP	1.00		0.19		2.355	2.353	0.020	0.000
766	2015	19533R	9	QCP	0.84	0.42	0.67	0.19	2.361	2.366	0.012	0.007
767	2015	19533R	9	QCP	0.26	0.09	0.43	0.19	2.371	2.379	0.007	0.015
768	2015	19533R	9	QCP	0.91	0.17	0.58	0.39	2.379	2.385	0.032	0.058
769	2015	19533R	9	QCP	0.57		0.05		2.354	2.363	0.017	0.000
770	2015	19533R	9	QCP	0.82	0.63	0.01	0.36	2.366	2.372	0.017	0.011
771	2015	19534R	9	QCP	0.71	0.85	0.22	0.64	2.366	2.358	0.021	0.021
782	2015	19534R	9	QCP	0.40	0.75	0.48	0.22	2.353	2.344	0.015	0.012
783	2016	19534R	9	QCP	0.69	0.53	0.94		2.342	2.347	0.016	0.018
784	2016	19533R	9	QCP	0.43	0.69	0.44		2.353	2.367	0.025	0.025

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
785	2016	19523R	9	QCP	1.00				2.353	2.355	0.018	0.000
786	2016	19523R	9	QCP	1.00		0.86		2.353	2.352	0.012	0.000
787	2017	19523R	9	QCP	0.13	0.12	0.18		2.369	2.387	0.017	0.001
788	2017	19523R	9	QCP						2.366		0.002
789	2016	19605FR	9	QCP								
790	2016	19605FR	9	QCP								
791	2017	19605FR	9	QCP								
792	2017	19605FR	9	QCP								
793	2015	HMA Binder	9	QCP								
794	2015	HMA Binder	9	QCP								
795	2015	HMA Binder	9	QCP	0.03	0.93	0.46	0.46	2.353	2.374	0.013	0.013
797	2016	19535	9	PFP	0.50	0.48	0.82		2.315	2.307	0.016	0.005
798	2016	19535	9	PFP	0.71	0.96	0.01	0.24	2.324	2.320	0.019	0.016
799	2016	19532R	9	PFP	0.02	0.89	0.92	0.19	2.364	2.336	0.019	0.018
800	2016	19532R	9	PFP	0.15	0.68	0.02	0.63	2.360	2.373	0.013	0.010
801	2017	19533R	9	QCP	0.77		0.64		2.351	2.346	0.011	0.000
802	2016	19533R	9	QCP	0.87	0.07	0.56	1.00	2.341	2.336	0.019	0.041
803	2017	19534R	9	PFP	0.96	0.14	0.61	0.42	2.341	2.336	0.020	0.034
804	2017	19532R	9	PFP	0.13	0.96	0.08	0.63	2.365	2.375	0.012	0.011
805	2015	19533R	9	QCP	0.81	0.82	0.11	0.00	2.362	2.365	0.018	0.017
806	2016	19534R	9	QCP	0.21	0.46	0.06		2.329	2.343	0.016	0.005
807	2015	19534R	9	QCP	0.40		0.90		2.344	2.368	0.012	0.000
808	2016	19534R	9	QCP	0.79	0.88	0.41	0.73	2.346	2.352	0.029	0.028
809	2016	19606FR	9	QCP								
810	2016	19534R	9	QCP	1.00		0.46		2.321	2.323	0.004	0.000
815	2016	19533R	9	QCP	0.29	0.00	0.02		2.366	2.384	0.025	0.000
816	2015	19523R	9	QCP	0.16	0.44	0.72	0.93	2.358	2.369	0.016	0.020
817	2016	19523R	9	QCP	0.57		0.37		2.380	2.368	0.010	0.000
818	2015	19523R	9	QCP	1.00		0.98		2.375	2.377	0.020	0.000
819	2015	19523R	9	QCP	0.48	1.00	0.91	0.09	2.354	2.359	0.012	0.010
820	2015	19523R	9	QCP	0.17	0.23	0.39		2.372	2.380	0.005	0.001
821	2016	19532R	9	QCP	0.49	0.17	0.00	0.43	2.403	2.410	0.008	0.014

ICT Code	Year	Mix Code	District	Quality Program	MW P-Value	Levene's P-Value	Contractor SW P-Value	Agency SW P-Value	Contractor Mean	Agency Mean	Contractor St. Dev.	Agency St. Dev.
822	2016	19532R	9	QCP	1.00		0.40		2.400	2.402	0.019	0.000
823	2016	19522R	9	QCP	0.05	0.85	0.31	0.02	2.360	2.369	0.006	0.006
828	2017	19532R	9	QCP	0.59	0.90	0.27	0.67	2.389	2.391	0.010	0.008
829	2017	19524R	9	QCP	0.29		0.39		2.337	2.324	0.008	0.000
830	2017	19534R	9	QCP	0.71	0.07	0.14	0.37	2.347	2.348	0.013	0.024
831	2016	19532R	9	PFP			0.19		2.367		0.015	
832	2016	19523R	9	QCP	0.27	0.83	0.11		2.357	2.377	0.013	0.008
833	2016	19535R	9	PFP					2.232		0.000	
834	2017	19523R	9	QCP	0.30	0.65	0.36	0.90	2.336	2.345	0.008	0.006
835	2017	19532R	9	PFP					2.379		0.000	
836	2017	19532R	9	PFP	0.57		0.34		2.375	2.365	0.007	0.000

APPENDIX D: ROUND ROBIN RESULTS

D.1 ROUND ROBIN RESULTS

Table D.1. G_{mb} Analysis Results Summary

Year	District/ CBM	Gyratory Compactor Type	G_{mm} #1	G_{mm} #2	G_{mm} Avg.	G_{mb} Gyro #1	G_{mb} Gyro#2	G_{mb} Avg.
2015	1	Troxler 4141	2.468	2.463	2.466	2.313	2.312	2.313
2015	2	Troxler 5850	2.473	2.469	2.471	2.337	2.337	2.337
2015	9	Troxler 4140	2.473	2.467	2.47	2.327	2.314	2.321
2015	9	Pine AFG1	2.461	2.468	2.465	2.321	2.319	2.32
2015		Troxler 4140	2.467	2.466	2.467	2.342	2.345	2.344
2015		Pine AFG2	2.467	2.467	2.467	2.341	2.345	2.343
2015	1	Pine AFG2	2.463	2.459	2.461	2.317	2.307	2.312
2015	2	Troxler 4140	2.464	2.466	2.465	2.325	2.333	2.329
2015	2	Troxler 4141	2.468	2.475	2.472	2.325	2.325	2.325
2015	2	Troxler 5850	2.465	2.467	2.466	2.345	2.341	2.343
2015	5	Troxler 4140	2.478	2.478	2.478	2.324	2.32	2.322
2015	6	Troxler 4140	2.465	2.464	2.465	2.315	2.325	2.32
2015	6	Troxler 4140	2.462	2.466	2.464	2.32	2.327	2.324
2015	6	Troxler 5850	2.465	2.464	2.465	2.315	2.325	2.32
2015	8	Pine AFG2	2.462	2.461	2.462	2.328	2.327	2.328
2015	8	Troxler 4140	2.462	2.461	2.462	2.33	2.328	2.329
2015	8	Troxler 4140	2.462	2.461	2.462	2.332	2.33	2.331
2015	9	Pine AFG2	2.46	2.462	2.461	2.343	2.338	2.341
2015	1	Pine AFGC125X	2.477	2.474	2.476	2.346	2.345	2.346
2015	1	Troxler 4141	2.464	2.463	2.464	2.309	2.304	2.307
2015	1	Pine AFGB1	2.481	2.48	2.481	2.306	2.306	2.306
2015	1	Pine AFG2	2.473	2.474	2.474	2.325	2.322	2.324
2015	1	Troxler 4141	2.471	2.467	2.469	2.304	2.306	2.305
2015	1	Pine AFGB1	2.448	2.452	2.45	2.321	2.32	2.321
2015	1	Pine AFGB1	2.485	2.486	2.486	2.307	2.31	2.309
2015	5	IPC Servopac 2500	2.468	2.473	2.471	2.309	2.312	2.311
2015	5	Troxler 4140	2.469	2.47	2.47	2.327	2.33	2.329
2015	6	Troxler 4141	2.472	2.471	2.472	2.327	2.327	2.327
2015	2	Troxler 5850	2.471	2.473	2.472	2.321	2.319	2.32
2015	5	Troxler 5850	2.469	2.472	2.471	2.333	2.338	2.336
2015	8	Troxler 5850	2.469	2.467	2.468	2.309	2.318	2.314
2015	8	Troxler 4141	2.469	2.472	2.471	2.316	2.313	2.315
2015	6	Troxler 4141	2.472	2.475	2.474	2.319	2.322	2.321
2016	9	Pine AFG2	2.464	2.468	2.466	2.356	2.355	2.356
2016	9	Pine AFG1	2.463	2.468	2.466	2.332	2.343	2.338
2016		Pine AFG2	2.468	2.466	2.467	2.355	2.354	2.355
2016		Troxler 4140	2.469	2.467	2.468	2.331	2.331	2.331
2016	1	Pine AFG2	2.466	2.464	2.465	2.323	2.323	2.323
2016	1	Pine AFG2	2.466	2.464	2.465	2.322	2.332	2.327

Year	District/ CBM	Gyratory Compactor Type	G_{mm} #1	G_{mm} #2	G_{mm} Avg.	G_{mb} Gyro #1	G_{mb} Gyro#2	G_{mb} Avg.
2016	2	Troxler 4140	2.46	2.461	2.461	2.34	2.339	2.34
2016	2	Troxler 4141	2.46	2.46	2.46	2.345	2.349	2.347
2016	2	Troxler 5850	2.468	2.469	2.469	2.346	2.348	2.347
2016	1	Pine AFGB1	2.467	2.47	2.469	2.379	2.379	2.379
2016	5	Troxler 4140	2.466	2.468	2.467	2.332	2.33	2.331
2016	6	Troxler 4141	2.458	2.465	2.462	2.336	2.331	2.334
2016	8	Pine AFG2	2.457	2.458	2.458	2.335	2.344	2.34
2016	8	Troxler 4140	2.457	2.458	2.458	2.337	2.336	2.337
2016	8	Troxler 4140	2.457	2.458	2.458	2.339	2.334	2.337
2016	9	Pine AFG2	2.479	2.481	2.48	2.348	2.344	2.346
2016	1	Troxler 4141	2.455	2.457	2.456	2.331	2.325	2.328
2016	1	Pine AFG2	2.464	2.469	2.467	2.327	2.335	2.331
2016	1	Pine AFGB1	2.47	2.467	2.469	2.32	2.322	2.321
2016	1	Pine AFG2	2.466	2.465	2.466	2.336	2.336	2.336
2016	1	Troxler 5850	2.476	2.475	2.476	2.338	2.333	2.336
2016	6	Troxler 5850	2.453	2.455	2.454	2.322	2.33	2.326
2016	5	IPC Servopac 2500	2.478	2.472	2.475	2.326	2.325	2.326
2016	8	Troxler 4141	2.459	2.458	2.459	2.324	2.326	2.325
2016	5	Pine AFGB1	2.458	2.458	2.458	2.329	2.33	2.33
2016	5	Troxler 5850	2.468	2.47	2.469	2.336	2.337	2.337
2016	2	Pine AFGB1	2.453	2.45	2.452	2.358	2.35	2.354
2016	8	Troxler 4140	2.456	2.461	2.459	2.33	2.333	2.332
2016	6	Troxler 4141	2.47	2.471	2.471	2.321	2.318	2.32
2016	6	Troxler 4140	2.461	2.465	2.463	2.348	2.347	2.348
2016	6	Troxler 4140	2.462	2.464	2.463	2.348	2.347	2.348
2017	1	Troxler 4141	2.488	2.491	2.49	2.333	2.343	2.338
2017	9	Pine AFG2	2.474	2.473	2.474	2.349	2.348	2.349
2017	9	Pine AFGB1	2.469	2.473	2.471	2.369	2.366	2.368
2017		Troxler 4140	2.47	2.475	2.473	2.366	2.366	2.366
2017		Pine AFG2	2.472	2.469	2.471	2.376	2.372	2.374
2017	1	Pine AFG2	2.483	2.478	2.481	2.327	2.337	2.332
2017	1	Pine AFG2	2.483	2.478	2.481	2.337	2.34	2.339
2017	2	Troxler 4140	2.484	2.482	2.483	2.348	2.343	2.346
2017	2	Troxler 4141	2.486	2.487	2.487	2.334	2.338	2.336
2017	2	Troxler 5850	2.489	2.489	2.489	2.347	2.348	2.348
2017	5	Troxler 4140	2.48	2.479	2.48	2.354	2.355	2.355
2017	8	Troxler 4141	2.477	2.476	2.477	2.33	2.329	2.33
2017	6	Troxler 5850	2.475	2.472	2.474	2.349	2.345	2.347
2017	6	Troxler 5850	2.484	2.488	2.486	2.336	2.337	2.337
2017	8	Pine AFG2	2.476	2.474	2.475	2.35	2.351	2.351
2017	8	Troxler 4140	2.476	2.474	2.475	2.347	2.358	2.353
2017	8	Troxler 4140	2.476	2.474	2.475	2.345	2.357	2.351
2017	9	Pine AFG2	2.476	2.472	2.474	2.354	2.352	2.353
2017	1	Troxler 4141	2.475	2.48	2.478	2.391	2.388	2.39
2017	1	Pine AFG2	2.476	2.476	2.476	2.332	2.33	2.331
2017	1	Pine AFGB1	2.484	2.483	2.484	2.33	2.338	2.334

Year	District/ CBM	Gyratory Compactor Type	G_{mm} #1	G_{mm} #2	G_{mm} Avg.	G_{mb} Gyro #1	G_{mb} Gyro#2	G_{mb} Avg.
2017	1	Pine AFG2	2.488	2.487	2.488	2.33	2.332	2.331
2017	1	Pine AFG1	2.483	2.482	2.483	2.35	2.349	2.35
2017	5	IPC Servopac 2500	2.489	2.486	2.488	2.344	2.346	2.345
2017	2	Pine AFG1	2.472	2.475	2.474	2.341	2.347	2.344
2017	5	Pine AFGB1	2.477	2.478	2.478	2.343	2.346	2.345
2017	2	Troxler 5850	2.47	2.478	2.474	2.342	2.342	2.342
2017	5	Troxler 5850	2.476	2.476	2.476	2.35	2.353	2.352
2017	2	Pine AFG2	2.475	2.478	2.477	2.36	2.359	2.36
2017	8	Troxler 5850	2.476	2.479	2.478	2.34	2.344	2.342
2017	6	Troxler 4141	2.472	2.473	2.473	2.361	2.361	2.361
2017	6	Troxler 4140	2.481	2.483	2.482	2.355	2.36	2.358
2017	6	Troxler 4140	2.483	2.484	2.484	2.36	2.357	2.359
2018	1	Pine AFG2	2.438	2.439	2.439	2.327	2.325	2.326
2018	9	Pine AFG1	2.43	2.434	2.432	2.339	2.333	2.336
2018		Troxler 4140	2.447	2.448	2.448	2.333	2.34	2.337
2018		Pine AFG2	2.444	2.445	2.445	2.331	2.337	2.334
2018	1	Pine AFG2	2.455	2.458	2.457	2.309	2.317	2.313
2018	2	Troxler 4140	2.446	2.444	2.445	2.327	2.323	2.325
2018	2	Troxler 4141	2.449	2.446	2.448	2.332	2.323	2.328
2018	2	Troxler 5850	2.444	2.441	2.443	2.327	2.32	2.324
2018	5	Troxler 4140	2.446	2.448	2.447	2.333	2.323	2.328
2018	6	Troxler 4140	2.433	2.432	2.433	2.332	2.336	2.334
2018	6	Troxler 5850	2.433	2.432	2.433	2.33	2.327	2.329
2018	6	Troxler 5850	2.427	2.434	2.431	2.314	2.317	2.316
2018	8	Pine AFG2	2.455	2.453	2.454	2.315	2.309	2.312
2018	8	Pine AFG2	2.455	2.453	2.454	2.314	2.315	2.315
2018	9	Pine AFG2	2.433	2.432	2.433	2.329	2.327	2.328
2018	6	Troxler 4141	2.434	2.442	2.438	2.319	2.315	2.317
2018	1	Troxler 4141	2.455	2.452	2.454	2.29	2.289	2.29
2018	1	Pine AFG2	2.455	2.454	2.455	2.3	2.31	2.305
2018	1	Pine AFGB1	2.448	2.444	2.446	2.305	2.302	2.304
2018	1	Pine AFG2	2.446	2.444	2.445	2.313	2.311	2.312
2018	1	Troxler 5850	2.447	2.446	2.447	2.323	2.327	2.325
2018	5	IPC Servopac 2500						
2018	5	IPC Servopac 2500	2.45	2.448	2.449	2.27	2.28	2.275
2018	8	Troxler 4141	2.44	2.436	2.438	2.322	2.317	2.32
2018	5	Troxler 4140	2.448	2.448	2.448	2.319	2.32	2.32
2018	1	Pine AFG2	2.442	2.437	2.44	2.298	2.291	2.295
2018	5	Troxler 5850	2.43	2.437	2.434	2.329	2.331	2.33
2018	2	Troxler 4141	2.438	2.446	2.442	2.307	2.313	2.31
2018	2	Pine AFG1	2.438	2.449	2.444	2.314	2.315	2.315
2018	8	Troxler 4141	2.456	2.45	2.453	2.323	2.323	2.323
2018	6	Troxler 4140	2.438	2.444	2.441	2.322	2.32	2.321
2019	8	Pine AFG2	2.434	2.438	2.436	2.329	2.336	2.333
2019	5	IPC Servopac 2500	2.447	2.445	2.446	2.304	2.312	2.308
2019	1	Pine AFGB1	2.445	2.449	2.447	2.337	2.334	2.336

Year	District/ CBM	Gyratory Compactor Type	G_{mm} #1	G_{mm} #2	G_{mm} Avg.	G_{mb} Gyro #1	G_{mb} Gyro#2	G_{mb} Avg.
2019	2	Pine AFGB1	2.442	2.447	2.445	2.345	2.344	2.345
2019	5	Pine AFGB1	2.44	2.44	2.44	2.33	2.338	2.334
2019	2	Troxler 5850	2.428	2.436	2.432	2.331	2.329	2.33
2019	9	Pine AFG2	2.436	2.438	2.437	2.348	2.343	2.346
2019	6	Troxler 4140	2.439	2.434	2.437	2.356	2.355	2.356
2019	5	Troxler 4140	2.444	2.439	2.442	2.338	2.342	2.34
2019	8	Pine AFG2	2.434	2.438	2.436	2.344	2.341	2.343
2019	2	Troxler 4140	2.438	2.442	2.44	2.347	2.347	2.347
2019	5	Troxler 4140	2.433	2.435	2.434	2.338	2.346	2.342
2019	6	Troxler 5850	2.439	2.434	2.437	2.337	2.335	2.336
2019	2	Troxler 5850	2.431	2.432	2.432	2.329	2.33	2.33
2019	6	Troxler 4140	2.436	2.436	2.436	2.344	2.344	2.344
2019	5	Troxler 5850	2.446	2.443	2.445	2.341	2.339	2.34
2019	1	Pine AFG2	2.442	2.448	2.445	2.34	2.336	2.338
2019	1	Troxler 5850	2.454	2.455	2.455	2.314	2.321	2.318
2019	5	Troxler 4140	2.428	2.436	2.432	2.353	2.351	2.352
2019	6	Troxler 5850	2.431	2.438	2.435	2.343	2.342	2.343
2019	1	Pine AFG2	2.44	2.439	2.44	2.346	2.341	2.344
2019	6	Troxler 4140	2.428	2.43	2.429	2.341	2.337	2.339
2019	1	Troxler 5850	2.448	2.442	2.445	2.346	2.352	2.349
2019	8	Pine AFG2	2.443	2.444	2.444	2.343	2.349	2.346
2019	8	Pine AFG2	2.436	2.44	2.438	2.332	2.334	2.333
2019	1	Pine AFG2	2.445	2.447	2.446	2.33	2.33	2.33
2019	9	Pine AFG2	2.426	2.431	2.429	2.365	2.35	2.358
2019	9	Pine AFG1	2.432	2.431	2.432	2.344	2.345	2.345
2019	1	Pine AFG2	2.449	2.449	2.449	2.335	2.329	2.332
2019	1	Pine AFGB1	2.451	2.449	2.45	2.316	2.312	2.314
2019	2	Troxler 5850	2.439	2.438	2.439	2.34	2.334	2.337
2019		Troxler 4140	2.444	2.448	2.446	2.338	2.345	2.342
2019		Pine AFG2	2.446	2.443	2.445	2.35	2.351	2.351

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