Development and Implementation of a Highway Construction Quality Assurance Program for the Connecticut Department of Transportation

Phase I – HMA Concrete Construction

Prepared by:
Edgardo D. Block, P.E.
Brian R. Hogge

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Connecticut Department of Transportation
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Office of Research and Materials

Keith R. Lane, P.E.
Director of Research and Materials

James M. Sime, P.E.
Manager of Research

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16. Abstract

In the late 1990's, the Connecticut Department of Transportation embarked on a Quality Assurance (QA) initiative for highway construction. Hot-mix asphalt (HMA) was selected as the first materials area to implement a QA system; this research project began in January 2001. Herein are the results of various technical tasks undertaken to facilitate QA implementation in HMA construction. A series of four (4) focus projects were selected and QA implementation issues were studied over a period of two years. Data analysis has provided guidance in terms of the location of sampling, the sources of variability in the data, the appropriate lot size used for measurement, and a possible effect of material segregation on sampling.

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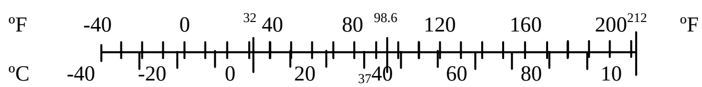
METRIC CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO METRIC MEASURES

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
mi^2	square miles	2.59	square kilometers	km^2
ac	Acres	0.405	hectares	ha
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb.)	0.907	Megagrams	Mg
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	ml
gal	gallons	3.785	liters	l
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		TEMPERATURE (exact)		
ºF	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	ºC

APPROXIMATE CONVERSIONS FROM METRIC MEASURES

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
km^2	square kilometers	0.386	square miles	mi^2
ha	hectares (10,000 m^2)	2.47	acres	ac
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg	Megagrams (1000 kg)	1.103	short tons	T
		VOLUME		
ml	milliliters	0.034	fluid ounces	fl oz
l	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		TEMPERATURE (exact)		
ºC	Celsius temperature	9/5 (then add 32)	Farenheit temperature	ºF



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INTRODUCTION

The Connecticut Department of Transportation (ConnDOT) has identified a need to implement a Quality Assurance (QA) program for highway construction. Though there have been many specific accomplishments in this area, this research project has the objective of "accomplishing a series of technical tasks that will result in the unification of the specific, focused QA implementation accomplishments into a comprehensive QA program for highway construction at ConnDOT, with practical working procedures for field and office personnel."[1]

The project reflects an effort to accomplish progress in several fronts, but most importantly to obtain a comprehensive view of the elements required to implement a philosophy of quality into the work performed by and for this transportation agency.

BACKGROUND

Historical Perspective

Though quality has probably been a concern of all buyers of goods and services throughout history, the implications for industry have come to bear in a different light during the latter half of the twentieth century. This is because producers have recognized the strategic necessity of focusing on quality control in order to meet the expectations of customers and other stakeholders. At the same time, there has been much development

[1] Block, Edgardo. Project Proposal SPR 2230

in quantitative methods of measuring quality through monitoring of “quality characteristics.”

One of the major factors responsible for the industrial success of the United States during World War II was the implementation of statistical process control procedures for manufacturing the arms and equipment required by the war effort. After the war, Japanese industry espoused the quality teachings of Shewhart, Deming, and Juran, and proceeded to implement systems of continuous improvement that allowed them to successfully compete in the global marketplace. At the same time, a focus on profits and productivity in the United States in the 1960’s and 1970’s led to stagnation in the field of quality management.[2] By 1990, Japan was an industrial powerhouse that not only competed but regularly beat the United States in terms of quality at a lower cost for many consumer goods.

In more recent years, the process of globalization has geometrically increased competition in many industries and across many markets. This competition has been recognized as an important factor compelling firms to pursue continuous improvement.[3] Firms in less competitive environments can still achieve higher margins through the improved efficiency achieved with improved processes and products, but globalization is

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[2] Zimmerman, Tim, “Quality Science – A Historical Perspective – Part 1” on the World Wide Web at http://www.msi.ms/MSJ/QUALITY_historical_1_20000603.htm.

[3] Tan, Keah Choon, Kannan, Vijay R., Handfield, Robert B., and Ghosh, Soumen. "Quality, manufacturing strategy, and global competition - An empirical analysis."

driving a paradigm shift where the relative power of the consumer is enhanced.[4]

Industry Perspective

In transportation construction, quality efforts have taken place dating back at least to the 1956 American Association of State Highway Officials (AASHO) Road Test[5] and subsequent focus on highway construction. In Connecticut, Stephens addressed the issue of sampling variability in 1966,[6] while Bowers and Lane implemented a statistical specification for hot-mix asphalt (HMA) construction in 1976.[7] Nationally, as of the 1970's several state agencies were "currently implementing highway-construction specifications based on the principles of statistical quality control."[8] The theoretical essence of quality assurance systems has not significantly changed since that time. Instead, the impetus for implementation of statistical process control and quality assurance programs has been provided by other forces.

Benchmarking: An International Journal, Vol. 7 No. 3, 2000, pp. 174-182. # MCB University Press, 1463-5771. Accessed on the World Wide Web at http://www.emeraldinsight.com.

[4] Aschner, Gabor S. "Meeting customers' requirements and what can be expected," The TQM Magazine, Volume 11. Number 6. 1999. pp. 450±455. Accessed on the World Wide Web at http://www.emeraldinsight.com.

[5] Burati, J.L., Weed, R.M., Hughes,C.S., and Hill, H.S. Optimal Procedures for Quality Assurance Specifications. Federal Highway Administration Report No. FHWA-RD-02-095, McLean, Virginia, June 2003.

[6] Stephens, Jack E. Reduction of Apparent Aggregate Variation Through Improved Sampling. Report No. JHR 66-1, May 1966, Connecticut Department of Transportation.

[7] Bowers, David G., and Lane, Keith R. Implementation of Statistical Specification for the Control of Bituminous Concrete. Report V – Final Report. Report Number 376-5-76-13. Connecticut Department of Transportation, November 1976.

[8] Willenbrock, Jack H. A Manual for Statistical Quality Control of Highway Construction, Volume 1. Federal Highway Administration National Highway Institute, January 1976, Foreword.

Some of these forces are intrinsic to the HMA manufacturing process, while others are external, that is, related to the economic and social environment in which the HMA industry operates.

Industry Forces

The most prominent internal force has been the development of the Superpave mix-design method, a product of the Strategic Highway Research Program (SHRP). Superpave recognizes fundamental engineering properties that the HMA system is designed to exhibit. In turn, this requires an adequate production-control system that allows the achievement of the designed properties. The search for these systems took the form of National Cooperative Highway Research Program (NCHRP) Project 9-7, "Field Procedures and Equipment to Implement SHRP Asphalt Specifications," which focused on developing quality control/quality assurance (QC/QA) testing procedures for Superpave mixes. The FHWA literature states that "By allowing highway agencies to determine if the mix delivered to the job site matches the mix designed in the laboratory, the QC/QA procedures will ensure that Superpave pavements perform as expected."[9]

In addition to Superpave, the reduced availability of raw materials, coupled with improvements in recycling technology, have made the inclusion of recycled asphalt pavement (RAP) a

[9] Federal Highway Administration, accessed January 20, 2004 at http://www.tfhrc.gov/focus/archives/27nchr.htm

reality in the HMA industry. The use of RAP in pavements requires a higher degree of attention to the manufacturing process, since the recycling process is generally more difficult to control—especially with respect of mixing and blending of the asphalt binder, as well as the milling operation itself—resulting in greater variability. The use of RAP, then, has reinforced the importance of statistical process control for HMA production.

Additional impulse for quality assurance programs has come from the Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), and individual state and local transportation agencies, all of which, recognizing the value inherent in total-quality-management systems, have made significant contributions to QA implementation in terms of resources, guidance, and support of research in the area.

External forces

One of the most important external factors propelling the implementation of quality assurance programs has been the increased competition for taxpayers' dollars among the various functions of government, as health-care, education, and defense spending and cost have increased over the past three decades. This, coupled with improvements in management science, has resulted in non-profit agencies[10] seeking out ways to maximize the efficiency in the use of funds. The new initiatives have ranged from the use of management systems to staff reductions and the outright privatization of some of the functions related to the maintenance of the transportation infrastructure.

Additional impulse for quality-management initiatives came from the successful implementation of total quality management (TQM) in the manufacturing industry, providing firms competing globally with strong positions in the global marketplace for manufactured goods. TQM concepts are pervasive throughout the production and even services industry, in the form of lean production (true just-in-time) systems and six-sigma processes. The transportation construction industry’s TQM initiatives have taken the form of the National Quality Initiative (NQI).

The last major factor is the rapid advancement of information technology, which has made statistical process control more feasible as the processing capability and connectivity required to manage the flow of data becomes ever more accessible to everyone involved in the production process. Whereas at the time of Juran and Shewhart statistical process control would require exhaustive computational resources, the advent of the personal computer and spreadsheet software has made the required effort much more cost-effective in terms of computational resources. Computer networks, the Internet, and the Global Positioning System (GPS) are all providing solutions to some of the most difficult challenges facing implementation of QA programs.

[10] Drucker, Peter. Management.

Key Implementation documents

The key documents that guide QA implementation[11] are the 1992 NQI report entitled "National Quality Improvement Task Force Report on Quality Assurance Procedures for Highway Construction," a high-level document which defines the vision and lays the groundwork for the structure necessary to support efforts to achieve the vision; Federal Regulation 23 CFR 637B, "Quality Assurance Procedures for Construction," which translates the vision to a concrete objective and action steps—such as requiring the implementation of quality-assurance programs; and, the more specific "AASHTO Implementation Manual for Quality Assurance," which delineates a recommended structure of the quality-assurance program itself.

Problem Statement

Given that the implementation of a Quality Assurance program is a desired Connecticut Department of Transportation (ConnDOT) goal, this project deals with the completion of technical tasks that are necessary for QA implementation, specifically in the area of HMA construction. Guidance for the specific tasks was obtained from the key issues facing the State's HMA Task Force for Pavement Improvement, in particular the QA Development section. The selected approach was to employ focus projects on which QA implementation issues were studied. The activities have been categorized as preparatory activities,

[11] Cooper, Stephen, and Block, Edgardo. Quality Assurance Implementation PowerPoint Presentation.

focus-project field activities, and analysis and recommendation (post-execution) tasks.

Key Theoretical Considerations

Even though the techniques of quality management are quantitative in nature and quite mathematical, the central issue of quality management remains a philosophical one. This is because continual improvement requires a focus on quality from all participants and conviction and perseverance in the pursuit of the quality goal. The motivation for this focus on quality is dependent to a large extent by the customer-producer “power” relationship in the market for each particular product. Groocock[12] posits that combinations of strong producers and weak consumers tend to incorporate quality initiatives as internal quality-improvement programs, whereas weak producers and strong consumers have customer-defined quality-assurance programs as the driver behind efforts to improve product quality.

Examples of strong-producer, weak-customer product markets include the services industry (telephone and cable companies) and the retail automobile market. The most extreme cases are markets served by a monopoly; examples listed by Groocock include government agencies such as tax-collection and social security agencies. In these situations the customer is left to the “mercy” of the supplier, and has been dubbed by the same author as a “patient.”

[12] Groocock, John. The impact of powerful and weak customers on

Examples of strong customers include automobile manufacturers and government defense agencies. Suppliers have little choice but to meet requirements set by the customers if they are to participate in the market. In fact, the seminal document in the development of most government QA programs MIL-Q-9858A “Quality Program Requirements,” which the USA's Department of Defense imposed on its suppliers in 1963.

In the case of Connecticut HMA production, the power relationship is not clear-cut. Groocock defines the following three requisites of a “strong customer:”

1. The customer must have an excess of suppliers having the capability to meet its requirements. If this is not the case and it applies the sanction of rejecting bad product it will find it lacks supplies. Also, it will not be able to transfer its business from an unsatisfactory supplier to a better one.
2. The customer must buy from each supplier enough of the latter's turnover for the threat of its applying its sanctions to be taken seriously by the supplier.
3. The customer must have the technical and other capabilities to carry out its part of the quality system it imposes on its suppliers.

The only clear requisite met by the transportation agency is the second one. The Connecticut Department of Transportation is the single largest customer for HMA for all major producers in

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quality assurance systems and quality improvement programs, The TQM the state. This research effort represents an attempt to make progress in the third requisite. A more detailed and focused effort is needed to determine if the first condition is met. Perhaps a more apt description of current conditions is that the customer is a "potential strong customer;" with implementation and enforcement of a QA program, it is possible that a quality-assurance system could provide the checks and balances needed to make improvements in HMA quality. However, if all three conditions are not met, it is reasonable to suppose that quality improvement is likely to require active cooperation from the suppliers in the form of quality-improvement initiatives.

Ultimately, the success of the QA program will be as much a function of the expertise put into it and knowledge gained from it as it will be a function of the robustness of the measurement techniques, testing schedules, and enforcement. We thus return to the central theme of QA implementation: the success of the effort hinges on the continued commitment by all stakeholders to the pursuit of continual quality improvement.

The more traditional question about a QA program is its costs and benefits relative to existing systems. The question centers around the apparent paradox that by transferring responsibility to the producer, there is no reduction in the amount of effort required of the consumer—the transportation agency. While this is a valid observation of fact, it is not so obvious why a working QA system should be compared to existing

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Magazine, Vol. 12 No. 6, 2000, pp. 372-388.

systems that may or may not provide the same level of assurance for the quality of the material, unless the risks, to both producers and the customers, are taken into account. Any increase in the quantity of testing has to be measured against the risk of not having sufficient measurements and its effect on the duration of the pavement or on underpayment of a quality mix.

Management Buy-In

One of the keys for success of a QA program is the commitment from upper management of all parties involved, in industry as well as the agency. In order to do this, the first major task of the project was to develop an informational presentation and present it to ConnDOT top management in order to obtain its approval and commitment. The presentation, which took place on May 31, 2001, resulted in the formation of a QA Steering Committee to oversee the process whereby Industry participants would be brought into the QA implementation process. The Steering Committee identified industry buy-in as a major key in the success of QA implementation, and determined that an informational seminar should be held for Industry and State personnel, and that periodic training should take place to maintain a reasonable level of awareness among system participants.

Training

Realizing the importance of training and as a result of the recommendations of ConnDOT management, a one-day informational seminar was conducted in September, 2001, open to Industry and State personnel where major QA concepts would be introduced and a survey would be distributed to participants. The seminar, including presentations from FHWA, State DOTs, and Industry, was well-attended and well-received. The survey and summary of responses are included as Appendix X.

Subsequent to that session, periodic training has been conducted for State and Industry personnel using a variety of forums: The HMA Task Force Annual meeting—attended by State and Industry personnel--and special presentations that took place at winter training sessions for ConnDOT Project engineers and inspectors.

Literature Review and Major Project Questions

A review of the literature raised issues regarding the values that are to be used to control the system. It became apparent that data comparison issues would be important. Data comparisons are affected by variability, equipment, personnel, sampling methods, and a variety of factors. One of the surprising findings regarding sampling was the large number of states that sampled HMA at the point of placement. The importance of this point is that the sampling location has a bearing on the ability to obtain a random sample and the amount of variability that is taken into account.

Another important issue for continual improvement is the feedback cycle from in-service pavements. This cycle is necessary in order to establish a quantitative link between quality characteristics measured at the time of construction and the subsequent in-service pavement performance. Since most project data are collected with a different focus, namely, to execute the work and make payment, a study of the formatting issues and work procedures was deemed necessary.

At the same time, there were specific questions regarding statistical process control issues, which are listed below.

1. Lot size definition
2. Number of samples required per lot (how to arrive at the required number of samples to manage risk)
3. How to determine “default” or population values to use for process variance.
4. What effort is required (and at what cost) to perform QA activities on each project.

Additional recurring themes in the literature review included

- the difficulty in implementing quality-improvement programs in the construction industry in general
- The importance of partnering in achieving success in a QA program
- The importance of organizational commitment to QA in achieving QA implementation success.

Research Project Approach: Focus Projects

In order to study the issues of QA implementation identified above, a focus-project approach was selected. Focus projects were to be places of observation and measurement of the specific issues, and a test-tube environment in which to analyze how QA specifications and control systems could be put into place. The criteria for selection of potential projects were the following:

1. Number of focus projects that is manageable for project resources.
2. Cover a significant range of possible implementation conditions.
3. Cover projects of sufficient production quantity to allow for the study of quality characteristics over time.

Based on this criteria, a total of four (4) Focus Projects were selected, to be completed over a span of two years, at a rate of two (2) per year.

The purpose of material sampling was to answer the following key QA implementation questions:

1. What is the aspect of a QA specification that is most critical and likely to bring out more issues?
2. What is the optimum lot definition that should be used for quality monitoring?
3. What is the testing frequency that should be used to assess the quality of the material and manage the Contractor’s and Agency risk?
4. What will be the data-comparison issues selecting different sampling methodologies?
5. What aspects of HMA production contribute most to process variability?

6. What is a feasible method of determining system variability for each project? Does this have to be done for each project or is this something that can be done on a less frequent schedule?

Four data sets, obtained in parallel, were available to address these questions. The first data set comprised the tests results of samples obtained as part of the quality-control process (standard operating procedure). These tests were performed at the field laboratory by ConnDOT personnel or, in one case, by Contractor personnel responsible for QC. Every time that material was obtained for a QC test, additional material was obtained for performing the same tests at the central laboratory. This made up the second data set, and is referred to as the "Plant Split" sample set. The third data set was a random sampling procedure from the truck at the plant. The fourth data set was obtained in the field, behind the paver, following a prescribed random sampling plan. This data set is described as the point-of-placement, or "POP" Sample set.

Areas of Focus

A Quality Assurance system consists of all elements necessary to ensure that the quality of a product or service is acceptable to the customer. The NETTCP program identified seven key elements of a QA program: Quality Control (QC), Acceptance, Independent Assurance (IA), Laboratory Accreditation, Personnel Qualification, Dispute Resolution, and Partnering.

Quality control: Defined as "The sum total of the activities performed by the seller (Manufacturer, Producer, and/or Contractor) to make sure that a product meets contract specification requirements."[13]

Acceptance: Acceptance is the responsibility of the customer (the transportation agency). The Agency Acceptance system will include:

a) Monitoring the Contractor's QC activity,
b) Acceptance sampling and testing, and
c) Inspection.

Conceptually, "the Acceptance system defines a set of rational procedures to be used by the Agency to determine the degree of compliance with contract requirements and the value of the product delivered by the Contractor."[14]

Independent Assurance (IA): Defined in federal regulations as "Activities that are unbiased and independent evaluation of all the sampling and testing procedures used in the acceptance program."[15]

Laboratory Accreditation: Under the federal regulations, all Agency central laboratories are required to be accredited through the AASHTO Accreditation Program (AAP). In addition, non-Agency laboratories performing sampling and testing for either Independent Assurance or Dispute Resolution must be accredited through AAP. All laboratories involved in the acceptance program must be qualified.[16] The federal regulations specify minimum requirements for qualification, but the Agency is responsible for defining "qualification" and establishing a program that meets those requirements.[17]

Personnel Qualification: The federal regulations require that personnel involved in the acceptance or IA program must be "qualified."[18] Each Agency can define appropriate qualification programs.[19]

Dispute Resolution: Defined as a "Formal procedure used to resolve conflicts resulting from discrepancies between

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[13] From "Quality Assurance Guide Specification" Section QA-100 – Definitions. A Report of the AASHTO Subcommittee on Construction, February 1996.

[14] From "NETTCP – Quality Assurance Technologist Certification Course, Pilot Course - February 13-15, 2001." Participant book developed by the New England Transportation Technician Certification Program, Sec. 2.4.

[15]23 CFR 637.203. Available on the World Wide Web at http://a257.g.akamaitech.net/7/257/2422/10apr20061500/edocket.access.gpo.gov/cfr_2006/aprqtr/pdf/23cfr637.203.pdf.

[16] 23 CFR 637.209. Available on the World Wide Web at http://a257.g.akamaitech.net/7/257/2422/10apr20061500/edocket.access.gpo.gov/cfr_2006/aprqtr/pdf/23cfr637.209.pdf.

[17] 23 CFR 637.203.

[18] 23 CFR 637.209.

[19] 23 CFR 637.203.

the Agency's and Contractor's results of sufficient magnitude to impact payment."[20]

Partnering: "A formal, organized method of improving communications on a project; it seeks to minimize disputes and claims, and established a shared commitment to solve problems in a manner that is timely and cost-effective."[21]

A detailed discussion of each element is included in the QA Manual.[22] The following is a discussion of each only as it affects project tasks and findings.

Quality Control (QC)

QC is the role of the producer. The major QA implementation issue for the accepting agency is whether or not to combine contractor's QC data with Acceptance data for payment purposes. This complex question touches on the following issues:

1. Equipment used,
2. Personnel qualification,
3. Timeliness of response, and
4. Dispute resolution issues.

This research project included training activities that highlighted the importance of process control for successful QA implementation. At the same time, actual process-control activities are beyond the scope of this research. For instance, the proper procedure for crushing aggregate is only known to the

[20] From "Quality Assurance Guide Specification" Section QA-100 – Definitions. A Report of the AASHTO Subcommittee on Construction, February 1996.

[21] From "Quality Assurance Guide Specification" Section QA-100 – Definitions. A Report of the AASHTO Subcommittee on Construction, February 1996.

[22] Block, E., and Hogge, Brian. Quality Assurance Manual. Connecticut Department of Transportation, 2004.

aggregate producer, while the method and frequency for checking aggregate gradations as the material is being stockpiled for later use are the purview of the HMA producer. From an Agency standpoint, the emphasis on QC activities should be in raising awareness. It is incumbent on the producer to implement internal systems to improve quality, especially in its own productions and up the supply chain.

Acceptance

This is the heart of the QA implementation field project activities. The major issues that the customer (in this case, the Transportation Agency) are likely to face are:

1. Selection of appropriate quality characteristics,
2. Lot definition,
3. Data comparison methods,
4. Data management, and
5. Risk management (size and number of samples required).

This research project addressed this issue through collection of a large amount of data, on selected "focus projects," data that can be used to find out some of the key numbers that must be available for the agency to implement a QA system, namely: How the agency comes up with an appropriate number for "historical" variance for a particular project or mix; how the agency determines the sampling and testing schedule; and how QA specifications are developed, modified, and improved. By obtaining material beyond that required for current requirements, the effect of sample size on material quality can be examined.

Independent Assurance

Independent assurance issues were addressed by collecting additional material from the plant at the time of QC data collection. These samples are in essence split samples (from the same truck) and the equipment and personnel issues can be observed in the data.

Laboratory Accreditation

Laboratory accreditation is outside the scope of this research. The Connecticut DOT Central laboratory is accredited through AAHSTO, as are laboratories used for Acceptance and Independent Assurance purposes; QC laboratories are qualified through the Department's qualification program.

Personnel Qualification

Through NETTCP, all QA personnel, both from the Contractor as well as the State perspective, are NETTCP certified. This is how the Connecticut Department of Transportation has defined QA personnel to be qualified (as required under the federal regulations.)

Dispute Resolution

Dispute resolution language, developed by the HMA Task Force's QA Development section and contained in the QA Manual, was reviewed. In this research effort, sufficient data sets have been collected to simulate the probability of disputes as well as the ability of a dispute-resolution mechanism to resolve them. Because time spent in dispute resolution is time taken away from focusing on quality, it is incumbent on the designers of the system to design a system where the opportunity for disputes (due to data discrepancies) are minimized.

Partnering

Although used for other construction-project activities, partnering concepts are difficult to envision if an adversarial relationship exists between the customer and the producer. Because of the numerous opportunities for conflict – data differences, competing interest – between the producer and customer, partnering must have as a minimum objective to avoid situations where these discrepancies impede the achievement of the highest quality possible. Quality improvement is not likely to occur unless everyone involved is focused on improving quality.

Attribute sampling plans vs. variable sampling plans

For most intents and purposes, HMA manufacturing does not result in discrete units produced (beyond a lot of asphalt). Instead, there is a continuous flow of material each time the plant is started. Process control for this type of production requires sampling plans by variables as opposed to sampling plans by attributes. This, in turn, makes the statistical analysis more difficult.

Quality Characteristics

Although quality initiatives recognize that specifications should be related to performance, there is an insufficient body of knowledge in this field to make a definitive link. Moreover, the mere breadth of meaning in “performance” makes “quality” become an intangible property of the constructed material. For instance, in terms of HMA, quality has at least a stiffness dimension, a serviceability dimension, a durability dimension, and a workmanship dimension.

Due to the difficulty in defining and quantifying quality, surrogates are normally used. These are quantitative measures of some variable or group of variables which, based on engineering judgment and experience, are believed to affect the “performance.” These measures are called “quality characteristics” and are the yardsticks used to assess quality. In this framework, quality is degree of proximity to a target value and uniformity of construction. The reader is referred to the appended Quality Assurance Manual for a discussion of specific terms and definitions associated with QA systems and programs.

Some quality characteristics are related to the engineering design parameters of the material, while others are related to the workmanship of the construction. In HMA materials, quality is normally measured in terms of three broad characteristics: Mix volumetrics, placement, and smoothness. Placement quality refers to the degree of compaction, appearance and degree of compaction of the joint, thickness uniformity, and material segregation. There is currently much work being completed at ConnDOT to revise compaction specifications, and consequently these data are not emphasized in the study.

By the same token, research into measures of smoothness has brought out limitations in the types of specifications that can be reliably implemented. The format of Connecticut DOT specifications is an end-result specification with incentives and disincentives. Because of the difference in specification type with respect to classic QA specifications, measures of smoothness are not emphasized in the study.

Given that the relationship between the quality characteristics and performance has not been established to the degree that would allow for quantitative measurement of the contribution of each variable, it is important to accumulate pavement in-service data in order to arrive at that definitive relationship and identify the most effective quality characteristics to measure at the time of construction. In essence, there needs to be a mechanism to feed in-service performance back into the QA program. At present, however, construction data are stored in a format basically incompatible for long-term retrieval unless there is additional data collection in the project. This is cumbersome for inspectors and project engineers who have to remain focused on the proper acceptance and payment for work done in those construction projects.

At the same time, since acceptance data have to be provided to the contractor and QC data to the Agency, there is a need to account for all samples collected and to quickly report the gathered data in order to respond to any quality issues that may arise.

Data needs include the storage of process-capability data and specification-performance data. That is, there needs to be a mechanism for evaluating how well producers are able to meet the requirements of the customer (Agency) and what values are reasonable to use as defaults or “historical” values when evaluating constructed jobs in terms of Percent Within Limits (PWL) and other QA requirements.

The discussion above highlights the need for a focus on a data-management system for QA implementation, regardless of the material being considered. In fact, there are many issues that transcend the specific industry or material being studied. These have to do with procedures for comparing data, methodology for specification modification, and data management activities. Much work remains in this area for a fully-operational QA program and progress in this aspect results in great value added, the research project focused on these aspects of QA implementation.

For this investigation, and following traditional HMA practice, quality characteristics were those included in Table 1 below.

SPSS Variable	Description
p200	Percent passing the #200 sieve, by weight

p100	Percent passing the #100 sieve, by weight
p50	Percent passing the #50 sieve, by weight
p30	Percent passing the #30 sieve, by weight
p16	Percent passing the #16 sieve, by weight
p8	Percent passing the #8 sieve, by weight
p4	Percent passing the #4 sieve, by weight
p3_8	Percent passing the 3/8" sieve, by weight
p1_2	Percent passing the 1/2" sieve, by weight
p3_4	Percent passing the 3/4" sieve, by weight
bit	Percent binder by weight
gmm	Maximum theoretical specific gravity
gse	Aggregate effective specific gravity
va	Percent air voids
vma	Voids in the mineral aggregate, percent
vfa	Percentage of voids filled with asphalt

Table 1 – List of quality characteristics used.

Once the quality characteristics have been determined, quality is measured in terms of deviation from target values—the engineered material—and in terms of process capacity to maintain uniformity around the target values.

Conformance to a target value

Conformance to the target, or design, value, is traditionally measured by a specification, which may have one or two limits. In a QA system, however, conformance to the target acquires additional importance, as any deviation, even within the specification range, implies a higher probability of a lower percentage of production falling into the specification limits.

Uniformity of production

The actual percentage of material within specification limits is estimated by examining not only the target value but also the uniformity as expressed by the standard deviation of the material.

Reduction in variation

Given that we must meet target values, one of the main objectives of a QA program is to obtain a homogeneous material; in practical terms, this is equivalent to reducing the variability of the product.

Sources of Variability

Product variability (as observed in a measurement) has many components and dimensions. For analysis purposes, it is convenient to select a perspective that is congruent with the objective of the quality assurance program and with the particular role of the individual within that program. Naturally a producer will be interested to measure process variability as far upstream as possible; doing this gives the producer the most opportunities to correct problems long before they become acceptance issues, and provides the greatest degree of control over the process and the product. The customer, on the other hand, will desire to measure material variability as close to the end of the process as possible in order to minimize his or her risk of paying for more quality than is present. Measuring variability of the material for acceptance at the end of the process makes the system transparent and clears up the responsibilities of each party. Figure 1 shows the major components of the HMA production process from a QA perspective. There is material variability, production variability, sampling variability, and testing variability.

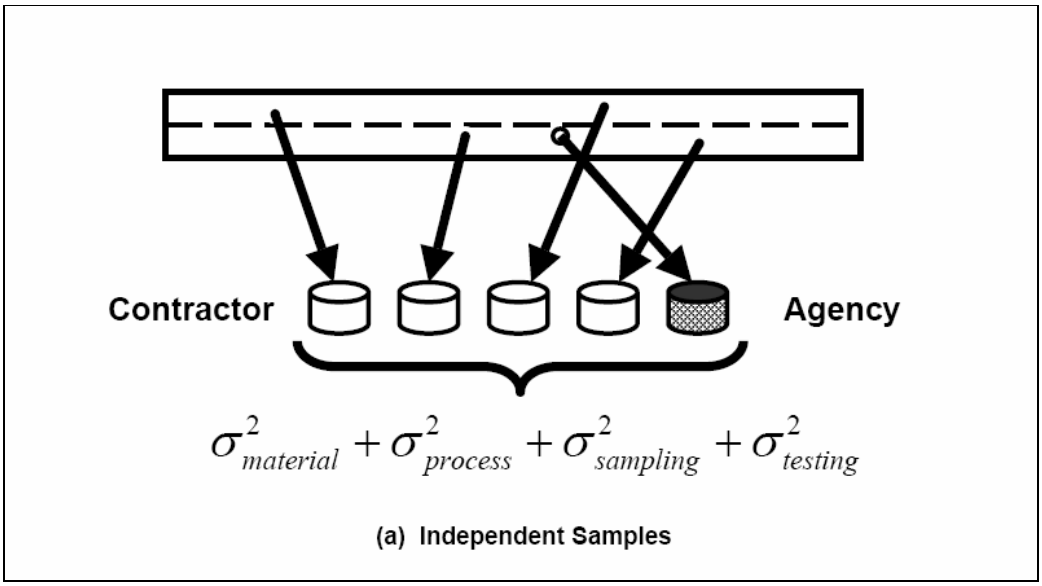

Figure 1 – Sources of variability included in samples taken at the point of placement.[23]

Three of the four components of variability listed in Figure 1 are present regardless of the point of sampling. However, the process variability taken into consideration depends on the point of the production process at which samples are obtained. Figure 1 represents the major components of process

[23] Burati, J.L., R.M. Weed, C.S. Hughes, and H.S. Hill, Optimal Procedures for Quality Assurance Specifications. Publication No. FHWA-RD-02-095, June 2003. U.S. Department of Transportation, Federal Highway Administration, McLean, VA, p. 46.

variability. They include the feeding, mixing, and conveying variability at the plant, and the transporting and placing variability on the road. It is important to note that the pavement that is finally accepted is subject to all variability in the process.

The sources of material and process variability should all be the focus of the producer, which aims to minimize its risk of manufacturing at less than optimum quality.

Material variability can be addressed by placing stricter specifications on the raw materials and conducting inspection as the materials arise. The producer can manage raw-materials inventory size in order to maintain control over the variability of the inputs and adjust accordingly. Material variability should be measured at the point furthest upstream of the manufacturer’s continuously controlled production process. This means that if aggregate gradations are taken on a particular stone used for the mix, they can be used with confidence in characterizing the gradation of the resulting mix.

Process variability should be measured as materials enter the production facility and as soon as they leave. For an HMA plant, this means checking belt gradations and sampling from the truck before the truck leaves the plant. Handling and placement variability can be measured by taking a measurement after the material has been subjected to the placement process and comparing to the variability as the material left the plant.

The variability of the in-service material is the property on which the customer desires to base his or her payment. Therefore, the best point at which to measure variability is after placement. However, since this requires time-consuming and testing that may disrupt the paved mat, the next best thing is to measure variability as close to the end of the process as possible.

In recognition of this fact, many state highway agencies where QA programs have been implemented employ “behind-the-paver” sampling, which in this project is referred to as point-of-placement, or “POP” sampling. Since ConnDOT traditional practice has been to sample at the plant (to fulfill its process-control responsibility in a method-specification control system), one of the tasks of this study was to develop and test a POP sampling procedure that could be used for acceptance purposes, and to compare this procedure to current ConnDOT procedures. The issues that arise when comparing POP sampling versus sampling at the plant (from trucks) are discussed in a separate chapter.

Sampling Location: POP Sampling and Truck Sampling at the Plant

Sampling from a truck at the plant is the current standard practice at the Connecticut Department of Transportation. POP sampling is done after the paver distributes the HMA mat and before compaction takes place. The following section compares the benefits and challenges of each sampling arrangement.

Sampling at the Plant

Advantages

- Speed. This relates to both obtaining a sample as well as providing the shortest turnaround of data for quality-assessment purposes. There is essentially no delay from the time a sample is taken to the time testing commences.
- Convenience. The inspector does not have to move far to find the next location for the sample. The job of selecting a truck to sample is limited to monitoring the sequence of trucks.
- Safety. Although there are safety risks in obtaining a sample from a truck at the plant, the time spent in a workzone with heavy equipment is limited to that necessary to obtain a sample.
- No reheating required. Since the test is performed immediately after the sample is obtained, there is no need to reheat the sample, a time-consuming process and one which subjects the binder to additional curing time. This project examined the issue of curing time and a significant effect on some volumetric properties was observed at long curing times, although the effect can be accounted for easily.

Disadvantages

- Randomness. The most fundamental disadvantage of sampling at the plant is that, with existing equipment and procedures, it is difficult, if not impossible, to perform random sampling. Random sampling, in turn, underpins any quality-assurance program. In order to overcome the impossibility of giving every section of the truck load an equal chance of being sampled, specialized equipment to reach all sections of the truck load must be developed. With the inspector obtaining the sample, it is possible to sample only a small section of the load, in discrete locations, which results in a small portion of the material with a disproportionate chance of being sampled, and larger portions that have little or no chance of being sampled.

- <u>Measurement of Process Variability.</u> Samples obtained at the plant do not experience the same treatment as those that are laid down on the pavement mat. After the truck leaves the plant, the HMA travels to the job site at a temperature that, though falling, is still close to the temperature at the plant. This induces additional curing of the asphalt and some movement of the material. Subsequently, the HMA is transferred to a paver or a paving train with a material-transfer device, drops into a hopper and is augered and then screeded onto the pavement surface. This is not accounted for when sampling HMA from a truck at the plant.
- <u>Sequential sampling.</u> Current procedures use sequential sampling, that is, a test is completed before HMA is sampled again. A considerable amount of time elapses between two sampling events. If sampling is done

independently of the testing, then the curing-time issue may become significant in the case of long curing times.

Sampling at the Point of Placement (POP Sampling)

Sampling at the point of placement has several advantages over other types of sampling. On the other hand, there are additional issues to consider if this type of sampling is to be used for acceptance purposes.

Advantages

- Measurement of Process Variability. Most of the process variability is included in the sample. It is the location closest to the end of the placement process, so that material, handling, production, and placement variability are all accounted for.
- Randomness. The sampling procedure gives any portion of the HMA produced an equal chance of being sampled.
- Availability of sampling personnel. The sampling can be carried out by Contractor personnel under the observation of the Agency inspector and after training. This reduces the need for materials-testing personnel in the field, though increases the need for personnel at the laboratory charged with conducting sample testing. The increase in laboratory personnel responds to the probability of one plant producing HMA for more than one project, where the variability introduced after the trucks leave the plant—through hauling and placement conditions and techniques - may vary among projects. In this case, the sample size

must be sufficiently large for each project (as opposed to a plant lot covering more than one project.)

- Laboratory location. The sampling method makes the laboratory location independent of the sampling location. Accordingly, production (sample processing and testing) rates can be higher if samples are sent to a high-production laboratory and highly-controlled equipment is used to run all samples from different jobs.
- Location-referenced representation of as-built properties. The sample obtained represents conditions on the road surface. Furthermore, if the sample is geo-referenced it is simple to retrieve materials data to explain either exceptional or poor performance, and to identify whether the sample data is indicative of the HMA material properties or whether there was error in sampling or testing.

Disadvantages

- Disruption of the in-place material. The process is “dirtier.” The mat has to be disrupted, however slightly, to obtain material from the road surface.
- Safety. Although Contractor personnel on the paving operation could obtain the sample, if Agency individuals have to do it this introduces a level of complexity into the sampling procedure. Research-project personnel were able to safely conduct the testing, but training and communication are important to stay safe.

- Re-heating. Since the lab is not at the same location, samples have to be subjected to a period of re-heating. This induces additional curing of the asphalt and can affect the maximum theoretical gravity as well as bulk specific gravity of the mix if the curing time is extensive. This could be alleviated if HMA hauling trucks are used to send the material back to the plant for testing immediately after they are obtained.
- Sampling intensity. Sampling at the plant allows for material being sent to more than one paving job to be part of the same plant lot. When sampling behind the paver, variability introduced after the trucks leave the plant may vary among projects (based on hauling distance, placement equipment and personnel, and various other conditions); therefore, when a plant is producing material for more than one project, additional testing is required in order to make an appropriate assessment of mix uniformity.

Lot definition

This is the unit quantity on which payment is made. It is assumed to be a homogeneous unit of material. The quality characteristic is measured with a test or a set of tests and the underlying population distribution is used to estimate the percentage of material within specification limit or limits. Lot definition is determinant in defining the frequency of sampling. In the HMA industry, lot definition typically takes on three major forms: by quantity placed, by time unit, or by project completed. Of these three, the quantity placed is the most arbitrary, since there is no process basis on which to support the decision to end and start a lot. In contrast, each project generally requires a mix design—which means a difference in material quantities from project to project, and there are climatic and process conditions that could change from day to day or week to week, where it is reasonable to assume a higher probability of a process change than a certain quantity of material produced. In addition to these lot-breaking points, provisions are usually made to terminate and begin lots when there are changes in the mix. This is probably the most logical lot-breaking criterion, but its successful implementation requires prompt communication of mix-design changes in order to ensure appropriate sampling rates for the last lot before the change and for the new lot.

All else being equal, the number of samples required decreases with larger lot sizes. The tradeoff is lowered responsiveness to those quality problems that may develop, since the time between tests and the reporting of data for a production lot is longer. The effect of lot definition on payment diminishes with a higher capability of the producer to maintain consistency in the manufactured product. This project examines the effect of different lot sizes on the measurement of uniformity of the material. In general, larger lot sizes should be considered once the capability of a producer has been well established, i.e., when the producer demonstrates that it can correct variation issues through process control checkpoints and acceptance is not affected.

Data comparison issues

Unless the producer is relying entirely on process-control and acceptance information provided by the Agency, it is likely that at one point or another there will be a discrepancy in the lot data used for acceptance and the data used for process control. The potential for discrepancy is positively correlated with sample size, number of sampling locations, number of testing methods, number of quality characteristics, and mix variability. The potential for discrepancy is inversely related to personnel and equipment proficiency and/or calibration.

Increasing the sample size can result in a data discrepancy yet not indicate process-control problems. Increasing the sample size only reduces risk of inaccurate quality-level measurement. The price for this risk reduction is that smaller data differences can be detected with larger sample sizes, for a given level of variability in the material. If the producer has control of its process, these data discrepancies will be sufficiently small so as not to impact payment.

Comparing data obtained from different sampling locations (along the production process) can cause data discrepancies because of the additional variability contained in the later measurement. For instance, POP sampling measures more of the process variability than plant sampling. The variability may be larger than that observed at the plant if no variability-reduction measures are taken downstream in the production process, or smaller if such measures are taken. For instance, Material Transfer Vehicles (MTVs) are often used to re-mix HMA prior to placement and increase uniformity. In this case, the POP variability could conceivably be lower than the variability of samples obtained at the plant.

The number of testing methods may result in data discrepancies, especially with respect to variance. For any quality characteristic, therefore, it is advisable to standardize the testing methods used to measure that quality characteristic.

Larger numbers of quality characteristics present a correspondingly higher number of data checkpoints where a data difference can be observed. Although appropriate apportioning of payment incentives/disincentives can reduce the impact of these discrepancies, the system is more complex to manage and the data-discrepancy resolution process becomes more cumbersome. Given that many potential quality characteristics are not independent of each other, care should be taken not to select many overlapping characteristics. Examples of these characteristics include some sieves, and overlapping volumetric properties. Those characteristics that go the furthest in describing the actual in-place behavior of the HMA should be prioritized. Examples include level of compaction, smoothness, and other volumetric properties that have been shown to at least theoretically relate to in-place performance.

Larger mix variability itself may cause data discrepancies. Ultimately, the goal of the QA program is to reduce mix variability as much as possible. It is important to identify data discrepancies arising from larger mix variability and to resolve them. There is little that can be done to reduce this kind of data discrepancy beyond reducing mix variability, and, in fact, this is the focus of the QA program.

A data discrepancy need not result in a data dispute, especially if it does not impact payment. Stated otherwise, there needs to be a decision that relates the practical significance of a difference in two sets of data to the payment schedule. With large sample sizes, small data differences can result in rejection of the null hypothesis that the means or variances of two samples are equal. Some of these small data differences, however, may be insignificant in practice. Regardless, the occurrence of a data discrepancy should result in an investigation of root cause, because it can pinpoint potential problems that, if unchecked, may eventually lead to data differences that have a significant impact on quality and, consequently, in payment.

Opportunities for data disputes

Data disputes usually arise between the producer’s QC data set and the agency’s Acceptance data set, when the discrepancy is sufficiently large to impact payment. However, data discrepancies can also be identified through the IA program and cause disputes with respect to whose personnel and equipment are off. These IA discrepancies should always be addressed quickly so that any QC vs. Acceptance disputes can be ascribed to factors other than personnel or equipment.

Percent Within Limits (PWL) analysis versus traditional Job Mix Formula (JMF) tolerance

One of the most difficult QA concepts to assimilate for producers and agencies is the relationship between test results and conformance to specification or tolerance limits. Systems where PWL is used consider the variance (standard deviation) of the sample to describe the variance of the product. It is possible to have all tests fall within specification tolerances but the PWL to be less than 100%. The PWL is related to mix variability and sample size. It is important to control both the agency as well as the producer’s risk of an “inaccurate” measurement of quality level so that everyone has confidence in the results. In this project, PWL results were compared for varying lot sizes. In QA systems, PWL is used to determine the quality level and the payment level.

Split Samples (Independent Assurance)

Split sampling provides an opportunity to isolate variability in test results that is due to equipment and personnel. Differences in IA data should be resolved quickly so that these two variables are promptly eliminated as adversely affecting the characterization of the quality level of the product. This project proposed to study this issue through collection of split samples of the material used for QC tests at the plants. The samples were analyzed to find which corresponding quality characteristics were most likely to be impacted.

Dispute resolution simulation

Scenarios of dispute based on test data discrepancies can be simulated by collecting multiple data sets, tabulating the instances where data discrepancies arise, and applying a proposed resolution mechanism. In this research three data sets were collected independently for each focus project: QC samples, independent plant samples, and POP samples. The quality characteristics measured were the various gradation parameters and the binder content. Independent plant samples were not tested for volumetrics, given the large number of samples and limitations on the physical ability of the laboratory facilities to hold all material for the complete battery of tests. Split plant samples did receive the complete battery of tests but provide an imperfect data set to arbiter between POP and QC samples.

Data management issues

Proper data management is crucial for the successful implementation of a quality-assurance program for several reasons. First, the number of projects to be managed places a strain on the data processing and proper referencing of samples and test results. While construction-management systems such as AASHTOWare’s Site Manager do provide for a tracking mechanism, the missing link is spatial referencing of the location on the road of the lot or sublot which the sample represents. This can only be achieved by closing the data loop in the project.

Data management issues become increasingly important as the QA program is expanded beyond a few projects. The sheer number of samples to process, combined with a multitude of projects, places a considerable strain on the documentation of the tests and test results.

Data management system requirements

The data-management needs of a sustainable and scalable QA system present challenges in several dimensions. During execution of a construction project, the primary focus must be interconnectivity and timely feedback from each system component to the rest of the program elements so that payments can be made, the material quality is assured, and disputes can be resolved with minimal impact on the producer and customer. At the completion of the construction, however, the emphasis is on logical and comprehensive data storage. During the service life of the facility, there is a need to retrieve the stored data in order to monitor performance and feed back so that the QA system can be refined, improved, and/or validated. Data-management needs vary among program participants, especially between the QC and Acceptance functions. To date, data-management needs in HMA construction projects have been addressed separately among the many QA system components. While highway agencies have painstakingly implemented sophisticated project-processing systems such as the afore-mentioned Site Manager, less attention has been paid to the relationship among the various data repositories and perspectives, and even less has been accomplished to relate construction-quality data to its in-service performance as an element of the customer's highway network. This is not to say that some foresighted agencies have not made great strides in this regard. Washington DOT, for instance, has developed a construction-quality database that allows the extraction of material-quality data referenced by highway-network element. Maryland DOT is undertaking a similar project.

In this context, it is convenient to categorize project data needs according to each project perspective, as in Table 2 below. A focus on the critical needs of each data-management-system component gives QA system administrators the best chance of implementing useful, stable, and practical data-management systems.

Project Function	Critical Data Needs	Required System Features	Technological Demands
Payment	Materials quality data (acceptance testing results) Rapid Feedback of QC, Acceptance, Independent Assurance, and Dispute Resolution testing results	Sample-tracking mechanism. Interconnectivity among data sets on a lot basis. Ability to display, compare, and evaluate the various data sets Near-real-time communication of results and decisions.	Network or Internet connectivity Unique sample ID and lot ID Decision-support mechanism
Dispute	Near-real-time	Sample-tracking	Network or

Resolution	comparison of QC and Acceptance testing results Communication to third party and triggering of third-party activities Referencing on a lot basis.	mechanism Interconnectivity among data sets on a lot basis and on a case basis.	Internet connectivity Decision-support mechanism
In-service monitoring	Referencing lots to the highway network Linkage to construction-quality data	Sample-tracking mechanism Way of storing location of work performed and time work was performed.	Barcode tagging of samples GPS based referencing Linkage between GPS and project-location data (project-based stations) Analysis capabilities and decision-support mechanisms.

Table 2 – Project Data Needs By Activity

The additional connectivity among data sets requires translation tables to achieve the QA program administrators to view the project from the various perspectives. If the common data elements are stored separately, significant additional effort on the part of project personnel will be required to enter the fields in the appropriate data table.

What is needed is to follow simple procedures and make use of technology to achieve simple data entry and referential integrity of the data. In this respect, mobile data-collection devices and GPS positioning data can help to minimize the amount of effort needed to accomplish the work at hand. If sample-tracking information is linked to these data items in an easy way that simplifies and clarifies the activities of project field personnel, significant gains can be achieved with less effort than in current systems. The final link is a tracking component that accounts for all data elements as they traverse the system toward their final repositories. This will provide accountability of data requests, transparency in the data transactions, and referential integrity.

For this project, a data-collection device with both GPS positioning capability and barcode scanning ability was tested. The GPS positioning was recorded for each sampling location in the field as well as for recording the physical location of the construction. With a single menu, a single device, and minimal data-collection requirements, the user was able to record the start and end of work, the location of samples, the sample ID, and location- and time-specific data (such as mix temperature, truck number, etc). In the background, Toyota Production System principles ("pull" versus "push" production systems) were followed to streamline the sample tracking process. In particular, *kanban* principles and demand-based testing were employed so that sample accountability was achieved with little effort. The importance of

The system assumes that project inspection personnel receive notification by the producer of the intent to produce material. Payment for the work requires the collection of quality characteristics, an activity which is achieved through sample collection and testing. It is the project inspector who requests that samples be taken. These sample requests are in effect the orders for production from the testing team. The inspector loads the requests in the tracking mechanism and a sample order is generated, along with a set of unique sample IDs that will be tracked until the information cycle is completed. These numbers are stored on a status database (one record per sample), and barcodes printed and handed off to sampling personnel. Sampling personnel are responsible for all sample requests originated by project inspectors. They must either deliver the sample to the laboratory (the next checkpoint in the tracking system), or report unused sample numbers back to the database. At the laboratory, received samples generate two activities: they change the status of the sample requests in the project inspectors’ to indicate receipt at the lab, and the kind of samples generates orders to run a battery of tests on the samples. The project engineer will see, on the status database that the sample is at the lab, and will see a record for each test required of the sample. Once tests are completed, the project engineer will have the testing information available (or will know where to look for data that are missing or that produced invalid results.)

In the field, the sampling inspector will attach the barcode label to the retrieved sample and will record the GPS coordinates, read the sample ID from the barcode, and store the time code for the data (all without the need to type in any of the data, since it will be available electronically). In terms of activity, the sampling inspector will concentrate on attaching a (unique) label to each sample, and using the handheld data collection device to read the barcode label, the time, and the GPS coordinates of the sample. (Initially, a paper trail can also be generated, but this can be expected to be needless once the system has been beta-tested).

If the data are collected at a plant, the same device can be used, but the GPS coordinates will not be necessary, unless they are used to identify the plant where the material was obtained.

In any case, the “paperwork” requirements for the sampler will be reduced. If the same data are collected for the limits and time of work for the lot, then linking routines can be used to match the work performed to the samples obtained and tested. Further, the GPS coordinates can be used to automatically link to data referencing on a highway-network basis.

A single-point data operation, a tracking mechanism, and back-end standard routines, and all the data needs have been met, all the while simplifying the work in the field. Errors are minimized, efficiency achieved, transparency and clarity increased, and productivity improved.

If this approach is taken, many activities beyond those in the QA program can be positively affected. For instance, if project work elements are reported according to GASB 34 standard, there would not be any additional data-entry activities required, but the link could be built to the auditing and accounting systems.

The importance of making field personnel's jobs easier on the success and sustainability of the QA system cannot be overemphasized. Thus, the agency should look to invest time and effort into technology and equipment that achieves these ends, not merely the data needs of the data-management system repository.

While a device was found that satisfied these requirements, specialized equipment and software exists that makes the assembly much less crude and cumbersome to operate. The data-collection devices and software can be purchased off the shelf, or slightly modified while working together with the device manufacturers.

Once the work in the field is related to lots in raw materials as well as the roadway network, the linkages are fairly straightforward. Overall, the resulting system is fairly complex in structure, but relatively simple in operation and maintenance.

Effective Graphical User Interface (GUI) development is a key component of a data management system. As with the vast majority of database projects, the bottleneck of work ends up being the development of GUIs that allow the data entry to be as error-free and easy to accomplish as possible. On a worker-day basis, GUI development could require the majority of the effort relative to database design, query design, or report design. In fact, GUI design would probably require as much effort as the other three elements combined. This is because the most robust data-storage structures can be ill-suited to simple data entry and edit operations. This is especially true when the required database contains many one-to-many and many-to-many relationships. Further, GUI development costs are difficult to estimate and GUI requirements difficult to specify – if efficiency in data entry is to be achieved. Information technology (IT) projects that include GUI development often end up being large database design and process-review projects, with basic forms provided to the customer and most customization left to the discretion of the customer. On implementation, personnel responsible for the data entry can end up frustrated if the quantity of data to be tracked is significant. More importantly, if, once implemented, data entry is the most labor-intensive component of operation—and it almost invariably is—any inefficiency in data entry translates to an inefficiency in the operation of the system, on a scale closer to 1:1 the more data-entry intensive the system is. The result is often frustration on the part of the end user of the application or at least the personnel in charge of implementing the system within the organization, and unfulfilled cost savings that were foreseen as operations and functions were reviewed and streamlined as part of the project.

Research Project Activities: Sampling at the Point of Placement; Data Management Field Data Collection; Focus Project Locations, Features, Data Collection

POP Sampling Technique Development and Requirements

Random Sampling Plan

A random sampling plan was designed using Microsoft Excel using a double-random procedure (a seed value which was assigned to a number scale which was then selected at random for each test). Random locations were expressed as a fraction of the sublot length in the longitudinal direction, and as a fraction of the paver pass width in the transverse direction. In order to avoid joint (especially cold joint) disturbance, the outer 0.3 meters (1 foot) of the paving pass were excluded from the selection. Transverse location was estimated visually, given that the use of a ruler proved cumbersome. Transverse location by estimation yielded an accuracy of +/- 1 foot, which was considered adequate. In the field, a printout of the sampling plan was used to adjust to production conditions for that day based on the number of passes and expected length of pass. Sublots were constructed following the paver, that is, if a paving pass could not be divided into equally long sublots, the last partial sublot was continued on the next paving pass. Once the length of paving was established by the completion of the first pass, the sublot length was adjusted accordingly; that is, if the paving pass was longer than estimated, the remaining sublots were be lengthened accordingly, and if it was shorter, the remaining sublots were shortened correspondingly. On some occasions when the amount of paving was longer than expected, the sublot length was not adjusted and instead an extra sublot (and test) were obtained. In this case, the last random location was “compressed” (by multiplying the fraction of length times the actual sublot length). Both techniques work; the simplest operational procedure involves not re-adjusting the sublot length based on the first paving pass, but rather selecting a sublot length based on length of paving on the low end of the estimate (given by the paving foreman). This results in somewhat more samples than required in many occasions.

Sample Containers

POP samples required sufficient material to conduct both gradation and volumetrics tests. Existing sample boxes used by ConnDOT proved inefficient and too small. Cubic sample boxes were procured. These sample boxes, 8 inches on a side, were designed by Maine DOT for its POP sampling technique. Two boxes sufficed to obtain material behind the paver. Given that the box manufacturer did not have to create a new set of die to cut them, they were reasonably priced (at roughly $0.87 per box).

Field Equipment

Field equipment consisted of a spatula, a flat-bottom scoop, sample boxes, a sample steel template 18” a side with tapered edges to cut into the mix, two thermometers, two cylindrical 10-gallon buckets for replacement material, and a foldable wheelbarrow to haul the materials for at least two tests. The foldable wheelbarrow had bicycle tires and, folded, fits into the trunk of an average car. This setup proved more than adequate for project needs.

Location Referencing

A GPS datalogger (Trimble GeoXM) with an attached simple barcode reader was used to collect sample data and automatically relate a sample number (written in a pre-printed barcode label and attached to the sample box) to the time and location where it was collected. Data were downloaded at the office into a personal computer. This system proved highly useful for recording not only POP samples, but the location of start and end of paving each day, with proper menu setup at the office.

Evolution of the POP procedure

The POP sampling technique designed in the office prior to project execution and tested on two occasions, was not effective during the first day of production. The major problem component turned out to the a metal plate placed prior to the paving train with a guide wire attached to it so that the metal plate could be easily located within the mat. The metal plate slipped along with the paving train, and on one occasion dragged for over six feet, creating a void in the mat that had to be hand-filled (while the paving train stopped). This last occurrence prompted project personnel to modify the sampling procedure to exclude the placement of the metal plate below the mat. The metal plate was subsequently used on top of the mat as support for sampling personnel while the sample was being obtained. This resulted in highly reduced mat disturbance and procedure cleanliness, and was adopted for the remainder of the project. Data analysis subsequently showed that the difference in gradation or asphalt content due to the intrusion of tack coat or exclusion of fines adhered to the tack coat and not sampled, was negligible for the size of sample obtained from the sampling location. After these findings, the metal plate was not included again for POP sampling on any of the focus projects. Alternatives could be considered for future, modified techniques, including covering the area where samples are to be obtained prior to application of the tack coat, and then removing the cover, so that the sampled area does not contain tack coat, or improving on the metal plate so that it does not slip when under the paving train.

In this project, the procedure for replacing the sampled material in the mat was also modified. The original plan called for a hand scale to weigh both the sampled material and the material to be replaced, but this proved too cumbersome and disruptive of the paving process. The modified method consisted of filling the sampled cavity to about one inch above the surrounding material and then striking off the material using the metal plate used for standing. This resulted in “patches” of acceptable visual appearance and density comparable or higher than the surrounding paved areas, with no need for additional raking by producer personnel. Density measurements were taken by the Connecticut

Advanced Pavement Laboratory team, which collected measurements in three locations after rolling: one six feet ahead of the POP spot, one at the POP spot, and one six feet down the road in the direction of travel. No potholes have been formed to date because of this material-replacement technique.

Data management: Field Data Collection

Barcode tracking

In the office, barcode labels were pre-printed and taken out to be used to retrieve POP samples. With a data-management system, this would have generated test request records in the database used to monitor project data, and would have assigned responsibility for those requests (the barcode numbers) to the field inspector. The status of the request would be “requested” and would remain so until the field inspector either a) returned unused barcodes, which would cause that record to indicate “Canceled” as the status, or b) delivered to the laboratory, where another barcode reader would “receive” them, change the record status as “received at lab”, and generate test requests for the material (volumetrics and gradation), with the barcode sample number in a field and the status “test requested.” The ownership of the sample changes from field inspector to lab technician. As the lab completed each test (with a form where the sample number is printed with a barcode font), the status in the database would be changed to “tested.” Once all tests are completed, the database would inform the sampling manager (or person responsible for asking for tests) to make a decision regarding the material. This closes the complete sample loop, and provides the person who needs the sampling information to make a payment decision to always be able to track the sample.

Location referencing

Using the GPS datalogger, the physical roadway location of each POP sample can be related to the mix information. This is crucial for Pavement Management data analysis over the in-service life of a pavement. This was part of the procedure and no additional work was required to acquire the data (beyond using the GPS receiver with barcode reader).

Laboratory data entry

Using barcode fonts (which are very inexpensive) and computer-printed test forms (a computer was actually used with the barcode reader to do this for this project), and a barcode reader, lab test data entry can be even simplified from current practice. The data can be fed to the data management system and error-checking routines built into the forms to avoid human error.

Focus Project 1, 2002: Route 94, Glastonbury

Features

This project was programmed as part of the state's Vendor-In-Place paving program. It was selected because of the following features:

1) Daytime paving operations
2) Superpave mix design

3) “Traditional” inspection by state Materials Lab personnel.

4) Limited space around work zones

5) Sufficient quantity of material to obtain process data over time.

Project description data are presented in Table 3. Table 4 presents a data-collection summary.

Item	Units	Value
Route		Connecticut Route 94
Functional Class		43 (Pop 50,000+, Other Principal Arterial)
Termini	Beginning, MP	0.66 (0.03 mi. E/O SR 910)
	Ending, MP	8.57 (Glastonbury-Hebron TL)
Length	Centerline miles	7.91
Number of Lanes		Varies 2 to 4
Traffic Volume	Vehicles/day	23,200 (0.66-0.74) 20,100 (0.74-0.96) 16,200 (0.96-2.46) 13,100 (2.46-3.31) 9,400 (3.31-4.14) 8,300 (4.14-4.61) 6,800 (4.61-5.80) 6,200 (5.80-7.18) 3,900 (7.18-8.57)
Pavement Type		Full-depth Hot-mix asphalt over granular base
Depth of Milling	Inches	2 (varies)
Overlay Thickness	Inches	2
Leveling Course	Location, type, thickness	Occasional as needed to cover underlying pavement deterioration, 0.5” Superpave at 1” thickness or less.
Mix Design		0.5” Superpave Level 3
Producer		Tilcon-Newington

Table 3 – Focus Project 1, 2002 Project Description

Data collection dates

Date	Plant Independent (Truck)	Field (POP)	QC (Plant, truck)	Plant Split (Plant, truck)
9/ 3/2002	[4]	[3]		
9/ 4/2002	[3]	[3]		

9/ 5/2002	6	5	3	3
9/ 6/2002	7	10	3	3
9/ 9/2002	6	6	3	3
9/10/2002	6		2	2
9/11/2002	7		3	3
9/12/2002	5	7	2	2
9/13/2002	7	6	4	4
9/17/2002		6	2	
9/18/2002		7	4	
TOTALS: 11 days	51 samples	53 samples	26 samples	20 samples

Table 4 – Focus Project 1, 2002: Dates of Data Collection and Total Number of Samples Collected. Note: Samples in brackets were not used for comparison purposes.

Climatic data

Climatic data were obtained from the National Weather Service and are presented in Figure 2.

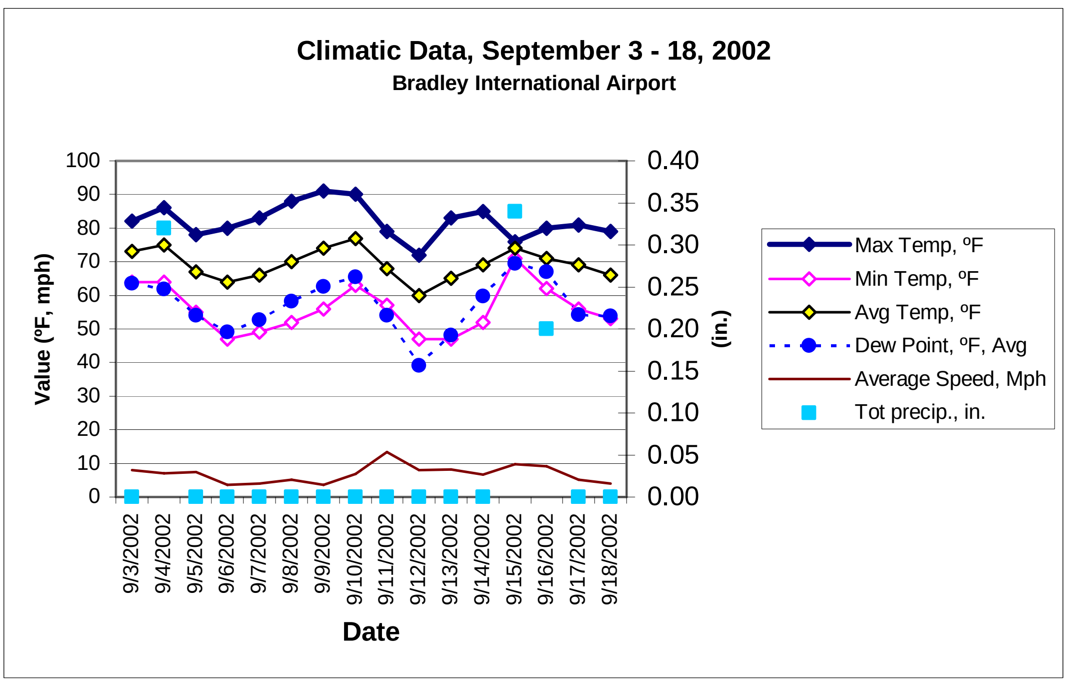

Figure 2 – Climatic Data for Focus Project 1, 2002 – Source: National Weather Service (http://www.erh.noaa.gov/box/dailystns.shtml)

Job Mix Formula

The job mix formula (JMF) is presented in Table 5.

Sieve (mm)	in	Tol (+/-)	JMF
0.075	#200	2	3.6
0.150	#100	3	4.7
0.300	#50	3	10.4
0.600	#30	4	17.9
1.18	#16	4	24.4
2.36	#8	6	33.4
4.75	#4	6	43.7
9.5	3/8"	6	71.9
12.5	1/2"	6	92.8
19.0	3/4"	6	100
AC	%	0.4	5.3
Gmm			2.639
Va			4
VMA			14.0
VFA			70.0

Table 5 – Job Mix Formula (JMF) for 2002 Focus Project 1, Route 94, Glastonbury, Connecticut.

Descriptive Statistics

Complete descriptive statistics for this project can be found in APPENDIX B. Salient characteristics are presented in the following figures. This project included a major change in placement through the introduction of an MTV (Materials Transfer Vehicle) on September 11, 2002. [24]

[24] Note: MTV use was discontinued for the last day of paving due to equipment breakdown, but this research project did not include data collection for that day of production.

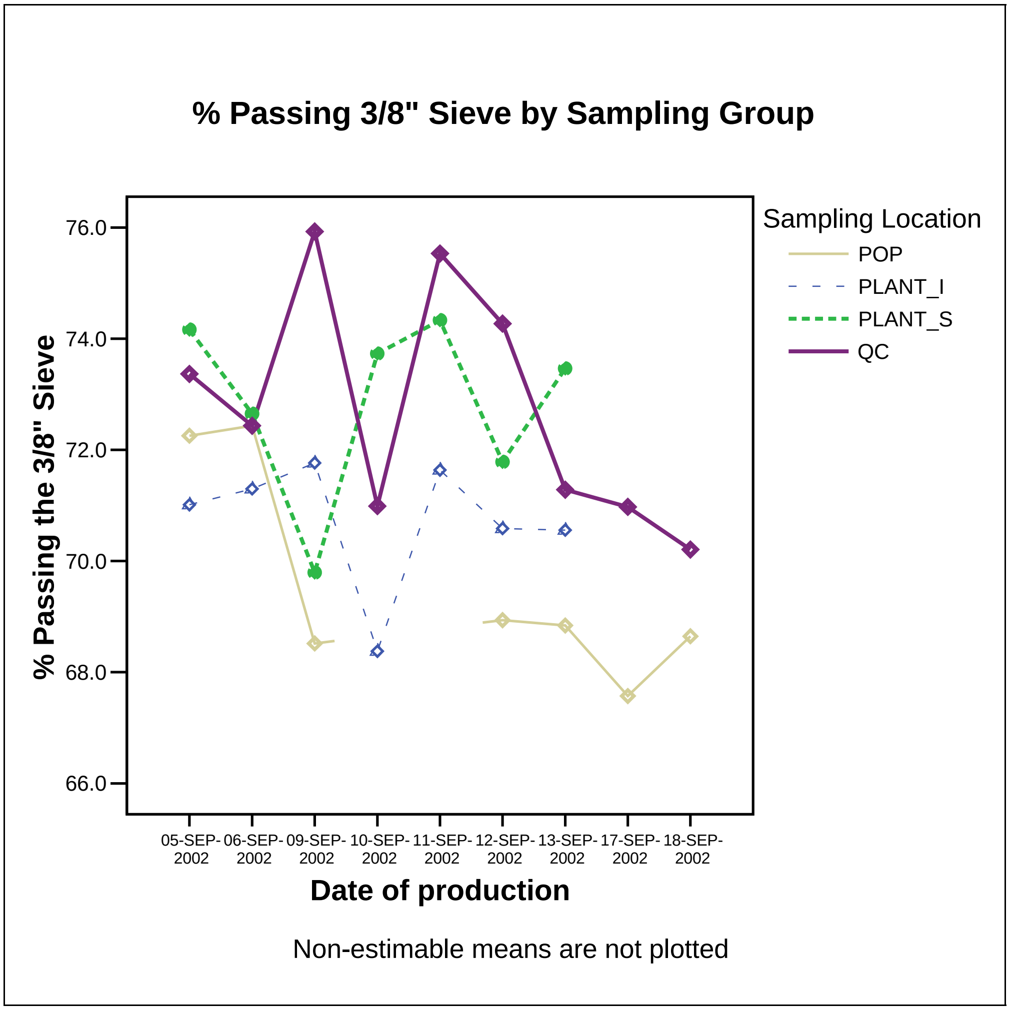

Figure 3, depicting the daily production means for material passing the 3/8" sieve, note the "coarseness" of the POP sample data after this date, which is discussed in the section on segregation findings.

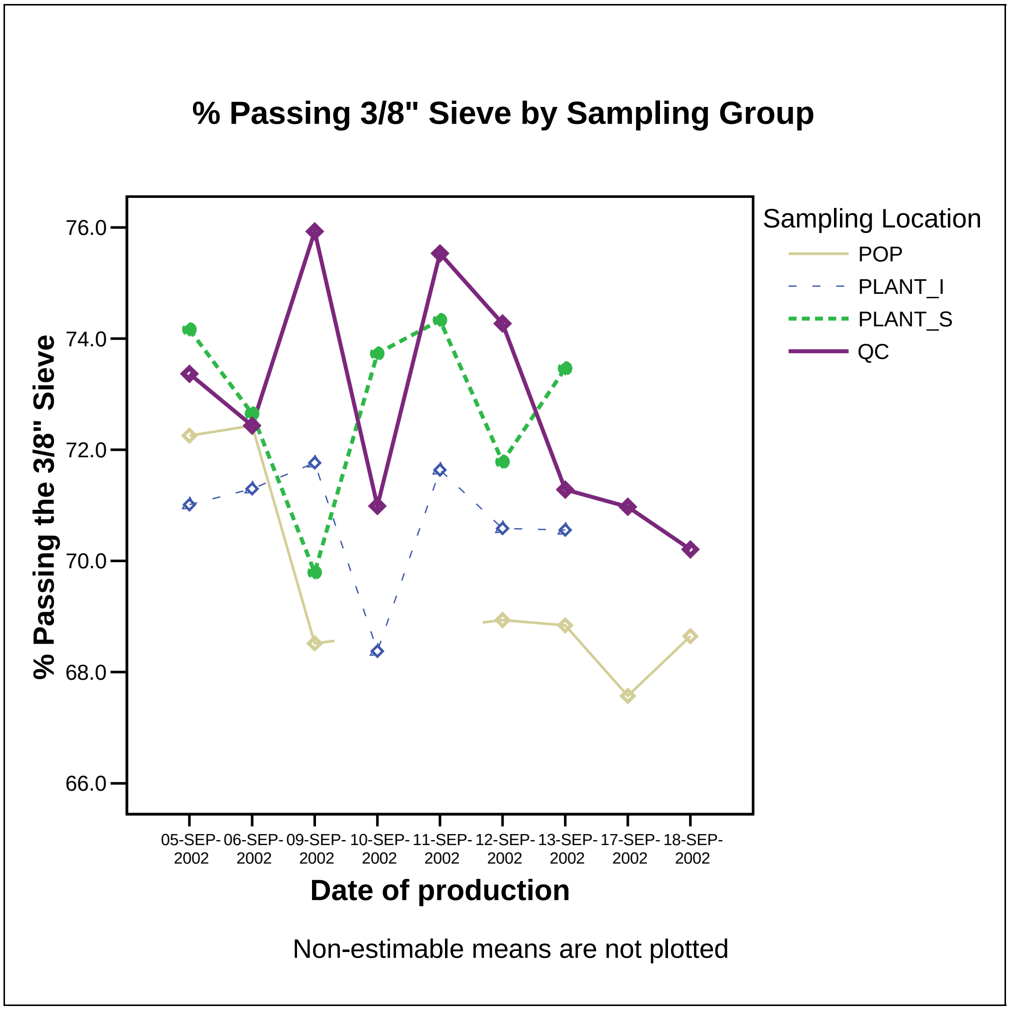

Figure 3 - % Passing the 3/8" sieve by day of production, 2002 Focus Project 1, grouped by sampling group. (POP=Point of Placement; PLANT_I = Plant Independent; PLANT_S = Plant Split; QC = Quality Control)

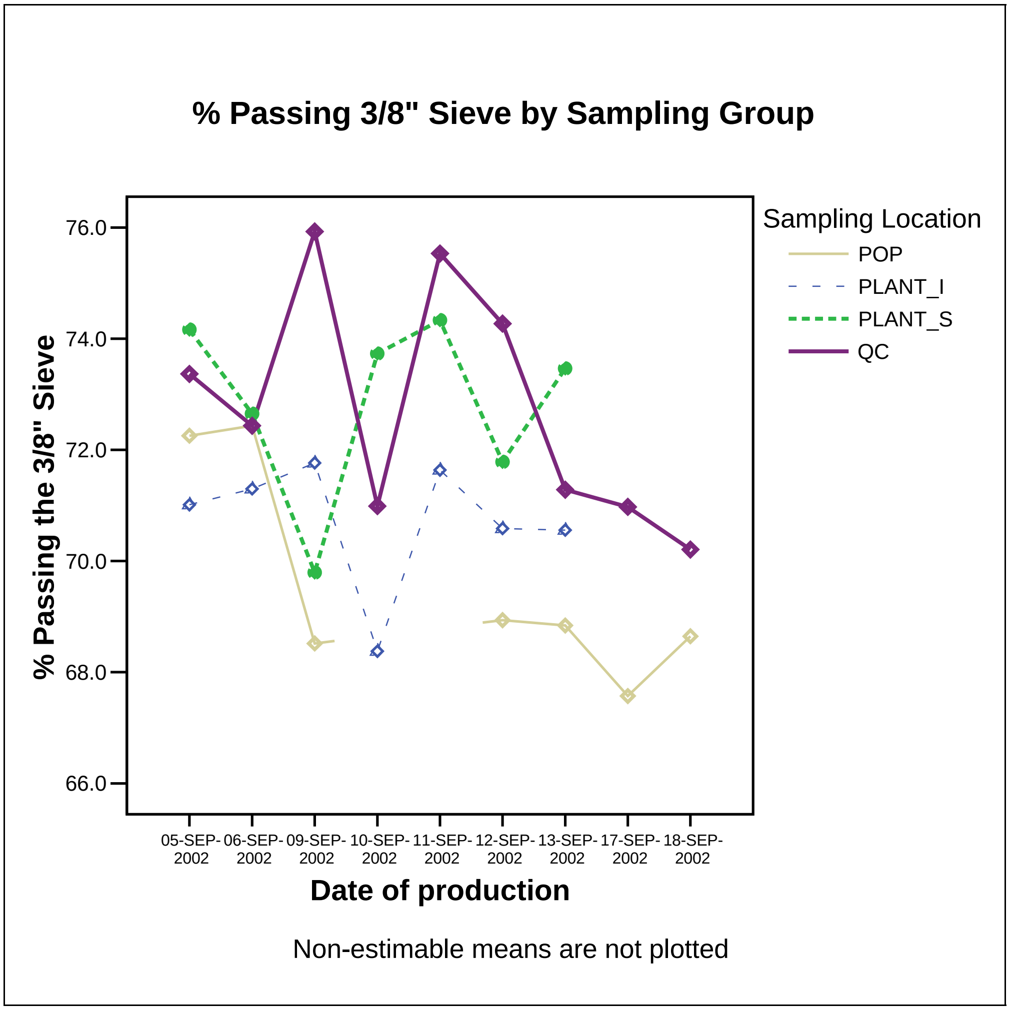

Figure 3 is to look at the material actually retained on (recovered from) that particular sieve, as shown in Figure 4.

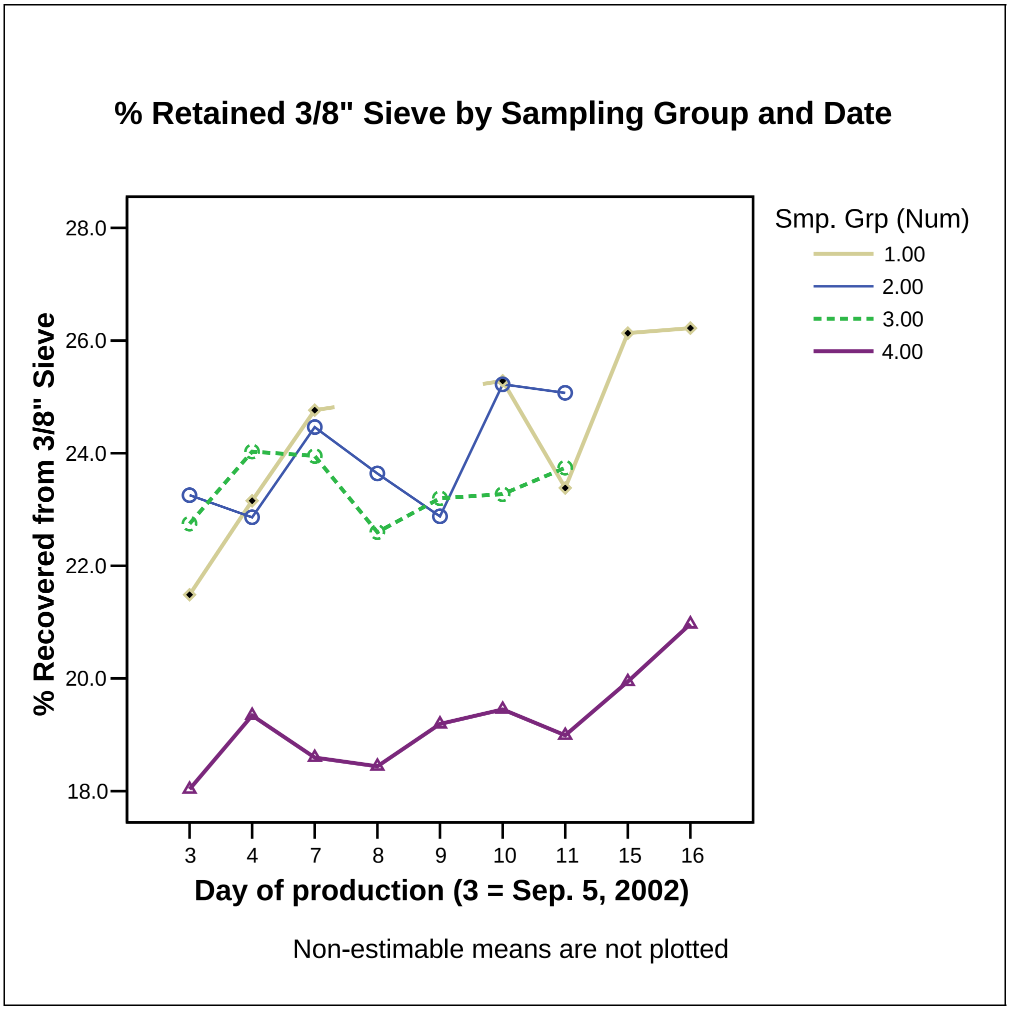

Figure 4 - % Retained in the 3/8" sieve by day of production and sampling group, 2002 Focus Project 1 (Group 1 = Point of Placement; Group 2 = Plant Independent Samples; Group 3 = Plant Split Samples ; Group 4 = Quality Control)

This is further discussed in the segregation analysis based on 2002 Focus Project 1 data.

Focus Project 2, 2002: Interstate Route 95, Darien and Norwalk

This project was programmed as part of the state's Vendor-In-Place paving program. It was selected because of the following features:

1) Nighttime paving operations.

2) Superpave mix design, Level 4.

3) QA-type specifications, providing one additional data set on occasion.

4) High-volume traffic.

5) Late-season paving (November/December).

6) Sufficient quantity of material to obtain process data over time.

7) Table 6 includes project-description data.

Item	Units	Value
Route		Interstate Route 95
Functional Class		41 (Interstate, Pop 50,000+)
Termini (segment within which monitoring took place, as opposed to project limits)	Beginning, MP	13.38 (NB) (surface as of 2004) 13.38 (SB) (surface as of 2004)
	Ending, MP	15.32 (NB) (surface as of 2004) 15.32 (SB) (surface as of 2004)
Length	Centerline miles	1.94
Number of Lanes		6
Traffic Volume	Vehicles/day	126,500 (13.32-14.65) 120,800 (14.65-14.73) 140,900 (14.73-15.05) 137,200 (15.05-15.21) 121,300 (15.21-15.32)
Pavement Type		Composite
Depth of Milling	Inches	3-4 (varies)
Overlay Thickness	Inches	4.5 (1 lift 9.5-mm leveling course, 1 lift 2-in binder course*, 1.5-in wearing course
Leveling Course		9.5-mm Superpave leveling course
Mix Design		12.5-mm Superpave Level 4
Producer		O&G – Stamford

*** This is the course monitored as part of this project**

Table 6 – Focus Project 2, 2002, Project Description

Data collection dates

Table 7 lists the data-collection dates and number of samples obtained for this project.

Date	Plant Independent (Truck)	Field (POP)	QC (Plant, truck)	Plant Split (Plant, truck)
11/13/2002	6	[2]	3	2
11/14/2002	9	[2]	4	4
11/18/2002	8	6	2	1
11/20/2002	10	6	4	4
11/24/2002	11	6	3	3
11/25/2002	9	6	2	2
TOTALS: 6 days	53 samples	28 samples (24 for cmp)	18 samples	16 samples

Table 7 – Focus Project 2, 2002: Dates of Data Collection and Total Number of Samples Collected. Note: Samples in brackets were not used for comparison purposes.

Climatic data

Climatic data were obtained from the National Weather Service data from a nearby monitoring station and are included in Figure 5.

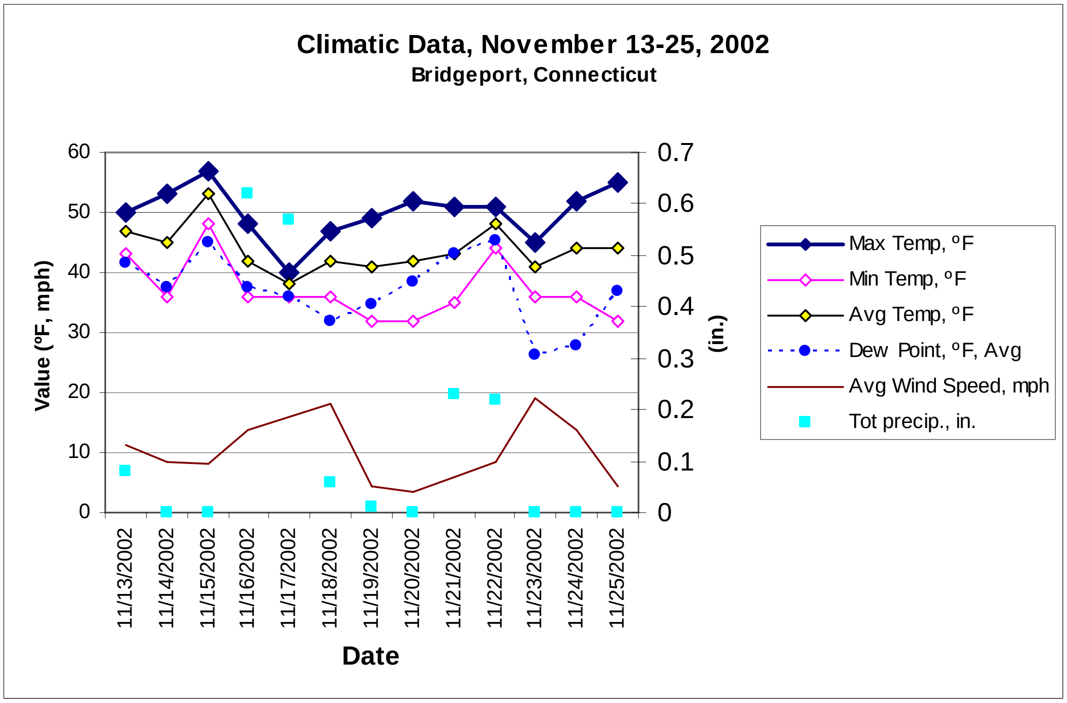

Figure 5 – Climatic Data for Focus Project 2, 2002 – Source: National Weather Service (http://www.erh.noaa.gov/box/dailystns.shtml)

Job Mix Formula

The job mix formula (JMF) is presented in Table 8.

Sieve (mm)	in	Tol (+/-)	JMF
0.075	#200	2	3
0.150	#100	3	5
0.300	#50	3	13
0.600	#30	4	22
1.18	#16	4	27
2.36	#8	6	35
4.75	#4	6	50
9.5	3/8"	6	78
12.5	1/2"	6	95
19.0	3/4"	6	100
AC	%	0.4	4.8
Gmm			2.648

Va			4.0
VMA			14.0
VFA			70.0

Table 8 – Job Mix Formula for 2002 Focus Project 2.

Descriptive Statistics

Complete descriptive statistics are included in APPENDIX B. is an example that serves to illustrate a salient point of the data comparisons. Groups 1 and 2 (POP and Plant Independent, respectively) present different characteristics than Group 3 (QC). In this project, clearly QC data showed a statistically different mean than the other two data groups. This relationship was not, however, confirmed at alpha = 0.05 with the split tests, which indicated a mean difference in the same direction but not of sufficient statistical significance. That may be a function of the number of pairs used to make a determination, which was much smaller than the independent sample comparisons.

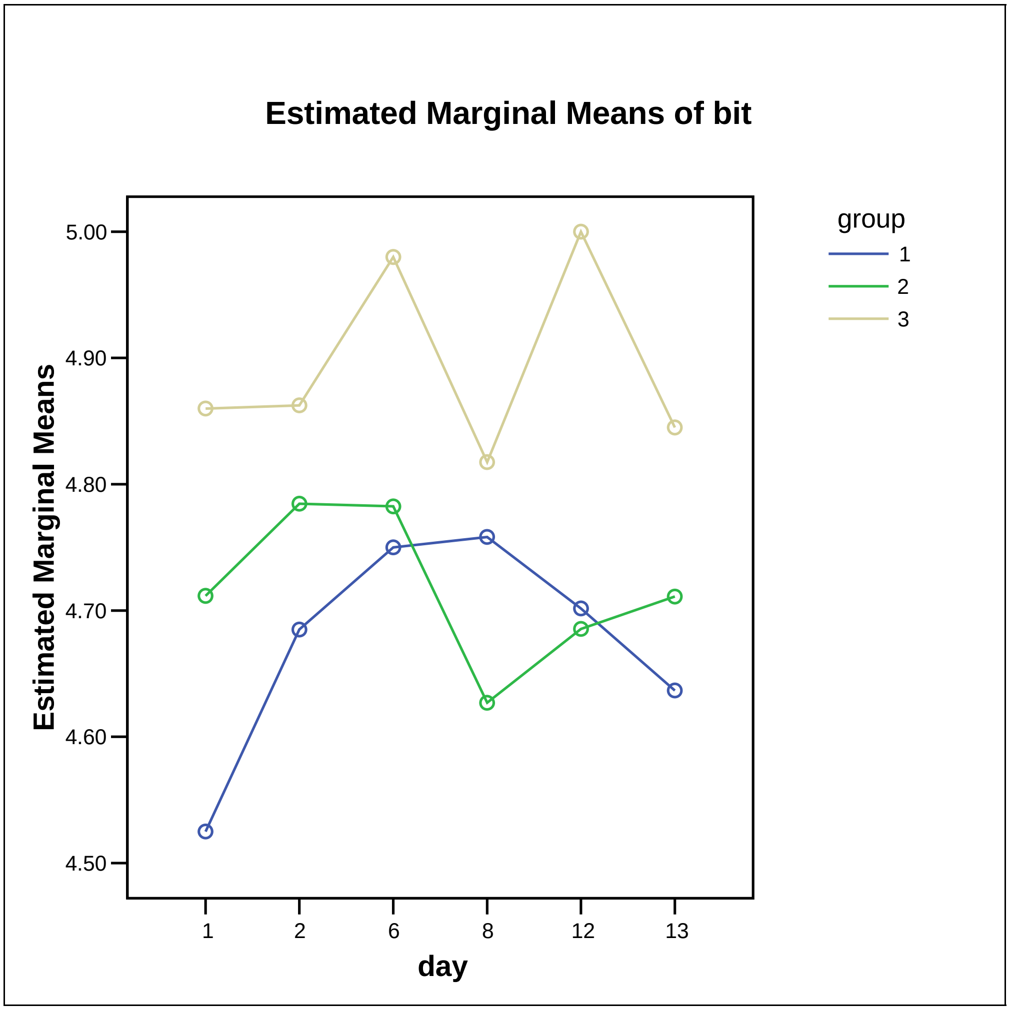

Figure 6 - % Binder content by sampling group and day of production (group 1 = POP, group 2 = Plant Independent, group 3 = QC). Day is day of production. "Estimated Marginal Mean" is the average of samples for a particular sampling group on a particular day. The Y axis is % Asphalt Content in the mix by weight.

Focus Project 1, 2003: Interstate Route 384, Manchester

This project was programmed as part of the state's Vendor-In-Place paving program. It was selected because of the following features:

1) Daytime paving operations.

2) 0.5" Superpave mix design, Level 3.

3) Traditional Vendor-In-Place specifications.

4) High-volume traffic.

5) Use of Material Transfer Vehicle (one (1) or two (2) vehicles, one (1) or two (2) pavers).

6) Sufficient quantity of material to obtain process data over time.

Table 9 lists project description data.

Item	Units	Value
Route		Interstate Route 384
Functional Class		41, (Interstate, Pop. 50,000+)
Termini	Description, MP	0.07 mi. E/O Underpass SR 502 (Spencer Street, Manchester), MP 1.41.
	Description, MP	Underpass US Rtes 6&44, Bolton, MP 8.30.
Length	mi.	6.89
Number of Lanes		Varies 4-8
Traffic Volume	Vehicles/day	26,600 – 49,300 (2004)
Pavement Type		Composite
Depth of Milling	Inches	3-4 (varies)
Overlay Thickness	Inches	2 (1 lift) + 1-2 inches of leveling (prior to project)
Leveling Course		Yes, 1-inch 9.5-mm Superpave
Mix Design		12.5-mm Superpave Level 4
Producer		Tilcon-Newington

Table 9 – Focus Project 1, 2003, Project Description

Data collection dates

Table 10 lists the number of samples and dates obtained at each location and using each sampling strategy.

Date	Plant Independent (Truck)	Field (POP)	QC (Plant, Truck)	Plant Split (Plant, Truck)
8/7/2003	6		4	2
8/8/2003	7	[2]	3	3

8/11/2003	11	3	3	3
8/12/2003	7	6	3	3
8/13/2003	5	5	3	3
8/14/2003	6	4	4	3
8/15/2003	8			2
8/18/2003	8			3
8/19/2003	7	5	4	2
8/20/2003	7	3	3	2
8/26/2003	4	5	3	2
8/27/2003	9	6	3	
8/28/2003		3	4	
TOTALS: 13 days	85 samples	42 samples	37 samples	28 samples

Table 10 – Focus Project 1, 2003: Dates of Data Collection and Total Number of Samples Collected. Note: Samples in brackets were not used for comparison purposes.

Climatic data

Climatic data, obtained from the National Weather service, are presented in Figure 7.

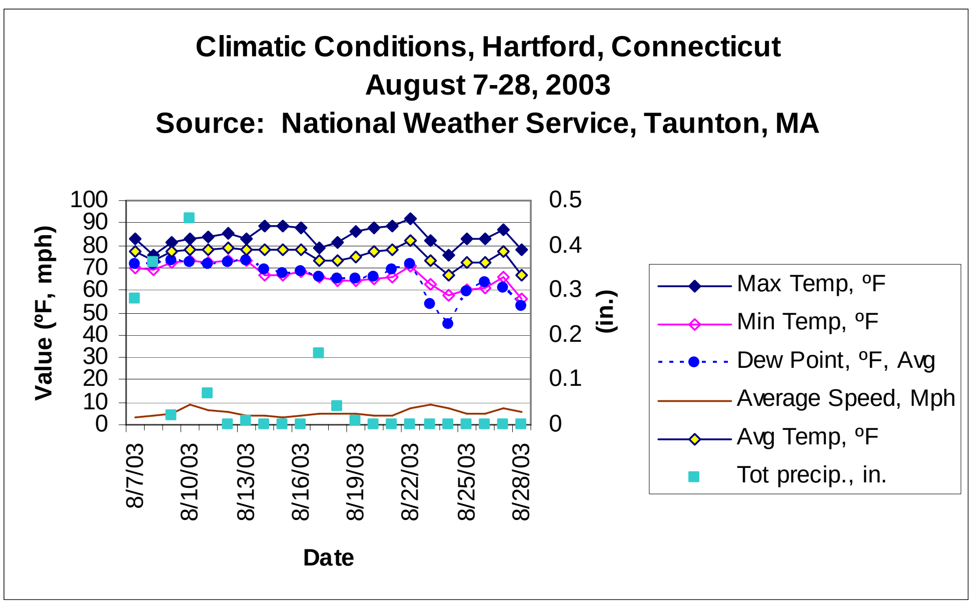

Figure 7 – Climatic Data for Focus Project 1, 2003 – Source: National Weather Service (http://www.erh.noaa.gov/box/dailystns.shtml)

Job Mix Formula

The JMF for 2003 Focus Project 1 is presented in Table 11.

Sieve Size	in	Tol (+/-)	JMF
0.075	#200	2	4.0
0.150	#100	3	6.0
0.300	#50	3	11.0
0.600	#30	4	18.0
1.18	#16	4	25.0
2.36	#8	6	35.0
4.75	#4	6	45.0
9.5	3/8"	6	75.0
12.5	1/2"	6	93.0
19.0	3/4"	6	100.0
AC	(%)	0.4	5.1
Gmm			2.662
Va			4.0
VMA			15.0
VFA			73.0

Table 11 – Job Mix Formula for 2003 Focus Project 1

Descriptive Statistics

Complete sets of descriptive statistics are included in APPENDIX B. Figure 8 lists one particular quality characteristic that, for the same plant and a similar JMF used in 2002 Focus Project 1, had presented a significant difference based on location of sampling. For 2003 Focus Project 1, MTVs were used throughout the project.

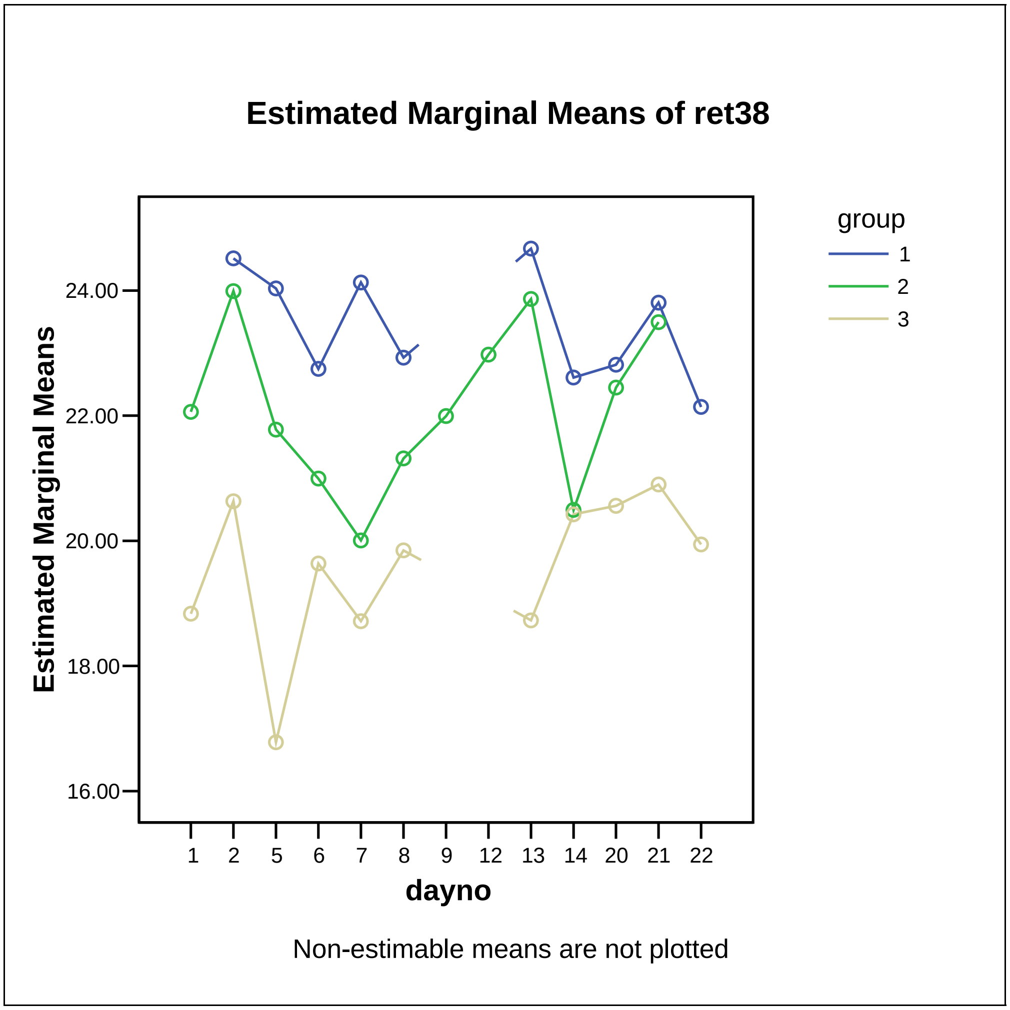

Figure 8 – % Retained in the 3/8" Sieve, 2003 Focus Project 1. Group 1 = POP, Group 2 = Plant Independent, Group 3 = QC. Y axis shows Percent Retained on (recovered from) the 3/8" Sieve. Dayno is the day of production. "Estimated Marginal Mean" is the average of samples for a particular sampling group on a particular day.

Note in Figure 8 that the amount recovered from the 3/8" sieve is largest in the field samples. This may be an indication of the fact that the material is being re-mixed with an MTV prior to sampling in the field, with no corresponding ability to sample it at the plant (which, in turn, may indicate that this material is found in inaccessible, discrete locations within the truck bed.)

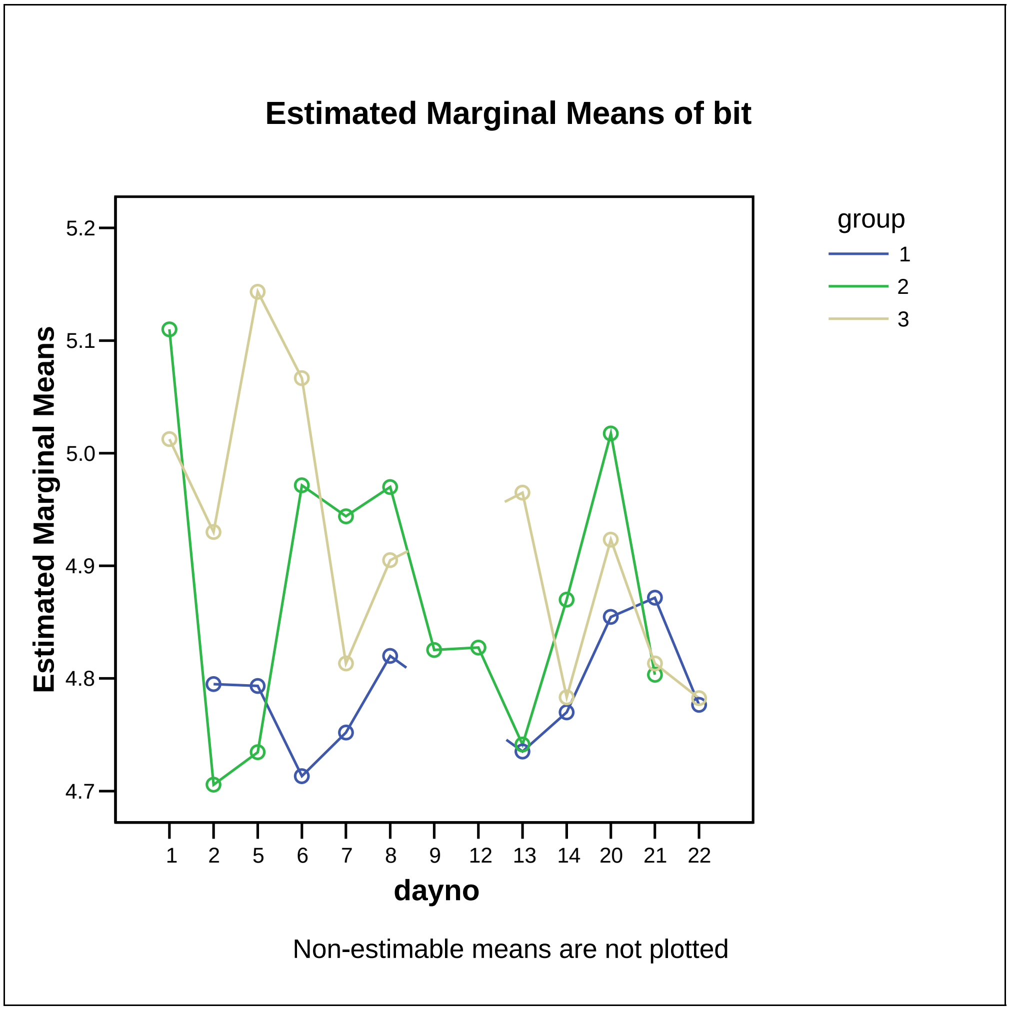

Figure 9 - % Binder content by day of production and sampling group (Group 1 = POP, Group 2 = Plant Independent, Group 3 = QC). Y axis value is % asphalt content by weight of the mix. Dayno is the day of production. "Estimated Marginal Mean" is the average of samples for a particular sampling group on a particular day.

Figure 9 lists the binder content by day of production based on sampling group. The average of production is well below the target of 5.1% regardless of sampling group. Only in a couple of days (and only in the QC and Plant Independent data sets) does production approach mix design values.

Focus Project 2, 2003: Route 6, Coventry, Columbia, Windham, and Mansfield

This project was programmed as part of the state's Vendor-In-Place paving program. It was selected because of the following features:

1) Daytime paving operations
2) Superpave mix design, Level 3
3) Traditional (V-I-P) specifications.
4) Low-volume traffic
5) Sufficient quantity of material to obtain process data over time.
6) Extended work hours allowing a longer production day.

Project description data are presented in Table 12.

Item	Units	Value
Route		US Route 6
Functional Class		02 (Other Freeway/Expressway, Rural) (87.81 – 89.51) 22 (Other Freeway/Expressway, Pop. 10-25 Thousand) (89.51 – 92.78)
Termini	Description, MP	87.81 NB (Route 66) 87.81 SB (Route 66)
	Description, MP	92.78 NB (0.10 mi W/O Underpass Route 6 – Boston Post Road) 92.78 SB (Same location WB, no Underpass in WB direction)
Length	Centerline mi.	4.97
Number of Lanes		Varies 4-8
Traffic Volume	Vehicles/day	11,600 (87.81 – 87.87) 16,800 (87.87 – 89.59) 12,800 (89.59 – 90.02) 21,800 (90.02 – 90.92) 13,800 (90.92 – 92.15) 20,800 (92.15 – 92.68) 12,800 (92.68 – 92.78)
Pavement Type		Full-depth HMA
Depth of Milling	Inches	2

Overlay Thickness	Inches	2 (1 lift)
Leveling Course		No (one location SB wedge course left lane 12.5-mm Superpave 1" or less)
Mix Design		12.5-mm Superpave Level 3
Producer		Tilcon-Manchester

Table 12 – Project Description, 2003 Focus Project 2.

Data collection dates

Data collection dates and number of samples collected are presented in Table 13.

Date	Plant Independent (Truck)	Field (POP)	QC (Plant, Truck)	Plant Split (Plant, truck)
9/25/2003	4		4	
9/26/2003		4		
9/29/2003	7		3	3
9/30/2003	7	4	2	2
10/1/2003		5	2	2
10/2/2003	4	8	1	1
10/3/2003	7	5	1	
10/4/2003		4		
10/6/2003			3	
10/7/2003		6	2	5
10/8/2003	5	7	2	
10/9/2003	6	6	2	
10/10/2003		8	3	
10/11/2003		6		
10/16/2003	3		2	1
10/17/2003	3	4	2	2
10/18/2003		6		
TOTALS: days	46 samples	73 samples	29 samples	16 samples

Table 13 – Focus Project 2, 2003: Dates of Data Collection and Total Number of Samples Collected. Note: Samples in brackets were not used for comparison purposes.

Climatic data

Climatic data for this project were collected from a nearby station by the National Weather Service and are summarized in Figure 10.

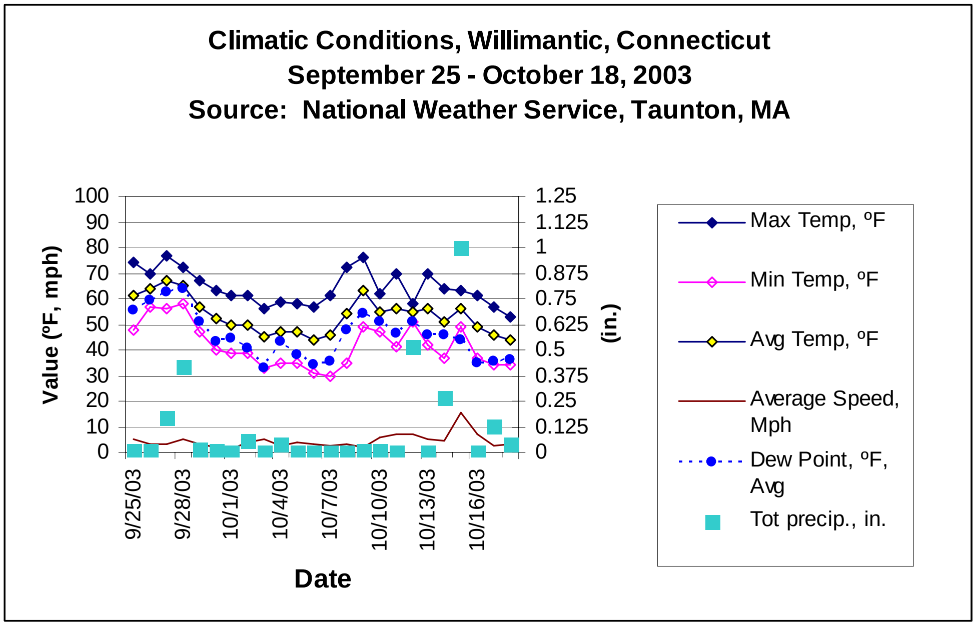

Figure 10 – Climatic Data for Focus Project 2, 2003 – Source: National Weather Service (http://www.erh.noaa.gov/box/dailystns.shtml)

Job Mix Formula

The job mix formula used for this project is presented in Table 14.

Sieve Size	in	Tol (+/-)	JMF
0.075	#200	2	4.0
0.150	#100	3	8.0
0.300	#50	3	15.0
0.600	#30	4	24.0
1.18	#16	4	31.0
2.36	#8	6	43.0
4.75	#4	6	58.0
9.5	3/8"	6	82.0
12.5	1/2"	6	97.0

19.0	3/4"	6	100.0
AC	(%)	0.4	5.2
Gmm			
Va			4.0
VMA			15.0
VFA			73.0

Table 14 – Job Mix Formula for Focus Project 2, 2003.

Descriptive Statistics

Complete sets of descriptive statistics are included in APPENDIX B. The examples below are included to demonstrate the salient points.

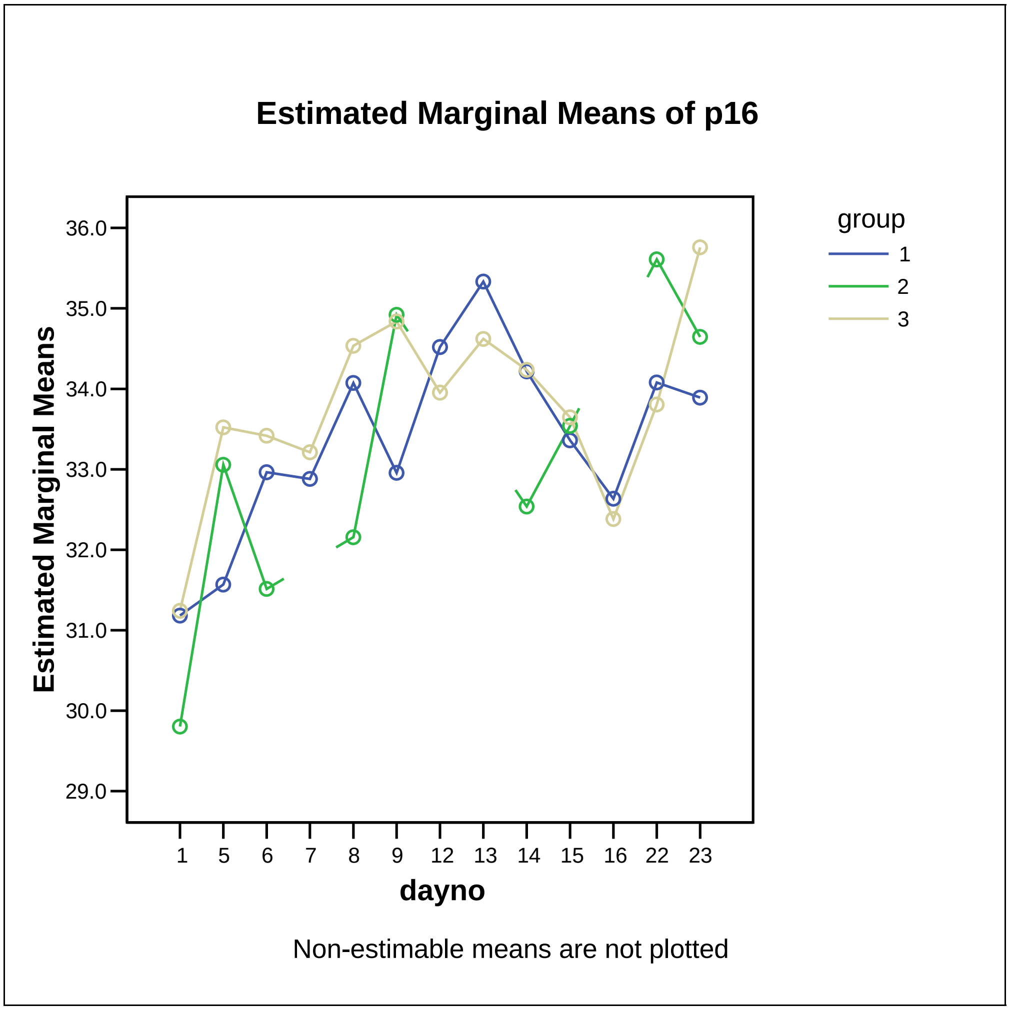

Figure 11 - % Passing the #16 Sieve, 2003 Focus Project 2. Group 1 = POP, Group 2 = Plant Independent, Group 3 = QC. Y axis value is the % Passing the #16 Sieve. Dayno is the day of production. "Estimated Marginal Mean" is the average of samples for a particular sampling group on a particular day.

Note in Figure 11 that all data sets show correlation (a positive) but the process itself is varying with a trend, or "drifting" (not a positive).

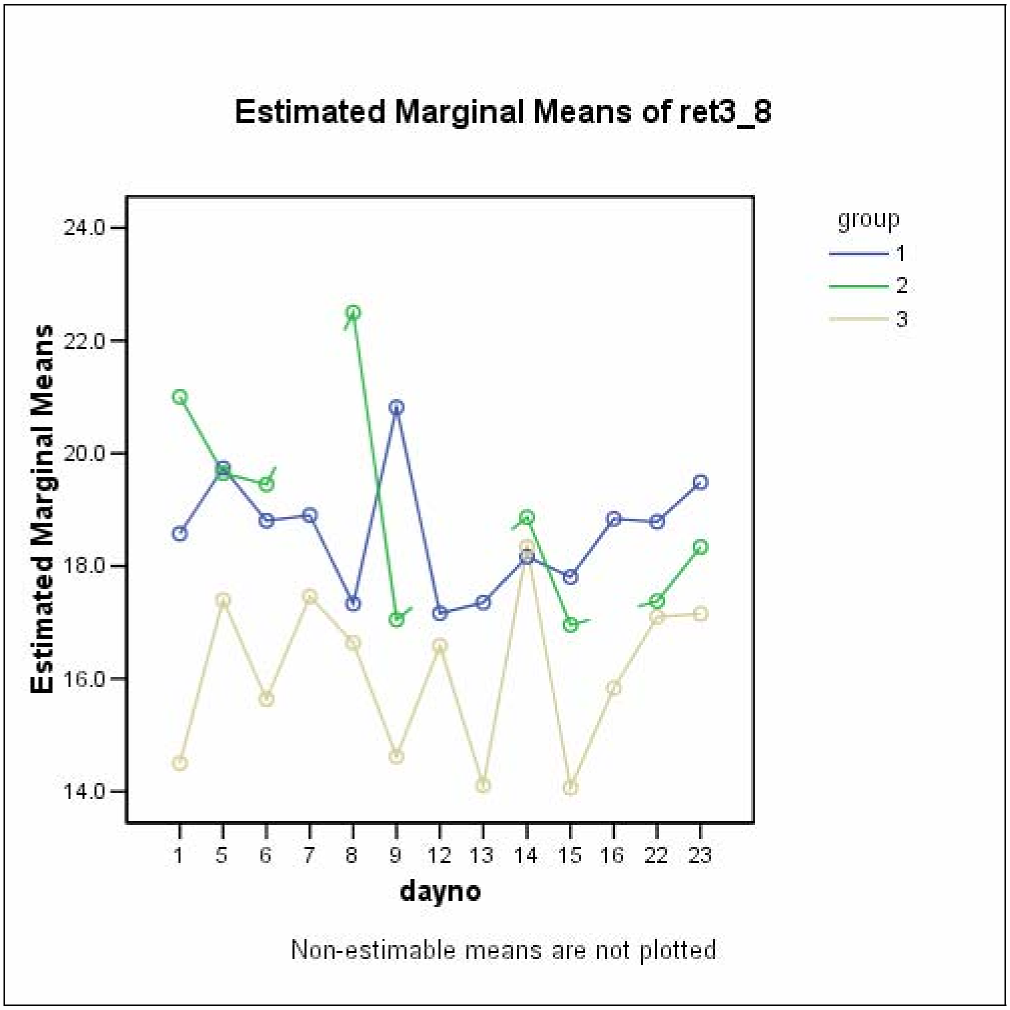

Figure 12 - % Retained in the 3/8" sieve; Group 1 = POP, Group 2 = Plant Independent, Group 3 = QC. Y axis value is the % of material retained on (recovered from) the 3/8" sieve. Dayno is the day of production. "Estimated Marginal Mean" is the average of samples for a particular sampling group on a particular day.

In Figure 12 note that the material actually recovered from this sieve is coarser for samples obtained in the field than for QC samples. However, in this case data comparisons do not lead to rejection of the null hypothesis that the difference in means is not statistically different (through GLM multivariate analysis controlling for group and day of production).

Analysis of Data and Project Findings

Use of Control charts

Control charts are extremely useful for the QC aspects of a QA program. They give the most immediate feedback to the producer regarding the state of its process control. An example of a control chart is given in Figure 13.

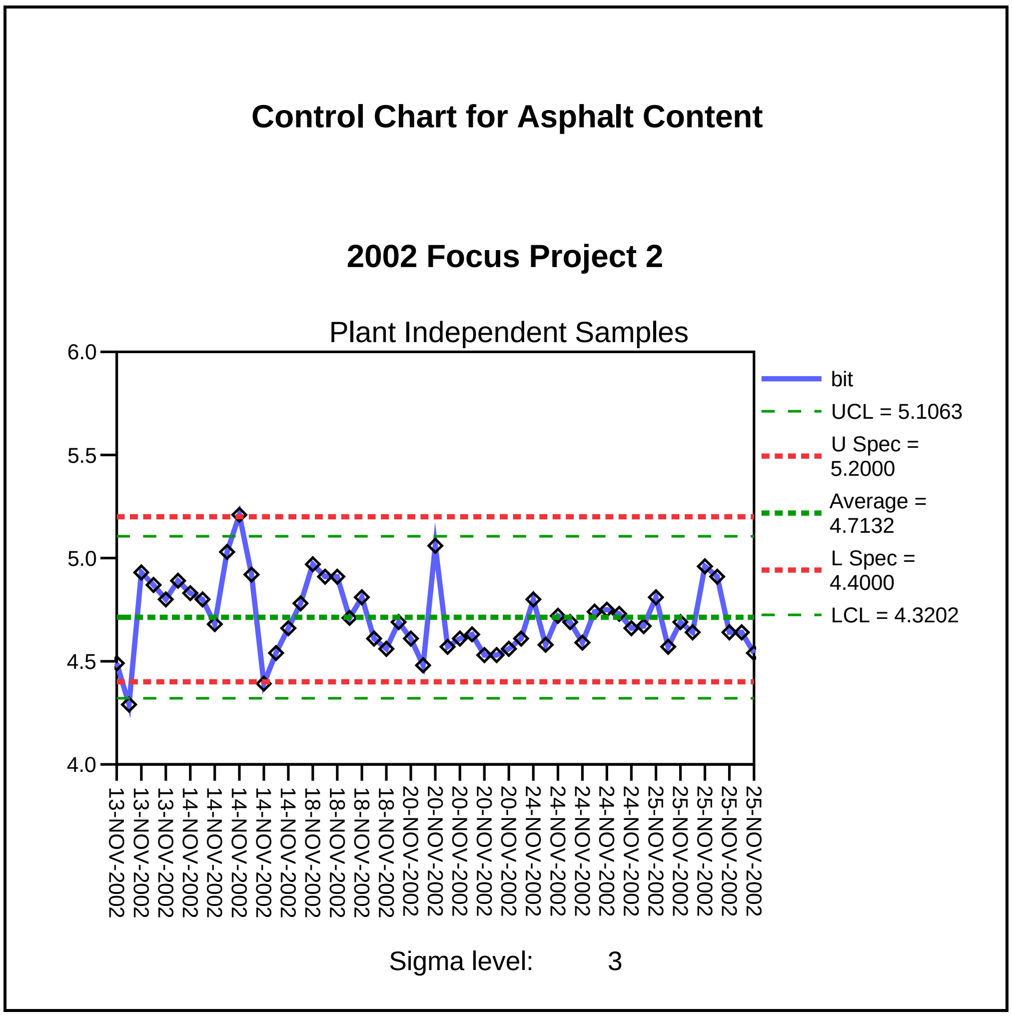

Figure 13 – Control chart for binder content, 2002 Focus Project 2, Plant Independent samples. Y axis value is the % asphalt in the mix, by weight. UCL = Upper Control Limit; LCL = Lower Control Limit; U Spec = Upper specification limit; L Spec = Lower specification limit.

This control chart shows a process that is more or less in control, especially beginning on November 20th, 2002. For definitions of Lower Control Limit and Upper Control Limit, see the QA Manual (Appendix). The 13th and 14th of November appear to have presented production challenges. Note that the control limits almost match the specification limits in amplitude, but that they are offset by roughly 0.1 (% asphalt binder by weight) on the vertical scale. This difference could be due to equipment differences, as the QC data set (asphalt extracted at the plant) showed a higher asphalt average value than both the plant independent and the POP samples, as shown in the control chart corresponding to the same production period (Figure 14):

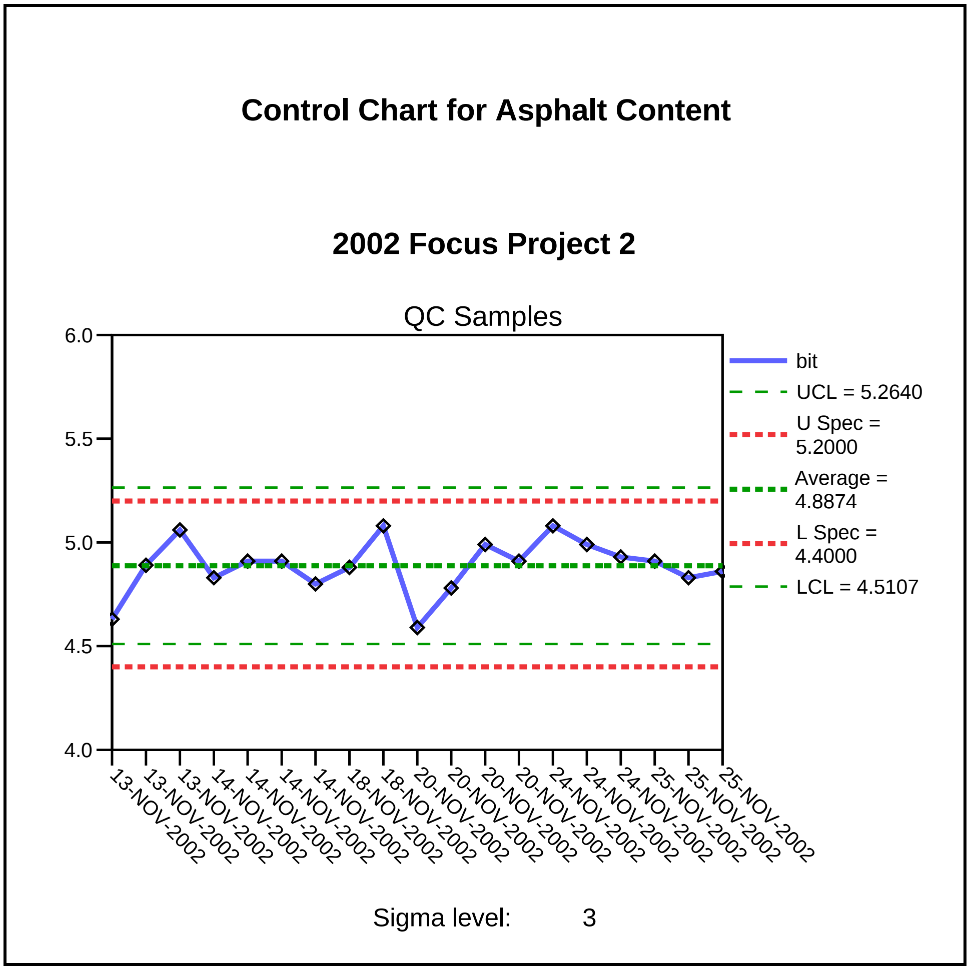

Figure 14 – Control Chart for binder content, QC samples, 2002 Focus Project 2. Y axis values are % asphalt in the mix by weight. UCL = Upper Control Limit; LCL = Lower Control Limit; U Spec = Upper specification limit; L Spec = Lower specification limit.

Processes completely under control should look more or less like a saw, with alternating slopes joining points; there would be no more than two or at most three consecutive points with the same trend. In The figure above, on November 24th, 2002 and November 25th, 2002, there is a string of values that indicates a decreasing trend that continues during five samples. This should result in corrective action, but, by the same token, the variation is minimal and within the standard error of the mean of production.

Figure 15 presents a control chart for the same quality characteristic (binder content) that shows a different pattern from Figure 14. In 2003 Focus Project 2 the average of asphalt content for the entire project is actually below the specification limit. Note that the specification limit is the job-mix formula +/- 0.4%. The average of production for 2003 Focus Project 2 is less than 0.1% from that for 2002 Focus Project two. One variable that may account for this difference could be not using an ash correction value for the extraction and gradation test. An alternative explanation is that the binder content production is actually targeted below the JMF. One way for a producer to avoid this problem would be to double-check actual pulls for a day of production against what the test results are saying, but in any case the ash correction should be done.

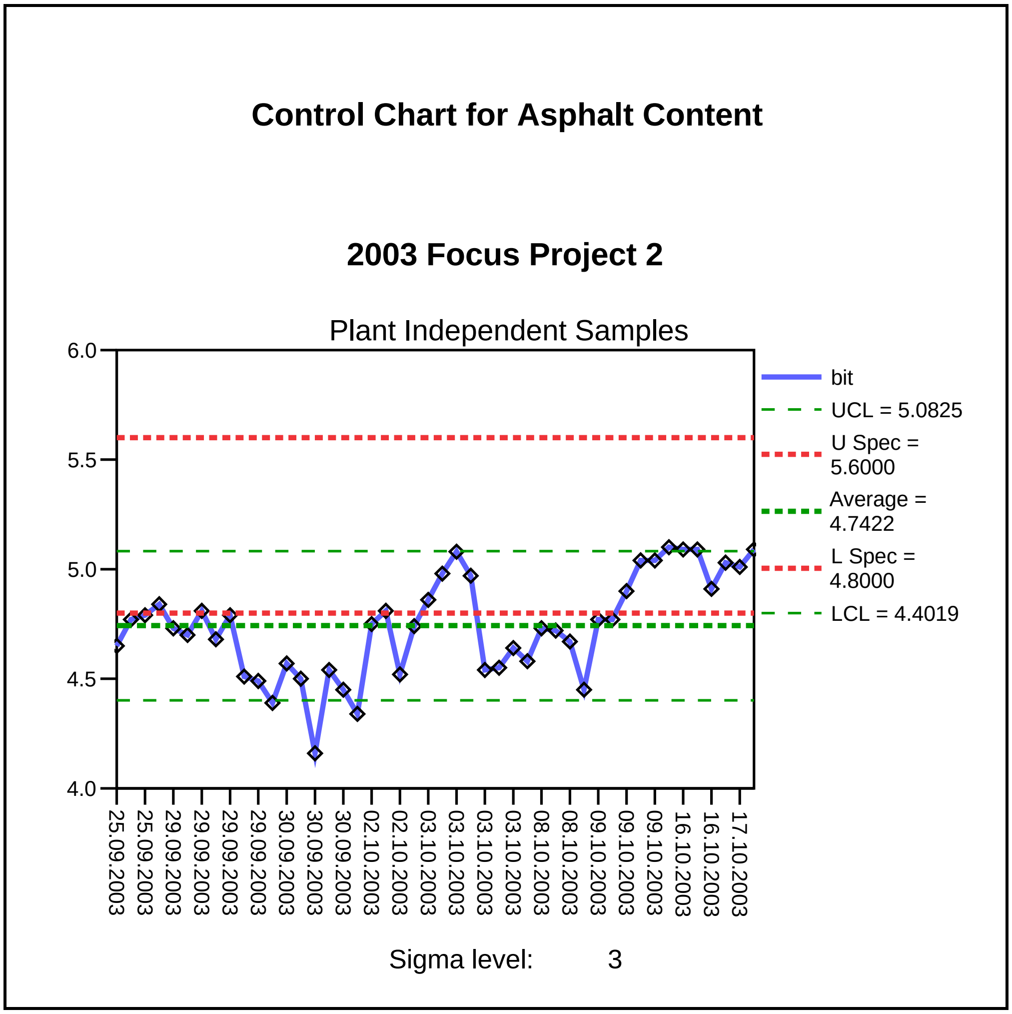

Figure 15 – Control chart for binder content, Plant Independent Samples, 2003 Focus Project 2. Actual % outside specification limits = 63%. Y axis values are % asphalt in the mix by weight. UCL = Upper Control Limit; LCL = Lower Control Limit; U Spec = Upper specification limit; L Spec = Lower specification limit.

There are many differences in the process control in these two projects that are apparent in these graphs. The first is an overall (ascending) trend in the data from beginning to end of the project. The second is a great difference in the actual location of the specification limits (the target asphalt content) and the production limits. In fact, the average of production lies below the lower specification limit for this project. The data were obtained from samples obtained exclusively for this project at the plant. Samples obtained in the field exhibit a similar trend (note the subtle differences in the time domain between the two figures), but the average of production is slightly higher. This may be due to a phenomenon similar to that detected in 2002 Focus Project 1 (coarser material in the coarser sieves in the field samples combined with use of a material transfer vehicle). However, the control chart using QC samples (Figure 17) is different in the trends, though the average of production is almost identical to (and not statistically different from) the plant-independent data. Tests for normality indicate that production characteristics may have changed at certain times in the project and also within a day's production (where the switch to material from a silo for the afternoon paving may have caused variation in materials.) The number of tests needed to accurately characterize production is based on a homogeneous lot. In this case, the sample size for QC samples may not have been sufficient to capture production variation during this project (the control chart does not show the variation or the trends of the other two data sets).

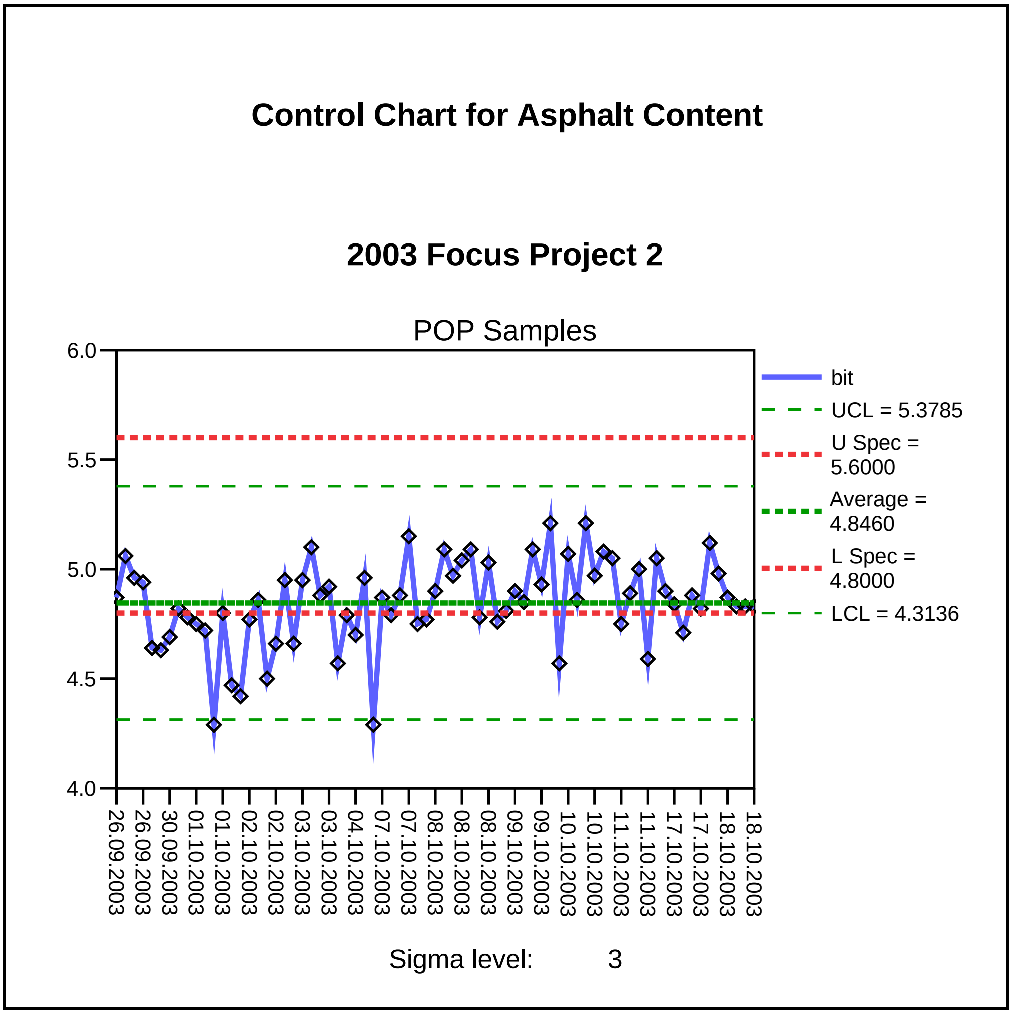

Figure 16 – Control Chart for binder content, POP samples, 2003 Focus Project 2. Actual % outside specification limits = 36%. Y axis values are % asphalt in the mix by weight. UCL = Upper Control Limit; LCL = Lower Control Limit; U Spec = Upper specification limit; L Spec = Lower specification limit.

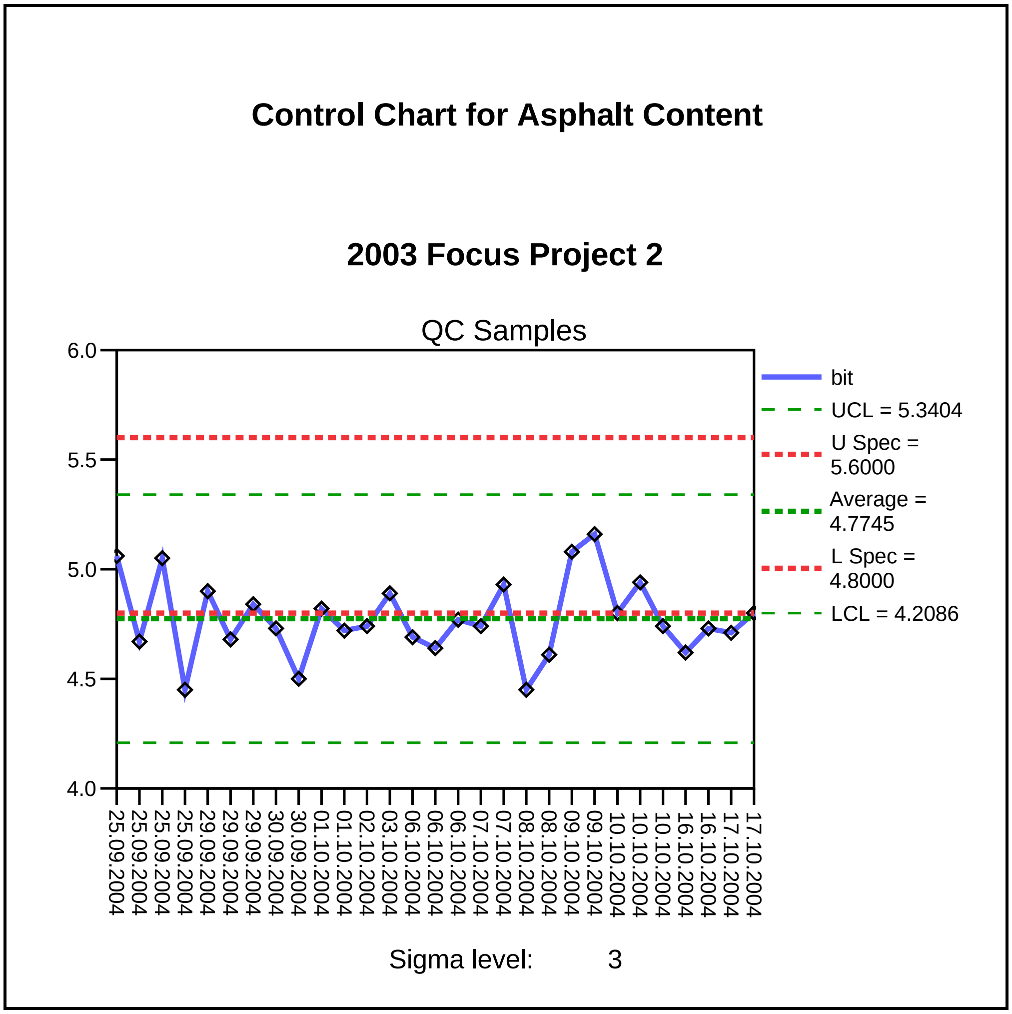

Figure 17 – Control Chart for binder content, QC Samples, Focus Project 2, 2003. Actual % Outside Specification Limits = 59%. (Ash correction was applied). Y axis values are % asphalt in the mix by weight. UCL = Upper Control Limit; LCL = Lower Control Limit; U Spec = Upper specification limit; L Spec = Lower specification limit.

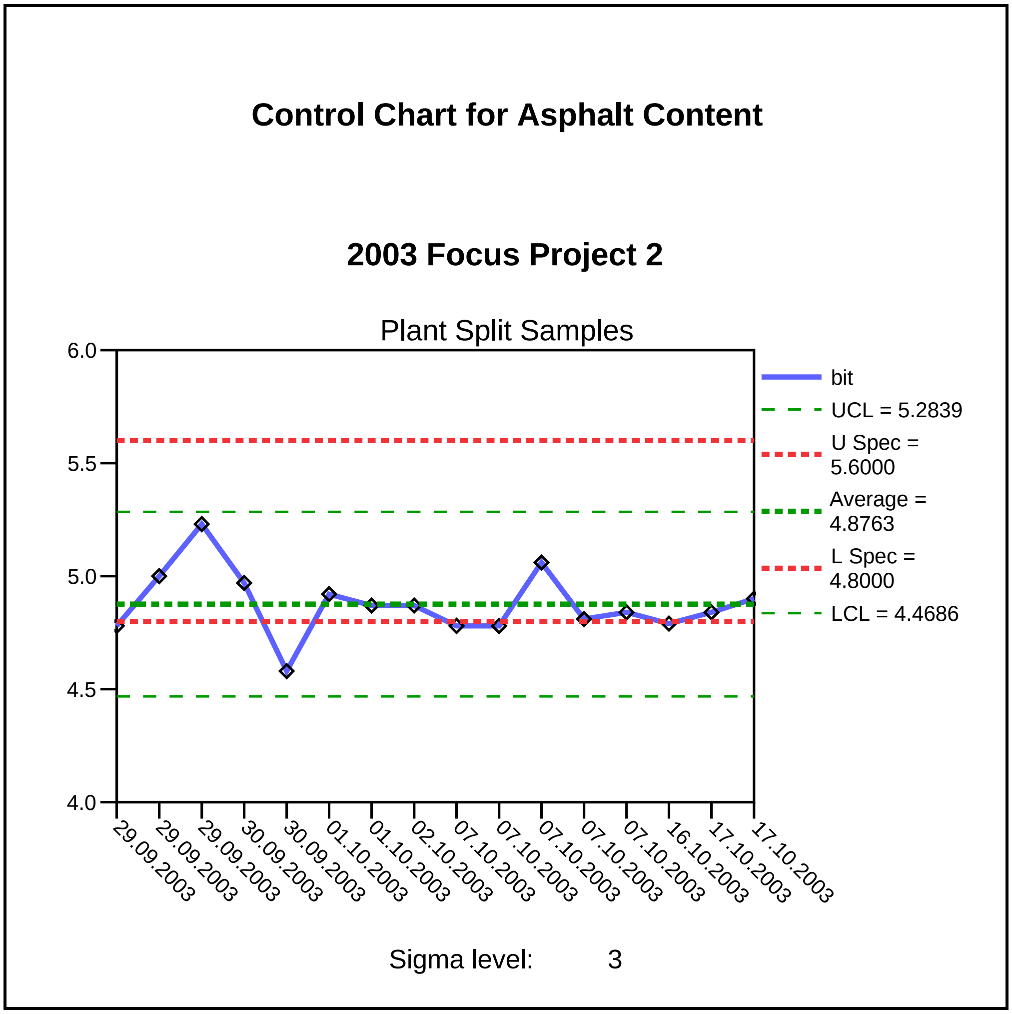

Figure 18 – Control Chart for Binder Content, Plant Split Samples, 2003 Focus Project 2. Actual % outside specification limits = 32%. Y axis values are % asphalt in the mix by weight. UCL = Upper Control Limit; LCL = Lower Control Limit; U Spec = Upper specification limit; L Spec = Lower specification limit.

Control chart analysis such as this is extremely useful in identifying potential issues. In these cases the following issues are crucial:

1. Matching the average of production to the target value. It is obvious that, for 2003 Focus Project 2, the percent within specification limits would have been greatly improved if the target production rate had been the job-mix formula target value. Looking at Table 15, the

descriptive statistics for asphalt content by day of production, only once out of 73 samples does the maximum value exceed the target value for asphalt content. The 95% confidence interval for the mean of each day of production is always less than the job-mix formula target value.

Day		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	Between Component Variance
						Lower Bound	Upper Bound			
1		4	4.9575	.07848	.03924	4.8326	5.0824	4.87	5.06	
5		4	4.6950	.08737	.04368	4.5560	4.8340	4.63	4.82	
6		5	4.6680	.21347	.09547	4.4029	4.9331	4.29	4.80	
7		8	4.6613	.19105	.06754	4.5015	4.8210	4.42	4.95	
8		5	4.8840	.19424	.08687	4.6428	5.1252	4.57	5.10	
9		4	4.6850	.28455	.14227	4.2322	5.1378	4.29	4.96	
12		6	4.8683	.14784	.06036	4.7132	5.0235	4.75	5.15	
13		7	4.9857	.11297	.04270	4.8812	5.0902	4.78	5.09	
14		6	4.8900	.11541	.04712	4.7689	5.0111	4.76	5.09	
15		8	5.0025	.20954	.07408	4.8273	5.1777	4.57	5.21	
16		6	4.8633	.16919	.06907	4.6858	5.0409	4.59	5.05	
22		4	4.8125	.07274	.03637	4.6967	4.9283	4.71	4.88	
23		6	4.9100	.11815	.04824	4.7860	5.0340	4.83	5.12	
Total		73	4.8460	.19447	.02276	4.8007	4.8914	4.29	5.21	
Model	Fixed Effects			.16641	.01948	4.8071	4.8850			
	Random Effects				.03560	4.7685	4.9236			.01087

Table 15 – Descriptive Statistics for Asphalt (binder) Content by day of production, POP samples, 2003 Focus Project 2.

2. The lack of an observable trend in the QC and Plant Split sets (whereas it is present in both the POP and Plant Independent sets) could be ascribed to insufficient sampling to capture production characteristics, or to a non-randomness in the sampling scheme. In this case, it

was observed that asphalt production was put through a silo for the afternoon production – presumably to avoid an unnecessary shutdown in the middle of the production run.

3. Avoiding long-term trends and short-term changes in production without initiating new lots of material. Ideally, if the process is in control and the inputs are not changing radically, there should be no such need to deviate from the target values.

Testing for the Normality Assumption

The vast majority of QA programs rely on the assumption of normality to make quantitative comparisons work. Most processes related to HMA construction have been assumed to be naturally normal, that is, to follow the normal distribution. Data comparison methods such as the t-test (comparing the means of two samples) are robust to violations of the assumption of normality, but this is not necessarily the case for common tests comparing variances (the F-test in particular.)

It can be hypothesized that there may be several factors that cause the assumption of normality to be violated. These include:

1. A naturally non-normal process or data distribution. In this case we would expect the assumption of normality to be violated in the vast majority of cases. None of the data observed presented these characteristics.
2. Heterogeneous lots (two or more underlying populations are included). This would occur when there are changes to the

quality characteristics' values that are not corresponded with a lot change. For instance, if the lot is a day of production and there is a change in mix properties in the middle of the production run, there may be a "bi-modal" or two-peak distribution. Figure 19 represents daily values for which the normality test (Shapiro-Wilk) failed. The horizontal scale value represents the order (in time) in which the samples were obtained.

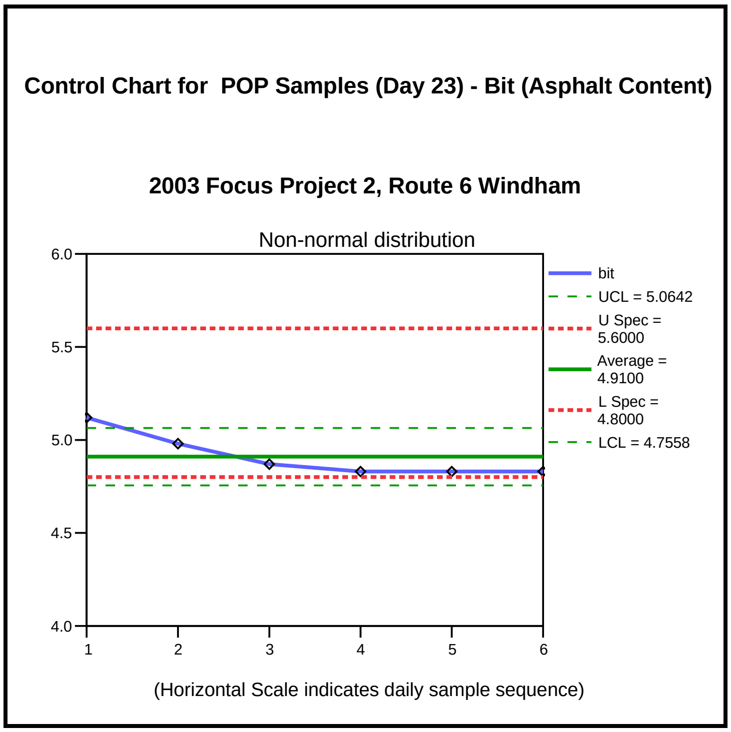

Figure 19 – Control Chart for binder content, Day 23, 2003 Focus Project 2, POP samples. Y axis values are % asphalt in the mix by weight. UCL = Upper Control Limit; LCL = Lower Control Limit; U Spec = Upper specification limit; L Spec = Lower specification limit.

However, it is possible to have a process change and have the data not fail the normality test, as shown in Figure 20.

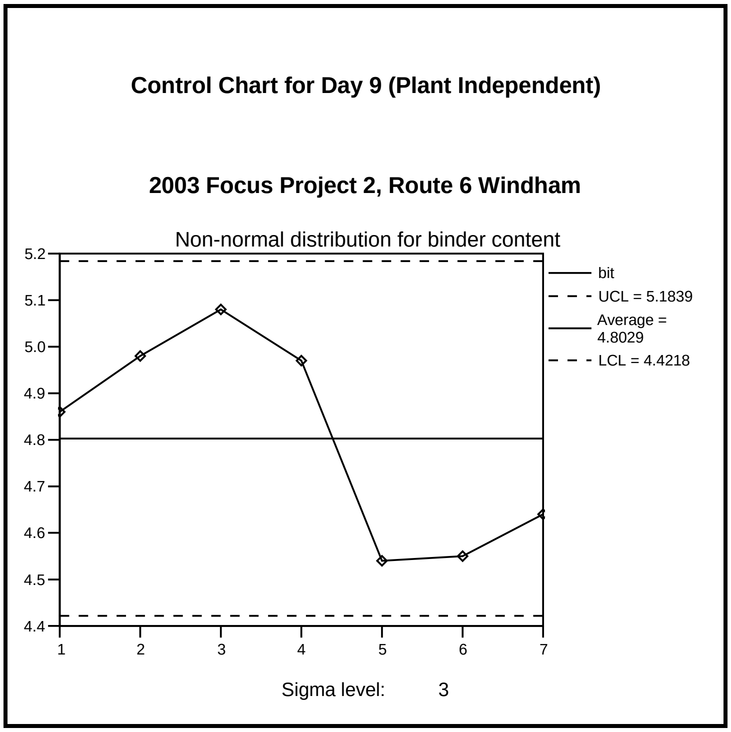

Figure 20 – Control Chart for binder content, 2003 Focus Project 2, Day 9, Plant Independent Samples. Y axis values are % asphalt in the mix by weight. UCL = Upper Control Limit; LCL = Lower Control Limit; U Spec = Upper specification limit; L Spec = Lower specification limit.

Clearly these two examples reflect changes in the process characteristics. One affects the normality assumption while the other one does not. But a change in production characteristics can be the cause of non-normal data sets that in reality belong to a normal distribution. The key point is that lots should be terminated when a production change is to take place at the plant.

3. <u>“Near-outliers” in the data</u>, especially in smaller sets. Outliers which are not removed from the data set (because they may “technically” not be outliers) could cause skews in the way the distribution of the data is estimated. The smaller the set, the greater the “weight” of the outlier on

the distribution estimations, and the greater the chance of a beta error (of accepting the alternative hypothesis when it is false). This only applies if a “near-outlier” is in the data set or if an actual outlier is not removed. We would expect comparisons of the lots not containing an outlier to result in the inability to reject the null hypothesis among means. Figure 21 represents asphalt content values from 2002 Focus Project 2 for “Day 9” of production, from the “Plant Independent” data set.

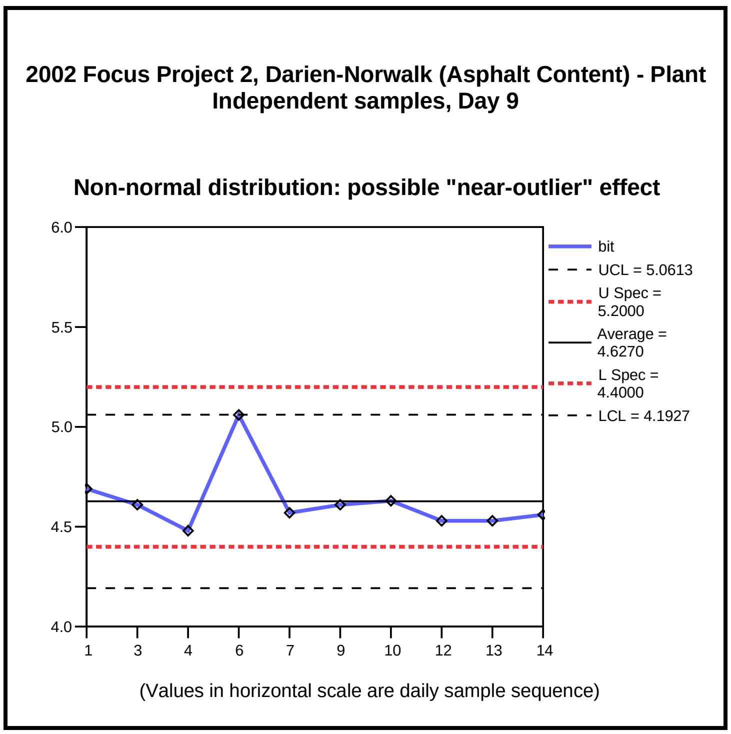

Figure 21 – Control chart for binder content, 2002 Focus Project 2, Plant Independent Samples, Day 9. Y axis values are % asphalt in the mix by weight. UCL = Upper Control Limit; LCL = Lower Control Limit; U Spec = Upper specification limit; L Spec = Lower specification limit.

It is apparent that one value in Figure 21 (sample “6”) differs from the rest of the values.

During the course of the project, these values were analyzed using histograms. Histograms provide a convenient and powerful visual representation of the data distribution. However, histograms may not explain as much as a control chart the root cause of the deviation from the assumption of normality. In fact, they can lead to misleading conclusions without further analysis (examination of control charts, to name but one such technique.) Figure 22, corresponding to the same data used to construct Figure 19 (Asphalt content, Day 23, POP Samples, 2003 Focus Project 2) gives no indication of a process change, and could easily be interpreted as a non-normal process.

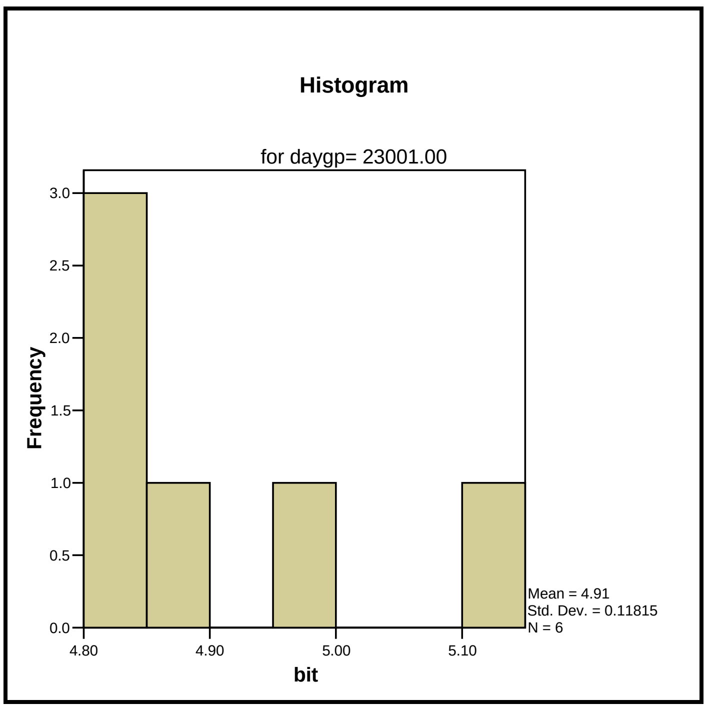

Figure 22 – Histogram for binder content, 2003 Focus Project 2, POP Samples, Day 23.

Selecting an appropriate alpha level does not automatically control the power of the statistical test, but it does control the error of rejecting the null hypothesis when it is in fact true. A significance (alpha) level of 0.05 was selected for this test.

Examination of the data by the means described above shows that the reason for non-normality, when it does occur, is not non-normality in the nature of the process itself (See APPENDIX D for complete normality data for each focus project.) That is, in all cases the majority of the sets exhibit a normal distribution of the population of data. This is consistent with generally accepted assumptions of HMA-construction QA programs throughout. The presence of near-outliers may be at play in a couple of instances, in particular in Sampling Group 4 (QC), where the sample sizes are small (N=3 or 4; Plant split data by day (Sampling Group 3) did include several N=2 samples, for which the normality assumption could not be checked; however, weekly data did indicate that the data by and large follows the normal distribution.

The significance of this finding for QA implementation in Connecticut is that parametric tests (t test and F test), which are the ones on which PWL specifications are based, are appropriate for the quality characteristics included in the study.

Lot size and PWL findings

Percent Within Limits (PWL) is a common measure of uniformity in QA programs for HMA construction. PWL is defined as

> "The cumulative area under the Normal (Beta) Distribution Curve which represents the estimated percentage of a Lot that falls above the Lower Specification Limit, beneath the Upper Specification Limit, or between the Upper and Lower Specification Limits."[25]

The following figures illustrate the effect of using bigger lots on the Percent Within Limits (PWL) of a project. In addition, they also illustrate (in the case of this particular project) the need to adhere to JMF targets. In particular, the PWL of the binder content was affected by the average of production being much lower than the mix-design value. The production target offset could be due to the lack of use of ash correction, which would account for the difference. Independently of all other steps taken, ash corrections and ignition oven corrections should be included if any data comparisons are to be made regarding the most expensive material in the mix. 2003 Focus Project 2 was used to analyze lot size. The first set of figures (Figure 23, Figure 24, Figure 25) are examples of PWL on a daily basis:

[25] QA Technologist Course, p. 6-14.

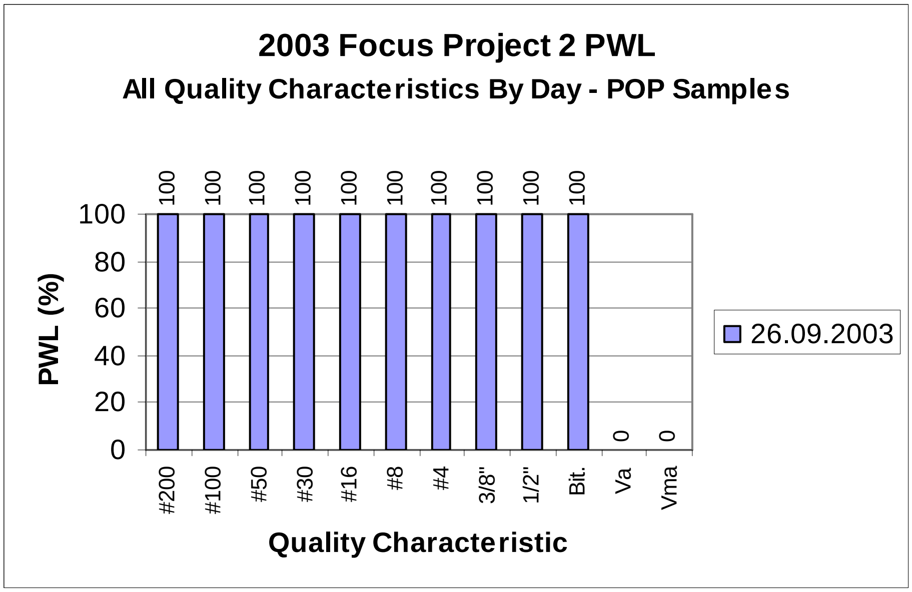

Figure 23 – PWL for 1st day of production, 2003 Focus Project 2, POP Samples. Bit = binder % by weight; Va = Air voids; VMA = Voids in the mineral aggregate; all other values are % passing the sieve indicated.

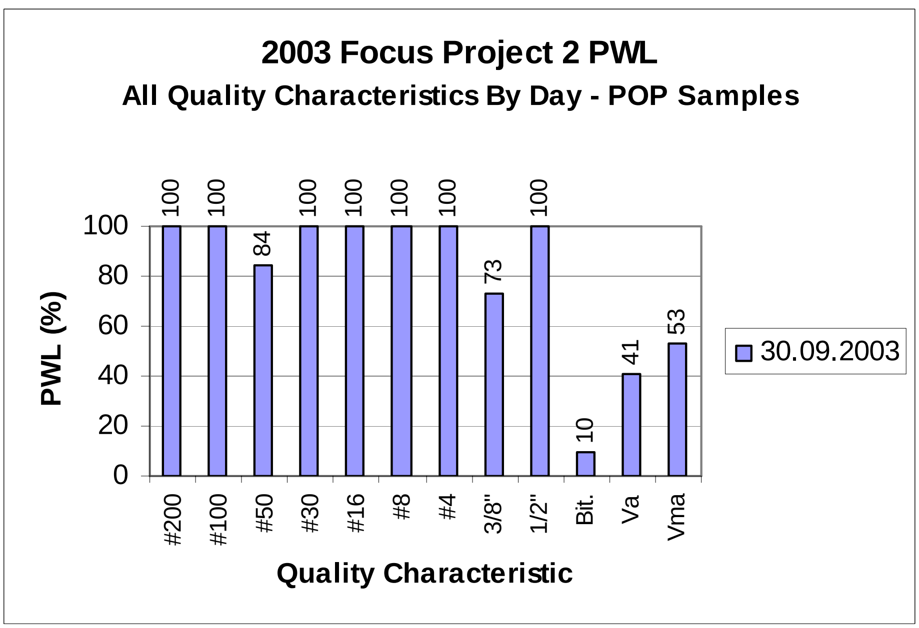

Figure 24 – PWL for 2nd day of production, 2003 Focus Project 2, POP Samples. Bit = binder % by weight; Va = Air voids; VMA = Voids in the mineral aggregate; all other values are % passing the sieve indicated.

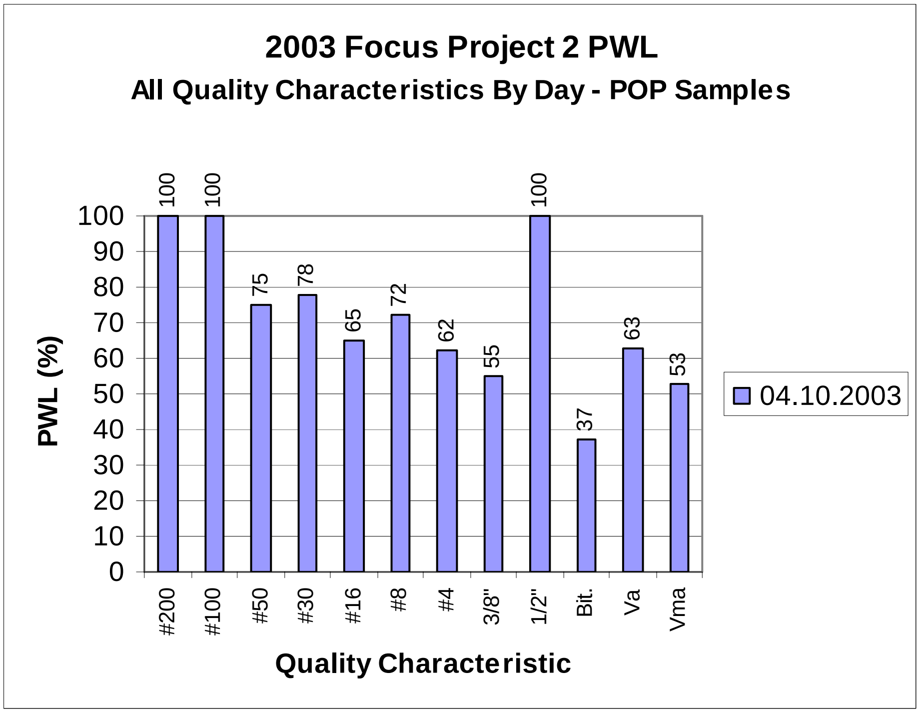

Figure 25 – PWL for October 10th, 2003 Focus Project 2, POP samples. Bit = binder % by weight; Va = Air voids; VMA = Voids in the mineral aggregate; all other values are % passing the sieve indicated.

These are examples of PWL's obtained on this job. Much of the problem lay in being off-target with respect to the job-mix formula.

The next two graphs (Figure 26 and Figure 27) show PWL for the entire project.

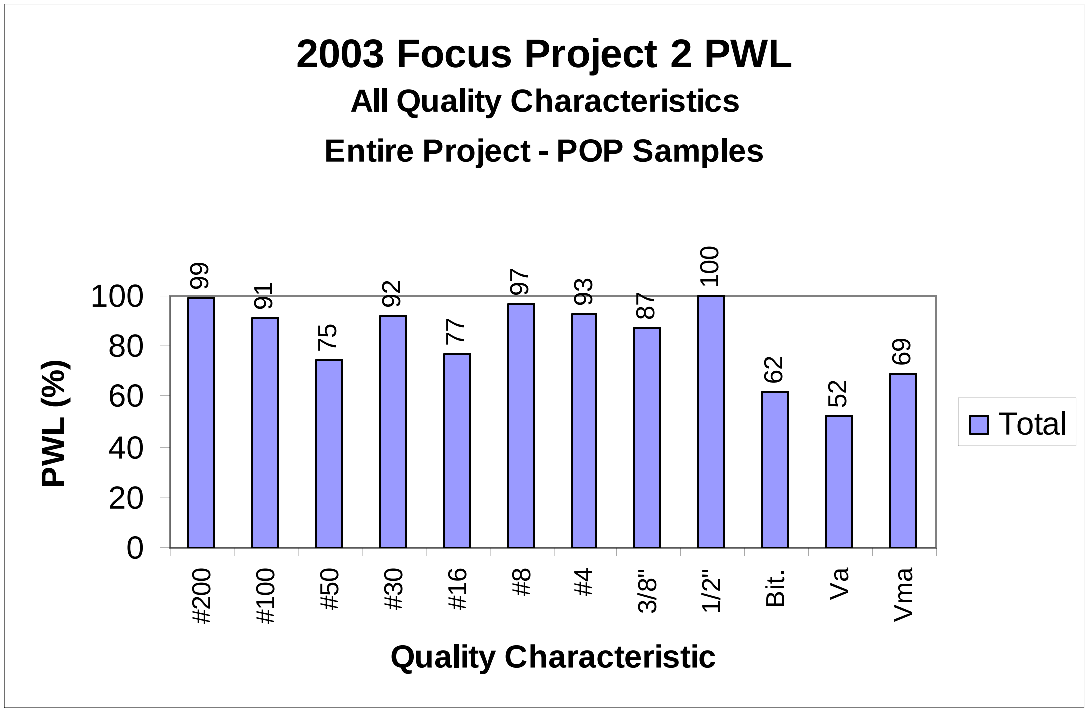

Figure 26 – PWL for Entire Project, POP samples, 2003 Focus Project 2. Bit = binder % by weight; Va = Air voids; VMA = Voids in the mineral aggregate; all other values are % passing the sieve indicated.

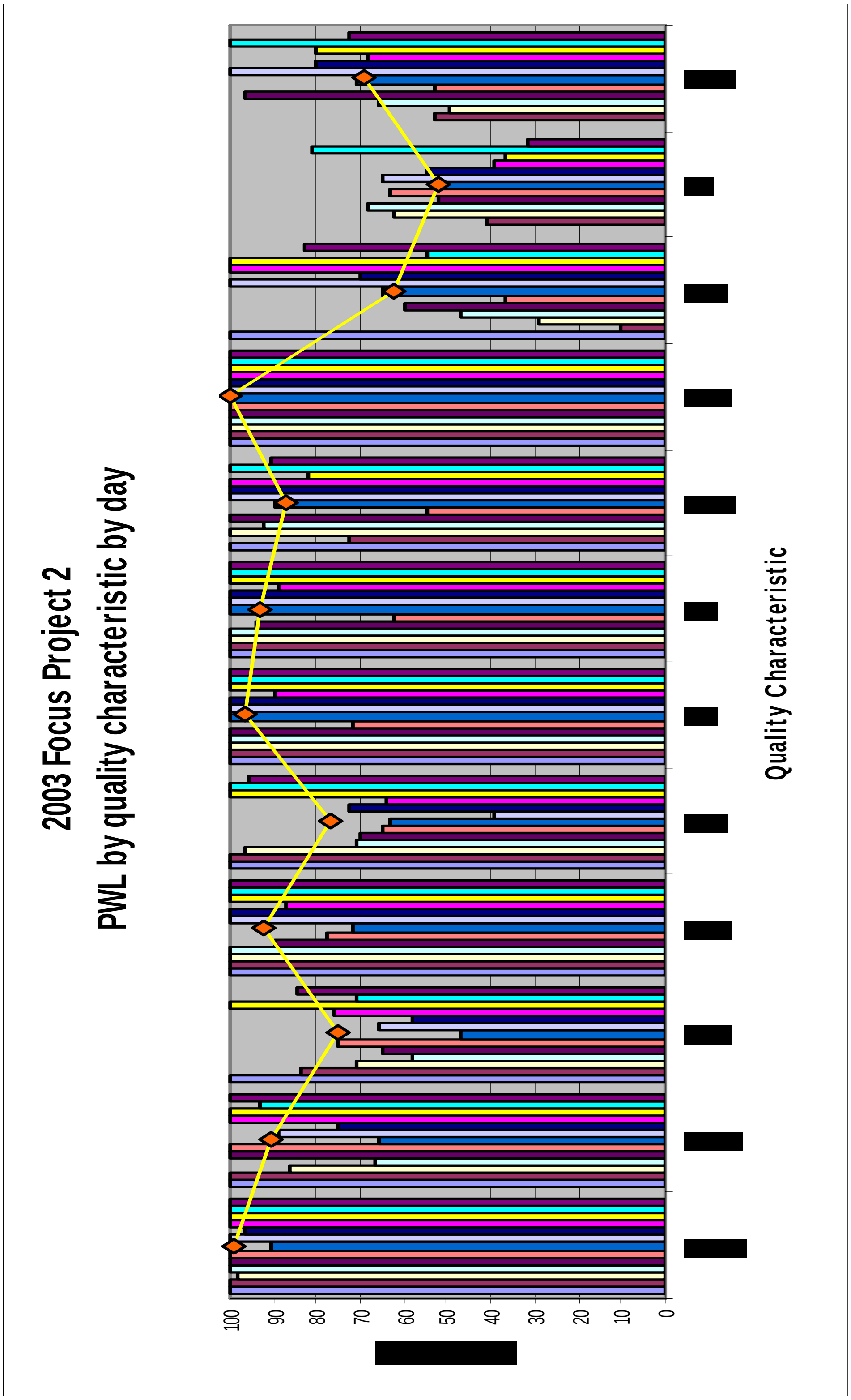

Figure 27 – PWL for daily production and overall project production (as one lot), 2003 Foc. Proj. 2. Bit=Binder% by wt; Va=Air voids; VMA=Voids in the mineral aggregate; all other values are % passing the sieve indicated.

Figure 27 (presenting the PWL results by day, where each bar is a different day and each bar group is a quality characteristic), clearly shows that all of the volumetrics, and some of the fine, exhibit the lowest PWLs for this project.

From a risk perspective, the smaller the lot the more specific and accurate the payment is. Smaller lots will isolate quality problems and apply a penalty only to the lot of material where they occur. Likewise, high-quality production will be rewarded where it actually takes place. This is salutary to maintain producer focus on high quality all the time, because the impact is immediate and dramatic. Examine Table 16 and Table 17, which present PWL analysis. Table 16 compares PWL values obtained by using weekly lots with those taking the entire project as a lot. 2003 Focus Project 1 was analyzed for this table. It is clear that if all PWLs are high (or low), little difference will be seen between using one lot size versus another. But while the average PWL of the weekly lots approaches that of the project lot, individual lots are considerably off the value. For example, p8, Plant Independent, has a minimum lot PWL of 54, while the overall project value is 82 and the average of the weekly lots is 79. There are only four weekly lots in this sample (for some sampling groups there were less weekly lots with N > 2 where PWL calculations could be conducted). The set of weekly PWLs for p8, Plant Independent is {91, 89, 81, 54}. Depending on the distribution of payment factors, this may not translate equally to the average. While on a weekly basis the effect is not that dramatic, Table 17 (composed using all data from 2003 Focus Project 2) shows, for p16 (or asphalt content {bit)), that a daily lot can be way off the average PWL for the project. Intuitively this material may fail way before the project as an average does. The PWL of 8 for p16 was calculated for a sample with N=3. The value happened to lie just outside the specification limits and the variation (as expressed by the standard deviation) was sufficiently (and abnormally) small to cause the PWL to be extremely low. This is an example of having a sample size sufficiently large to control risks. In this case it is the producer who incurs in risk. But the agency also incurs in risk in some lots where the PWL is abnormally high, for purely probability reasons.

Table 17 also can be used to compare PWLs for different sampling groups. Plant Splits and QC had too few tests (N=2) to usefully describe PWL on a daily basis. On the right side of the table the project PWLs are presented by sampling group and it is apparent that there is a wide range of PWLs for some quality characteristics, depending on the sampling group.

		Entire Proj. Lot		**Weekly Lots**		**Minimum by Wks**	**Difference from Overall PWL**	
Sample Group	**Quality Char.**	**N**	**PWL**	**N**	**PWL**	**PWL**	**Avg Wk - Proj**	**Min Wk - Proj**
POP	p200	42	99	40	100	99	1	0
	p100	42	99	40	100	99	1	0
	p50	42	99	40	100	99	1	0
	p30	42	98	40	100	99	2	1
	p16	42	91	40	94	83	3	(8)

	p8	42	70	40	67	42	(3)	(28)
	p4	42	53	40	45	22	(8)	(31)
	p3_8	42	87	40	87	83	(0)	(4)
	p1_2	42	99	40	99	98	0	(1)
	p3_4	42	100	40	100	100	0	0
	bit	42	65	40	67	58	2	(7)
Plant Independent	p200	85	100	85	100	100	0	0
	p100	85	100	85	100	100	0	0
	p50	85	96	85	96	91	0	(5)
	p30	85	98	85	100	99	2	1
	p16	85	93	85	94	84	1	(9)
	p8	85	82	85	79	54	(3)	(28)
	p4	85	70	85	65	40	(6)	(30)
	p3_8	85	97	85	97	93	(0)	(4)
	p1_2	85	95	85	96	92	1	(3)
	p3_4	85	n/a	85	n/a	n/a	n/a	n/a
	bit	85	76	85	79	74	3	(2)
Plant Split	p200	28	99	26	99	98	0	(1)
	p100	28	98	26	99	97	1	(1)
	p50	28	89	26	94	83	5	(6)
	p30	28	98	26	98	94	0	(4)
	p16	28	95	26	97	91	2	(4)
	p8	28	90	26	96	87	6	(3)
	p4	28	83	26	93	79	10	(4)
	p3_8	28	96	26	98	93	2	(3)
	p1_2	28	95	26	95	89	0	(6)
	p3_4	28	n/a	26	n/a	n/a	n/a	n/a
	bit	28	84	26	85	75	1	(9)
QC	p200	37	100	37	100	99	(0)	(1)
	p100	37	100	37	100	99	(0)	(1)
	p50	37	98	37	97	88	(1)	(10)
	p30	37	99	37	100	98	1	(1)
	p16	37	98	37	100	98	2	0
	p8	37	95	37	99	95	4	0
	p4	37	91	37	95	80	4	(11)
	p3_8	37	98	37	99	96	1	(2)
	p1_2	37	99	37	99	97	(0)	(2)
	p3_4	37	n/a	37	n/a	n/a	n/a	n/a
	bit	37	91	37	92	86	1	(5)

Table 16 - PWL values obtained by using weekly lots with those taking the entire project as a lot.

Quality Charact.	POP Avg (days)	POP Min (days)	Plant Independent Avg (days)	Plant Independent Min (days)	POP all (N=52)	Plant Independent all (N=46)	QC all (N=29)	Plant Split all (N=16)

#200	**99**	91	**99**	88	**99**	**99**	98	**99**
#100	91	66	98	83	91	**97**	**97**	87
#50	74	47	81	44	75	**85**	77	58
#30	94	72	**95**	77	92	93	93	80
#16	80	39	**81**	8	77	**81**	**81**	56
#8	97	72	98	92	97	96	**99**	93
#4	96	62	87	58	93	89	**98**	95
3/8"	91	55	81	35	87	78	**98**	97
1/2"	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Bit.	66	10	46	0	62	41	45	**69**

Table 17 - PWL comparison by using daily lots versus taking the entire project as a lot.

Gradation only

Percent Within Limits analysis should only yield unacceptable quality levels on a short-time basis. Low PWLs should, with incentives and disincentives, result in the producer quickly gaining control of its process. It is very costly to gather verifying information once the project is completed, and, more fundamentally, quality cannot be corrected at all. The use of smaller lots provides for corrective measures. If impending production changes are known ahead of time, lots can also be terminated and begun on the basis of changes in production only. In fact, these changes can be programmed in advance as changes in the raw-material supply are foreseen through testing at the sources, and should be accompanied by trial testing of the properties, especially Superpave-related properties.

The result of larger lot sizes is likely to be less samples required to make a less risky decision about the quality of the material placed. However, this must be balanced against the need to correct quality problems as they arise. To this end, the active use of control charts by the producer will prove invaluable.

Focus Project 2, 2003 - Route 6, Andover-Windham

For this project, the PWL obtained was often below 100%. In the case of percentage of binder, the PWL, computed from the job-mix formula and using QC data, was only 45%. If the job mix formula target value had been the achieved average of production, the PWL would have been 97%.

Analysis of the binder PWL:

The fact that the PWL was corrected by simply changing the target value strongly suggests that the most significant problem was not one of variability but rather of an asphalt dosage into the production mix that was different from the target value of the job-mix formula.

Analysis of the gradation PWL (Passing #50 sieve):

For the material passing the #50 sieve, the PWL of the behind-the paver samples was 73%. Mathematically, if the target value is shifted to match the average of production, the PWL would be 98%. The PWL for the QC samples was 77%. If the target value for the material passing the #50 sieve is shifted to theoretically, match the average of production, the PWL decreased to 75%. The POP data indicates that the proportion of material passing the #50 sieve was different from the job-mix formula, but the QC data indicates a need to better control that fraction of the aggregate structure.

Lot Size Analysis:

Bigger lots reduce the producer’s and buyer’s risk, for the same number of samples per quantity produced. In other words, while production remains homogeneous the larger number of samples to represent a single homogeneous lot results in less opportunity for committing either alpha or beta errors. For acceptance purposes, however, a difference in test results that impacts payment would become a bigger issue to resolve if larger lots were to be used. Having prompt feedback such as that provided by smaller lots, on the other hand would allow the producer to increase its out-of-control binder dosage as soon as the problem is discovered by the agency (the results that impact payment).

Sampling Location Analysis:

For most variables, POP sampling yielded lower PWLs than QC data for this project, albeit with increased sample size. However, this is true even when the project is taken to be a single lot. This indicates that the POP sampling method is capturing variability from the handling, placement, and behind-the-paver sampling processes.

Segregation findings

2002 Focus Project 1 – Route 94, Glastonbury: Segregation and Sampling Location

This project provided an opportunity to test sampling methods behind the paver in an undivided highway with day paving and limited room in which sampling equipment and personnel operated. Several factors are important to consider regarding the feasibility of POP sampling as well as the ability of this sampling location to detect segregation, as noted below:

Material Transfer Vehicle (MTV)

A Material Transfer Vehicle (MTV) was used for a substantial length, beginning on September 11, 2002. The MTV was subsequently damaged and was not used on the last day of production (the easternmost limits of the project). However, POP samples were not collected on the last day of production.

Sampling Space Requirements

There were limited mobility options for sampling personnel in numerous areas, due to conditions such as narrow shoulders (especially in cut and fill areas) and guiderail. These conditions proved to require the greatest amount of precautions and adjustments in order to move sampled material, set up for sampling, and parking. However, sampling locations were not changed for any of these reasons.

Segregation

Because areas of coarse texture were observed in some of the paving lots where the MTV was not used, one paving lot measuring roughly 0.5 miles was visually inspected for the presence of segregation (by identifying areas with coarse surface texture) by a walking survey of three personnel, including the project PI. Over 90 locations of distinct coarse texture were identified; load-to-load patterns as well as random segregation were observed.

Although not inspected in a walking survey, identifiable coarse-texture areas were not present in those areas where an MTV was used. The QA project team was interested in the effect of the use of the MTV on segregation as measured by gradation variability in the POP samples. The hypothesis is that the MTV, by helping re-distribute aggregate particles in the mix, would reduce the amount of segregation (at least load-to-load segregation) in the paved mat, and that this would be identified by the POP samples through reduced variability in the gradation and/or asphalt content. A General Linear Model Multivariate analysis was run to determine, at 0.05 significance, the significance of the sampling group and MTV variables on the various quality characteristics being measured. In the analysis, the sampling group and the MTV were included as factors affecting both gradation and volumetrics (for the volumetric analysis, only the POP and QC data were used, since non-split independent plant samples did not have volumetric testing performed).

Dependent variables	Factors	Significant factors (sig.)*	Power	Groups used
% Passing (all sieves, bit. Content)	MTV, Location, MTV*Location	MTV (0.000) Location (0.000) MTV*Location (0.042)	MTV: 1.000 Location: 0.995 MTV*Location: 0.854	POP, Plant Independent, QC
Volumetrics	MTV, Location, MTV*Location	MTV (0.000), Location (0.000)	MTV: 1.000 Location: 1.000 MTV*Location: 0.654	POP, QC

Table 18 – Results of GLM Multivariate Analysis for 2002 Focus Project 1.

* Pillai's trace was used, since it is most robust to violations of assumptions and to unequal cell sizes.

Having established that the MTV is a factor at 0.000 significance, as presented in Table 18, the expectation would be that the variability of POP samples would be lower after the MTV were introduced, controlling for variability in the samples obtained at the plant during the same production periods. Levene's test for equality of variances was used to determine, at significance = 0.05, whether the null hypothesis of equality across variance groups could be rejected. For samples obtained at the plant, the hypothesis of equality of variances could be rejected for two variables (% Passing the #8 sieve, sig = 0.029, and % Passing the #200 sieve, sig = 0.042). The t-test, using the correct assumption regarding variance equality, caused the null hypothesis (of equality in means) to be rejected for the % Passing #200 sieve only (sig. = 0.004, with the mean being higher on those days when the MTV was introduced). For field-obtained samples (the POP set), the hypothesis of equality of variances could be rejected (at significance 0.05) for two variables (% Passing the #8 sieve, sig. 0.033, and % Passing the #4 sieve, sig. 0.016). The t-test, however, caused the null hypothesis (of equality in means) to be rejected for the following sieves: (% Passing the #16, #8, #4, 3/8”, and ½” sieves), with means being lower for the samples obtained when the MTV was used in the paving train. This strongly suggests that, though variability was not significantly reduced, the samples were “coarser” when the MTV was used.

Significant Observations:

1. The expected variance inequalities in the POP data set were not sufficiently conclusive to point to the MTV as the primary factor. However, when one
2. The percentage of material passing the coarser sieves (#16 and larger) was lower for POP samples once the MTV was introduced.
3. The percentage of material passing the #200 sieve was higher at the plant (p=0.004) once the MTV was introduced, but was not significantly different in the POP samples (p=0.779).

These observations prompt the following questions:

1. Does the lack of rejection of the null hypothesis for variance inequality (an expected reduction when the MTV was

introduced) indicate that the MTV is not effective at reducing segregation?

2. Why would the gradations of the larger sieves be different (reduced % passing values, indicating coarser material) with the presence of the MTV?
3. Why would the significant increase in % Passing #200 material not be reflected also in the field (POP) samples?

Although a much more controlled and rigorous experiment is needed in order to conclusively answer these questions, there are possible hypotheses that warrant consideration: An alternative to the explanation that the MTV is not effective at reducing segregation is that the sampling rate in the field is insufficient to capture the segregation reduction in terms of a variability decrease. This is consistent with the fact that the areas of visible segregated ("coarse") texture are small with respect to the overall surface area of the paved mat. This sampling rate insufficiency (in its ability to detect coarse-particle areas) would be manifested in the inability of the t-test to differentiate between means of plant-obtained and pavement-obtained sections where the MTV had not been used.

There is another explanation, however, related to this specific data set and which is just as likely to explain the results. One sample from the MTV set was taken in the first 10 meters of paving for the day and was substantially coarser than the remaining samples for all days of POP samples when an MTV was used. The data comparisons after removal of this sample from the POP+MTV data set do show both a significant difference in variance (reduction with MTV use) and an increased “coarseness” of the placed mix.

The increased coarseness observed in the larger sieves only in the POP samples does suggest that additional coarse particles are being included in the samples of material remixed with the MTV. Sampling methodology variability in the POP data set is an unlikely source of a change in means within the POP data set itself—the variability would be affected. This leaves the MTV as the most likely source of this significant difference in means (increased coarseness). Thus, the reduction in segregation due to the introduction of the MTV is being reflected in a coarser gradation in the samples as well as in a decrease in variability. Finding an increased coarseness or decreased variability in the POP samples is probably a function of the severity of the segregation and sample size.

The next step in this analysis was to carry it out onto the remaining three (3) focus projects. Controlling for sampling group (POP, Plant Independent, and QC) as well as week of production (day of production could have been used as well, yielding similar results); the increased “coarseness” in the coarse sieves was observed in the POP samples of one of the remaining three projects. In order to target the observed difference further, and having established through multivariate analysis that the coarseness could indeed be observed, the next logical move was to indicate sampling location via a variable that was “P” (for Plant) whenever a sample was taken at the plant and “F” (Field) for the POP samples. This resulted in combining the Plant Independent and QC samples into a single set. Plant Split samples were not used (though they were substituted for QC samples in a couple of cases to verify that the effect would be similar), because they were not obtained independently of the QC samples. The results are presented in Table 19 (they are simplified for reading ease into a general conclusion; there are multiple null hypotheses being tested with the t-test, for example):

Project	GLM controls	t-test Plant/Field	MTV Used
2002 Focus Project 1, no MTV	Week/day, sampling group (1-4)	Accept H_o in coarse sieves	NO
2002 Focus Project 1, MTV	Week/day, sampling group (1-4)	Reject H_o in coarse sieves	YES
2002 Focus Project 2	Week/day, sampling group (1-4)	Accept H_o in coarse sieves (actually reject but on fine side, small amount, for Passing ½”)	YES
2003 Focus Project 1	Week/day, sampling group (1-4)	Reject H_o in coarse sieves	YES
2003 Focus Project 2	Week/day, sampling group (1-4)	Accept H_o in coarse sieves	YES

Table 19 – GLM Multivariate analysis and t-test of variables of interest (once differences were found) to see effect of sampling location on gradation on coarse sieves.

The actual GLM and t-test data are included as APPENDIX G. It is important to note that the fraction that is coarser may be in one or two size ranges only, but its effects are felt down the sieves in terms of percent passing, as shown in the series of graphs presented in Figure 28 through Figure 31.

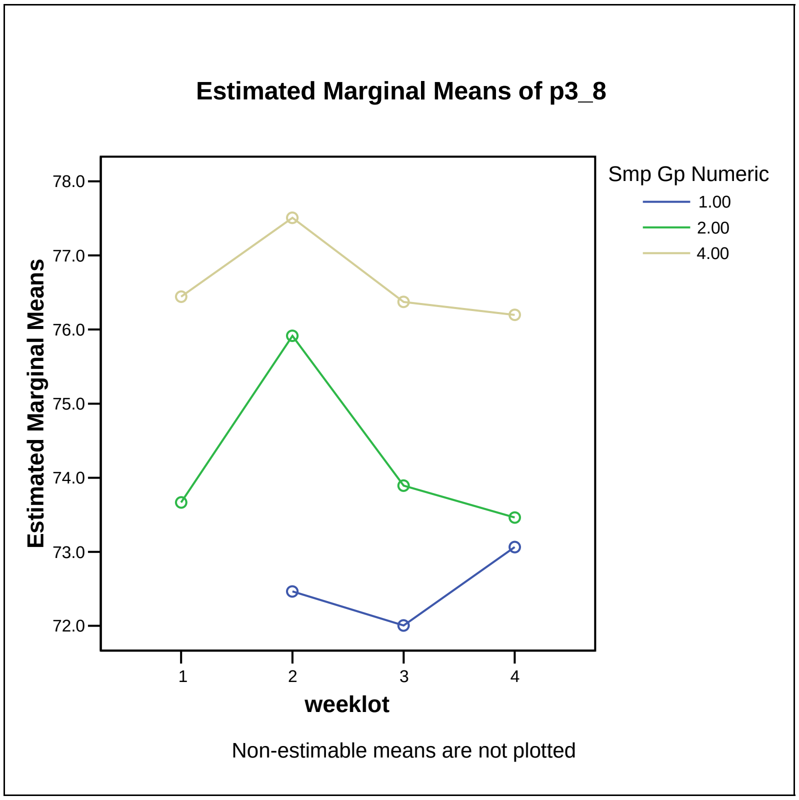

Figure 28 - % Passing 3/8" Sieve, 2003 Focus Project 1, Group 1 = POP, Group 2 = Plant Independent, Group 4 = QC. "Estimated Marginal Mean" is the average of the variable by sampling group and weekly lot.

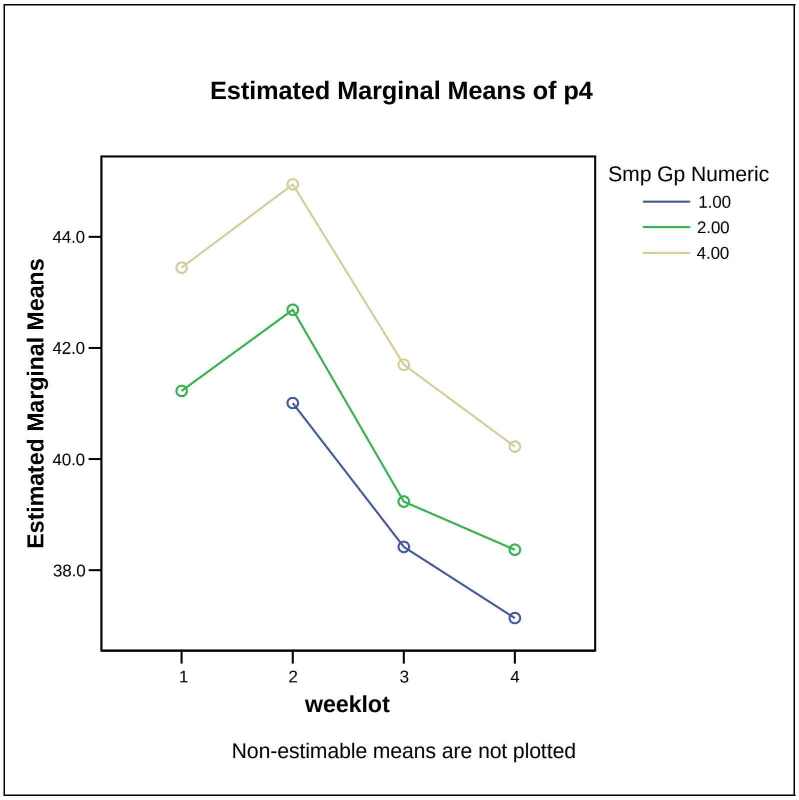

Figure 29 - % Passing #4 Sieve, 2003 Focus Project 1, Group 1 = POP, Group 2 = Plant Independent, Group 4 = QC. "Estimated Marginal Mean" is the average of the variable by sampling group and weekly lot.

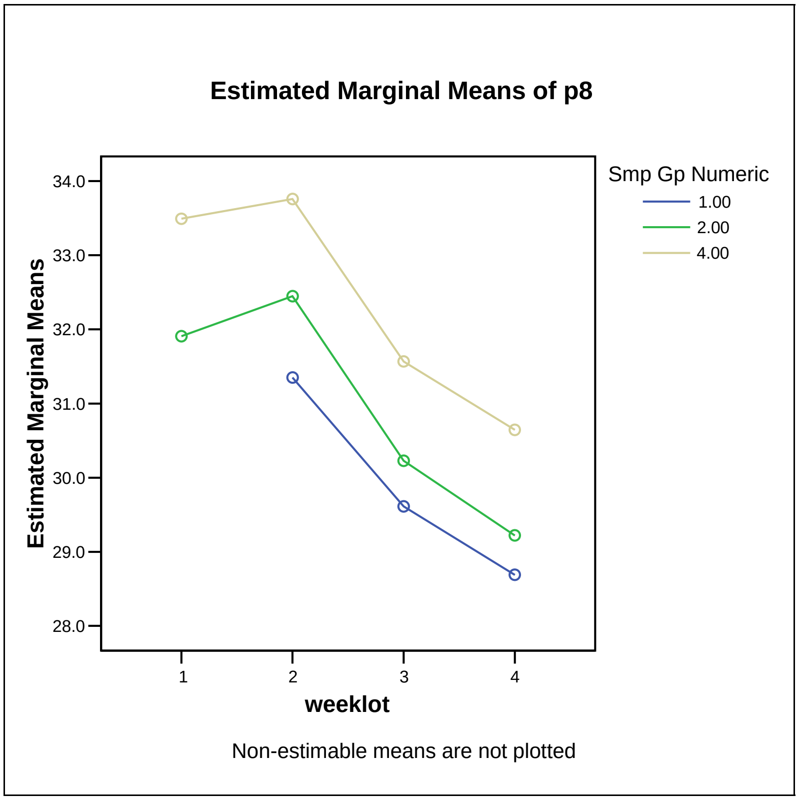

Figure 30 - % Passing #8 Sieve, 2003 Focus Project 1, Group 1 = POP, Group 2 = Plant Independent, Group 4 = QC. "Estimated Marginal Mean" is the average of the variable by sampling group and weekly lot.

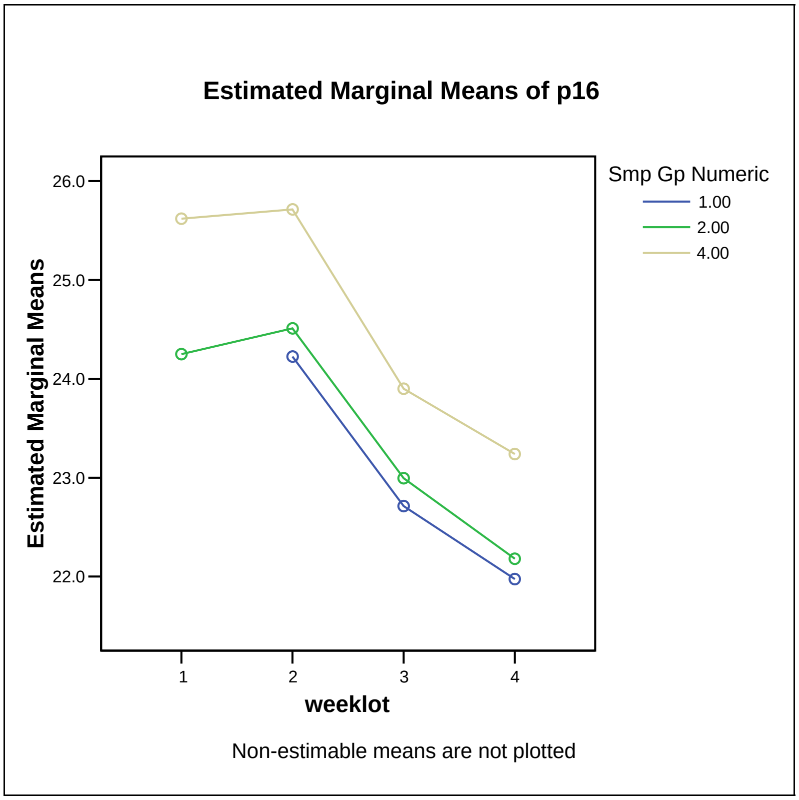

Figure 31 - % Passing #16 Sieve, 2003 Focus Project 1, Group 1 = POP, Group 2 = Plant Independent, Group 4 = QC. "Estimated Marginal Mean" is the average of the variable by sampling group and weekly lot.

Further research should be conducted to validate the hypothesis presented herein. Suggestively, the two projects where the POP coarseness was observed were ½" Superpave mix produced at a single plant, using similar job mix formulae. The other two projects did not present this particularity.

These project findings are significant if segregation is considered a significant quality characteristic. Segregation is difficult to define, identify, and (especially) measure. The findings of this data analysis exercise suggest that, if segregation is visually observed when HMA is placed without an MTV, the inclusion of an MTV in the paving train, coupled with POP sampling (as opposed to plant sampling) can correspondingly mitigate the segregation issue as well as help obtain mix information that more closely relates to in-place HMA characteristics. A more radical solution would involve being able to detect the propensity of a mix to segregate prior to determining whether either an MTV or POP sampling are necessary (or to preclude mixes prone to segregation from being placed in the first place). This approach, however, is well beyond the scope of the Quality Assurance project and the reader is referred to existing literature sources and on-going research on a national scale. Table 20 is presented as helpful in developing a strategy for addressing segregation.

Measure	Scope of influence	Benefit	Concern
Take POP samples	Measurement of segregation (mix variability and gradation)	More accurately reflect in-place properties of HMA that is prone to segregation.	More difficult than plant sampling; feedback of results may take longer than plant sampling; sampling size must be sufficiently large to have a reasonable probability of containing a sample from a “coarse” area.
Use MTV	Mitigation of segregation	Reduce mix variability, re-distribute coarse mix particles uniformly into the mix	Cost
Increase POP sample size	Measurement of segregation	Increase chances of detecting HMA segregation when MTV is not used	Time, labor, increased disturbance of the HMA mat.
Modify plant	Measurement of	Provide ability to	Cost of implementing automated sampling

sampling to allow for truly random sampling within each truck	segregation	measure HMA segregation when MTV is not used.	devices; availability of such equipment; may not reflect mix properties if MTV is used and HMA is prone to segregation.
Increase "modified" plant sample size	Measurement of segregation	Increase chances of detecting HMA segregation when MTV is not used.	May not reflect mix properties if MTV is used and HMA is prone to segregation.
Use cores from the pavement to measure gradation	Measurement of segregation		The question of whether quantity sampled is sufficient to capture variability changes (and gradation changes due to severed aggregate particles on the cores' side faces) in the mix (due to use of the MTV) should be studied; disturbance of the paving mat; feedback of results; sample size sufficiently large to sample coarse material.

Table 20 – Segregation measures

Effect of Reheating findings

The effect of reheating was measured in the laboratory. Controlling for mix and asphalt content (by using a single mix design and the same material), samples were split into single-heated and re-heated samples. Moreover, the curing time was varied up to six hours on the re-heated samples. Since re-heating constitutes about 1.5 hours of additional curing, it was also possible to “extend” the curing timeline to see if any effects were present. Two gyratory compactors were used to see whether that variable had an effect as well. The data are presented in Figure 32 through Figure 35.

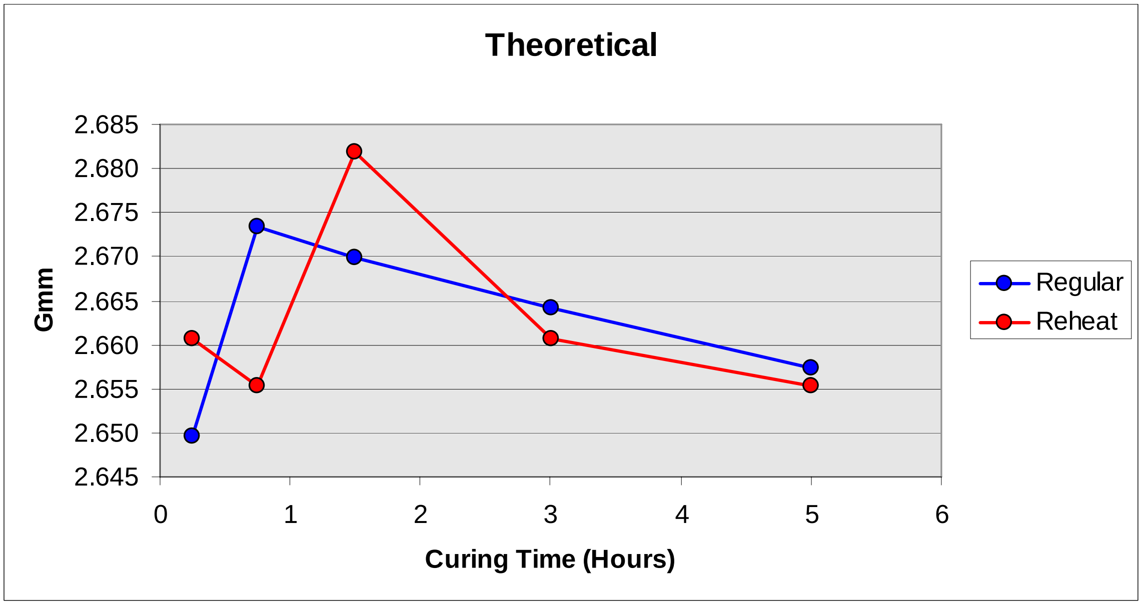

Figure 32 – Effect of curing time and/or reheating on Gmm.

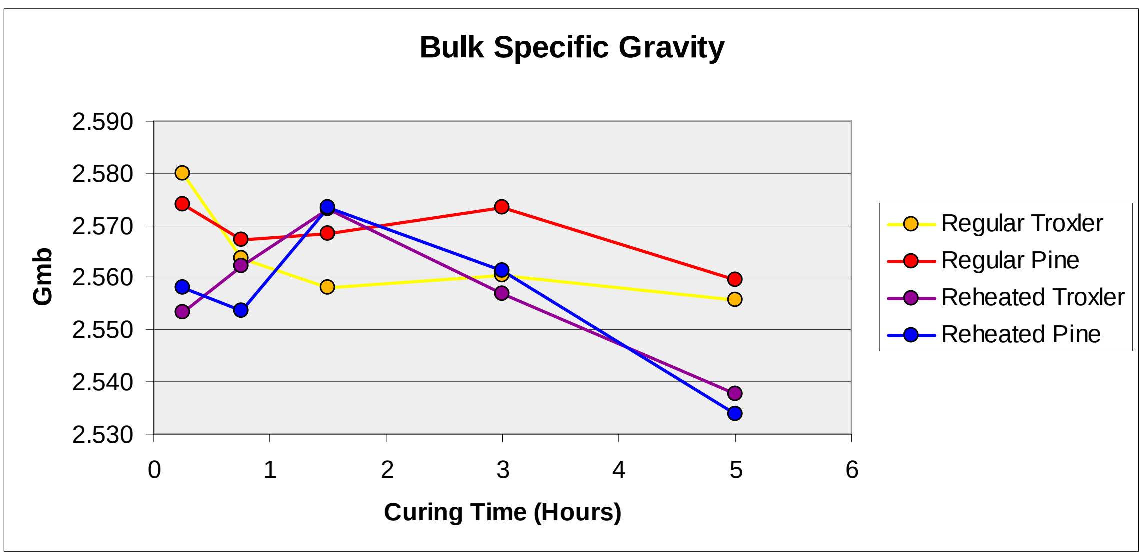

Figure 33 – Effect of curing time and/or reheating on Gmb.

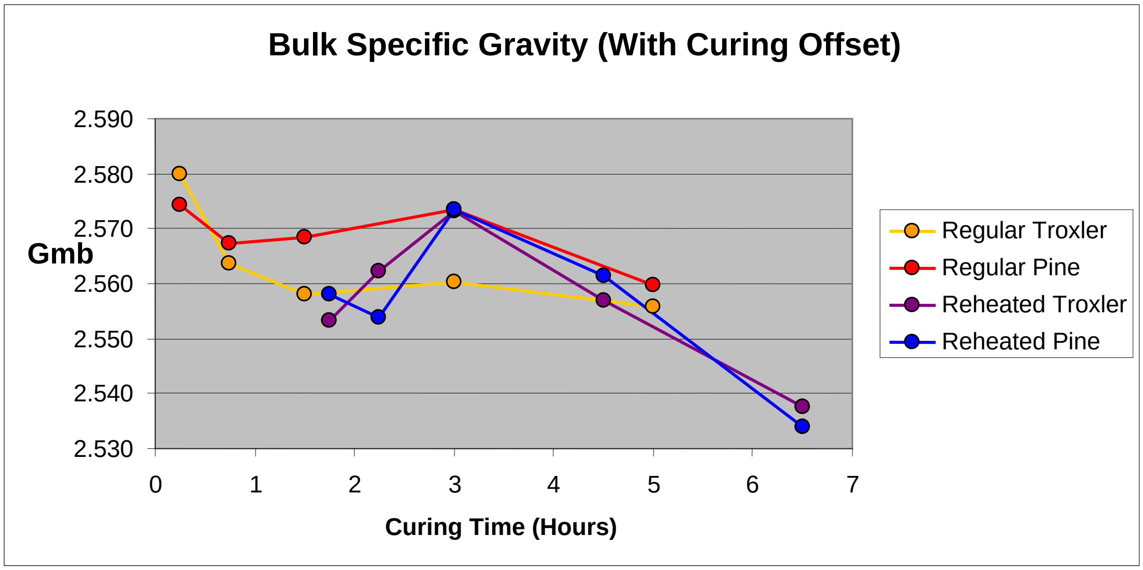

Figure 34 – Effect of curing time on Gmb, with curing offset by 1.5 hours for reheated samples.

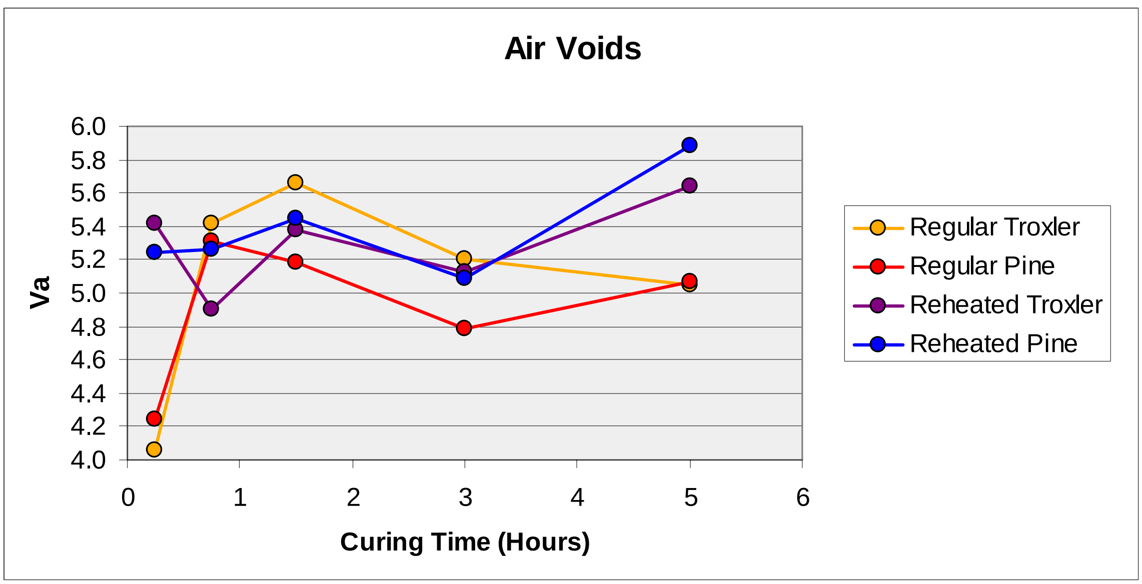

Figure 35 – Effect of curing time on air voids.

1. It must be noted that the "curing offset" was not included for Gmm or air voids, but if the reheated data points are shifted to the right by 1-2 hours, they appear to fall on a single curve, only extended.

Data Comparison Issues

In order to simulate the effect of a specification provision that allows the use of contractor data for acceptance decisions, the collected data were analyzed as three groups. The Point-of-Placement data were used as the Acceptance data set, the QC data were considered the contractor data set, and the plant independent samples were considered as the third-party, dispute resolution data set. Alternatively, the plant split data could be considered the QC data set against which the POP data set would be compared. Total possible combinations are listed in Table 21.

QC Data Set	Acceptance Data Set	Dispute Resolution Data Set		Quality Characteristics
QC	POP	Plant Independent		Gradation+AC%
Plant Independent	POP	Plant Splits		Gradation+AC% Volumetrics
Plant Splits	POP	Plant Independent		Gradation+AC%
QC	Plant Independent	POP		Gradation+AC%

Table 21 – Possible 3-way data-comparison sets and quality characteristics.

The issue when introducing a dispute-resolution data set is how to compare the three sets of data. If a straight “closest-to” value is used, it is entirely possible to obtain a data set that matches some quality characteristics better in one data set and some better against the other. If a three-way comparison is conducted, the power of the test is reduced, providing inconclusive results for many of the quality characteristics that show a difference when the F and t tests are applied.

The simplest way to run the dispute resolution is to minimize the quality characteristics being measured or to obtain independent samples for each quality characteristic (the latter being an impractical solution). A simpler way is to use Independent Assurance to compare against the data sets to see if equipment, etc are functioning, and use the contractor's data exclusively and only if the Acceptance test does not match the IA results and the contractor's do.

If neither set matches, a default payment can be made. In theory, if IA results do not match either data set, both sets of procedures and equipment should be checked before proceeding, since the quality level cannot be ascertained; perhaps a third data set could be obtained from the road, but this introduces additional sources of variation and uncertainty.

This simulation points out the difficulty in combining contractors' and Agency test results until a level of confidence in sampling, testing, and equipment is developed such that data-comparison issues are minimized. Until that point, it is more prudent to use only Agency test results, and provide the Contractor with a mechanism to challenge those results if its own QC testing presents a different portrait of production (perhaps storing an appropriate quantity of random samples of its own, obtained independently of its QC tests).

The data sets exhibited discrepancies in at least one quality characteristic in all but one of the days for which comparisons are available, as shown in Table 22. A Dispute

Resolution procedure (for means) with a binomial outcome (match closest mean from either QC or Acceptance data set) does not indicate a bias toward either the Acceptance or QC data set. But ANOVA analysis comparing all three data sets does indicate a reduction in the power of the test and, in some cases, discrepancies that had not existed when comparing simply the two data groups.

The objective of a dispute-resolution procedure should be, first and foremost, to minimize disputes in data sets of sufficient magnitude to affect payment. The all-or-nothing approach of matching the closest data set is expedient, but there is the possibility of introducing additional error in taking a third set of samples, as demonstrated by the instances when ANOVA results indicate that not all means are equal, or when Homogeneity of Variance tests suggest differences not present in the comparison of the two data sets.

The simulated IA tests, obtained by split sampling the QC results, indicate differences, especially in volumetrics and asphalt content. These differences are best resolved prior to production of material. Once all equipment, laboratory, and material variability have been accounted for, there will be fewer opportunities for a data discrepancy to arise. However, given that gradation comparisons generally do not indicate a difference, the emphasis must be on mix volumetrics. Further, the differences in gradation that appear between the QC and the Acceptance results are consequently more likely to be caused at least partly by differences in material variability, which is something that the Agency (customer) is interested in identifying through point-of-placement sampling.

TABLE:
POP vs. QC with Plant Independent samples used for Dispute Resolution

Day Number	Levene's Equality of Variance test differences	t-test differences	Dispute Resolution (t-tests)	ANOVA differences in mean detected among groups (sig. 0.05)	Homogeneity of Variance differences detected (sig 0.05) (3-way comparison)
5	P100 GMM	P50 P16 P8 P4 P3/8 BIT GSE	P50-QC P16-QC P8-QC P4-QC P3/8-QC BIT-Acc GSE N/A	P3/8	P100
6	None	BIT GSE	BIT-QC GSE-N/A	P200 P100 P4 P1/2 BIT	P30 P16
7	VA VFA	P4 P3/8	P4-QC P3/8-QC VA-NA VFA-NA	P4 P3/8 P1/2	None
8	None	None	Not Necessary	None (also-Not Necessary)	P200 P100 P50 BIT
13	P200 P100 P/38 BIT	P30 P16 P8 P4 P/38	P30-Acc P16-Acc P8-Acc P4-Acc P3/8-Acc	P16 P8 P4 P3/8	P200 P100 P50 BIT

	VMA				
14	P100	None	Not Necessary	None (also-not necessary)	P100
20	P200 P1/2 GMM	P3/8 GMB	P3/8-Acc	None	P50 P1/2
21	P200 P100 P4	None	Not Necessary	None (also-not necessary)	P200 P100 P1/2
22	None	P16 P8 P4 GMM	N/A (no data)	N/A (no data)	N/A (no data)
Summary			QC: 8 Acc: 8		

Table 22 – Data Comparison Simulation, POP vs. QC with Plant Independent Samples used for Dispute Resolution.

The General Linear Model

The General Linear Model (GLM) is the term often used to describe the family of ANOVA-related procedures that are used to find explanatory factors which are of a categorical or nominal nature. GLM can be used to find a number of independent variables for a single dependent variable (Univariate analysis) or for a multitude of dependent variables (Multivariate analysis). It is reasonable to treat sampling group and day of production as fixed factors, even though there was some relationship between day number and temperature, since sampling at all projects took place during the latter half of the year and the temperature was unlikely to increase. The group's variable is definitely nominal, since the group number (1-3) was arbitrarily assigned and bears no relation to any known trend in the data.

GLM analysis in SPSS reports the significance of each of these factors on the dependent variables, as well as the significance of the interaction of both factors (group * day number).

The general results for all four focus projects indicate that both day number (lot) and group (sampling location) had significant effects on many of the dependent variables. The results are listed in Table 23.

Dep. Variable	2002						2003						
	Focus Project 1			Focus Project 2			Focus Project 1			Focus Project 2			
%Pass:	D	G	D*G	D	G	D*G	D	G	D*G	D	G	D*G	
#200	Xy							Xy		Xy	Xy		
#100		Xy						Xy		Xy	X		
#50	Xy			Xy			Xy			Xy		X	
#30	y						Xy			Xy			
#16	y	y					Xy	Xy		Xy			
#8		y					Xy	Xy		Xy	X		
#4	X	y					Xy	Xy	y	Xy	Xy		
3/8″	X	Xy					Xy	Xy	y	Xy	Xy		
½″	Xy	Xy			y		Xy	Xy		X	Xy		
¾″													
Bit	X	Xy			Xy			Xy	y	Xy		X	
Gmm	X	Xy					yX						
Gmb	Xy	Xy			y					*xy*	*xy*		
Va	Xy	Xy			y					*xy*	*xy*		
VMA	Xy	Xy			y		y	Xy		*xy*	*xy*		
VFA	Xy	Xy			y					*y*	*xy*		
% Ret:													
#200		Xy			Xy					X			
#100		Xy		Xy	y		Xy			Xy			
#50	Xy	y		y			Xy			Xy			
#30	Xy	Xy					Xy	Xy		Xy			
#16		y	y				Xy	Xy	y	Xy			

#8	Xy	Xy					Xy	Xy		Xy	Xy		
#4		Xy					Xy	y		X			
3/8″		Xy			y			Xy	y		Xy	X	
½″	Xy	Xy		X	y		Xy	Xy		Xy	Xy		

Table 23 – Data Comparison issues using multivariate GLM analysis. Note: The X was obtained using QC for the third set and the Y using Plant Splits.

Note that both day of production as well as sampling group were factors in the majority of the cases. This suggests that using entire project data as one lot is not recommendable. This returns us to the argument of the best way to define a lot. Probably the safest definition is to define lots by homogeneous production, ensuring that the producer communicates changes in production promptly so that the lot changeover procedure can be followed.

Paired Samples Analysis (Independent Assurance simulation)

Plant Split samples were obtained whenever a QC test was obtained. Although not every QC sample had a corresponding Plant Split sample, every Plant Split sample had a corresponding QC sample. For each project, it was possible to compare data on a gradation, extraction, and volumetric basis. The results are summarized Table 24. Complete test results and statistics are included in APPENDIX E.

Quality Characteristic	2002 FP1 Null Hypothesis test result*	2002 FP2 Null Hypothesis test result*	2003 FP1 Null Hypothesis test result*	2003 FP2 Null Hypothesis test result*
P200	A	R	A	R
P100	A	A	A	A

P50	A	A	A	R
P30	A	A	A	R
P16	A	A	A	A
P8	A	A	A	A
P4	A	A	A	A
P3_8	A	A	A	A
P1_2	R	R	A	R
Bit	R	A	A	R
Gmm	R	R	A	R
Gse	R	R	A	R
Va	R	R	A	R
Vma	R	R	A	R
Vfa	A	R	A	R
Ret200	R	R	A	A
Ret100	R	A	A	A
Ret50	R	A	A	A
Ret30	R	A	R	A
Ret16	R	A	A	A
Ret8	A	A	R	A
Ret4	R	A	A	A
Ret3_8	A	A	R	A
Ret1_2	R	R	R	R

Table 24 – Paired t-tests on Plant Split and QC samples, all projects.

*(diff in means = 0) ([A]ccept, [R]eject) Alpha = 0.05, two-tailed (0.025 in each tail)

Note that these results are only indicative of personnel, plant, and equipment, not of the material itself. In truth, since so much material was obtained (it was not a "pure" split sample but rather twice the material was obtained) at the plant, some variability in quantity could also be present. Since all the Plant Split Samples were run at the Agency's central laboratory, the differences in paired-t test results are an indication of the capability of each plant laboratory used. The best results obtained depend on the group of quality characteristics monitored. 2003 Focus Project 2 shows the greatest proportion of gradation paired t-test failures, while most projects present volumetrics rejections of the null hypothesis. For % Retained, the amounts retained in each sieve (especially for larger sieves) have a higher C.V., but this should not have affected paired t-test results, since with a larger variation around the mean and no bias, rejection of the null hypothesis would have been actually more difficult. Overall, the results point to a need to develop these relationships and closely monitor plant equipment and personnel through a strong Independent Assurance program.

Use of Gradation Quality Characteristics: Collinearity

The classic measurement of aggregate gradation is the “percent passing” (% Passing) each sieve. Superpave mixes in Connecticut with a maximum nominal aggregate size of 0.5 inches are tested using a set of ten sieves (3/4”, ½”, 3/8”, #4, #8, #16, #30, #50, #100, and #200). There are sieve tolerances in the Standard Specifications which, if exceeded, put in motion a quality-control procedure (notification and, in repeated instances, shutdown of production). For measurement of quality, the % Passing variable is problematic if all sieves are used. This is due to the high degree of collinearity among the values obtained at each sieve, as shown by the correlations in Table 25. The table contains data from 2003 Focus Project 1. (Complete partial correlations for all projects, controlling for sampling group and day of production, are found in APPENDIX F. Note that correlations vary slightly based on the control factors being included; however, the general relationship holds.)

	¾″	½″	3/8″	#4	#8	#16	#30	#50	#100	#200
¾″	1	*-.092* *-.090*	*-.090* *-.075*	*-.025* *-.001*	*.009* *.028*	*.047* *.059*	*.045* *.059*	*.029* *.039*	*.033* *.032*	*-.063* *-.062*
½″		1	**.581** **.549**	.318 .304	.299 .285	.252 .244	.278 .258	.208 .220	.390 .397	.356 .363
3/8″			1	**.740** **.733**	**.710** **.694**	**.650** **.632**	**.614** **.551**	.470 .487	.467 .500	.499 .539
#4				1	**.956** **.971**	**.919** **.944**	**.882** **.896**	**.702** **.724**	**.512** .474	.474 .451
#8					1	**.978** **.985**	**.944** **.946**	**.749** **.760**	**.558** .499	**.518** .472
#16						1	**.976** **.973**	**.784** **.782**	**.583** **.503**	**.535** .469
#30							1	**.835** **.821**	**.615** **.508**	**.573** .474
#50								1	**.626** **.609**	**.585** **.571**
#100									1	**.931** **.934**
#200										1

Table 25 – Partial and zero-order correlations for % Passing in gradation sieves, 2003 Focus Project 1. N = 158

The number on the top row of each cell is the "partial" correlations, meaning that all three sampling data sets were used (POP, Plant Independent, and QC) but the correlations were controlled for this variable as well as the day of production. Zero-order correlations are shown in the bottom row of each cell. Significance was 0.000 for all correlations except the ¾" sieve, meaning that the correlations can be considered significant. The lack of significance in the ¾" sieve is easily explained by the fact that the % Passing ¾" sieve was 100% in all cases. The similarity in the partial correlations to the zero-order correlations indicates the lack of causality of the controlled variables on the dependent variables (meaning that the correlation is unlikely to be caused by the group or by the day of production).

These correlations strongly suggest the existence of collinearity among the dependent variables, which is a condition likely to confound an equation that attempts to explain a quality dependent variable (such as performance) in terms of a combination of these correlated variables. In turn, this suggests that, in terms of predicting quality, only a subset of these sieves should be used, a subset that does not present high bi-variate correlations. In the case above, combinations such as (1/2”, #4, and #200) appear at first glance to be reasonable from a statistical standpoint. This is not to say that there are not engineering reasons why other sieves should be used instead, including the aggregate blend being used (how many different kinds of stone are used to make the HMA aggregate blend).

A further problem with % Passing as a quality variable is that it masks the variability of the sieve being measured by including all the material in the aggregate blend. One would expect the variability in % Passing, expressed as the coefficient of variation (C.V.) to increase as the absolute combined weight of the % Passing decreases. Unless interpreted with great caution, this peculiarity tends to mask the real sources of gradation variability in the mix.

A more intuitive set of variables is the % Retained in the sieve (the actual mass of material weighed at each sieve, expressed as a percentage of the total mass of the aggregate sample).

The % Retained correlation matrix for the same project (2003 Focus Project 1) is shown in Table 26:

	½″	3/8″	#4	#8	#16	#30	#50	#100	#200	Pan*
½″	1	*.090* *.122*	-.349 -.266	-.275 -.283	-.352 -.345	-.156 -.176	-.185 -.173	*.126* *.103*	-.367 -.374	-.356 -.363
3/8″		1	-.186 -*.129*	**-.578** **-.647**	**-.680** **-.714**	**-.657** **-.726**	-.365 -.322	-.235 -.208	-.211 -.255	-.390 -.448
#4			1	-.330 -.380	-.258 -.358	-.343 -.392	-.195 -.486	-.351 -.475	-.174 -*.126*	*.019* *.043*
#8				1	**.658** **.742**	**.549** **.679**	.314 .433	.256 .317	.274 .292	.271 .316
#16					1	**.775** **.835**	.474 **.570**	.295 .364	.387 .381	.412 .427
#30						1	**.547** **.606**	.268 .326	.412 .379	.362 .385
#50							1	-.180 *.106*	*.144* *.118*	*.141* *.112*
#100								1	-.193 -.180	-.188 -.177
#200									1	**.713** **.719**
Pan*										1

Table 26 – Partial and zero-order correlations for 2003 Focus Project 1, Gradations. *This value is the same as the % Passing the #200 Sieve.

Notice that the correlation coefficients among sieves are (disregarding signs), lower than those obtained with % Passing. In addition, the natural tendency is for values to exhibit a negative correlation to other sieves, which is due to the fact that if a higher fraction of material is retained on any particular sieve, it must come at the expense of another sieve (or a number of sieves). Correlations of % Retained also give an indication regarding the fraction of stone used and the presence of gradation "gaps" due to the "raw" stone gradations being used. Notice that the negative correlation of the 3/8" sieve is well over 50% for the #8, #16, and #30 sieves, yet is rather small for the #4 sieve. The larger negative correlations indicate the locations of natural breakpoints in stone gradation. Conversely, the high positive correlation between the #200 and the Pan material suggests a single stone fraction at that size range.

Beyond correlations, observation of the change of % retained can also be more "dramatically" informative regarding gradation changes. For instance, as crusher wear increases and aggregate is produced "coarser," we would expect to see a shift in the balance of % Retained in two consecutive sieves outside of the breakpoint, whereas gradation changes due to re-proportioning of the aggregate would be more dramatic around those natural breakpoints.

The drawback to using % Retained is that, since % Retained does not aggregate variability through the sieve set, the values recorded are smaller at the larger sieves, thereby increasing the coefficient of variation (C.V.) So, whereas the C.V. of % Passing ranges from 1-2% at the largest sieves to 10-12% at the smallest sieves, the C.V. for % Retained is in the 10-15% range regardless of sieve size (in some instances, the largest sieve, with little material, might see a higher C.V. – one large stone represents more percentage than a few “specks” of dust). This apparent increase in variability may make control charts more difficult to read, but, on the other hand, changes are more easily and readily detected when all sieves are observed as an entire set. The apparent increase in variability also means that control and specification limits would have to be adjusted accordingly, and there is little comfort to an inveterate specifications engineer in changing these by an order of magnitude (in terms of the number itself) – as well as increased concern by equally inexperienced quality-control personnel.

Implementability: Organizational Factors

An objective assessment of the project scope some distance in time from the actual period of execution yields the estimation that the project objectives were both ambitious and ambiguous. The expectation of the principal investigator, at the outset, was that the agency, at the end of the project, would be ready to implement a comprehensive QA program for HMA construction, even though project objectives were “to complete technical tasks” related to this implementation. The vagueness in the write-up reflected the recognition that implementation of a complete QA program would represent a completely new endeavor for the agency and that key implementation issues would not become apparent until they were faced by the organization. In addition to the technical issues that make up the largest portion of this report, other implementation issues proved just as important in affecting the outcome of this effort.

A QA Executive presentation was held on May 31, 2001, where Messrs. Stephen J. Cooper (FHWA, Connecticut Office) and Edgardo D. Block (the PI for the project) took a top-down (macro-to-micro) approach in introducing the topic, the organizational context, and the proposed research effort designed to make major strides in achieving QA implementation at the State. In the literature review, buy-in by executives was identified as a key factor for success of QA implementation. The presentation resulted in the formation of a QA Implementation Steering Committee, which was in charge of overseeing further efforts in getting the research program off on the right foot. The agency's Chief Engineer at the time specifically asked for cost-benefit analysis, to see if QA would result in improved cost efficiencies. Once the research project was initiated, yearly presentations were made at the HMA Task Force meetings, where the issue was kept on the table for the duration of the project.

It is not the point of this research project to discuss organizational behavior, yet it would be irresponsible to ignore organizational issues that are crucial for the success of QA implementation. An analysis of the outcome of the project cannot but point to major difficulties for the PI to effect significant change in the organization with respect to QA. Briefly, state financial constraints (budget shortfalls) and the necessity to manage increasing amounts of work with fewer personnel (a long-term trend in the agency (see Census Bureau data on ConnDOT employees over the past 10 years)), including the layoff of the individual hired to assist in the research project and continue QA program implementation after its completion, all conspired to encumber efforts to implement QA in Connecticut. Moreover, an underestimation by the PI of the depth of statistical knowledge required to take sure and effective steps to developing a robust QA program can also be considered to have contributed to the progress in QA implementation being less than expected by the PI at the outset. In addition, assent by top executives is evidently not sufficient to drive the program. Someone with discretionary authority to affect major resource allocation has to champion the change initiative if it has any chance of succeeding. This is because QA initiatives are not simply specification modifications, but encompass all system inputs and reach far beyond sampling and test measurements, and represent a major change in business procedures and practices. Consequently, a comprehensive, organization-wide effort is required in order to make it work.

Going forward, it is imperative that, once executives have given the blessing to a major initiative such as QA implementation, thorough analysis and process mapping take place within the organization, including resource-allocation, financial, and technical issues in substantial detail, that benchmarks and deadlines are assigned, and that the QA program is recognized with a project manager with a level of authority commensurate with the responsibility that such an undertaking requires. The level of responsibility is clearly there, but the level of authority is clearly not; in fact, it is possible that these issues are not even within the control of the agency itself but subject to the State's budget office. If this is so, the agency must make the case for QA to whoever is responsible, or else decline to undertake the initiative – the latter, however, made difficult by the existence of federal regulations requiring QA systems in order to access federal funding for highway construction. It is also feasible to have formal QA systems that meet the letter but at best marginally the spirit of the regulation; for implementation of these, the findings of this report, a thorough knowledge of statistics, a robust information infrastructure, and the extensive knowledge base in the research and publication literature (and increased knowledge of statistical methods) amply suffice.

Conclusions and Recommendations

APPENDIX A is presented as a blueprint for moving the QA program forward. It was developed as the result of the conclusions and recommendations presented below as well as the findings of the report discussed throughout the body of the document. Successful QA implementation depends on a variety of factors, both internal and external to the organization, and a dedicated effort and commitment by the agency, the personnel in charge of running it, the producers, and all stakeholders in the system.

Specific conclusions and recommendations of the project have either been discussed or hinted at in the course of the report. They are summarized into major findings in the following sections.

Validity of methods

Normality Assumption

Weekly lot data for quality characteristics studied followed the normal distribution, for the most part. On a daily basis, some exceptions were observed, which could be the result of process changes that did not result in new lots.

In general, parametric statistical methods are appropriate for use in a QA system. However, the normality assumption should be checked at those times when lot termini do not match process changes. This is because there is a higher likelihood of there being a combination of data from two populations; the usual result is that at least in some parameters the distribution of the sample data for that lot could be non-normal.

The assumption of normality should not be extrapolated to quality characteristics that have not been examined, but rather data should be collected and analyzed using normality tests and plots to ascertain whether the data follow the normal distribution. In the case of HMA construction, compaction should be investigated for normality over a sufficiently large range of values, and especially at in-place air-void values close to the mix design air void value. If a QA program is to be expanded to other construction materials, the case of concrete compressive strength values should also be analyzed before applying statistical procedures that rely on the normality assumptions.

Another conclusion from this examination of the data is that control charts are the best representation of process-control characteristics that may be affecting the results. This exercise demonstrates the value and importance of control charts for any respectable quality-control process.

At this point, and until alternate methods are established, mild departures from normality could be "lived with," until other, more robust procedures and methods can be implemented. Furthermore, much of the data did show normality, as expected. Further research should include an investigation of non-parametric data-comparison methods, which could handle the potential issue.

Use of Control Charts

Control charts are mainly the purview of the contractor, but they should be shared among all parties so that data discrepancies can be resolved at the lowest possible level and so that production problems or issues can be quickly addressed. They can be helpful in demonstrating to personnel the imperative necessity of maintaining a controlled and uniform process throughout the project in order to achieve a quality product.

Collinearity

The number of sieves used to characterize (and especially pay for) quality should be limited to those that do not exhibit high collinearity plus those that are necessary for engineering reasons, as excessive incentives or penalties could result from “doubling up” on consecutive sieves that are essentially contributing little information to the QA system. The subset of sieves selected, if gradation quality characteristics are used, should not present high bi-variate correlations.

Lot size, PWL

From a risk perspective, the smaller the lot the more specific and accurate the payment is. A sample size for a lot should be sufficiently large to control these risks. For most quality characteristics, N>=5 will suffice to control both the alpha and beta risks.

Low PWLs should, with incentives and disincentives, result in the producer quickly gaining control of its process. Thus, from a principle standpoint, entire-project PWLs are not recommended. Thus, PWLs developed on daily or weekly lots are more appropriate. Given that the PWLs are not radically different, however, it is suggested that, as long as a number of key variables is seen to remain constant (like aggregate gradations, binder lot properties, etc), lots could eventually be defined on the basis of changes in production only, to achieve sampling efficiencies.

Lots should be terminated when a production change is to take place at the plant. In fact, these lots can be programmed ahead of time if the contractor is proactive in assessing the raw materials before they enter the manufacturing process.

Entire-project lots should be avoided, as there is no chance of improving quality once the project is completed. Smaller lots, based on a day's or week's production, or on planned production changes-if the process is known to be under control-are more effective at achieving corrections in quality while there is still an opportunity to do so. In addition, daily plant problems could also change lot definition, so that if a plant that is known to have numerous issues is used for a project, smaller lots should be used so that the proper number of samples is always obtained.

There appear to be no significant gains by moving to larger lots until the process has been demonstrated to be in control and matches the mix parameters approved by the agency. In that case, the number of samples required could be reduced without seriously impacting the producer's and buyer's risk. It seems an obvious conclusion, but the significance of the smaller lot sizes and more frequent sampling is that they are much more responsive to resolving mix-quality issues.

Theoretically, the most robust lot definition is by homogeneous production, ensuring that the producer communicates changes in production promptly so that the lot changeover procedure can be followed. This should only be attempted once a level of comfort and fluid communication has been achieved for a substantial period of time, especially given that the resulting lots may be larger than currently defined lots (day of production.)

Data Comparisons

1. Emphasize the IA aspect of the QA program, especially prior to the start of production, in order to minimize the probability of data discrepancies during production. This can be done by either correcting procedures or by developing correction or adjustment factors to be applied to the various data sets.
2. Avoid including QC results in the Acceptance decision. This step should only be taken once data-comparison issues have been shown to be minor, since the inclusion of these data introduces undue complexity at this stage of QA program implementation.
3. Consider point-of-placement sampling for the Acceptance decision.
4. Overall, the results point to a need to develop these relationships and closely monitor plant equipment and personnel through a strong Independent Assurance program.
5. Independently of all other steps taken, ash corrections and ignition oven corrections should be included if any data comparisons are to be made regarding the most expensive material in the mix.

Sampling Location

This project has demonstrated that the POP sampling method can be carried out in Connecticut in a variety of situations. The POP sampling method is capturing mix variability from the handling, placement, and behind-the-paver sampling processes. It is the opinion of this investigator that the sampling procedure could be implemented and replaces current Acceptance procedures. At the same time, it would be difficult to include both Agency and Contractor data in the acceptance decision without additional data-comparison safeguards, since the material undergoes different treatment before sampling. More likely, the role of the Agency would be to monitor the Contractor for QC compliance and use only data from the road in acceptance decisions. Dispute resolution decisions would probably involve coring, which would most closely resemble the data used for acceptance, because of the variability that is being measured. POP Sampling would allow the Agency additional flexibility in coverage of paving jobs, but would require additional work and equipment at the central laboratory.

Effect of Re-heating Samples

1. Given that curing time has been shown to affect mix volumetric measurements in the laboratory, account for mix curing time during testing; develop correction curves for this curing time, and increase curing time to match the longest allowable curing time during production. This is likely to better represent the curing undergone by the material that will actually be subjected to traffic and environmental conditions on the road.

2. The effect appears more drastic with tests that depend on the gyratory compaction (Gmb and air voids versus Gmm). At the same time, the relationship is clearly not linear, and curing time between 1-5 hours is likely safe for data comparisons based on this variable.
3. Curing time should be limited to no more than five (5) hours, otherwise in-place behavior is likely to be different from what sample test data show, especially if the data are obtained at the plant.

Segregation

The findings of data analysis on 2002 Focus Project 1 regarding segregation suggest that, if segregation is visually observed when HMA is placed without an MTV, the inclusion of an MTV in the paving train, coupled with POP sampling (as opposed to plant sampling) can correspondingly mitigate the segregation issue as well as help obtain mix information that more closely relates to in-place HMA characteristics. A more radical solution would involve being able to detect the propensity of a mix to segregate prior to determining whether either an MTV or POP sampling are necessary (or to preclude mixes prone to segregation from being placed in the first place). This approach, however, is well beyond the scope of the Quality Assurance project and the reader is referred to existing literature sources and on-going research on a national scale.

Likelihood of disputes

Disputes are more likely if the proper ground rules have not been set. Dispute resolution language usually addresses those data discrepancies that impact payment (PWL). In private industry, there has been a push to “Six Sigma,” which strives to make dispute-resolution as irrelevant as possible (by always controlling the process so that the specification limits are at least three standard deviations away from the production target value at either specification limit. Unfortunately, given the nature of variables sampling plans and the nature of the product and process as we know it today, it is not feasible to achieve that in HMA in Connecticut: Specification limits, if opened further, lead to variation that alters the behavior of the in-place material. So, Six Sigma may not be a realistic goal.
On the other hand, having too much data and using statistics blindly can also lead to unnecessary disputes. A clear definition of statistical versus practical significance needs to be written into the PWL specifications. For instance, a difference of 0.2% in two means of % Passing a sieve may be statistically significant but not practically significant (especially given the sieve tolerances for any sieve). The level of difference in means and variances that should be considered practically significant should be spelled out in order to avoid the vast majority of disputes that arise in the course of a project.

QA systems accommodate the use of validated contractor's QC data in the payment decision. Validation includes collection of acceptance samples and combination of data sets if the means and variance are not statistically different. Given the frequency of data discrepancies among data sets in this project, it is more advisable to expend effort in fortifying the IA program and in eliminating potential sources of discrepancies before embarking on an activity that adds a level of complexity to the entire system. In other words, a substantial level of comfort with the data compatibility among the sampling sets has to be firmly in place for the combination of multiple data sets. The same can be argued for increasing lot sizes. For a given quantity of material, the sampling requirements decrease with increasing lot size. However, when problems or disputes do arise, they are of a correspondingly greater magnitude.

Scope of reach of the QA program

Although PWL specifications allow for incentives based on uniformity of production, there is a larger question that remains outside the scope of a QA system as investigated in this project. The product will be only as good as the design and the placement. An HMA QA system requires attention to all aspects of HMA, namely:

1. Appropriateness of the HMA mix design;
2. Conformance to mix-design values during production;
3. Quality Inspection at placement; and,
4. Quality control by the contractor.

Beyond the actual product, business processes, control systems, resources, and culture must also reflect a total quality philosophy. If these components are not in place, the chances of attaining quality improvement over the medium to long term can be expected to be much lower. This will require an institutional focus and commitment to quality by all stakeholders. After all the planning, training, discussion, and research regarding the subject, each organization’s structure, culture, and procedures will reflect its true commitment to quality. A good starting point is the establishment of a quality engineer with sufficient authority and training on the subject, and sufficient support to ensure that the program is effective.

Benefits of QA program

A rigorous cost-benefit analysis of a QA program is difficult. This is because of the lack of performance data related to increased uniformity of inputs. The closest benefit measurement is a hypothetical. The benefits of a QA program are probably best measured by considering the cost of not implementing such a program, but are likely to be difficult to estimate.

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(25) Note: MTV use was discontinued for the last day of paving due to equipment breakdown, but this research project did not include data collection for that day of production.

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APPENDICES

APPENDIX A

Blueprint for QA Implementation

1. **Develop a level of comfort with the system before adding levels of complexity.**
   QA systems are more complex than traditional method specifications. They require changes in roles, responsibilities, and approach to the work. Things such as combining agency and contractor's data sets (which increases the chances of data discrepancies and disputes) or increasing lot sizes (which increases the magnitude of any disputes) should be left until there is more assurance in the data quality. This means that initial steps should be to ensure that a robust and thorough IA program exists (in particular with respect to gyratory compactors and with the establishment of lab specific, mix specific ash correction and ignition oven correction factors) and that the appropriate quality characteristics are being focused on.
2. **Decide on quality characteristics for payment and for control.**
   In the case of gradation quality characteristics, consecutive sieve sizes may be highly correlated based on the aggregate fractions used. A correlation matrix should be set up for every mix produced to determine which sieves should be selected for payment measurement. Alternatively, the payment adjustment should be appropriately distributed to take into account the covariance of the individual quality characteristics. In other words, if the full set of sieves is used, not all sieves are independent of one another. This needs to be reflected in the payment formula.

   A similar procedure should be included in the case of volumetrics. For instance, air voids, VMA, and Gmb are correlated because the actual definition of the values is related as well. Further, volumetric properties are a function of the mix ingredients, including the aggregate structure, yet the volumetric properties are the central objectives of the Superpave mix design (a design air void content and the compactability of the mix itself).
3. **Implement PWL Specifications based on quality characteristics chosen.**
   Percent Within Limits specifications are likely to require close attention by the producer on the target values and how well the producer can control the process.

4. **Implement a procedure for handling changes between job mix formula and production, including a procedure for handling production averages different from the job mix formula.**

   Approval of a mix design is based on laboratory values. If, when production is started, mix average values are different from those at the time the mix was designed, performance may differ as well. The battery of Superpave tests should be run on the new, effective mix target to confirm that they can perform the function for which they were designed (Superpave mix level and target air voids in particular).
5. **Continue efforts to identify potential of mixes to segregate.**

   Based on the project findings regarding POP sampling on mixes prone to segregation where an MTV is used, an MTV should be specified whenever a mix that segregates is used. An alternative is to not approve mix designs that result in segregation, but in this case the propensity of a mix to segregate has to be estimated prior to mix approval. The problem with identifying and measuring segregation is that it may not be apparent until long after the project is done. However, at the very least, those mixes that exhibit segregation immediately should be placed using an MTV. Meanwhile, efforts to quantify segregation readily, as well as efforts to prevent it, should all be continued.
6. **Implement sample-tracking, location-referencing, and data-management systems.**

   In order to close the data feedback loop from in-service data and to ensure quick data feedback for data comparisons during a project, implementation of a sample tracking mechanism, location-referencing, and data-management system is imperative.

In order to relate samples obtained at the plant with lots of HMA placed on a roadway, there must be a link between the placement records system and the sample tracking system.

In any case, the “paperwork” requirements for the sampler should be minimized or actually reduced. If the same data are collected for the limits and time of work for the lot, then linking routines can be used to match the work performed to the samples obtained and tested. Further, the GPS coordinates can be used to automatically link to data referencing on a highway-network basis.

The use of GPS-based data recording for both samples and the location and dates of work performed, combined with a back-end database that relates the two attributes, can achieve a robust data-management system that provides benefits not only at the time of project execution, but also to combine materials data at the time of construction with in-service performance data collected with the pavement management system.

7. **Formally designate a quality engineer specifically charged with running the QA program.**

Train this individual on the following aspects of statistics and their application to highway construction, materials, and processes:

a. Design of experiments
b. Multivariate statistics, including:
   i. Analysis of Variance
   ii. General Linear Model (formerly MANOVA, MANCOVA)
   iii. Mixed Models
   iv. Operating Characteristics Curves for Variables Sampling Plans
c. Regression
d. Non-parametric methods
e. Reliability analysis and Statistical Process Control

These required elements were identified in the course of data analysis in the project. Statistical analysis proved to be the most dangerous element of this research project, because of the intricacies and subtleties at every step of the analysis. The training required to achieve this level of proficiency should be designed with civil engineering and statistics faculty and tailored to the requirements of the position. Over time, redundancy also needs to be built, so that the system is not dependent on any one person. This will probably mean having at least a second individual be trained on the job.

8. **Formally designate the data-collection requirements and data-analysis techniques that will be used to monitor each quality characteristic.**

   In order to avoid false steps and incorrect analysis, lay out the plan for evaluating each change to the system. This will probably involve activities similar to the ones undertaken for this project: experiment design, data collection in abundance and in parallel to existing procedures, and statistical data analysis.

APPENDIX B

Descriptive Statistics.

Group 1 = POP, Group 2 = Plant Independent, Group 3 = Plant Split, Group 4 = QC

2002 Focus Project 1

Descriptive Statistics, Gradation and Binder Content

	dayno	Smp. Grp (Num)	Mean	Std. Deviation	N

p200	1	2.00	2.3125	.25493	4
		Total	2.3125	.25493	4
	2	2.00	2.9639	.39138	3
		Total	2.9639	.39138	3
	3	1.00	3.4200	.59102	5
		2.00	3.0900	.12981	6
		3.00	3.3048	.04941	3
		4.00	3.3467	.09504	3
		Total	3.2703	.33843	17
	4	1.00	3.2302	.45394	10
		2.00	2.8467	.38611	7
		3.00	2.8599	.20183	3
		4.00	3.1667	.11060	3
		Total	3.0569	.40549	23
	7	1.00	3.0055	.31803	6
		2.00	3.4286	.24711	6
		3.00	2.8004	.29203	3
		4.00	2.8815	.99230	3
		Total	3.0917	.48892	18
	8	2.00	3.2208	.16245	6
		3.00	2.8153	.84931	2
		4.00	2.6040	.14082	2
		Total	3.0163	.41432	10
	9	2.00	3.3818	.10758	7
		3.00	3.1850	.44354	3
		4.00	3.6132	.08028	3
		Total	3.3898	.25028	13
	10	1.00	3.1968	.29643	6
		2.00	3.2621	.24774	5
		3.00	2.6261	.05433	2
		4.00	2.8627	.64332	2
		Total	3.0979	.36362	15
	11	1.00	3.1542	.28894	6
		2.00	3.2800	.33077	7
		3.00	3.2755	.65077	4
		4.00	3.0315	.56324	4
		Total	3.1959	.41770	21
	15	1.00	3.1546	.34161	6
		4.00	3.4204	.13416	2
		Total	3.2210	.31791	8
	16	1.00	3.3619	.40371	7
		4.00	3.3755	.10591	4
		Total	3.3668	.31812	11
	Total	1.00	3.2174	.39010	46
		2.00	3.1264	.38701	51
		3.00	3.0217	.44998	20
		4.00	3.1702	.47307	26
		Total	3.1490	.41415	143
p100	1	2.00	5.221	.6674	4
		Total	5.221	.6674	4

	2	2.00	6.313	.5728	3
		Total	6.313	.5728	3
	3	1.00	7.302	.9659	5
		2.00	6.717	.3638	6
		3.00	7.599	.2949	3
		4.00	6.533	.0577	3
		Total	7.013	.6726	17
	4	1.00	6.868	.8362	10
		2.00	6.630	.9877	7
		3.00	7.065	1.2404	3
		4.00	6.367	.1528	3
		Total	6.756	.8594	23
	7	1.00	6.413	.4530	6
		2.00	8.097	.6747	6
		3.00	6.525	.6260	3
		4.00	5.951	1.5438	3
		Total	6.916	1.1373	18
	8	2.00	6.804	.5730	6
		3.00	6.966	2.4384	2
		4.00	5.421	.1757	2
		Total	6.560	1.1004	10
	9	2.00	7.326	.7679	7
		3.00	6.795	.4344	3
		4.00	6.988	.0778	3
		Total	7.126	.6186	13
	10	1.00	7.200	.9896	6
		2.00	7.462	1.0301	5
		3.00	5.763	.1137	2
		4.00	5.941	.7305	2
		Total	6.928	1.0763	15
	11	1.00	7.145	1.0368	6
		2.00	7.399	.9990	7
		3.00	7.176	1.8085	4
		4.00	6.132	.6640	4
		Total	7.043	1.1584	21
	15	1.00	6.672	.3943	6
		4.00	6.731	.2911	2
		Total	6.687	.3519	8
	16	1.00	7.435	.7769	7
		4.00	6.414	.2550	4
		Total	7.064	.8041	11
	Total	1.00	6.996	.8267	46
		2.00	6.987	1.0204	51
		3.00	6.906	1.1490	20
		4.00	6.303	.6724	26
		Total	6.854	.9530	143
p50	1	2.00	11.544	1.8382	4
		Total	11.544	1.8382	4
	2	2.00	13.016	.4606	3
		Total	13.016	.4606	3

	3	1.00	12.950	1.0079	5
		2.00	12.647	.6665	6
		3.00	13.575	.4413	3
		4.00	13.033	.3215	3
		Total	12.968	.7339	17
	4	1.00	12.755	.4479	10
		2.00	12.363	.9302	7
		3.00	12.761	.7568	3
		4.00	12.633	.2309	3
		Total	12.620	.6380	23
	7	1.00	12.056	.3662	6
		2.00	12.856	.8957	6
		3.00	11.672	.8909	3
		4.00	12.159	2.1907	3
		Total	12.276	1.0659	18
	8	2.00	12.193	.7822	6
		3.00	12.136	1.4141	2
		4.00	11.128	.1975	2
		Total	11.968	.8737	10
	9	2.00	12.589	.5746	7
		3.00	13.307	.1896	3
		4.00	13.538	.3821	3
		Total	12.974	.6240	13
	10	1.00	12.557	.2849	6
		2.00	12.832	.2932	5
		3.00	11.765	.0280	2
		4.00	12.228	.5200	2
		Total	12.499	.4489	15
	11	1.00	12.389	.1758	6
		2.00	12.904	1.0702	7
		3.00	13.272	1.6691	4
		4.00	12.446	.7850	4
		Total	12.740	.9909	21
	15	1.00	13.028	.4762	6
		4.00	13.287	.5304	2
		Total	13.093	.4654	8
	16	1.00	12.957	.4769	7
		4.00	12.460	.7656	4
		Total	12.776	.6126	11
	Total	1.00	12.678	.5621	46
		2.00	12.560	.9149	51
		3.00	12.742	1.1191	20
		4.00	12.577	.9779	26
		Total	12.626	.8576	143
p30	1	2.00	18.810	3.1737	4
		Total	18.810	3.1737	4
	2	2.00	20.446	.8395	3
		Total	20.446	.8395	3
	3	1.00	19.799	1.3517	5
		2.00	19.171	1.1081	6

		3.00	20.696	.7418	3
		4.00	19.567	.4726	3
		Total	19.695	1.1111	17
	4	1.00	19.759	1.2086	10
		2.00	19.029	1.5556	7
		3.00	20.001	1.4598	3
		4.00	19.100	.3606	3
		Total	19.482	1.2728	23
	7	1.00	18.528	.5489	6
		2.00	19.550	1.4667	6
		3.00	18.197	1.0060	3
		4.00	18.935	2.5142	3
		Total	18.882	1.3671	18
	8	2.00	18.308	1.1143	6
		3.00	19.035	1.6370	2
		4.00	17.125	.0072	2
		Total	18.217	1.1862	10
	9	2.00	18.816	1.0548	7
		3.00	20.386	.4413	3
		4.00	20.319	.6840	3
		Total	19.525	1.1414	13
	10	1.00	18.663	.5361	6
		2.00	19.055	.5905	5
		3.00	18.186	.1413	2
		4.00	18.712	.4083	2
		Total	18.736	.5454	15
	11	1.00	18.577	.4470	6
		2.00	19.513	1.5921	7
		3.00	20.225	2.3093	4
		4.00	18.853	.9418	4
		Total	19.256	1.4578	21
	15	1.00	19.275	.7390	6
		4.00	19.632	.8696	2
		Total	19.364	.7249	8
	16	1.00	19.143	.7550	7
		4.00	18.522	.8248	4
		Total	18.917	.8027	11
	Total	1.00	19.149	.9681	46
		2.00	19.128	1.4497	51
		3.00	19.659	1.5295	20
		4.00	19.008	1.1854	26
		Total	19.187	1.2792	143
p16	1	2.00	24.832	4.0231	4
		Total	24.832	4.0231	4
	2	2.00	26.324	1.1530	3
		Total	26.324	1.1530	3
	3	1.00	25.307	1.8425	5
		2.00	24.291	1.5496	6
		3.00	26.342	.9351	3
		4.00	25.300	.6083	3

		Total	25.130	1.5196	17
	4	1.00	25.074	1.7750	10
		2.00	24.094	2.0388	7
		3.00	25.602	2.1236	3
		4.00	24.800	.6245	3
		Total	24.809	1.7744	23
	7	1.00	23.500	.6222	6
		2.00	24.813	2.1032	6
		3.00	23.390	1.2109	3
		4.00	25.140	2.7273	3
		Total	24.193	1.7434	18
	8	2.00	23.058	1.4729	6
		3.00	24.383	2.0613	2
		4.00	22.359	.3267	2
		Total	23.183	1.4733	10
	9	2.00	23.757	1.4021	7
		3.00	25.961	.7138	3
		4.00	26.485	.9397	3
		Total	24.895	1.6991	13
	10	1.00	23.472	.7903	6
		2.00	23.998	.7881	5
		3.00	23.314	.2318	2
		4.00	24.640	.4296	2
		Total	23.782	.7823	15
	11	1.00	23.321	.6946	6
		2.00	24.670	2.0047	7
		3.00	25.814	3.0017	4
		4.00	24.624	1.2128	4
		Total	24.494	1.9167	21
	15	1.00	23.943	1.0224	6
		4.00	25.188	1.1206	2
		Total	24.254	1.1216	8
	16	1.00	23.801	1.0572	7
		4.00	23.908	.8935	4
		Total	23.840	.9555	11
	Total	1.00	24.115	1.3909	46
		2.00	24.292	1.9368	51
		3.00	25.127	1.9448	20
		4.00	24.757	1.4376	26
		Total	24.436	1.7119	143
p8	1	2.00	33.517	4.9060	4
		Total	33.517	4.9060	4
	2	2.00	34.321	1.4029	3
		Total	34.321	1.4029	3
	3	1.00	32.384	2.5520	5
		2.00	31.141	2.1586	6
		3.00	33.971	1.1773	3
		4.00	31.967	.8145	3
		Total	32.152	2.0898	17
	4	1.00	32.335	3.0397	10

		2.00	30.706	2.7320	7
		3.00	32.854	2.9137	3
		4.00	31.333	.9609	3
		Total	31.776	2.7135	23
	7	1.00	29.854	.9275	6
		2.00	31.773	3.0153	6
		3.00	30.375	1.6543	3
		4.00	32.566	2.8234	3
		Total	31.033	2.3155	18
	8	2.00	29.525	2.1658	6
		3.00	31.508	2.9192	2
		4.00	28.344	.6990	2
		Total	29.685	2.1823	10
	9	2.00	30.550	1.7381	7
		3.00	33.484	.8144	3
		4.00	33.702	1.0642	3
		Total	31.955	2.0757	13
	10	1.00	29.858	1.2273	6
		2.00	30.831	1.0836	5
		3.00	33.007	3.5460	2
		4.00	31.799	.5253	2
		Total	30.861	1.7337	15
	11	1.00	29.667	1.0496	6
		2.00	31.643	2.5572	7
		3.00	33.775	4.6111	4
		4.00	31.520	1.4529	4
		Total	31.461	2.7914	21
	15	1.00	30.217	1.4971	6
		4.00	31.706	1.2388	2
		Total	30.589	1.5150	8
	16	1.00	30.129	1.4873	7
		4.00	30.333	1.1340	4
		Total	30.203	1.3129	11
	Total	1.00	30.734	2.1628	46
		2.00	31.296	2.6494	51
		3.00	32.809	2.7322	20
		4.00	31.531	1.7684	26
		Total	31.370	2.4358	143
p4	1	2.00	46.139	5.3273	4
		Total	46.139	5.3273	4
	2	2.00	46.701	1.5935	3
		Total	46.701	1.5935	3
	3	1.00	43.942	3.7952	5
		2.00	41.946	3.3101	6
		3.00	45.818	1.7578	3
		4.00	43.233	1.3577	3
		Total	43.444	3.1025	17
	4	1.00	44.002	4.7331	10
		2.00	42.267	3.8460	7

		3.00	44.503	3.9859	3
		4.00	42.733	.9609	3
		Total	43.374	3.9403	23
	7	1.00	40.150	1.7198	6
		2.00	42.659	3.8445	6
		3.00	41.363	2.1229	3
		4.00	45.049	2.7208	3
		Total	42.005	3.1130	18
	8	2.00	39.897	2.9873	6
		3.00	43.511	2.6388	2
		4.00	39.192	1.1710	2
		Total	40.478	2.9190	10
	9	2.00	41.729	1.8125	7
		3.00	45.416	1.5820	3
		4.00	45.440	.8069	3
		Total	43.436	2.4193	13
	10	1.00	38.935	2.3254	6
		2.00	40.658	1.7729	5
		3.00	43.181	4.6002	2
		4.00	42.524	.5926	2
		Total	40.554	2.6520	15
	11	1.00	38.593	1.6972	6
		2.00	40.967	3.5220	7
		3.00	44.262	6.5973	4
		4.00	41.300	.8572	4
		Total	40.980	3.8684	21
	15	1.00	40.023	2.2793	6
		4.00	41.849	.8039	2
		Total	40.480	2.1254	8
	16	1.00	39.597	2.6153	7
		4.00	40.483	2.0909	4
		Total	39.919	2.3697	11
	Total	1.00	40.938	3.6511	46
		2.00	42.151	3.5758	51
		3.00	44.087	3.6287	20
		4.00	42.447	2.2911	26
		Total	42.085	3.5255	143
p3_8	1	2.00	73.732	2.9578	4
		Total	73.732	2.9578	4
	2	2.00	74.871	.3218	3
		Total	74.871	.3218	3
	3	1.00	72.255	3.5716	5
		2.00	71.011	3.0052	6
		3.00	74.163	1.8005	3
		4.00	73.367	1.1590	3
		Total	72.349	2.8407	17
	4	1.00	72.435	3.7743	10
		2.00	71.298	3.7732	7
		3.00	72.650	3.3876	3
		4.00	72.433	1.2583	3

		Total	72.117	3.3481	23
	7	1.00	68.517	2.9248	6
		2.00	71.766	3.9223	6
		3.00	69.792	2.0399	3
		4.00	75.928	1.7035	3
		Total	71.048	3.8466	18
	8	2.00	68.377	3.9321	6
		3.00	73.732	1.1816	2
		4.00	70.988	.8216	2
		Total	69.970	3.7265	10
	9	2.00	71.637	1.6613	7
		3.00	74.331	2.4912	3
		4.00	75.532	2.8930	3
		Total	73.158	2.6290	13
	10	1.00	68.935	3.3786	6
		2.00	70.584	3.8420	5
		3.00	71.783	4.6584	2
		4.00	74.270	2.1086	2
		Total	70.576	3.6706	15
	11	1.00	68.839	2.3159	6
		2.00	70.557	3.3965	7
		3.00	73.464	5.9907	4
		4.00	71.283	.9313	4
		Total	70.758	3.5990	21
	15	1.00	67.571	2.3972	6
		4.00	70.973	1.2019	2
		Total	68.421	2.6061	8
	16	1.00	68.646	3.7276	7
		4.00	70.206	1.2518	4
		Total	69.214	3.0702	11
	Total	1.00	69.768	3.5794	46
		2.00	71.252	3.4005	51
		3.00	72.885	3.4502	20
		4.00	72.700	2.4397	26
		Total	71.266	3.4993	143
p1_2	1	2.00	95.425	1.0070	4
		Total	95.425	1.0070	4
	2	2.00	95.386	1.4448	3
		Total	95.386	1.4448	3
	3	1.00	94.940	1.0259	5
		2.00	94.792	1.5885	6
		3.00	95.226	.3473	3
		4.00	93.833	.4509	3
		Total	94.743	1.1420	17
	4	1.00	95.225	1.3480	10
		2.00	94.337	1.0383	7
		3.00	94.880	1.0605	3
		4.00	93.467	1.2662	3
		Total	94.680	1.2899	23
	7	1.00	93.553	1.0098	6

		2.00	94.915	1.4932	6
		3.00	93.330	1.0572	3
		4.00	94.460	1.4259	3
		Total	94.121	1.3391	18
	8	2.00	93.218	1.9254	6
		3.00	94.865	.6744	2
		4.00	92.538	.7330	2
		Total	93.412	1.6833	10
	9	2.00	94.971	1.1592	7
		3.00	95.486	1.5340	3
		4.00	94.433	1.0609	3
		Total	94.966	1.1791	13
	10	1.00	94.093	1.5490	6
		2.00	94.763	1.3887	5
		3.00	94.534	.3560	2
		4.00	94.300	.5607	2
		Total	94.403	1.2372	15
	11	1.00	92.872	1.2952	6
		2.00	95.052	1.2071	7
		3.00	94.307	1.8854	4
		4.00	93.016	1.3313	4
		Total	93.899	1.6206	21
	15	1.00	92.989	1.4796	6
		4.00	91.594	.6086	2
		Total	92.641	1.4260	8
	16	1.00	93.770	1.3431	7
		4.00	92.307	1.3639	4
		Total	93.238	1.4783	11
	Total	1.00	94.008	1.5101	46
		2.00	94.701	1.4131	51
		3.00	94.639	1.2512	20
		4.00	93.336	1.3280	26
		Total	94.221	1.4870	143
p3_4	1	2.00	100.00	.000	4
		Total	100.00	.000	4
	2	2.00	100.00	.000	3
		Total	100.00	.000	3
	3	1.00	100.00	.000	5
		2.00	100.00	.000	6
		3.00	100.00	.000	3
		4.00	100.00	.000	3
		Total	100.00	.000	17
	4	1.00	100.00	.000	10
		2.00	100.00	.000	7
		3.00	100.00	.000	3
		4.00	100.00	.000	3
		Total	100.00	.000	23
	7	1.00	100.00	.000	6
		2.00	100.00	.000	6
		3.00	100.00	.000	3

		4.00	100.00	.000	3
		Total	100.00	.000	18
	8	2.00	100.00	.000	6
		3.00	100.00	.000	2
		4.00	100.00	.000	2
		Total	100.00	.000	10
	9	2.00	100.00	.000	7
		3.00	100.00	.000	3
		4.00	100.00	.000	3
		Total	100.00	.000	13
	10	1.00	100.00	.000	6
		2.00	100.00	.000	5
		3.00	100.00	.000	2
		4.00	100.00	.000	2
		Total	100.00	.000	15
	11	1.00	100.00	.000	6
		2.00	100.00	.000	7
		3.00	100.00	.000	4
		4.00	100.00	.000	4
		Total	100.00	.000	21
	15	1.00	100.00	.000	6
		4.00	100.00	.000	2
		Total	100.00	.000	8
	16	1.00	100.00	.000	7
		4.00	100.00	.000	4
		Total	100.00	.000	11
	Total	1.00	100.00	.000	46
		2.00	100.00	.000	51
		3.00	100.00	.000	20
		4.00	100.00	.000	26
		Total	100.00	.000	143
bit	1	2.00	5.2638	.34099	4
		Total	5.2638	.34099	4
	2	2.00	5.0467	.28042	3
		Total	5.0467	.28042	3
	3	1.00	4.7530	.36008	5
		2.00	4.8525	.15436	6
		3.00	5.1800	.27527	3
		4.00	4.5700	.17521	3
		Total	4.8312	.30142	17
	4	1.00	4.9845	.22275	10
		2.00	4.9043	.33997	7
		3.00	5.1967	.36662	3
		4.00	4.6800	.34699	3
		Total	4.9480	.30729	23
	7	1.00	4.8900	.11336	6
		2.00	5.1250	.34961	6
		3.00	4.9917	.11184	3
		4.00	4.9400	.14799	3
		Total	4.9936	.23274	18

	8	2.00	4.7525	.26013	6
		3.00	5.1475	.10960	2
		4.00	4.4700	.09899	2
		Total	4.7750	.30309	10
	9	2.00	4.8629	.16849	7
		3.00	5.2333	.10396	3
		4.00	4.9733	.28431	3
		Total	4.9738	.23128	13
	10	1.00	4.9492	.18186	6
		2.00	5.0850	.17194	5
		3.00	5.0075	.10960	2
		4.00	4.8450	.12021	2
		Total	4.9883	.17068	15
	11	1.00	4.8342	.08375	6
		2.00	5.0157	.33743	7
		3.00	5.1450	.25810	4
		4.00	4.5975	.04573	4
		Total	4.9088	.28711	21
	15	1.00	5.0358	.16827	6
		4.00	4.8300	.05657	2
		Total	4.9844	.17251	8
	16	1.00	5.0929	.14824	7
		4.00	4.7625	.14361	4
		Total	4.9727	.21714	11
	Total	1.00	4.9460	.21070	46
		2.00	4.9702	.29342	51
		3.00	5.1348	.20929	20
		4.00	4.7392	.22373	26
		Total	4.9434	.26853	143

2002 Focus Project 1
Descriptive Statistics
Volumetrics

	dayno	Smp. Grp (Num)	Mean	Std. Deviation	N
gmm	3	1.00	2.68383	.015869	5
		3.00	2.66374	.007184	3
		4.00	2.67379	.001838	3
		Total	2.67562	.013741	11
	4	1.00	2.67247	.010262	10
		3.00	2.67067	.008919	3
		4.00	2.67254	.010745	3
		Total	2.67214	.009472	16
	7	1.00	2.66861	.004566	6
		3.00	2.66758	.010643	3
		4.00	2.65961	.007857	3

		Total	2.66610	.007538	12
	8	3.00	2.67411	.017469	2
		4.00	2.68877	.005678	2
		Total	2.68144	.013569	4
	9	3.00	2.66588	.006717	3
		4.00	2.65445	.007242	3
		Total	2.66016	.008841	6
	10	1.00	2.67507	.012317	6
		3.00	2.67525	.002550	2
		4.00	2.66666	.003784	2
		Total	2.67342	.009965	10
	11	1.00	2.68084	.002955	6
		3.00	2.66154	.021363	4
		4.00	2.65886	.014107	4
		Total	2.66905	.016374	14
	15	1.00	2.67816	.007035	6
		4.00	2.66787	.008372	2
		Total	2.67559	.008249	8
	16	1.00	2.66898	.007767	7
		4.00	2.66765	.010409	4
		Total	2.66850	.008316	11
	Total	1.00	2.67484	.010206	46
		3.00	2.66742	.011898	20
		4.00	2.66669	.011975	26
		Total	2.67093	.011664	92
gse	3	1.00	2.91752	.004057	5
		3.00	2.91646	.006480	3
		4.00	2.89508	.009004	3
		Total	2.91111	.011724	11
	4	1.00	2.91644	.010676	10
		3.00	2.92638	.027638	3
		4.00	2.89959	.012736	3
		Total	2.91514	.016328	16
	7	1.00	2.90634	.007200	6
		3.00	2.91069	.007341	3
		4.00	2.89787	.009118	3
		Total	2.90531	.008487	12
	8	3.00	2.92768	.015843	2
		4.00	2.90788	.001458	2
		Total	2.91778	.014662	4
	9	3.00	2.92218	.009474	3
		4.00	2.89329	.009615	3
		Total	2.90774	.017980	6
	10	1.00	2.91771	.013479	6
		3.00	2.92124	.009389	2
		4.00	2.90143	.011368	2
		Total	2.91516	.013399	10
	11	1.00	2.91845	.003735	6
		3.00	2.91157	.013314	4

		4.00	2.87824	.019276	4
		Total	2.90500	.021195	14
	15	1.00	2.92650	.009404	6
		4.00	2.90209	.013545	2
		Total	2.92040	.014730	8
	16	1.00	2.91816	.007425	7
		4.00	2.89809	.013145	4
		Total	2.91086	.013691	11
	Total	1.00	2.91724	.009834	46
		3.00	2.91856	.013704	20
		4.00	2.89560	.013491	26
		Total	2.91141	.015391	92
va	3	1.00	5.12981	1.227455	5
		3.00	4.25268	.173951	3
		4.00	4.05636	.239275	3
		Total	4.59783	.940936	11
	4	1.00	4.80284	.538796	10
		3.00	4.07714	.418945	3
		4.00	4.26941	.647438	3
		Total	4.56676	.596875	16
	7	1.00	4.54083	.475531	6
		3.00	4.76767	1.249889	3
		4.00	3.82213	.919417	3
		Total	4.41787	.823975	12
	8	3.00	4.77057	1.861857	2
		4.00	5.83125	.101154	2
		Total	5.30091	1.238517	4
	9	3.00	3.76990	.242809	3
		4.00	2.80636	.266638	3
		Total	3.28813	.574929	6
	10	1.00	4.26385	.635811	6
		3.00	4.99908	.463496	2
		4.00	4.25027	1.071529	2
		Total	4.40818	.687788	10
	11	1.00	4.83032	.320091	6
		3.00	4.01802	.777380	4
		4.00	3.38190	.564793	4
		Total	4.18440	.807288	14
	15	1.00	3.81333	.499118	6
		4.00	3.15599	1.359607	2
		Total	3.64900	.731170	8
	16	1.00	3.72396	.618234	7
		4.00	3.71004	.874741	4
		Total	3.71890	.677442	11
	Total	1.00	4.44424	.769472	46
		3.00	4.31068	.812377	20
		4.00	3.83483	.960285	26
		Total	4.24298	.867756	92

vma	3	1.00	14.58434	.404654	5
		3.00	14.81644	.527483	3
		4.00	13.76895	.274181	3
		Total	14.42526	.569177	11
	4	1.00	14.85550	.200150	10
		3.00	14.45480	.308888	3
		4.00	14.10186	.231802	3
		Total	14.63906	.373713	16
	7	1.00	14.65850	.308160	6
		3.00	14.98802	.678802	3
		4.00	14.35131	.721901	3
		Total	14.66408	.526317	12
	8	3.00	14.92499	1.009344	2
		4.00	14.80080	.359717	2
		Total	14.86289	.622788	4
	9	3.00	14.36690	.372718	3
		4.00	13.64366	.482702	3
		Total	14.00528	.552895	6
	10	1.00	14.25859	.223661	6
		3.00	14.96154	.431954	2
		4.00	14.42028	.944376	2
		Total	14.43152	.479593	10
	11	1.00	14.47662	.240361	6
		3.00	14.65128	.273113	4
		4.00	13.67475	.083268	4
		Total	14.29742	.462258	14
	15	1.00	13.83263	.414428	6
		4.00	13.39084	.995629	2
		Total	13.72218	.553276	8
	16	1.00	14.10058	.287434	7
		4.00	13.83294	.455011	4
		Total	14.00326	.360437	11
	Total	1.00	14.42476	.440088	46
		3.00	14.71283	.482474	20
		4.00	13.95584	.573588	26
		Total	14.35486	.557571	92
vfa	3	1.00	64.95049	7.585046	5
		3.00	71.28559	1.169291	3
		4.00	70.54885	1.359478	3
		Total	68.20507	5.783362	11
	4	1.00	67.67278	3.559279	10
		3.00	71.80757	2.589508	3
		4.00	69.72185	4.558764	3
		Total	68.83226	3.753820	16
	7	1.00	69.06247	2.672550	6
		3.00	68.40338	7.075486	3
		4.00	73.51838	5.306467	3
		Total	70.01167	4.692465	12
	8	3.00	68.38588	10.336770	2

		4.00	60.59849	.274171	2
		Total	64.49218	7.473674	4
	9	3.00	73.77066	1.266537	3
		4.00	79.42719	1.915739	3
		Total	76.59893	3.421779	6
	10	1.00	70.11992	4.237563	6
		3.00	66.61793	2.134144	2
		4.00	70.70621	5.512276	2
		Total	69.53678	4.035114	10
	11	1.00	66.65164	1.748181	6
		3.00	72.51192	5.632172	4
		4.00	75.28582	4.007278	4
		Total	70.79292	5.218939	14
	15	1.00	72.47614	3.034862	6
		4.00	76.74490	8.424211	2
		Total	73.54333	4.541125	8
	16	1.00	73.64397	4.006798	7
		4.00	73.30407	5.442022	4
		Total	73.52037	4.306593	11
	Total	1.00	69.27933	4.684317	46
		3.00	70.79285	4.767556	20
		4.00	72.69645	5.957865	26
		Total	70.57406	5.243394	92
gmb	3	1.00	2.57864	.016876	5
		3.00	2.58212	.009194	3
		4.00	2.59788	.005997	3
		Total	2.58484	.014507	11
	4	1.00	2.57693	.005395	10
		3.00	2.59182	.002852	3
		4.00	2.59308	.005450	3
		Total	2.58275	.009103	16
	7	1.00	2.58144	.009743	6
		3.00	2.57440	.022066	3
		4.00	2.59121	.023238	3
		Total	2.58212	.016397	12
	8	3.00	2.57898	.030136	2
		4.00	2.56777	.008377	2
		Total	2.57337	.019183	4
	9	3.00	2.59767	.006744	3
		4.00	2.61264	.007132	3
		Total	2.60515	.010283	6
	10	1.00	2.59689	.008162	6
		3.00	2.57780	.010438	2
		4.00	2.58833	.025024	2
		Total	2.59136	.013488	10
	11	1.00	2.58695	.007595	6
		3.00	2.58628	.003585	4
		4.00	2.60152	.002946	4

			Mean	Std. Deviation	N
		Total	2.59092	.008695	14
	15	1.00	2.60996	.009733	6
		4.00	2.61808	.026325	2
		Total	2.61199	.013446	8
	16	1.00	2.60444	.010961	7
		4.00	2.60419	.012983	4
		Total	2.60435	.011076	11
	Total	1.00	2.59011	.015401	46
		3.00	2.58484	.013516	20
		4.00	2.59829	.016865	26
		Total	2.59127	.016045	92

2002 Focus Project 2

Note that Days 1 and 2, Group 1 (POP Samples) were not included in analysis because the random sample procedure was not followed; rather, they were "trial" days to get the sampling procedure squared away.

Descriptive Statistics
Gradation and Binder content

	day	S loc num	Mean	Std. Deviation	N
p200	1	2.00	2.920746	.5804920	6
		3.00	2.447638	.4092804	2
		4.00	2.516425	.3129345	3
		Total	2.724457	.5062102	11
	2	2.00	2.995916	.5743001	9
		3.00	2.841260	.4810519	4
		4.00	3.356230	.4455872	4
		Total	3.044306	.5305430	17
	6	1.00	3.096159	.3872293	6
		2.00	2.914449	.4347714	8
		3.00	2.845858	.	1
		4.00	2.541255	.1523069	2
		Total	2.930642	.4010159	17
	8	1.00	2.983888	.5301271	6
		2.00	2.895290	.4551617	10
		3.00	2.651319	.4093640	4
		4.00	2.574949	.3064624	4
		Total	2.823387	.4484657	24
	12	1.00	2.911729	.2831764	6
		2.00	3.045300	.4173892	11
		3.00	2.912643	.6040953	3
		4.00	3.116916	.0715153	3
		Total	3.002493	.3702736	23
	13	1.00	3.061330	.3624741	6

		2.00	3.058853	.3360513	9
		3.00	2.633770	.4672340	2
		4.00	2.967825	.8687940	2
		Total	3.005308	.3984007	19
	Total	1.00	3.013276	.3807837	24
		2.00	2.977060	.4469688	53
		3.00	2.732308	.4225571	16
		4.00	2.869050	.4819449	18
		Total	2.932096	.4403095	111
p100	1	2.00	5.823637	.7318404	6
		3.00	5.214213	.4314363	2
		4.00	5.203444	.4303102	3
		Total	5.543689	.6533802	11
	2	2.00	5.865025	.6160953	9
		3.00	5.759832	.5433762	4
		4.00	6.178414	.4768689	4
		Total	5.914012	.5590668	17
	6	1.00	5.999080	.6100822	6
		2.00	5.849813	.5873046	8
		3.00	5.772872	.	1
		4.00	5.140324	.0127849	2
		Total	5.814500	.5809908	17
	8	1.00	5.943572	.7476201	6
		2.00	5.868957	.5726949	10
		3.00	5.520121	.4086380	4
		4.00	5.272035	.4897786	4
		Total	5.729984	.6060919	24
	12	1.00	5.741611	.3617005	6
		2.00	5.968650	.5178608	11
		3.00	5.881076	.8032139	3
		4.00	6.112456	.1359965	3
		Total	5.916757	.4765225	23
	13	1.00	5.984567	.5381282	6
		2.00	6.027296	.4781420	9
		3.00	5.587058	.5719647	2
		4.00	5.556544	1.1237895	2
		Total	5.917909	.5518332	19
	Total	1.00	5.917207	.5522422	24
		2.00	5.907848	.5522994	53
		3.00	5.633653	.5075952	16
		4.00	5.619068	.6193063	18
		Total	5.823519	.5655076	111
p50	1	2.00	13.332112	.6832508	6
		3.00	12.607165	.4095288	2
		4.00	12.520429	.4022741	3
		Total	12.978935	.6694051	11
	2	2.00	13.442161	.6499615	9
		3.00	13.323579	.5554478	4

		4.00	13.267830	.5779366	4
		Total	13.373240	.5811766	17
	6	1.00	12.835591	.8128721	6
		2.00	12.504229	.8083251	8
		3.00	13.531353	.	1
		4.00	12.006864	.4200365	2
		Total	12.623086	.7914519	17
	8	1.00	13.560506	.8188103	6
		2.00	13.664353	.8580316	10
		3.00	13.082632	.6739957	4
		4.00	12.679472	.3504837	4
		Total	13.377291	.8083827	24
	12	1.00	12.771950	.3042071	6
		2.00	12.826170	.6342857	11
		3.00	13.105300	.5367993	3
		4.00	13.226638	.3702977	3
		Total	12.900669	.5196718	23
	13	1.00	13.140683	.8180666	6
		2.00	13.128942	.6733445	9
		3.00	13.714168	1.0021866	2
		4.00	12.323529	1.8514492	2
		Total	13.109472	.8622172	19
	Total	1.00	13.077183	.7460019	24
		2.00	13.149016	.7926368	53
		3.00	13.194673	.6066768	16
		4.00	12.760622	.7264381	18
		Total	13.077083	.7523311	111
p30	1	2.00	21.696085	.6332711	6
		3.00	20.394118	.3045244	2
		4.00	20.779225	1.0213222	3
		Total	21.209311	.8654358	11
	2	2.00	20.722768	1.2430723	9
		3.00	21.095683	.4965565	4
		4.00	20.370907	1.1060829	4
		Total	20.727722	1.0554283	17
	6	1.00	20.719987	.8573659	6
		2.00	20.679144	.8477300	8
		3.00	22.036466	.	1
		4.00	20.348198	.8728803	2
		Total	20.734467	.8473184	17
	8	1.00	20.843817	.8803496	6
		2.00	20.664331	1.1254952	10
		3.00	20.494752	1.0313424	4
		4.00	20.432816	.3753033	4
		Total	20.642354	.9184206	24
	12	1.00	20.880391	.9878802	6
		2.00	20.352739	.9121471	11
		3.00	21.368977	.6990283	3

		4.00	21.140053	.8912840	3
		Total	20.725633	.9340982	23
	13	1.00	21.064244	.6554914	6
		2.00	21.115357	.7795196	9
		3.00	22.127358	1.5836020	2
		4.00	20.174889	2.2265855	2
		Total	21.106746	1.0084794	19
	Total	1.00	20.877110	.8060450	24
		2.00	20.805212	1.0023624	53
		3.00	21.096756	.9372018	16
		4.00	20.556606	.9466602	18
		Total	20.822467	.9446633	111
p16	1	2.00	27.528540	.7168165	6
		3.00	26.004826	.1426218	2
		4.00	26.531245	1.2108577	3
		Total	26.979512	.9916282	11
	2	2.00	26.238129	1.5279044	9
		3.00	26.846160	.5880713	4
		4.00	25.922370	1.5379834	4
		Total	26.306899	1.3371336	17
	6	1.00	26.481091	1.0198663	6
		2.00	26.244800	1.0426754	8
		3.00	28.534329	.	1
		4.00	26.028572	1.2737297	2
		Total	26.437436	1.1032008	17
	8	1.00	26.229543	1.1274681	6
		2.00	26.177434	1.4018774	10
		3.00	26.251913	1.3724925	4
		4.00	26.294340	.7527455	4
		Total	26.222359	1.1691517	24
	12	1.00	26.523175	1.0837415	6
		2.00	25.644490	1.1817766	11
		3.00	27.262986	.7609134	3
		4.00	26.723375	1.0303966	3
		Total	26.225545	1.1934972	23
	13	1.00	26.480457	1.1471055	6
		2.00	26.520258	1.0274089	9
		3.00	27.789428	1.4183057	2
		4.00	25.939272	2.7456517	2
		Total	26.580130	1.2563632	19
	Total	1.00	26.428567	1.0285567	24
		2.00	26.298469	1.2662874	53
		3.00	26.894006	1.0899796	16
		4.00	26.253688	1.2041724	18
		Total	26.405180	1.1871963	111
p8	1	2.00	37.333262	1.0491700	6
		3.00	35.066287	.1392114	2
		4.00	35.845529	1.3611880	3

		Total	36.515339	1.3707025	11
	2	2.00	35.512978	2.2786318	9
		3.00	36.912843	.7169582	4
		4.00	35.626130	2.3524055	4
		Total	35.868982	2.0220035	17
	6	1.00	35.701137	1.6949978	6
		2.00	35.628326	1.3242978	8
		3.00	37.602121	.	1
		4.00	34.517111	.8844208	2
		Total	35.639399	1.4538489	17
	8	1.00	35.154874	1.9386995	6
		2.00	35.137473	1.7889691	10
		3.00	35.938170	1.6752151	4
		4.00	35.557138	1.3854323	4
		Total	35.345217	1.6682293	24
	12	1.00	35.283348	1.4648185	6
		2.00	34.458654	1.8758056	11
		3.00	36.653129	1.1403932	3
		4.00	35.521463	1.3470810	3
		Total	35.098655	1.7141250	23
	13	1.00	35.164589	2.3471114	6
		2.00	35.295849	1.8371121	9
		3.00	36.862917	.4476010	2
		4.00	35.352438	4.7969792	2
		Total	35.425309	2.1403350	19
	Total	1.00	35.325987	1.7768842	24
		2.00	35.409916	1.8800239	53
		3.00	36.426498	1.1633076	16
		4.00	35.476286	1.8131813	18
		Total	35.549066	1.7767048	111
p4	1	2.00	51.064863	2.5261020	6
		3.00	48.792929	.4002292	2
		4.00	49.966905	1.7030696	3
		Total	50.352341	2.1499389	11
	2	2.00	49.055291	3.3681385	9
		3.00	51.512750	.7201402	4
		4.00	50.127748	2.3482203	4
		Total	49.885859	2.8049377	17
	6	1.00	50.020179	2.7529579	6
		2.00	49.266620	1.0541919	8
		3.00	50.029757	.	1
		4.00	47.767214	.1933662	2
		Total	49.401072	1.8352304	17
	8	1.00	50.285450	2.6224467	6
		2.00	49.444822	1.9872897	10
		3.00	50.937848	1.2824880	4
		4.00	50.541883	2.5690662	4
		Total	50.086660	2.1136031	24

	12	1.00	48.948709	2.0953717	6
		2.00	48.893691	2.7007222	11
		3.00	51.743819	1.4228765	3
		4.00	50.651566	1.9548687	3
		Total	49.509087	2.4451431	23
	13	1.00	50.541773	4.5015131	6
		2.00	49.423047	3.5020276	9
		3.00	51.493297	.9996234	2
		4.00	48.807412	6.2293380	2
		Total	49.929446	3.7357312	19
	Total	1.00	49.949028	2.9808986	24
		2.00	49.417094	2.6227852	53
		3.00	50.977254	1.3060812	16
		4.00	49.871288	2.4693701	18
		Total	49.830648	2.5615982	111
p_3_8	1	2.00	74.986249	3.5562869	6
		3.00	72.190884	.4875653	2
		4.00	74.155121	.8629827	3
		Total	74.251329	2.7698802	11
	2	2.00	74.746959	2.8537584	9
		3.00	76.290411	2.0625533	4
		4.00	75.578824	1.8347707	4
		Total	75.305857	2.4366955	17
	6	1.00	75.799651	2.8501544	6
		2.00	73.676724	1.7455814	8
		3.00	75.079803	.	1
		4.00	73.534681	1.1779192	2
		Total	74.491816	2.2512402	17
	8	1.00	76.181351	1.8964644	6
		2.00	75.453502	2.2642883	10
		3.00	77.319570	.8207507	4
		4.00	76.767107	3.7499203	4
		Total	76.165410	2.2858606	24
	12	1.00	74.561423	3.0705052	6
		2.00	74.786976	3.2210604	11
		3.00	76.366457	1.6524662	3
		4.00	76.536655	1.9543111	3
		Total	75.162374	2.8422516	23
	13	1.00	75.116298	2.8773920	6
		2.00	73.657692	3.0474839	9
		3.00	76.021948	.7157127	2
		4.00	74.636640	3.1944618	2
		Total	74.470221	2.7861606	19
	Total	1.00	75.414681	2.6081405	24
		2.00	74.569149	2.7645719	53
		3.00	75.940298	1.9749978	16
		4.00	75.433427	2.3916300	18
		Total	75.089763	2.5941024	111

p_1_2	1	2.00	95.792869	1.2403868	6
		3.00	93.865654	.5861475	2
		4.00	93.443124	.2663110	3
		Total	94.801627	1.4615830	11
	2	2.00	95.981131	.8566721	9
		3.00	95.982458	1.3602223	4
		4.00	94.709262	.6758348	4
		Total	95.682180	1.0530688	17
	6	1.00	95.118122	2.0485735	6
		2.00	95.536681	.8882344	8
		3.00	96.245198	.	1
		4.00	94.866397	3.5467377	2
		Total	95.351775	1.5999181	17
	8	1.00	95.865913	.7633393	6
		2.00	96.000486	.9421258	10
		3.00	96.375628	1.4223557	4
		4.00	95.276354	1.7222405	4
		Total	95.908678	1.1119163	24
	12	1.00	96.274069	1.3749227	6
		2.00	95.719117	1.3076182	11
		3.00	95.948349	1.6586678	3
		4.00	95.365422	2.1449762	3
		Total	95.847653	1.4022012	23
	13	1.00	95.510866	1.4369269	6
		2.00	94.799220	1.1103035	9
		3.00	95.635391	.4857386	2
		4.00	93.769593	.0464857	2
		Total	95.003586	1.2061833	19
	Total	1.00	95.692242	1.4455288	24
		2.00	95.641301	1.1010423	53
		3.00	95.782792	1.3405817	16
		4.00	94.646671	1.5591465	18
		Total	95.511419	1.3338245	111
p_3_4	1	2.00	100.00	.000	6
		3.00	100.00	.000	2
		4.00	100.00	.000	3
		Total	100.00	.000	11
	2	2.00	100.00	.000	9
		3.00	100.00	.000	4
		4.00	100.00	.000	4
		Total	100.00	.000	17
	6	1.00	100.00	.000	6
		2.00	100.00	.000	8
		3.00	100.00	.	1
		4.00	100.00	.000	2
		Total	100.00	.000	17
	8	1.00	100.00	.000	6
		2.00	100.00	.000	10

		3.00	100.00	.000	4
		4.00	100.00	.000	4
		Total	100.00	.000	24
	12	1.00	100.00	.000	6
		2.00	100.00	.000	11
		3.00	100.00	.000	3
		4.00	100.00	.000	3
		Total	100.00	.000	23
	13	1.00	100.00	.000	6
		2.00	100.00	.000	9
		3.00	100.00	.000	2
		4.00	100.00	.000	2
		Total	100.00	.000	19
	Total	1.00	100.00	.000	24
		2.00	100.00	.000	53
		3.00	100.00	.000	16
		4.00	100.00	.000	18
		Total	100.00	.000	111
bit	1	2.00	4.7117	.26049	6
		3.00	4.5450	.03536	2
		4.00	4.8600	.21656	3
		Total	4.7218	.23553	11
	2	2.00	4.7846	.25073	9
		3.00	4.8075	.09287	4
		4.00	4.8625	.05620	4
		Total	4.8083	.18626	17
	6	1.00	4.7500	.07849	6
		2.00	4.7825	.14782	8
		3.00	4.6000	.	1
		4.00	4.9800	.14142	2
		Total	4.7835	.14173	17
	8	1.00	4.7583	.18082	6
		2.00	4.6270	.16337	10
		3.00	4.7700	.11284	4
		4.00	4.8175	.17462	4
		Total	4.7154	.17146	24
	12	1.00	4.7017	.09517	6
		2.00	4.6855	.07090	11
		3.00	4.7200	.15100	3
		4.00	5.0000	.07550	3
		Total	4.7352	.13443	23
	13	1.00	4.6367	.16269	6
		2.00	4.7111	.14836	9
		3.00	4.8750	.10607	2
		4.00	4.8450	.02121	2
		Total	4.7189	.15666	19
	Total	1.00	4.7117	.13643	24
		2.00	4.7132	.17698	53

	3.00	4.7444	.13589	16
	4.00	4.8861	.13496	18
	Total	4.7454	.16739	111

2002 Focus Project 2
Descriptive Statistics
Volumetrics

Descriptive Statistics

	day	S loc num	Mean	Std. Deviation	N
gmm	1	3.00	2.655457	.0106161	2
		4.00	2.656667	.0049329	3
		Total	2.656183	.0063860	5
	2	3.00	2.649622	.0067293	4
		4.00	2.658500	.0091378	4
		Total	2.654061	.0088154	8
	6	1.00	2.651592	.0117022	6
		3.00	2.666908	.	1
		4.00	2.646750	.0003536	2
		Total	2.652218	.0109702	9
	8	1.00	2.660657	.0075305	6
		3.00	2.655638	.0019300	4
		4.00	2.653500	.0061237	4
		Total	2.657178	.0064654	14
	12	1.00	2.659746	.0098972	6
		3.00	2.649045	.0041073	3
		4.00	2.658000	.0101489	3
		Total	2.656634	.0093712	12
	13	1.00	2.664620	.0071630	6
		3.00	2.645008	.0021965	2
		4.00	2.656833	.0031754	3
		Total	2.658930	.0093629	11
	Total	1.00	2.659154	.0098964	24
		3.00	2.652251	.0070378	16
		4.00	2.655579	.0069567	19
		Total	2.656130	.0086430	59
gse	1	3.00	2.871193	.0111012	2
		4.00	2.889891	.0177835	3
		Total	2.882412	.0171412	5
	2	3.00	2.878209	.0108863	4
		4.00	2.892225	.0118585	4
		Total	2.885217	.0129301	8
	6	1.00	2.877549	.0170580	6
		3.00	2.888232	.	1
		4.00	2.884020	.0072845	2
		Total	2.880174	.0143344	9
	8	1.00	2.889227	.0137984	6
		3.00	2.883617	.0065718	4

		4.00	2.883559	.0092719	4
		Total	2.886005	.0105557	14
	12	1.00	2.884972	.0131207	6
		3.00	2.872772	.0106797	3
		4.00	2.899221	.0169019	3
		Total	2.885484	.0157037	12
	13	1.00	2.887491	.0157502	6
		3.00	2.876123	.0030177	2
		4.00	2.890379	.0060712	3
		Total	2.886212	.0126042	11
	Total	1.00	2.884810	.0147216	24
		3.00	2.878030	.0091590	16
		4.00	2.889981	.0118397	19
		Total	2.884637	.0131359	59
va	1	3.00	4.568916	.0960568	2
		4.00	4.086758	.6179501	3
		Total	4.279622	.5128166	5
	2	3.00	3.593160	.7221835	4
		4.00	3.496105	.5934691	4
		Total	3.544632	.6141315	8
	6	1.00	3.846165	.8053808	6
		3.00	5.400564	.	1
		4.00	3.819069	.4971870	2
		Total	4.012855	.8409772	9
	8	1.00	3.785476	.5925729	6
		3.00	4.290963	.3473073	4
		4.00	3.494107	.2664301	4
		Total	3.846653	.5291353	14
	12	1.00	4.055689	.3970844	6
		3.00	4.322001	.4813829	3
		4.00	3.323852	.8525647	3
		Total	3.939308	.6297590	12
	13	1.00	4.151023	.4454950	6
		3.00	3.682772	1.0574995	2
		4.00	2.999615	.7828493	3
		Total	3.751866	.7745639	11
	Total	1.00	3.959589	.5639145	24
		3.00	4.150402	.6965400	16
		4.00	3.517351	.6251718	19
		Total	3.868919	.6622853	59
vma	1	3.00	14.130233	.2886679	2
		4.00	14.124749	.6124984	3
		Total	14.126943	.4565287	5
	2	3.00	13.681884	.4598368	4
		4.00	13.539857	.2815472	4
		Total	13.610870	.3610499	8
	6	1.00	13.791277	.8129210	6
		3.00	14.560628	.	1

		4.00	14.315105	.3039578	2
		Total	13.993167	.7220154	9
	8	1.00	13.450705	.3470239	6
		3.00	14.077296	.2778635	4
		4.00	13.658903	.2207293	4
		Total	13.689216	.3850415	14
	12	1.00	13.671298	.3592522	6
		3.00	14.273273	.4702485	3
		4.00	13.524505	1.0026078	3
		Total	13.785093	.6100966	12
	13	1.00	13.539603	.4828099	6
		3.00	13.973095	.7771657	2
		4.00	13.151842	.7453729	3
		Total	13.512667	.6082435	11
	Total	1.00	13.613221	.5157778	24
		3.00	14.038989	.4452439	16
		4.00	13.675186	.6118138	19
		Total	13.748638	.5527582	59
vfa	1	3.00	67.651975	1.3406371	2
		4.00	71.155060	3.0652511	3
		Total	69.753826	2.9713115	5
	2	3.00	73.846740	4.4215062	4
		4.00	74.232707	3.8981934	4
		Total	74.039724	3.8643947	8
	6	1.00	72.278980	4.2077534	6
		3.00	62.909814	.	1
		4.00	73.352268	2.9073425	2
		Total	71.476470	4.7600885	9
	8	1.00	71.922159	3.7562321	6
		3.00	69.543494	1.9235587	4
		4.00	74.416773	1.9266825	4
		Total	71.955287	3.2850731	14
	12	1.00	70.352162	2.5230905	6
		3.00	69.766582	2.4183458	3
		4.00	75.638130	4.3840834	3
		Total	71.527259	3.6958200	12
	13	1.00	69.398376	2.2860271	6
		3.00	73.813796	6.1116692	2
		4.00	77.362630	4.5288716	3
		Total	72.373249	4.8624562	11
	Total	1.00	70.987919	3.2959443	24
		3.00	70.543877	4.2145548	16
		4.00	74.408943	3.5610261	19
		Total	71.969187	3.9680998	59
gmb	1	3.00	2.566208	.0061806	2
		4.00	2.579309	.0148995	3
		Total	2.574069	.0131164	5
	2	3.00	2.585419	.0150553	4

		4.00	2.598499	.0069741	4
		Total	2.591959	.0129179	8
	6	1.00	2.581364	.0246976	6
		3.00	2.549924	.	1
		4.00	2.576445	.0148242	2
		Total	2.576777	.0226857	9
	8	1.00	2.591345	.0105675	6
		3.00	2.572452	.0118116	4
		4.00	2.593796	.0050088	4
		Total	2.586647	.0129938	14
	12	1.00	2.581281	.0113934	6
		3.00	2.563714	.0171677	3
		4.00	2.602162	.0321157	3
		Total	2.582110	.0224154	12
	13	1.00	2.585656	.0150315	6
		3.00	2.578992	.0272287	2
		4.00	2.607624	.0209407	3
		Total	2.590436	.0200833	11
	Total	1.00	2.584911	.0158707	24
		3.00	2.572684	.0164101	16
		4.00	2.594176	.0181442	19
		Total	2.584579	.0184647	59

2003 Focus Project 1

Descriptive Statistics
Gradation and Binder Content

	dayno	Smp Gp Numeric	Mean	Std. Deviation	N
p200	1	2.00	3.370	.4679	6
		3.00	3.677	.2696	2
		4.00	3.492	.2661	4
		Total	3.462	.3725	12
	2	2.00	3.436	.0839	7
		3.00	3.489	.1187	3
		4.00	3.406	.0915	3
		Total	3.441	.0904	13
	5	1.00	3.238	.3675	3
		2.00	3.439	.2633	11
		3.00	2.982	.2180	3
		4.00	3.720	.1227	3
		Total	3.382	.3253	20
	6	1.00	2.909	.5202	6
		2.00	3.611	.1565	7
		3.00	3.332	1.2506	3
		4.00	3.163	.6940	3
		Total	3.275	.6339	19
	7	1.00	3.296	.3516	5

		2.00	3.702	.6598	5
		3.00	4.250	.6029	3
		4.00	3.803	.3870	3
		Total	3.696	.5784	16
	8	1.00	3.140	.3871	4
		2.00	3.591	.1824	6
		3.00	3.540	.3426	3
		4.00	3.147	.7864	4
		Total	3.372	.4674	17
	9	2.00	3.301	.3404	8
		3.00	3.347	.9443	2
		Total	3.310	.4354	10
	12	2.00	3.202	.2870	8
		3.00	3.843	.1182	3
		Total	3.377	.3876	11
	13	1.00	3.323	.3415	5
		2.00	3.118	.2517	7
		3.00	3.932	.1335	2
		4.00	3.618	.0907	4
		Total	3.377	.3617	18
	14	1.00	3.336	.4062	3
		2.00	3.474	.2969	7
		3.00	3.443	.3457	2
		4.00	3.549	.0918	3
		Total	3.457	.2761	15
	20	1.00	3.334	.3187	5
		2.00	3.428	.4147	4
		3.00	3.217	.3279	2
		4.00	3.587	.0237	3
		Total	3.398	.3074	14
	21	1.00	3.379	.4899	6
		2.00	3.262	.2459	9
		4.00	3.512	.0012	3
		Total	3.343	.3287	18
	22	1.00	3.340	.7234	3
		4.00	3.650	.1113	4
		Total	3.517	.4562	7
	Total	1.00	3.245	.4231	40
		2.00	3.396	.3338	85
		3.00	3.555	.5758	28
		4.00	3.510	.3695	37
		Total	3.410	.4132	190
p100	1	2.00	6.665	.7659	6
		3.00	7.084	.4539	2
		4.00	6.540	.4404	4
		Total	6.693	.6124	12
	2	2.00	6.730	.1537	7
		3.00	6.785	.1592	3
		4.00	6.431	.1202	3

	Total	6.674	.1952	13
5	1.00	6.500	.8171	3
	2.00	6.799	.4191	11
	3.00	6.218	.3674	3
	4.00	6.924	.1775	3
	Total	6.686	.4863	20
6	1.00	5.912	.9372	6
	2.00	7.045	.2409	7
	3.00	6.658	1.8394	3
	4.00	6.294	.8031	3
	Total	6.508	.9762	19
7	1.00	6.588	.7464	5
	2.00	7.335	.8601	5
	3.00	8.069	.9477	3
	4.00	7.442	.8733	3
	Total	7.259	.9258	16
8	1.00	6.264	.8777	4
	2.00	6.930	.2568	6
	3.00	6.824	.6708	3
	4.00	6.506	1.2142	4
	Total	6.655	.7584	17
9	2.00	6.350	.6766	8
	3.00	6.465	1.6697	2
	Total	6.373	.8175	10
12	2.00	6.245	.5191	8
	3.00	7.363	.1892	3
	Total	6.550	.6847	11
13	1.00	6.417	.6037	5
	2.00	6.043	.5093	7
	3.00	7.299	.3277	2
	4.00	7.042	.1180	4
	Total	6.509	.6467	18
14	1.00	6.506	.6180	3
	2.00	6.610	.5888	7
	3.00	7.333	1.8266	2
	4.00	6.935	.1283	3
	Total	6.751	.7226	15
20	1.00	6.445	.4025	5
	2.00	6.555	.7564	4
	3.00	6.251	.6939	2
	4.00	7.014	.0727	3
	Total	6.570	.5356	14
21	1.00	6.870	1.1175	6
	2.00	6.369	.5061	9
	4.00	7.000	.0642	3
	Total	6.641	.7541	18
22	1.00	6.425	1.1266	3
	4.00	7.199	.2222	4
	Total	6.867	.7868	7

	Total	1.00	6.432	.8000	40
		2.00	6.616	.6018	85
		3.00	6.951	.9634	28
		4.00	6.845	.5855	37
		Total	6.671	.7224	190
p50	1	2.00	12.291	1.3323	6
		3.00	13.038	.6061	2
		4.00	12.672	.6273	4
		Total	12.542	1.0164	12
	2	2.00	12.345	.2626	7
		3.00	12.500	.2105	3
		4.00	12.274	.2486	3
		Total	12.365	.2430	13
	5	1.00	12.384	.2427	3
		2.00	12.626	.6984	11
		3.00	11.994	.6357	3
		4.00	13.095	.2965	3
		Total	12.565	.6465	20
	6	1.00	11.880	1.0337	6
		2.00	12.929	.2889	7
		3.00	12.579	2.1898	3
		4.00	12.434	.9357	3
		Total	12.464	1.0747	19
	7	1.00	12.958	.5701	5
		2.00	13.353	.8598	5
		3.00	14.091	1.4143	3
		4.00	13.430	1.1334	3
		Total	13.382	.9396	16
	8	1.00	11.998	.3377	4
		2.00	12.310	.3881	6
		3.00	12.554	.4099	3
		4.00	12.138	1.3750	4
		Total	12.239	.6939	17
	9	2.00	11.957	.6062	8
		3.00	11.716	.9693	2
		Total	11.909	.6329	10
	12	2.00	11.594	1.5071	8
		3.00	13.041	.2107	3
		Total	11.989	1.4338	11
	13	1.00	11.799	.4872	5
		2.00	12.510	1.7569	7
		3.00	12.688	.7448	2
		4.00	12.374	.2379	4
		Total	12.302	1.1397	18
	14	1.00	12.057	.5940	3
		2.00	12.108	.3322	7
		3.00	12.941	1.0651	2
		4.00	12.151	.2875	3
		Total	12.217	.5271	15

	20	1.00	11.702	.2510	5
		2.00	11.898	.7116	4
		3.00	11.347	.0431	2
		4.00	12.047	.1876	3
		Total	11.781	.4401	14
	21	1.00	11.968	.8343	6
		2.00	11.501	.4830	9
		4.00	12.111	.1131	3
		Total	11.758	.6234	18
	22	1.00	11.817	.8728	3
		4.00	12.378	.2542	4
		Total	12.138	.6134	7
	Total	1.00	12.054	.7122	40
		2.00	12.259	.9800	85
		3.00	12.634	1.0820	28
		4.00	12.456	.7082	37
		Total	12.309	.9105	190
p30	1	2.00	18.907	1.9336	6
		3.00	19.943	.7679	2
		4.00	19.591	.8477	4
		Total	19.308	1.4626	12
	2	2.00	18.701	.4152	7
		3.00	18.973	.3897	3
		4.00	18.708	.4091	3
		Total	18.765	.3917	13
	5	1.00	19.036	.3734	3
		2.00	19.179	1.2161	11
		3.00	18.510	.9360	3
		4.00	19.998	.5958	3
		Total	19.180	1.0500	20
	6	1.00	18.525	1.5725	6
		2.00	19.650	.3383	7
		3.00	19.561	2.3871	3
		4.00	19.296	1.2042	3
		Total	19.225	1.3312	19
	7	1.00	19.671	.7911	5
		2.00	20.211	.9608	5
		3.00	20.989	2.1241	3
		4.00	19.920	1.3507	3
		Total	20.133	1.2192	16
	8	1.00	18.203	.6415	4
		2.00	18.353	.6131	6
		3.00	18.870	.4194	3
		4.00	18.271	1.4502	4
		Total	18.389	.8167	17
	9	2.00	17.848	.9147	8
		3.00	17.179	.7787	2
		Total	17.714	.8931	10
	12	2.00	18.116	.7065	8
		3.00	19.595	.1301	3

		Total	18.519	.9111	11
	13	1.00	17.597	.4462	5
		2.00	17.840	1.0633	7
		3.00	18.914	1.2973	2
		4.00	18.231	.3260	4
		Total	17.979	.8558	18
	14	1.00	17.844	.5857	3
		2.00	17.845	.5443	7
		3.00	19.167	1.1220	2
		4.00	17.756	.5865	3
		Total	18.003	.7345	15
	20	1.00	16.929	.7272	5
		2.00	17.748	1.0111	4
		3.00	16.952	.0608	2
		4.00	17.506	.3609	3
		Total	17.290	.7496	14
	21	1.00	17.308	.9442	6
		2.00	17.034	.6467	9
		4.00	17.357	.1683	3
		Total	17.179	.6965	18
	22	1.00	17.218	.5634	3
		4.00	17.909	.2668	4
		Total	17.613	.5272	7
	Total	1.00	18.027	1.1916	40
		2.00	18.421	1.2305	85
		3.00	19.064	1.4706	28
		4.00	18.585	1.1468	37
		Total	18.465	1.2739	190
p16	1	2.00	24.545	2.5529	6
		3.00	25.899	.9737	2
		4.00	26.181	1.2057	4
		Total	25.316	2.0257	12
	2	2.00	23.997	.5839	7
		3.00	24.567	.6599	3
		4.00	24.872	.6460	3
		Total	24.331	.6818	13
	5	1.00	24.438	.6394	3
		2.00	24.738	1.8316	11
		3.00	23.887	1.4329	3
		4.00	26.765	.9747	3
		Total	24.870	1.6982	20
	6	1.00	23.966	2.0594	6
		2.00	25.474	.5066	7
		3.00	25.839	2.5679	3
		4.00	25.962	1.4813	3
		Total	25.132	1.7138	19
	7	1.00	25.165	1.0444	5
		2.00	26.292	1.3104	5

		3.00	27.263	2.9629	3
		4.00	26.285	1.7403	3
		Total	26.121	1.7040	16
	8	1.00	23.278	1.0207	4
		2.00	23.701	.9041	6
		3.00	24.461	.5654	3
		4.00	24.311	1.5332	4
		Total	23.879	1.0695	17
	9	2.00	22.846	1.3619	8
		3.00	22.153	.5969	2
		Total	22.707	1.2521	10
	12	2.00	23.215	1.0929	8
		3.00	25.500	.1404	3
		Total	23.839	1.4067	11
	13	1.00	22.612	.5386	5
		2.00	22.898	1.0149	7
		3.00	24.803	1.7378	2
		4.00	24.239	.3658	4
		Total	23.328	1.1451	18
	14	1.00	22.881	.6452	3
		2.00	22.838	.8878	7
		3.00	24.730	1.3284	2
		4.00	23.448	.9226	3
		Total	23.221	1.0389	15
	20	1.00	21.724	.9560	5
		2.00	22.873	1.5263	4
		3.00	21.698	.0264	2
		4.00	23.055	.5974	3
		Total	22.334	1.1352	14
	21	1.00	22.036	1.2746	6
		2.00	21.871	.8936	9
		4.00	22.720	.3679	3
		Total	22.067	.9826	18
	22	1.00	22.267	.5496	3
		4.00	23.765	.3466	4
		Total	23.123	.8958	7
	Total	1.00	23.135	1.5594	40
		2.00	23.722	1.7214	85
		3.00	24.754	1.9630	28
		4.00	24.684	1.5946	37
		Total	23.938	1.7941	190
p8	1	2.00	32.389	3.1751	6
		3.00	34.152	1.4602	2
		4.00	34.211	1.7592	4
		Total	33.290	2.5508	12
	2	2.00	31.496	.8584	7
		3.00	32.626	1.1104	3
		4.00	32.535	.9733	3
		Total	31.996	1.0245	13

	5	1.00	31.531	.6841	3
		2.00	32.626	2.7289	11
		3.00	30.684	2.2878	3
		4.00	35.267	1.6769	3
		Total	32.566	2.5881	20
	6	1.00	31.164	2.9162	6
		2.00	33.876	.7157	7
		3.00	34.925	2.8012	3
		4.00	34.209	1.7630	3
		Total	33.238	2.4441	19
	7	1.00	32.533	1.5582	5
		2.00	35.212	2.0803	5
		3.00	36.212	4.2257	3
		4.00	34.297	2.3692	3
		Total	34.391	2.6404	16
	8	1.00	30.020	1.7804	4
		2.00	31.455	1.3217	6
		3.00	32.420	.8807	3
		4.00	31.883	1.6514	4
		Total	31.389	1.5745	17
	9	2.00	29.971	2.1142	8
		3.00	29.507	.1544	2
		Total	29.879	1.8755	10
	12	2.00	30.308	1.7496	8
		3.00	33.608	.2955	3
		Total	31.208	2.1299	11
	13	1.00	29.279	.7383	5
		2.00	30.078	.9535	7
		3.00	33.545	2.2086	2
		4.00	32.000	.5473	4
		Total	30.668	1.7004	18
	14	1.00	30.168	1.2779	3
		2.00	30.288	1.4246	7
		3.00	32.586	1.3885	2
		4.00	30.990	1.2325	3
		Total	30.711	1.4591	15
	20	1.00	28.444	1.3030	5
		2.00	30.222	2.3772	4
		3.00	28.379	.3628	2
		4.00	30.329	.9706	3
		Total	29.347	1.7022	14
	21	1.00	28.591	1.9417	6
		2.00	28.776	1.4511	9
		4.00	29.745	.5616	3
		Total	28.876	1.5180	18
	22	1.00	29.294	.6301	3
		4.00	31.555	.5782	4
		Total	30.586	1.3265	7
	Total	1.00	30.072	2.0865	40

		2.00	31.297	2.4737	85
		3.00	32.777	2.7567	28
		4.00	32.452	2.0599	37
		Total	31.482	2.5260	190
p4	1	2.00	41.839	3.6193	6
		3.00	43.770	1.6487	2
		4.00	44.262	2.1201	4
		Total	42.969	2.9746	12
	2	2.00	40.700	1.1071	7
		3.00	41.943	1.5594	3
		4.00	42.352	1.2785	3
		Total	41.368	1.3696	13
	5	1.00	40.856	.7721	3
		2.00	42.601	3.5864	11
		3.00	40.350	3.5349	3
		4.00	46.572	2.1983	3
		Total	42.598	3.5252	20
	6	1.00	40.519	3.9212	6
		2.00	44.118	.8988	7
		3.00	45.909	3.1514	3
		4.00	45.157	2.4325	3
		Total	43.428	3.2912	19
	7	1.00	42.805	1.8271	5
		2.00	47.318	2.1712	5
		3.00	48.589	4.0068	3
		4.00	46.651	1.4207	3
		Total	46.021	3.1566	16
	8	1.00	39.609	2.6815	4
		2.00	41.641	1.3456	6
		3.00	42.269	1.3771	3
		4.00	42.276	1.6529	4
		Total	41.423	1.9544	17
	9	2.00	39.440	3.2571	8
		3.00	38.448	.0120	2
		Total	39.241	2.9027	10
	12	2.00	38.402	2.5354	8
		3.00	42.113	.4896	3
		Total	39.414	2.7480	11
	13	1.00	37.598	1.1160	5
		2.00	38.988	1.0428	7
		3.00	43.879	3.1423	2
		4.00	42.098	.8624	4
		Total	39.836	2.5070	18
	14	1.00	39.795	2.2475	3
		2.00	40.438	1.5395	7
		3.00	42.558	1.2892	2
		4.00	41.164	1.0604	3
		Total	40.737	1.6626	15
	20	1.00	37.124	2.0477	5

		2.00	39.533	3.1394	4
		3.00	37.280	.7504	2
		4.00	40.145	1.2753	3
		Total	38.482	2.4017	14
	21	1.00	36.730	3.0341	6
		2.00	37.855	1.9225	9
		4.00	38.666	.6646	3
		Total	37.615	2.2362	18
	22	1.00	37.996	1.1947	3
		4.00	41.453	.4228	4
		Total	39.971	1.9949	7
	Total	1.00	39.138	3.0141	40
		2.00	40.910	3.3409	85
		3.00	42.692	3.6299	28
		4.00	42.770	2.7048	37
		Total	41.162	3.4438	190
p3_8	1	2.00	74.415	3.1031	6
		3.00	74.915	1.5375	2
		4.00	77.261	2.9680	4
		Total	75.447	2.9704	12
	2	2.00	73.024	1.4326	7
		3.00	74.207	1.0210	3
		4.00	75.354	1.6073	3
		Total	73.835	1.6205	13
	5	1.00	70.970	1.3701	3
		2.00	74.585	3.0347	11
		3.00	71.278	2.6225	3
		4.00	79.040	2.2153	3
		Total	74.215	3.6145	20
	6	1.00	72.030	4.5024	6
		2.00	76.592	1.2237	7
		3.00	77.754	3.1870	3
		4.00	75.779	2.9435	3
		Total	75.206	3.6700	19
	7	1.00	72.799	2.0958	5
		2.00	77.815	.9197	5
		3.00	78.357	.5937	3
		4.00	77.863	.9179	3
		Total	76.358	2.7815	16
	8	1.00	73.823	3.8216	4
		2.00	76.638	1.4523	6
		3.00	76.597	.9349	3
		4.00	77.391	1.3320	4
		Total	76.146	2.3884	17
	9	2.00	75.422	2.2288	8
		3.00	74.100	.1020	2
		Total	75.158	2.0434	10
	12	2.00	74.274	3.2966	8
		3.00	77.274	.6246	3

		Total	75.092	3.1062	11
	13	1.00	70.734	2.7998	5
		2.00	71.713	1.9689	7
		3.00	76.238	1.0910	2
		4.00	77.125	.9666	4
		Total	73.146	3.2947	18
	14	1.00	74.125	2.4592	3
		2.00	75.637	2.9570	7
		3.00	77.352	.6925	2
		4.00	75.371	1.9767	3
		Total	75.510	2.4722	15
	20	1.00	73.848	1.5420	5
		2.00	74.509	2.1542	4
		3.00	72.006	3.8880	2
		4.00	76.548	.4148	3
		Total	74.352	2.2486	14
	21	1.00	72.059	3.5753	6
		2.00	72.998	1.8249	9
		4.00	75.084	2.2060	3
		Total	73.033	2.6414	18
	22	1.00	73.768	2.8597	3
		4.00	76.773	.6594	4
		Total	75.485	2.3503	7
	Total	1.00	72.583	3.0122	40
		2.00	74.673	2.7154	85
		3.00	75.558	2.7668	28
		4.00	76.738	1.9240	37
		Total	74.765	2.9690	190
p1_2	1	2.00	96.475	.7482	6
		3.00	96.836	.5426	2
		4.00	96.096	1.2700	4
		Total	96.409	.8901	12
	2	2.00	97.014	1.0032	7
		3.00	96.708	1.2885	3
		4.00	95.987	2.6073	3
		Total	96.706	1.4483	13
	5	1.00	95.002	.6263	3
		2.00	96.363	1.3330	11
		3.00	95.843	1.2723	3
		4.00	95.821	1.8577	3
		Total	96.000	1.3239	20
	6	1.00	94.776	1.3711	6
		2.00	97.586	.9349	7
		3.00	96.584	.7471	3
		4.00	95.416	.6753	3
		Total	96.198	1.5736	19
	7	1.00	96.928	.5638	5
		2.00	97.820	.5108	5
		3.00	97.938	.0920	3

		4.00	96.578	.8799	3
		Total	97.331	.7614	16
	8	1.00	96.751	2.0347	4
		2.00	97.954	.9982	6
		3.00	96.052	2.0579	3
		4.00	97.237	.5381	4
		Total	97.167	1.4769	17
	9	2.00	97.415	1.0855	8
		3.00	96.083	1.4899	2
		Total	97.149	1.2161	10
	12	2.00	97.248	1.2971	8
		3.00	97.390	.6239	3
		Total	97.287	1.1225	11
	13	1.00	95.403	.9708	5
		2.00	95.577	1.2064	7
		3.00	96.601	.2126	2
		4.00	95.854	1.0586	4
		Total	95.704	1.0340	18
	14	1.00	96.734	.5419	3
		2.00	96.131	2.0952	7
		3.00	99.085	.2347	2
		4.00	95.793	.9324	3
		Total	96.578	1.7851	15
	20	1.00	96.663	1.5597	5
		2.00	96.958	.7368	4
		3.00	97.792	.2432	2
		4.00	97.106	.2153	3
		Total	97.003	1.0144	14
	21	1.00	95.865	1.2703	6
		2.00	96.493	.4305	9
		4.00	95.983	1.7371	3
		Total	96.199	1.0051	18
	22	1.00	95.907	.8593	3
		4.00	96.716	.8672	4
		Total	96.369	.8994	7
	Total	1.00	95.969	1.3562	40
		2.00	96.864	1.2701	85
		3.00	96.941	1.2487	28
		4.00	96.261	1.2230	37
		Total	96.569	1.3261	190
p3_4	1	2.00	100.000	.0000	6
		3.00	100.000	.0000	2
		4.00	100.000	.0000	4
		Total	100.000	.0000	12
	2	2.00	100.000	.0000	7
		3.00	100.000	.0000	3
		4.00	100.000	.0000	3
		Total	100.000	.0000	13
	5	1.00	100.000	.0000	3

	2.00	100.000	.0000	11
	3.00	100.000	.0000	3
	4.00	100.000	.0000	3
	Total	100.000	.0000	20
6	1.00	100.000	.0000	6
	2.00	100.000	.0000	7
	3.00	100.000	.0000	3
	4.00	100.000	.0000	3
	Total	100.000	.0000	19
7	1.00	100.000	.0000	5
	2.00	100.000	.0000	5
	3.00	100.000	.0000	3
	4.00	100.000	.0000	3
	Total	100.000	.0000	16
8	1.00	100.000	.0000	4
	2.00	100.000	.0000	6
	3.00	100.000	.0000	3
	4.00	100.000	.0000	4
	Total	100.000	.0000	17
9	2.00	100.000	.0000	8
	3.00	100.000	.0000	2
	Total	100.000	.0000	10
12	2.00	100.000	.0000	8
	3.00	100.000	.0000	3
	Total	100.000	.0000	11
13	1.00	100.000	.0000	5
	2.00	100.000	.0000	7
	3.00	100.000	.0000	2
	4.00	100.000	.0000	4
	Total	100.000	.0000	18
14	1.00	100.000	.0000	3
	2.00	100.000	.0000	7
	3.00	100.000	.0000	2
	4.00	100.000	.0000	3
	Total	100.000	.0000	15
20	1.00	100.000	.0000	5
	2.00	100.000	.0000	4
	3.00	100.000	.0000	2
	4.00	100.000	.0000	3
	Total	100.000	.0000	14
21	1.00	100.000	.0000	6
	2.00	100.000	.0000	9
	4.00	100.000	.0000	3
	Total	100.000	.0000	18
22	1.00	100.000	.0000	3
	4.00	100.000	.0000	4
	Total	100.000	.0000	7
Total	1.00	100.000	.0000	40
	2.00	100.000	.0000	85

		3.00	100.000	.0000	28
		4.00	100.000	.0000	37
		Total	100.000	.0000	190
bit	1	2.00	5.110	.1992	6
		3.00	4.985	.3748	2
		4.00	5.013	.2287	4
		Total	5.057	.2197	12
	2	2.00	4.706	.1520	7
		3.00	4.853	.1650	3
		4.00	4.930	.1900	3
		Total	4.792	.1793	13
	5	1.00	4.793	.1168	3
		2.00	4.735	.3048	11
		3.00	4.520	.1836	3
		4.00	5.143	.0702	3
		Total	4.773	.2951	20
	6	1.00	4.713	.1942	6
		2.00	4.971	.1559	7
		3.00	4.990	.2476	3
		4.00	5.067	.0839	3
		Total	4.908	.2137	19
	7	1.00	4.752	.3576	5
		2.00	4.944	.2196	5
		3.00	4.960	.0265	3
		4.00	4.813	.1858	3
		Total	4.863	.2456	16
	8	1.00	4.820	.2233	4
		2.00	4.970	.0805	6
		3.00	5.110	.1609	3
		4.00	4.905	.0681	4
		Total	4.944	.1585	17
	9	2.00	4.825	.1989	8
		3.00	4.885	.2051	2
		Total	4.837	.1899	10
	12	2.00	4.828	.1830	8
		3.00	5.050	.0954	3
		Total	4.888	.1899	11
	13	1.00	4.735	.2536	5
		2.00	4.741	.0921	7
		3.00	4.995	.0354	2
		4.00	4.965	.0896	4
		Total	4.818	.1812	18
	14	1.00	4.770	.1559	3
		2.00	4.870	.1277	7
		3.00	4.970	.0424	2
		4.00	4.783	.1242	3
		Total	4.846	.1317	15
	20	1.00	4.855	.1929	5
		2.00	5.018	.0150	4

		3.00	4.865	.0636	2
		4.00	4.923	.1026	3
		Total	4.917	.1359	14
	21	1.00	4.872	.1195	6
		2.00	4.803	.1155	9
		4.00	4.813	.0850	3
		Total	4.828	.1112	18
	22	1.00	4.777	.1387	3
		4.00	4.783	.1403	4
		Total	4.780	.1275	7
	Total	1.00	4.788	.2003	40
		2.00	4.857	.2058	85
		3.00	4.923	.2117	28
		4.00	4.921	.1619	37
		Total	4.865	.2023	190

2003 Focus Project 1
Descriptive Statistics
Volumetrics

	dayno	Smp Gp Numeric	Mean	Std. Deviation	N
gmm	1	3.00	2.65963	.015051	2
		4.00	2.66416	.012672	4
		Total	2.66265	.012130	6
	2	3.00	2.67213	.024547	3
		4.00	2.66298	.008112	3
		Total	2.66755	.017101	6
	5	1.00	2.65655	.008093	3
		3.00	2.65725	.015599	3
		4.00	2.65570	.000649	3
		Total	2.65650	.008819	9
	6	1.00	2.66547	.006121	2
		3.00	2.64756	.015165	3
		4.00	2.66596	.006598	3
		Total	2.65893	.013126	8
	7	1.00	2.65872	.017211	3
		3.00	2.65655	.000708	3
		4.00	2.66460	.003780	3
		Total	2.65996	.009527	9
	8	1.00	2.66931	.007413	3
		3.00	2.66588	.023866	3
		4.00	2.66785	.003123	4
		Total	2.66770	.012000	10
	9	3.00	2.64038	.002617	2
		Total	2.64038	.002617	2
	12	3.00	2.64187	.012015	3
		Total	2.64187	.012015	3
	13	1.00	2.67397	.003072	3

		3.00	2.66055	.022803	2
		4.00	2.66793	.007911	4
		Total	2.66830	.010861	9
	14	1.00	2.67229	.004308	3
		3.00	2.64865	.005519	2
		4.00	2.67706	.001456	3
		Total	2.66817	.012662	8
	20	1.00	2.65063	.029613	3
		3.00	2.66494	.017189	2
		4.00	2.67027	.005834	3
		Total	2.66157	.019735	8
	21	1.00	2.67833	.012442	3
		4.00	2.67953	.009176	3
		Total	2.67893	.009800	6
	22	1.00	2.66559	.002720	3
		4.00	2.67370	.003641	4
		Total	2.67022	.005284	7
	Total	1.00	2.66566	.014052	26
		3.00	2.65614	.016526	28
		4.00	2.66819	.008585	37
		Total	2.66376	.013907	91
gse	1	3.00	2.90069	.039618	2
		4.00	2.90754	.004833	4
		Total	2.90526	.018452	6
	2	3.00	2.90856	.021310	3
		4.00	2.90160	.018088	3
		Total	2.90508	.018084	6
	5	1.00	2.88599	.004645	3
		3.00	2.87219	.027392	3
		4.00	2.90425	.003603	3
		Total	2.88747	.019754	9
	6	1.00	2.89688	.005665	2
		3.00	2.88557	.017144	3
		4.00	2.91287	.005129	3
		Total	2.89863	.016031	8
	7	1.00	2.88118	.008654	3
		3.00	2.89515	.001960	3
		4.00	2.89710	.005730	3
		Total	2.89114	.009189	9
	8	1.00	2.90891	.014185	3
		3.00	2.91512	.021304	3
		4.00	2.90622	.004562	4
		Total	2.90970	.012956	10
	9	3.00	2.87093	.007810	2
		Total	2.87093	.007810	2
	12	3.00	2.88177	.018501	3
		Total	2.88177	.018501	3
	13	1.00	2.89428	.005972	3
		3.00	2.90214	.030521	2

		4.00	2.90969	.012601	4
		Total	2.90288	.015361	9
	14	1.00	2.90429	.013837	3
		3.00	2.88583	.004573	2
		4.00	2.91091	.005119	3
		Total	2.90216	.013273	8
	20	1.00	2.88026	.028666	3
		3.00	2.90042	.024924	2
		4.00	2.91026	.007122	3
		Total	2.89655	.023166	8
	21	1.00	2.91701	.018872	3
		4.00	2.91564	.007476	3
		Total	2.91632	.012860	6
	22	1.00	2.89631	.006956	3
		4.00	2.90671	.009258	4
		Total	2.90225	.009482	7
	Total	1.00	2.89609	.017063	26
		3.00	2.89268	.022213	28
		4.00	2.90753	.008759	37
		Total	2.89969	.017432	91
va	1	3.00	3.17	.545	2
		4.00	2.90	1.002	4
		Total	2.99	.825	6
	2	3.00	4.27	1.790	3
		4.00	3.30	.424	3
		Total	3.79	1.280	6
	5	1.00	2.78	.496	3
		3.00	3.43	.385	3
		4.00	3.04	.265	3
		Total	3.08	.441	9
	6	1.00	3.39	.536	2
		3.00	3.13	1.129	3
		4.00	3.66	1.311	3
		Total	3.39	.978	8
	7	1.00	2.49	1.116	3
		3.00	2.47	.226	3
		4.00	2.96	.221	3
		Total	2.64	.627	9
	8	1.00	3.36	.029	3
		3.00	3.19	1.351	3
		4.00	3.92	1.300	4
		Total	3.53	1.041	10
	9	3.00	2.12	.638	2
		Total	2.12	.638	2
	12	3.00	1.99	.425	3
		Total	1.99	.425	3
	13	1.00	3.56	.302	3
		3.00	2.78	.941	2
		4.00	3.25	.238	4

		Total	3.25	.496	9
	14	1.00	3.57	.254	3
		3.00	2.61	.443	2
		4.00	3.76	.390	3
		Total	3.40	.579	8
	20	1.00	2.78	.913	3
		3.00	3.37	.478	2
		4.00	3.60	.245	3
		Total	3.23	.662	8
	21	1.00	3.12	.303	3
		4.00	3.49	.660	3
		Total	3.30	.502	6
	22	1.00	3.79	.236	3
		4.00	3.50	.491	4
		Total	3.62	.406	7
	Total	1.00	3.20	.637	26
		3.00	2.98	1.002	28
		4.00	3.40	.712	37
		Total	3.21	.804	91
vma	1	3.00	14.081	.6306	2
		4.00	13.724	.2811	4
		Total	13.843	.4012	6
	2	3.00	14.554	.6725	3
		4.00	14.039	.1755	3
		Total	14.297	.5224	6
	5	1.00	13.665	.4273	3
		3.00	13.968	.5237	3
		4.00	14.239	.1806	3
		Total	13.957	.4293	9
	6	1.00	13.910	.0622	2
		3.00	14.442	1.1139	3
		4.00	14.391	.9253	3
		Total	14.290	.8095	8
	7	1.00	13.215	.3744	3
		3.00	13.536	.1744	3
		4.00	13.576	.4867	3
		Total	13.442	.3622	9
	8	1.00	13.880	.2138	3
		3.00	14.021	.2996	3
		4.00	14.409	1.1667	4
		Total	14.134	.7370	10
	9	3.00	13.691	.2906	2
		Total	13.691	.2906	2
	12	3.00	13.679	.0240	3
		Total	13.679	.0240	3
	13	1.00	13.576	.3511	3
		3.00	13.719	.1280	2
		4.00	13.864	.0637	4
		Total	13.736	.2285	9

	14	1.00	13.836	.2712	3
		3.00	13.929	.1733	2
		4.00	14.073	.4994	3
		Total	13.948	.3297	8
	20	1.00	13.887	.3322	3
		3.00	13.978	.0718	2
		4.00	14.275	.1234	3
		Total	14.055	.2668	8
	21	1.00	13.324	.1683	3
		4.00	13.782	.2322	3
		Total	13.553	.3096	6
	22	1.00	14.256	.1307	3
		4.00	13.947	.4383	4
		Total	14.080	.3592	7
	Total	1.00	13.721	.3944	26
		3.00	13.979	.5283	28
		4.00	14.024	.5389	37
		Total	13.924	.5100	91
vfa	1	3.00	77.562	2.8627	2
		4.00	78.978	6.8460	4
		Total	78.506	5.5041	6
	2	3.00	70.971	10.7341	3
		4.00	76.528	2.7297	3
		Total	73.750	7.6375	6
	5	1.00	79.674	3.2221	3
		3.00	75.492	2.2114	3
		4.00	78.650	1.6095	3
		Total	77.938	2.8336	9
	6	1.00	75.668	3.7420	2
		3.00	78.557	6.4634	3
		4.00	74.861	7.2526	3
		Total	76.449	5.6678	8
	7	1.00	81.188	8.3880	3
		3.00	81.784	1.4285	3
		4.00	78.240	.8406	3
		Total	80.404	4.5801	9
	8	1.00	75.792	.3062	3
		3.00	77.357	9.1973	3
		4.00	73.202	6.3731	4
		Total	75.226	5.9831	10
	9	3.00	84.548	4.3287	2
		Total	84.548	4.3287	2
	12	3.00	85.429	3.0867	3
		Total	85.429	3.0867	3
	13	1.00	73.791	1.5328	3
		3.00	79.764	6.6725	2
		4.00	76.585	1.7548	4
		Total	76.360	3.5645	9
	14	1.00	74.206	1.3429	3

		3.00	81.278	2.9440	2
		4.00	73.336	1.8556	3
		Total	75.648	3.8696	8
	20	1.00	79.885	6.9826	3
		3.00	75.910	3.5432	2
		4.00	74.795	1.7149	3
		Total	76.982	4.7492	8
	21	1.00	76.564	2.4853	3
		4.00	74.730	4.3523	3
		Total	75.647	3.3251	6
	22	1.00	73.398	1.5351	3
		4.00	74.986	2.8418	4
		Total	74.306	2.3547	7
	Total	1.00	76.724	4.4603	26
		3.00	78.818	6.3550	28
		4.00	75.903	4.1382	37
		Total	77.035	5.1025	91
gmb	1	3.00	2.60816	.027151	2
		4.00	2.61990	.013099	4
		Total	2.61598	.016945	6
	2	3.00	2.59408	.023435	3
		4.00	2.61145	.004287	3
		Total	2.60277	.017819	6
	5	1.00	2.61656	.011621	3
		3.00	2.59997	.016006	3
		4.00	2.60873	.007132	3
		Total	2.60842	.012735	9
	6	1.00	2.60946	.004725	2
		3.00	2.59703	.033968	3
		4.00	2.60217	.027721	3
		Total	2.60206	.024061	8
	7	1.00	2.62428	.012311	3
		3.00	2.62293	.002060	3
		4.00	2.61941	.005164	3
		Total	2.62221	.007097	9
	8	1.00	2.61535	.007914	3
		3.00	2.61486	.012206	3
		4.00	2.60090	.032407	4
		Total	2.60942	.021236	10
	9	3.00	2.61605	.008187	2
		Total	2.61605	.008187	2
	12	3.00	2.62302	.002326	3
		Total	2.62302	.002326	3
	13	1.00	2.61628	.009304	3
		3.00	2.61993	.001119	2
		4.00	2.61791	.001168	4
		Total	2.61782	.004931	9
	14	1.00	2.61395	.005850	3
		3.00	2.61630	.005770	2

		4.00	2.61377	.011717	3
		Total	2.61447	.007419	8
	20	1.00	2.60990	.000000	3
		3.00	2.61394	.003320	2
		4.00	2.61453	.001582	3
		Total	2.61264	.002741	8
	21	1.00	2.63235	.007638	3
		4.00	2.62476	.009750	3
		Total	2.62855	.008868	6
	22	1.00	2.60495	.003173	3
		4.00	2.61905	.010744	4
		Total	2.61301	.010855	7
	Total	1.00	2.61615	.010363	26
		3.00	2.61087	.017321	28
		4.00	2.61393	.015057	37
		Total	2.61362	.014654	91

2003 Focus Project 2

Group 1 = POP, Group 2 = Plant Independent, Group 3 = Plant Split, Group 4 = QC

2003 Focus Project 2
Descriptive Statistics
Gradation and Binder Content

	dayno	Sample Loc	Mean	Std. Deviation	N
p200	1	1.00	4.7895	.40163	4
		2.00	4.4594	.51950	4
		4.00	4.8740	1.01555	4
		Total	4.7076	.65863	12
	5	1.00	4.1467	.75366	4
		2.00	4.2047	.48243	7
		3.00	4.8172	.26583	3
		4.00	4.5321	.27949	3
		Total	4.3569	.52824	17
	6	1.00	4.9358	.66078	5
		2.00	4.3115	.48014	7
		3.00	4.4135	.82937	2
		4.00	4.0172	.18877	2
		Total	4.4825	.60706	16
	7	1.00	4.5484	.59271	8
		3.00	4.6450	.74037	2
		4.00	4.2384	.38356	2
		Total	4.5128	.55185	12
	8	1.00	4.4628	.32901	5
		2.00	4.7735	1.05552	4

		3.00	4.6053	.	1
		4.00	4.2312	.	1
		Total	4.5677	.64144	11
	9	1.00	4.2274	.56528	4
		2.00	4.2142	.35400	7
		4.00	4.0100	.	1
		Total	4.2016	.39898	12
	12	1.00	5.0594	.93625	6
		4.00	4.4077	.35054	3
		Total	4.8422	.82752	9
	13	1.00	4.2500	.55313	7
		3.00	3.8288	.64407	5
		4.00	3.2694	.51165	2
		Total	3.9595	.64362	14
	14	1.00	4.6424	.78404	6
		2.00	3.5577	.29701	5
		4.00	4.2643	.50967	2
		Total	4.1670	.75926	13
	15	1.00	4.5276	.40519	8
		2.00	3.7835	.47843	6
		4.00	3.3629	.38179	2
		Total	4.1030	.61043	16
	16	1.00	4.1028	.51927	6
		4.00	3.6288	.18840	3
		Total	3.9448	.48329	9
	22	1.00	4.3384	.56544	4
		2.00	4.2113	.56413	3
		3.00	4.8471	.	1
		4.00	3.7708	.73952	2
		Total	4.2376	.57662	10
	23	1.00	4.2753	.40303	6
		2.00	4.1209	.78845	3
		3.00	4.7312	.27557	2
		4.00	4.7739	1.03822	2
		Total	4.3865	.57973	13
	Total	1.00	4.4909	.61514	73
		2.00	4.1637	.59247	46
		3.00	4.4142	.62421	16
		4.00	4.1668	.69543	29
		Total	4.3343	.63860	164
p100	1	1.00	9.522	.4939	4
		2.00	8.911	.8013	4
		4.00	9.399	1.2302	4
		Total	9.277	.8545	12
	5	1.00	9.088	1.2401	4
		2.00	9.231	.8219	7
		3.00	9.974	.9188	3
		4.00	9.513	.2750	3
		Total	9.378	.8701	17

6	1.00	9.822	1.0822	5
	2.00	8.888	.7463	7
	3.00	9.687	2.2805	2
	4.00	9.102	.3002	2
	Total	9.307	1.0406	16
7	1.00	9.537	1.3387	8
	3.00	9.641	1.8500	2
	4.00	9.278	.5155	2
	Total	9.511	1.2204	12
8	1.00	9.454	.8124	5
	2.00	9.559	1.4364	4
	3.00	10.137	.	1
	4.00	9.656	.	1
	Total	9.573	.9605	11
9	1.00	9.042	.8620	4
	2.00	9.374	.9623	7
	4.00	9.366	.	1
	Total	9.262	.8569	12
12	1.00	10.531	1.8238	6
	4.00	9.755	.2874	3
	Total	10.272	1.5000	9
13	1.00	9.173	1.1548	7
	3.00	8.041	1.4802	5
	4.00	7.427	1.4015	2
	Total	8.520	1.3936	14
14	1.00	9.701	1.3871	6
	2.00	8.223	.4872	5
	4.00	9.370	.5356	2
	Total	9.081	1.1906	13
15	1.00	9.298	.8332	8
	2.00	8.134	1.1239	6
	4.00	7.769	.5698	2
	Total	8.671	1.0956	16
16	1.00	8.276	.9964	6
	4.00	8.046	.2455	3
	Total	8.199	.8055	9
22	1.00	9.541	1.1261	4
	2.00	9.438	1.2036	3
	3.00	9.990	.	1
	4.00	8.597	.6694	2
	Total	9.366	.9922	10
23	1.00	9.058	.8187	6
	2.00	8.635	1.7257	3
	3.00	9.822	1.1933	2
	4.00	10.208	1.7424	2
	Total	9.255	1.2115	13
Total	1.00	9.390	1.1649	73
	2.00	8.923	1.0342	46
	3.00	9.285	1.4613	16

		4.00	9.037	1.0256	29
		Total	9.186	1.1467	164
p50	1	1.00	16.481	.7879	4
		2.00	15.665	.8237	4
		4.00	16.185	1.4597	4
		Total	16.110	1.0293	12
	5	1.00	16.238	1.7232	4
		2.00	17.100	1.0072	7
		3.00	18.172	.4723	3
		4.00	17.350	.1472	3
		Total	17.130	1.1746	17
	6	1.00	17.268	1.1805	5
		2.00	16.515	.6646	7
		3.00	18.027	.9514	2
		4.00	16.971	.1974	2
		Total	16.996	.9411	16
	7	1.00	17.503	.9225	8
		3.00	17.936	1.0598	2
		4.00	17.246	.7775	2
		Total	17.532	.8625	12
	8	1.00	17.587	.8121	5
		2.00	17.244	1.2335	4
		3.00	17.344	.	1
		4.00	18.215	.	1
		Total	17.497	.8966	11
	9	1.00	17.255	.9631	4
		2.00	17.844	.7845	7
		4.00	18.064	.	1
		Total	17.666	.8274	12
	12	1.00	18.519	1.3519	6
		4.00	17.987	.7912	3
		Total	18.341	1.1703	9
	13	1.00	17.560	1.0063	7
		3.00	16.292	1.6394	5
		4.00	15.552	1.5984	2
		Total	16.820	1.4630	14
	14	1.00	17.934	.7782	6
		2.00	16.248	.6435	5
		4.00	17.598	.1776	2
		Total	17.234	1.0322	13
	15	1.00	17.073	.9237	8
		2.00	16.164	.8055	6
		4.00	15.880	.6794	2
		Total	16.583	.9535	16
	16	1.00	16.421	.4763	6
		4.00	15.837	.2265	3
		Total	16.226	.4897	9
	22	1.00	17.740	.4124	4

		2.00	18.115	.5001	3
		3.00	17.415	.	1
		4.00	17.042	.5809	2
		Total	17.680	.5592	10
	23	1.00	17.281	.5695	6
		2.00	17.437	.6899	3
		3.00	19.795	2.3092	2
		4.00	19.121	2.4056	2
		Total	17.987	1.4917	13
	Total	1.00	17.337	1.0585	73
		2.00	16.885	1.0558	46
		3.00	17.641	1.5997	16
		4.00	17.012	1.2922	29
		Total	17.182	1.1774	164
p30	1	1.00	24.000	.8474	4
		2.00	23.086	.9950	4
		4.00	24.045	1.8491	4
		Total	23.711	1.2693	12
	5	1.00	24.290	1.6173	4
		2.00	25.473	1.5245	7
		3.00	27.176	1.0742	3
		4.00	25.895	.2368	3
		Total	25.570	1.5590	17
	6	1.00	25.446	1.2987	5
		2.00	24.352	1.5033	7
		3.00	27.398	.2804	2
		4.00	25.617	1.0656	2
		Total	25.233	1.5673	16
	7	1.00	25.759	1.2490	8
		3.00	26.936	1.0835	2
		4.00	25.689	1.0147	2
		Total	25.943	1.1870	12
	8	1.00	26.337	1.2813	5
		2.00	25.224	1.6242	4
		3.00	25.366	.	1
		4.00	26.920	.	1
		Total	25.897	1.3634	11
	9	1.00	25.796	2.5552	4
		2.00	26.927	1.1993	7
		4.00	27.114	.	1
		Total	26.566	1.7003	12
	12	1.00	27.114	1.6734	6
		4.00	26.512	1.4751	3
		Total	26.913	1.5442	9
	13	1.00	26.919	.7715	7
		3.00	25.726	1.3423	5
		4.00	25.578	.3415	2
		Total	26.301	1.1188	14
	14	1.00	26.283	.7550	6
		2.00	24.593	.4518	5

		4.00	26.318	1.0194	2
		Total	25.638	1.0639	13
	15	1.00	25.587	1.5839	8
		2.00	25.292	.6982	6
		4.00	25.208	.6909	2
		Total	25.429	1.1800	16
	16	1.00	25.128	.7485	6
		4.00	24.585	.2632	3
		Total	24.947	.6643	9
	22	1.00	26.695	.3195	4
		2.00	27.580	.4795	3
		3.00	26.354	.	1
		4.00	26.224	.7131	2
		Total	26.832	.6664	10
	23	1.00	26.266	.5726	6
		2.00	26.816	.1255	3
		3.00	28.660	2.3700	2
		4.00	28.330	2.5963	2
		Total	27.078	1.4814	13
	Total	1.00	25.890	1.4348	73
		2.00	25.400	1.6326	46
		3.00	26.742	1.4708	16
		4.00	25.763	1.4848	29
		Total	25.813	1.5358	164
p16	1	1.00	31.182	1.0176	4
		2.00	29.803	1.2687	4
		4.00	31.242	2.3248	4
		Total	30.742	1.6363	12
	5	1.00	31.567	1.5296	4
		2.00	33.056	2.0414	7
		3.00	35.179	2.1633	3
		4.00	33.521	.4717	3
		Total	33.163	2.0104	17
	6	1.00	32.963	1.3176	5
		2.00	31.513	2.1195	7
		3.00	35.750	1.2017	2
		4.00	33.417	1.8475	2
		Total	32.734	2.1382	16
	7	1.00	32.880	1.8056	8
		3.00	34.840	1.1307	2
		4.00	33.211	.9251	2
		Total	33.262	1.6815	12
	8	1.00	34.073	1.6385	5
		2.00	32.157	2.1120	4
		3.00	32.271	.	1
		4.00	34.535	.	1
		Total	33.254	1.8682	11
	9	1.00	32.955	4.0111	4
		2.00	34.920	1.5809	7
		4.00	34.837	.	1

		Total	34.258	2.5842	12
	12	1.00	34.520	2.1641	6
		4.00	33.953	2.0533	3
		Total	34.331	2.0152	9
	13	1.00	35.333	.9937	7
		3.00	34.076	1.6771	5
		4.00	34.621	.8381	2
		Total	34.782	1.3170	14
	14	1.00	34.217	.9293	6
		2.00	32.538	.5852	5
		4.00	34.236	1.4326	2
		Total	33.574	1.1714	13
	15	1.00	33.360	2.3754	8
		2.00	33.539	.9516	6
		4.00	33.646	.5960	2
		Total	33.463	1.7237	16
	16	1.00	32.634	1.3059	6
		4.00	32.382	.4254	3
		Total	32.550	1.0617	9
	22	1.00	34.080	.4825	4
		2.00	35.608	.5410	3
		3.00	33.717	.	1
		4.00	33.804	.6480	2
		Total	34.447	.9219	10
	23	1.00	33.891	.6477	6
		2.00	34.646	.2319	3
		3.00	36.084	2.8836	2
		4.00	35.759	2.2020	2
		Total	34.690	1.4540	13
	Total	1.00	33.468	1.9251	73
		2.00	33.021	2.1507	46
		3.00	34.703	1.7743	16
		4.00	33.493	1.6895	29
		Total	33.467	1.9749	164
p8	1	1.00	41.113	1.1143	4
		2.00	39.178	1.6926	4
		4.00	41.002	2.9800	4
		Total	40.431	2.0979	12
	5	1.00	41.653	1.1193	4
		2.00	43.281	2.5536	7
		3.00	46.047	3.2410	3
		4.00	44.061	.9399	3
		Total	43.524	2.5004	17
	6	1.00	43.647	1.9540	5
		2.00	41.603	2.9529	7
		3.00	47.306	2.1303	2
		4.00	44.176	2.7346	2
		Total	43.276	2.9888	16
	7	1.00	42.718	2.4465	8

		3.00	45.330	.5355	2
		4.00	43.432	.7145	2
		Total	43.273	2.2089	12
	8	1.00	44.824	2.3537	5
		2.00	41.794	2.8370	4
		3.00	41.320	.	1
		4.00	44.958	.	1
		Total	43.416	2.7114	11
	9	1.00	42.829	5.4378	4
		2.00	45.839	2.2300	7
		4.00	45.530	.	1
		Total	44.810	3.5951	12
	12	1.00	44.230	2.5164	6
		4.00	44.038	2.1693	3
		Total	44.166	2.2679	9
	13	1.00	46.306	1.5945	7
		3.00	45.332	2.3905	5
		4.00	46.097	.8389	2
		Total	45.928	1.7900	14
	14	1.00	45.383	.6603	6
		2.00	43.941	1.0933	5
		4.00	45.375	1.2916	2
		Total	44.827	1.1183	13
	15	1.00	43.989	3.2163	8
		2.00	44.857	1.7014	6
		4.00	45.570	.1577	2
		Total	44.512	2.4773	16
	16	1.00	42.896	2.2837	6
		4.00	43.281	.9329	3
		Total	43.024	1.8746	9
	22	1.00	43.396	.8676	4
		2.00	46.199	1.2774	3
		3.00	42.752	.	1
		4.00	43.727	.5599	2
		Total	44.239	1.5965	10
	23	1.00	43.669	1.0644	6
		2.00	44.880	.5236	3
		3.00	45.615	2.8227	2
		4.00	45.439	1.1051	2
		Total	44.520	1.4209	13
	Total	1.00	43.742	2.5348	73
		2.00	43.501	2.8552	46
		3.00	45.336	2.4346	16
		4.00	44.009	2.0244	29
		Total	43.877	2.5687	164
p4	1	1.00	54.812	1.7257	4
		2.00	52.530	2.0676	4
		4.00	55.822	2.9711	4
		Total	54.388	2.5404	12

5	1.00	55.643	1.3637	4
	2.00	56.989	2.3543	7
	3.00	60.390	2.8432	3
	4.00	58.291	1.3175	3
	Total	57.502	2.5129	17
6	1.00	58.252	3.0602	5
	2.00	54.480	3.8358	7
	3.00	62.137	2.4559	2
	4.00	58.429	3.8266	2
	Total	57.110	4.1260	16
7	1.00	55.510	2.2121	8
	3.00	59.580	.0037	2
	4.00	57.562	.4010	2
	Total	56.531	2.4019	12
8	1.00	59.436	3.1057	5
	2.00	54.971	3.8310	4
	3.00	54.471	.	1
	4.00	59.590	.	1
	Total	57.375	3.7456	11
9	1.00	55.751	6.3006	4
	2.00	60.409	2.9645	7
	4.00	60.614	.	1
	Total	58.873	4.5761	12
12	1.00	58.141	2.8061	6
	4.00	58.545	1.9375	3
	Total	58.275	2.4291	9
13	1.00	60.589	1.9549	7
	3.00	59.730	2.4955	5
	4.00	60.287	1.3855	2
	Total	60.239	1.9984	14
14	1.00	59.749	.8614	6
	2.00	59.279	1.3438	5
	4.00	59.926	.0568	2
	Total	59.595	.9915	13
15	1.00	58.641	3.8124	8
	2.00	59.844	2.9123	6
	4.00	62.629	.1568	2
	Total	59.590	3.3689	16
16	1.00	56.557	3.3296	6
	4.00	58.018	1.3541	3
	Total	57.044	2.8144	9
22	1.00	55.882	1.9729	4
	2.00	60.260	1.9404	3
	3.00	55.610	.	1
	4.00	57.577	.8038	2
	Total	57.507	2.5116	10
23	1.00	56.407	1.2155	6
	2.00	57.945	.4961	3
	3.00	58.722	2.0492	2
	4.00	58.383	.4554	2

		Total	57.422	1.4294	13
	Total	1.00	57.524	3.1782	73
		2.00	57.461	3.6824	46
		3.00	59.424	2.7006	16
		4.00	58.539	2.2514	29
		Total	57.871	3.1882	164
p3_8	1	1.00	77.106	.5164	4
		2.00	74.913	2.3422	4
		4.00	78.783	1.3081	4
		Total	76.934	2.1851	12
	5	1.00	77.375	1.9303	4
		2.00	78.073	1.1019	7
		3.00	80.484	2.0732	3
		4.00	79.784	1.9801	3
		Total	78.636	1.8986	17
	6	1.00	79.745	1.8131	5
		2.00	77.631	4.1203	7
		3.00	83.057	1.2117	2
		4.00	81.359	2.0857	2
		Total	79.436	3.4421	16
	7	1.00	78.885	2.8281	8
		3.00	80.521	.4444	2
		4.00	80.338	.7514	2
		Total	79.400	2.3959	12
	8	1.00	81.099	1.9288	5
		2.00	75.182	4.3253	4
		3.00	74.567	.	1
		4.00	79.183	.	1
		Total	78.180	4.0450	11
	9	1.00	76.833	4.6431	4
		2.00	80.880	2.6641	7
		4.00	82.465	.	1
		Total	79.663	3.7841	12
	12	1.00	80.121	2.4877	6
		4.00	80.222	1.1064	3
		Total	80.155	2.0436	9
	13	1.00	80.492	1.7396	7
		3.00	80.558	2.5157	5
		4.00	82.561	1.4262	2
		Total	80.811	2.0127	14
	14	1.00	79.761	1.8496	6
		2.00	78.810	2.2650	5
		4.00	79.100	.2647	2
		Total	79.294	1.8314	13
	15	1.00	80.566	2.3733	8
		2.00	81.019	1.0715	6
		4.00	83.677	.5464	2
		Total	81.124	2.0176	16
	16	1.00	77.672	3.8357	6

		4.00	80.712	3.2189	3
		Total	78.685	3.7544	9
	22	1.00	78.827	1.2804	4
		2.00	81.118	1.1444	3
		3.00	80.763	.	1
		4.00	79.762	3.9798	2
		Total	79.895	1.9211	10
	23	1.00	78.336	1.3835	6
		2.00	79.670	.2609	3
		3.00	79.582	1.0816	2
		4.00	80.023	.3462	2
		Total	79.095	1.2125	13
	Total	1.00	79.167	2.5833	73
		2.00	78.674	3.1863	46
		3.00	80.368	2.4016	16
		4.00	80.434	2.0201	29
		Total	79.370	2.7270	164
p1_2	1	1.00	95.680	1.0517	4
		2.00	95.918	.4619	4
		4.00	93.281	1.7797	4
		Total	94.960	1.6645	12
	5	1.00	97.113	1.1576	4
		2.00	97.720	.5356	7
		3.00	98.033	.9533	3
		4.00	97.178	.8646	3
		Total	97.537	.8341	17
	6	1.00	98.549	.8681	5
		2.00	97.080	1.7960	7
		3.00	98.081	.1141	2
		4.00	96.995	1.5280	2
		Total	97.653	1.4665	16
	7	1.00	97.787	.8024	8
		3.00	98.311	2.0970	2
		4.00	97.799	.1371	2
		Total	97.876	.9233	12
	8	1.00	98.430	.6997	5
		2.00	97.684	.6060	4
		3.00	97.683	.	1
		4.00	95.820	.	1
		Total	97.853	.9486	11
	9	1.00	97.652	.5102	4
		2.00	97.928	.7717	7
		4.00	97.085	.	1
		Total	97.766	.6778	12
	12	1.00	97.283	1.2863	6
		4.00	96.806	1.2360	3
		Total	97.124	1.2136	9
	13	1.00	97.843	.8013	7
		3.00	97.547	.5870	5

		4.00	96.670	.1667	2
		Total	97.570	.7547	14
	14	1.00	97.927	1.0947	6
		2.00	97.675	1.1844	5
		4.00	97.444	.0370	2
		Total	97.756	1.0003	13
	15	1.00	98.370	.6657	8
		2.00	97.973	.8489	6
		4.00	97.742	1.0865	2
		Total	98.143	.7656	16
	16	1.00	96.510	1.4967	6
		4.00	96.546	.8207	3
		Total	96.522	1.2525	9
	22	1.00	97.612	.4423	4
		2.00	98.494	.7136	3
		3.00	98.356	.	1
		4.00	96.860	.3758	2
		Total	97.801	.7755	10
	23	1.00	97.824	.8323	6
		2.00	98.008	.4314	3
		3.00	98.040	.0443	2
		4.00	97.176	.2377	2
		Total	97.800	.6404	13
	Total	1.00	97.651	1.1281	73
		2.00	97.592	1.1040	46
		3.00	97.921	.7736	16
		4.00	96.517	1.6149	29
		Total	97.460	1.2658	164
p3_4	1	1.00	100.000	.0000	4
		2.00	100.000	.0000	4
		4.00	100.000	.0000	4
		Total	100.000	.0000	12
	5	1.00	99.682	.6361	4
		2.00	100.000	.0000	7
		3.00	100.000	.0000	3
		4.00	100.000	.0000	3
		Total	99.925	.3085	17
	6	1.00	100.331	.7403	5
		2.00	100.000	.0000	7
		3.00	100.000	.0000	2
		4.00	100.000	.0000	2
		Total	100.103	.4139	16
	7	1.00	100.000	.0000	8
		3.00	100.000	.0000	2
		4.00	100.000	.0000	2
		Total	100.000	.0000	12
	8	1.00	100.000	.0000	5
		2.00	100.000	.0000	4
		3.00	100.000	.	1

		4.00	100.000	.	1
		Total	100.000	.0000	11
	9	1.00	100.000	.0000	4
		2.00	100.000	.0000	7
		4.00	100.000	.	1
		Total	100.000	.0000	12
	12	1.00	100.000	.0000	6
		4.00	100.000	.0000	3
		Total	100.000	.0000	9
	13	1.00	99.785	.5693	7
		3.00	100.000	.0000	5
		4.00	100.000	.0000	2
		Total	99.892	.4025	14
	14	1.00	100.000	.0000	6
		2.00	100.000	.0000	5
		4.00	100.000	.0000	2
		Total	100.000	.0000	13
	15	1.00	100.000	.0000	8
		2.00	100.000	.0000	6
		4.00	100.000	.0000	2
		Total	100.000	.0000	16
	16	1.00	100.000	.0000	6
		4.00	100.000	.0000	3
		Total	100.000	.0000	9
	22	1.00	100.000	.0000	4
		2.00	100.000	.0000	3
		3.00	100.000	.	1
		4.00	100.000	.0000	2
		Total	100.000	.0000	10
	23	1.00	100.000	.0000	6
		2.00	100.000	.0000	3
		3.00	100.000	.0000	2
		4.00	100.000	.0000	2
		Total	100.000	.0000	13
	Total	1.00	99.985	.3030	73
		2.00	100.000	.0000	46
		3.00	100.000	.0000	16
		4.00	100.000	.0000	29
		Total	99.993	.2015	164
bit	1	1.00	4.9575	.07848	4
		2.00	4.7625	.08057	4
		4.00	4.8075	.29960	4
		Total	4.8425	.18844	12
	5	1.00	4.6950	.08737	4
		2.00	4.6729	.12685	7
		3.00	5.0033	.22502	3
		4.00	4.8067	.11372	3
		Total	4.7600	.17692	17
	6	1.00	4.6680	.21347	5

	2.00	4.4214	.14088	7
	3.00	4.7750	.27577	2
	4.00	4.6150	.16263	2
	Total	4.5669	.21515	16
7	1.00	4.6613	.19105	8
	3.00	4.8950	.03536	2
	4.00	4.7700	.07071	2
	Total	4.7183	.17979	12
8	1.00	4.8840	.19424	5
	2.00	4.7050	.12715	4
	3.00	4.8700	.	1
	4.00	4.7400	.	1
	Total	4.8045	.16705	11
9	1.00	4.6850	.28455	4
	2.00	4.8029	.22321	7
	4.00	4.8900	.	1
	Total	4.7708	.23212	12
12	1.00	4.8683	.14784	6
	4.00	4.7000	.06557	3
	Total	4.8122	.14771	9
13	1.00	4.9857	.11297	7
	3.00	4.8540	.11781	5
	4.00	4.8350	.13435	2
	Total	4.9171	.12905	14
14	1.00	4.8900	.11541	6
	2.00	4.6300	.11683	5
	4.00	4.5300	.11314	2
	Total	4.7346	.18649	13
15	1.00	5.0025	.20954	8
	2.00	4.9367	.14487	6
	4.00	5.1200	.05657	2
	Total	4.9925	.17654	16
16	1.00	4.8633	.16919	6
	4.00	4.8267	.10263	3
	Total	4.8511	.14443	9
22	1.00	4.8125	.07274	4
	2.00	5.0300	.10392	3
	3.00	4.7900	.	1
	4.00	4.6750	.07778	2
	Total	4.8480	.15317	10
23	1.00	4.9100	.11815	6
	2.00	5.0433	.04163	3
	3.00	4.8700	.04243	2
	4.00	4.7550	.06364	2
	Total	4.9108	.12372	13
Total	1.00	4.8460	.19447	73
	2.00	4.7422	.22922	46
	3.00	4.8763	.14505	16
	4.00	4.7745	.17772	29

		Total	4.8072	.20273	164

2003 Focus Project 2
Descriptive Statistics
Volumetrics

	dayno	Sample Loc	Mean	Std. Deviation	N
gmm	1	1.00	2.63964	.010714	4
		4.00	2.64988	.005020	4
		Total	2.64476	.009484	8
	5	1.00	2.65004	.013427	4
		3.00	2.64719	.004934	3
		4.00	2.64604	.012106	3
		Total	2.64798	.010071	10
	6	1.00	2.65313	.012974	5
		3.00	2.64077	.002145	2
		4.00	2.63796	.000000	2
		Total	2.64701	.011761	9
	7	1.00	2.65703	.011628	3
		3.00	2.65371	.002410	2
		4.00	2.64640	.005591	2
		Total	2.65305	.008607	7
	8	1.00	2.65047	.024677	4
		3.00	2.64193	.	1
		4.00	2.64050	.	1
		Total	2.64739	.019709	6
	9	1.00	2.64034	.022760	4
		4.00	2.63918	.	1
		Total	2.64011	.019718	5
	12	1.00	2.64552	.006630	4
		4.00	2.65110	.008151	3
		Total	2.64791	.007281	7
	13	1.00	2.63942	.015357	4
		3.00	2.63296	.022457	5
		4.00	2.64248	.009701	2
		Total	2.63704	.017274	11
	14	1.00	2.64561	.014989	4
		4.00	2.64079	.016263	2
		Total	2.64400	.013925	6
	15	1.00	2.64119	.009717	4
		4.00	2.63605	.018699	2
		Total	2.63948	.011559	6
	16	1.00	2.63773	.019438	4
		4.00	2.63354	.004621	3
		Total	2.63593	.014179	7
	22	1.00	2.62903	.010864	4
		3.00	2.62057	.	1
		4.00	2.63404	.001748	2

		Total	2.62925	.008931	7
	23	1.00	2.63565	.015644	4
		3.00	2.63762	.003661	2
		4.00	2.63713	.018379	2
		Total	2.63651	.012488	8
	Total	1.00	2.64337	.015368	52
		3.00	2.63957	.014741	16
		4.00	2.64210	.009846	29
		Total	2.64236	.013768	97
gse	1	1.00	2.87391	.012910	4
		4.00	2.87863	.018602	4
		Total	2.87627	.015036	8
	5	1.00	2.87265	.018526	4
		3.00	2.88588	.012964	3
		4.00	2.87367	.008951	3
		Total	2.87692	.014420	10
	6	1.00	2.87498	.015864	5
		3.00	2.86555	.017440	2
		4.00	2.85351	.008614	2
		Total	2.86812	.016049	9
	7	1.00	2.88542	.021592	3
		3.00	2.88804	.001065	2
		4.00	2.87218	.010729	2
		Total	2.88239	.014992	7
	8	1.00	2.88245	.025659	4
		3.00	2.87203	.	1
		4.00	2.86327	.	1
		Total	2.87752	.021474	6
	9	1.00	2.86003	.018784	4
		4.00	2.86968	.	1
		Total	2.86196	.016831	5
	12	1.00	2.87734	.012198	4
		4.00	2.87422	.013555	3
		Total	2.87600	.011765	7
	13	1.00	2.87673	.016812	4
		3.00	2.86011	.030045	5
		4.00	2.87079	.004789	2
		Total	2.86809	.022613	11
	14	1.00	2.87769	.017647	4
		4.00	2.85242	.013894	2
		Total	2.86926	.019894	6
	15	1.00	2.88296	.015713	4
		4.00	2.87822	.020416	2
		Total	2.88138	.015411	6
	16	1.00	2.87166	.022773	4
		4.00	2.85930	.007290	3
		Total	2.86636	.017908	7
	22	1.00	2.85299	.016059	4
		3.00	2.84132	.	1

		4.00	2.85185	.001966	2
		Total	2.85100	.012169	7
	23	1.00	2.86805	.022834	4
		3.00	2.86668	.006826	2
		4.00	2.85995	.026090	2
		Total	2.86568	.018445	8
	Total	1.00	2.87340	.018362	52
		3.00	2.86950	.021726	16
		4.00	2.86713	.014504	29
		Total	2.87089	.017951	97
va	1	1.00	1.8432	.44153	4
		4.00	3.2536	.80494	4
		Total	2.5484	.96412	8
	5	1.00	3.2552	1.60399	4
		3.00	3.0335	.28574	3
		4.00	3.6591	.23726	3
		Total	3.3098	.97759	10
	6	1.00	3.2700	.73851	5
		3.00	4.4028	.22015	2
		4.00	4.8904	.16288	2
		Total	3.8818	.91551	9
	7	1.00	3.6836	1.09281	3
		3.00	3.8167	.10886	2
		4.00	4.2158	.20929	2
		Total	3.8737	.68229	7
	8	1.00	3.4729	1.26676	4
		3.00	3.8666	.	1
		4.00	4.6097	.	1
		Total	3.7280	1.08361	6
	9	1.00	4.0119	1.05380	4
		4.00	5.0811	.	1
		Total	4.2257	1.03030	5
	12	1.00	3.0735	.55466	4
		4.00	4.6700	.43048	3
		Total	3.7577	.97149	7
	13	1.00	3.3749	.78253	4
		3.00	4.1066	1.10104	5
		4.00	5.1660	1.56662	2
		Total	4.0331	1.16048	11
	14	1.00	3.3845	1.17832	4
		4.00	4.4962	1.19068	2
		Total	3.7551	1.20257	6
	15	1.00	2.7800	.65151	4
		4.00	4.5119	.96178	2
		Total	3.3573	1.11337	6
	16	1.00	2.6950	.74722	4
		4.00	4.1162	.32164	3
		Total	3.3041	.94380	7
	22	1.00	3.3890	.40884	4

		3.00	2.6430	.	1
		4.00	4.2792	.49077	2
		Total	3.5368	.67465	7
	23	1.00	2.5986	.71462	4
		3.00	3.4710	.04481	2
		4.00	3.8880	.04032	2
		Total	3.1390	.76029	8
	Total	1.00	3.1330	.96372	52
		3.00	3.7202	.79551	16
		4.00	4.2392	.78342	29
		Total	3.5606	1.00682	97
vma	1	1.00	13.444	.1999	4
		4.00	14.313	.4672	4
		Total	13.879	.5712	8
	5	1.00	14.121	1.0211	4
		3.00	14.290	.2465	3
		4.00	14.794	.2988	3
		Total	14.374	.6859	10
	6	1.00	14.006	.4961	5
		3.00	15.503	.0185	2
		4.00	15.970	.0006	2
		Total	14.775	.9909	9
	7	1.00	14.341	.5884	3
		3.00	14.675	.0127	2
		4.00	15.242	.0691	2
		Total	14.694	.5279	7
	8	1.00	14.458	.3217	4
		3.00	15.076	.	1
		4.00	15.752	.	1
		Total	14.777	.5927	6
	9	1.00	15.090	1.2385	4
		4.00	16.342	.	1
		Total	15.341	1.2099	5
	12	1.00	14.273	.4207	4
		4.00	15.431	.5846	3
		Total	14.769	.7652	7
	13	1.00	14.855	.3882	4
		3.00	15.566	.7346	5
		4.00	16.267	.9577	2
		Total	15.435	.7964	11
	14	1.00	14.553	.6136	4
		4.00	15.460	.4332	2
		Total	14.856	.6947	6
	15	1.00	14.337	.6048	4
		4.00	16.146	.1998	2
		Total	14.940	1.0491	6
	16	1.00	14.262	.2837	4
		4.00	15.685	.0656	3

		Total	14.872	.7878	7
	22	1.00	15.020	.4094	4
		3.00	14.619	.	1
		4.00	15.816	.3071	2
		Total	15.190	.5514	7
	23	1.00	14.226	.3225	4
		3.00	14.865	.1197	2
		4.00	15.444	.4973	2
		Total	14.690	.6135	8
	Total	1.00	14.377	.6786	52
		3.00	15.030	.6479	16
		4.00	15.440	.7003	29
		Total	14.803	.8263	97
vfa	1	1.00	86.299	3.2549	4
		4.00	77.385	4.9725	4
		Total	81.842	6.1516	8
	5	1.00	77.487	10.0470	4
		3.00	78.777	1.9025	3
		4.00	75.241	2.0556	3
		Total	77.200	6.1266	10
	6	1.00	76.723	4.8377	5
		3.00	71.601	1.3861	2
		4.00	69.379	1.0187	2
		Total	73.952	4.8457	9
	7	1.00	74.496	6.6354	3
		3.00	73.992	.7642	2
		4.00	72.343	1.2478	2
		Total	73.737	3.9988	7
	8	1.00	76.075	8.5051	4
		3.00	74.352	.	1
		4.00	70.735	.	1
		Total	74.898	6.9308	6
	9	1.00	73.568	5.6607	4
		4.00	68.908	.	1
		Total	72.636	5.3270	5
	12	1.00	78.522	3.3877	4
		4.00	69.778	1.6309	3
		Total	74.775	5.3359	7
	13	1.00	77.334	4.9588	4
		3.00	73.749	6.1090	5
		4.00	68.472	7.7745	2
		Total	74.093	6.2393	11
	14	1.00	76.946	7.2488	4
		4.00	71.014	6.8895	2
		Total	74.968	7.0996	6
	15	1.00	80.708	3.9983	4
		4.00	72.091	5.6113	2
		Total	77.836	5.9744	6
	16	1.00	81.112	5.1441	4

		4.00	73.762	1.9557	3
		Total	77.962	5.4715	7
	22	1.00	77.462	2.4087	4
		3.00	81.920	.	1
		4.00	72.969	2.5782	2
		Total	76.815	3.6826	7
	23	1.00	81.781	4.7277	4
		3.00	76.651	.1134	2
		4.00	74.808	1.0723	2
		Total	78.755	4.5489	8
	Total	1.00	78.390	6.0193	52
		3.00	75.365	4.3698	16
		4.00	72.679	4.1114	29
		Total	76.183	5.7984	97
gmb	1	1.00	2.61455	.004774	4
		4.00	2.58774	.021144	4
		Total	2.60115	.020166	8
	5	1.00	2.58020	.016544	4
		3.00	2.59146	.003877	3
		4.00	2.57401	.006654	3
		Total	2.58172	.012524	10
	6	1.00	2.59177	.014259	5
		3.00	2.54938	.006479	2
		4.00	2.53267	.004323	2
		Total	2.56922	.029318	9
	7	1.00	2.58386	.019599	3
		3.00	2.57733	.000261	2
		4.00	2.55898	.000082	2
		Total	2.57489	.015960	7
	8	1.00	2.58260	.013440	4
		3.00	2.56384	.	1
		4.00	2.54260	.	1
		Total	2.57281	.019587	6
	9	1.00	2.55799	.031406	4
		4.00	2.52764	.	1
		Total	2.55192	.030395	5
	12	1.00	2.58789	.013172	4
		4.00	2.55062	.020636	3
		Total	2.57192	.025011	7
	13	1.00	2.57429	.011832	4
		3.00	2.54898	.024800	5
		4.00	2.53066	.032947	2
		Total	2.55485	.026116	11
	14	1.00	2.58006	.021784	4
		4.00	2.54599	.017855	2
		Total	2.56870	.025651	6
	15	1.00	2.59262	.014472	4
		4.00	2.54315	.007757	2
		Total	2.57613	.028109	6

16	1.00	2.59026	.006035	4
	4.00	2.55027	.004224	3
	Total	2.57312	.021930	7
22	1.00	2.56374	.014110	4
	3.00	2.57564	.	1
	4.00	2.54567	.012316	2
	Total	2.56028	.015596	7
23	1.00	2.59034	.007292	4
	3.00	2.56978	.005602	2
	4.00	2.55705	.017551	2
	Total	2.57688	.017365	8
Total	1.00	2.58401	.019500	52
	3.00	2.56573	.021433	16
	4.00	2.55429	.021945	29
	Total	2.57211	.024366	97

APPENDIX C

Homogeneity of Error Variances

Plant Split Data were not used for this analysis, since they do not represent an independent sample.

2002 Focus Project 1

2002 Focus Project 1
Gradation and Binder Content
Levene's Test of Equality of Error Variances (a)
(no "outlier" for sample on first truck of day)
Day Lots

	F	df1	df2	Sig.

p200	2.528	33	115	.000
p100	3.674	33	115	.000
p50	3.161	33	115	.000
p30	2.488	33	115	.000
p16	2.579	33	115	.000
p8	2.567	33	115	.000
p4	2.370	33	115	.000
p3_8	1.315	33	115	.146
p1_2	1.064	33	115	.392
p3_4	.	33	115	.
bit	1.994	33	115	.004

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a Design: Intercept+smp_gp+date+smp_gp * date

2002 Focus Project 1
Volumetrics
Levene's Test of Equality of Error Variances (a)
(no "outlier" for sample on first truck of day)
Day Lots

	F	df1	Df2	Sig.
bit	2.214	24	73	.005
gmm	2.449	24	73	.002
gse	2.452	24	73	.002
va	4.385	24	73	.000
vma	3.457	24	73	.000
vfa	3.477	24	73	.000
gmb	4.722	24	73	.000

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a Design: Intercept+smp_gp+date+smp_gp * date

2002 Focus Project 1
Gradation and Binder Content
Levene's Test of Equality of Error Variances (a)
(no "outlier" for sample on first truck of day)
Week Lots

	F	df1	df2	Sig.
p200	4.703	9	139	.000
p100	1.933	9	139	.052
p50	2.429	9	139	.014
p30	2.667	9	139	.007
p16	3.076	9	139	.002
p8	3.419	9	139	.001
p4	2.879	9	139	.004
p3_8	1.670	9	139	.102
p1_2	.983	9	139	.457
p3_4	.	9	139	.
bit	2.604	9	139	.008

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a Design: Intercept+smp_gp+weeklot+smp_gp * weeklot

2002 Focus Project 1
Volumetrics
Levene's Test of Equality of Error Variances (a)
(no "outlier" for sample on first truck of day)
Week Lots

	F	df1	df2	Sig.
bit	2.271	7	90	.036
gmm	.775	7	90	.610
gse	.490	7	90	.840
va	2.362	7	90	.029
vma	1.192	7	90	.315
vfa	2.263	7	90	.036
gmb	1.395	7	90	.217

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a Design: Intercept+smp_gp+weeklot+smp_gp * weeklot

2002 Focus Project 1
Gradation and Binder Content
Levene's Test of Equality of Error Variances (a)
Day Lots

	F	df1	df2	Sig.
p200	2.401	34	116	.000
p100	3.292	34	116	.000
p50	2.368	34	116	.000
p30	1.993	34	116	.004
p16	2.133	34	116	.002
p8	2.275	34	116	.001
p4	2.360	34	116	.000
p3_8	1.354	34	116	.120
p1_2	1.092	34	116	.356
p3_4	.	34	116	.
bit	1.977	34	116	.004

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a Design: Intercept+smp_gp+dayno+smp_gp * dayno

2002 Focus Project 1
Volumetrics
Levene's Test of Equality of Error Variances (a)
Day Lots

	F	df1	df2	Sig.
Gmm	3.106	26	76	.000
Gse	2.658	26	76	.001
Va	3.082	26	76	.000
Vma	2.256	26	76	.003
Vfa	3.001	26	76	.000
Gmb	2.564	26	76	.001

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a Design: Intercept+smp_gp+dayno+smp_gp * dayno

2002 Focus Project 1
Gradation and Binder Content
Levene's Test of Equality of Error Variances (a)
Week Lots

	F	df1	df2	Sig.
p200	4.064	10	140	.000
p100	1.884	10	140	.052
p50	1.501	10	140	.145
p30	1.524	10	140	.137
p16	1.887	10	140	.052
p8	2.373	10	140	.013
p4	2.392	10	140	.012
p3_8	1.676	10	140	.092
p1_2	1.069	10	140	.390
p3_4	.	10	140	.
Bit	2.441	10	140	.010

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a Design: Intercept+smp_gp+weeklot+smp_gp * weeklot

2002 Focus Project 1
Volumetrics
Levene's Test of Equality of Error Variances (a)
Week Lots

	F	df1	df2	Sig.
Gmm	1.067	8	94	.393
Gse	.575	8	94	.796
Va	1.307	8	94	.249
Vma	.727	8	94	.667
Vfa	1.407	8	94	.204
Gmb	.927	8	94	.498

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a Design: Intercept+smp_gp+weeklot+smp_gp * weeklot

2002 Focus Project 2

2002 Focus Project 2
Gradation and Binder Content
Levene's Test of Equality of Error Variances (a)
Daily Lots

	F	df1	df2	Sig.
p200	1.007	15	95	.455
p100	.946	15	95	.517

	F	df1	df2	Sig.
p50	1.594	15	95	.090
p30	.825	15	95	.648
p16	.583	15	95	.881
p8	1.127	15	95	.344
p4	2.033	15	95	.020
p_3_8	.886	15	95	.582
p_1_2	2.467	15	95	.004
p_3_4	.	15	95	.
bit	1.831	15	95	.041

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a Design: Intercept+dataset+date+dataset * date

2002 Focus Project 2
Volumetrics
Levene's Test of Equality of Error Variances (a)
Daily Lots

	F	df1	df2	Sig.
bit	1.189	15	43	.317
gmm	1.006	15	43	.467
gse	.705	15	43	.766
va	1.508	15	43	.145
vma	1.556	15	43	.128
vfa	1.462	15	43	.163
gmb	1.842	15	43	.060

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a Design: Intercept+smp_gp+date+smp_gp * date

2002 Focus Project 2
Gradation and Binder Content
Levene's Test of Equality of Error Variances (a)
Weekly Lots

	F	df1	df2	Sig.
p200	1.003	10	100	.446
p100	.689	10	100	.733
p50	.801	10	100	.628
p30	.994	10	100	.454
p16	.591	10	100	.818
p8	.867	10	100	.566
p4	2.088	10	100	.032
p_3_8	1.362	10	100	.209
p_1_2	1.418	10	100	.183
p_3_4	.	10	100	.
bit	1.903	10	100	.053

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a Design: Intercept+smp_gp+weeklot+smp_gp * weeklot

2002 Focus Project 2
Volumetrics
Levene's Test of Equality of Error Variances (a)
Weekly Lots

	F	df1	df2	Sig.
bit	.404	7	51	.895
gmm	.819	7	51	.576
gse	1.008	7	51	.437
va	1.069	7	51	.397
vma	1.128	7	51	.361
vfa	1.027	7	51	.424
gmb	.895	7	51	.518

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a Design: Intercept+smp_gp+weeklot+smp_gp * weeklot

2003 Focus Project 1

2003 Focus Project 1
Levene's Test of Equality of Error Variances (a)
Gradation and Binder Content
Daily Lots

	F	df1	df2	Sig.
p200	3.609	43	148	.000
p100	4.169	43	148	.000
p50	3.257	43	148	.000
p30	2.973	43	148	.000
p16	2.735	43	148	.000
p8	2.402	43	148	.000
p4	2.189	43	148	.000
p3_8	2.022	43	148	.001
p1_2	2.325	43	148	.000
p3_4	.	43	148	.
bit	1.789	43	148	.006

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a Design: Intercept+avT3D+S_Group+dayno+S_Group * dayno

2003 Focus Project 1
Levene's Test of Equality of Error Variances (a)
Gradation and Binder Content
Weekly Lots

	F	df1	df2	Sig.
p200	3.677	15	176	.000
p100	3.240	15	176	.000
p50	1.874	15	176	.029
p30	2.233	15	176	.007

p16	2.413	15	176	.003
p8	2.337	15	176	.005
p4	2.204	15	176	.008
p3_8	2.400	15	176	.003
p1_2	2.044	15	176	.015
p3_4	.	15	176	.
bit	1.977	15	176	.019

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a Design: Intercept+avT3D+S_Group+weeklot+S_Group * weeklot

2003 Focus Project 2

2003 Focus Project 2
Levene's Test of Equality of Error Variances (a)
Gradation and Binder Content
Daily Lots

	F	df1	df2	Sig.
p200	1.728	41	122	.012
p100	1.815	41	122	.007
p50	1.956	41	122	.003
p30	2.159	41	122	.001
p16	2.159	41	122	.001
p8	1.788	41	122	.008
p4	1.649	41	122	.019
p3_8	1.834	41	122	.006
p1_2	1.428	41	122	.070
p3_4	4.186	41	122	.000
bit	2.753	41	122	.000

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a Design: Intercept+ret30+sampgp+date+sampgp * date

2003 Focus Project 2
Levene's Test of Equality of Error Variances (a)
Gradation and Binder Content
Weekly Lots

	F	df1	df2	Sig.
p200	1.289	15	149	.216
p100	2.096	15	149	.013
p50	1.845	15	149	.033
p30	1.490	15	149	.116
p16	1.490	15	149	.116
p8	1.295	15	149	.212
p4	1.267	15	149	.230
p3_8	1.543	15	149	.097
p1_2	1.286	15	149	.217
p3_4	.718	15	149	.763

bit	3.661	15	149	.000

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a Design: Intercept+ret30+sampgp+wk+sampgp * wk

APPENDIX D

Normality Tests

Normality tests “daygp” or “dygp” are designated by multiplying the day of production x 1000 and adding the sampling group. For instance, daygp = 8004 is day 8, Sampling Group 4. Sampling groups are 1 = POP, 2= Plant Independent, 3= Plant Splits, 4= QC. The Shapiro-Wilk statistic is the preferred statistic for any of these tests.

2002 Focus Project 2

2002 Focus Project 2
Gradation and Binder Content
Tests of Normality
(b,c,d,e,f,g,h,i,j,k,l,m,n,o,p,q,r,s,t,u,v,w,x,y,z,aa,bb,cc,dd,ee,ff,gg,hh,ii,jj,kk,ll,mm,nn,oo,pp,qq,rr,ss,tt)

		Kolmogorov-Smirnov(a)			Shapiro-Wilk		
	daygp	Statistic	df	Sig.	Statistic	df	Sig.
p200	1001.00	.260	2	.			
	1002.00	.220	6	.200(*)	.960	6	.817
	1003.00	.260	2	.			
	1004.00	.186	3	.	.998	3	.920
	2001.00	.260	2	.			
	2002.00	.245	9	.126	.820	9	.034
	2003.00	.241	4	.	.881	4	.343
	2004.00	.229	4	.	.942	4	.666
	6001.00	.300	6	.097	.858	6	.183
	6002.00	.235	8	.200(*)	.902	8	.299
	6004.00	.260	2	.			
	8001.00	.208	6	.200(*)	.940	6	.658
	8002.00	.182	10	.200(*)	.873	10	.107
	8003.00	.143	4	.	.997	4	.990
	8004.00	.270	4	.	.948	4	.704
	12001.00	.199	6	.200(*)	.903	6	.390
	12002.00	.138	11	.200(*)	.912	11	.255
	12003.00	.285	3	.	.932	3	.497
	12004.00	.328	3	.	.870	3	.294
	13001.00	.195	6	.200(*)	.960	6	.817
	13002.00	.205	9	.200(*)	.930	9	.479
	13003.00	.260	2	.			
	13004.00	.260	2	.			
p100	1001.00	.260	2	.			

	1002.00	.165	6	.200(*)	.968	6	.876
	1003.00	.260	2	.			
	1004.00	.282	3	.	.935	3	.508
	2001.00	.260	2	.			
	2002.00	.201	9	.200(*)	.890	9	.202
	2003.00	.268	4	.	.877	4	.327
	2004.00	.268	4	.	.901	4	.437
	6001.00	.365	6	.012	.767	6	.029
	6002.00	.274	8	.078	.875	8	.169
	6004.00	.260	2	.			
	8001.00	.217	6	.200(*)	.927	6	.555
	8002.00	.197	10	.200(*)	.909	10	.272
	8003.00	.200	4	.	.984	4	.924
	8004.00	.303	4	.	.853	4	.236
	12001.00	.174	6	.200(*)	.937	6	.634
	12002.00	.190	11	.200(*)	.890	11	.141
	12003.00	.294	3	.	.921	3	.457
	12004.00	.371	3	.	.784	3	.077
	13001.00	.172	6	.200(*)	.985	6	.974
	13002.00	.215	9	.200(*)	.923	9	.418
	13003.00	.260	2	.			
	13004.00	.260	2	.			
p50	1001.00	.260	2	.			
	1002.00	.222	6	.200(*)	.935	6	.623
	1003.00	.260	2	.			
	1004.00	.260	3	.	.958	3	.607
	2001.00	.260	2	.			
	2002.00	.183	9	.200(*)	.889	9	.196
	2003.00	.233	4	.	.941	4	.660
	2004.00	.236	4	.	.943	4	.672
	6001.00	.197	6	.200(*)	.930	6	.578
	6002.00	.193	8	.200(*)	.930	8	.520
	6004.00	.260	2	.			
	8001.00	.250	6	.200(*)	.921	6	.511
	8002.00	.233	10	.134	.913	10	.301
	8003.00	.251	4	.	.903	4	.445
	8004.00	.247	4	.	.859	4	.258
	12001.00	.198	6	.200(*)	.971	6	.900
	12002.00	.211	11	.183	.918	11	.301
	12003.00	.305	3	.	.906	3	.403
	12004.00	.321	3	.	.881	3	.329
	13001.00	.249	6	.200(*)	.778	6	.037
	13002.00	.237	9	.154	.921	9	.397
	13003.00	.260	2	.			
	13004.00	.260	2	.			
p30	1001.00	.260	2	.			
	1002.00	.228	6	.200(*)	.923	6	.524
	1003.00	.260	2	.			

	1004.00	.318	3	.	.887	3	.345
	2001.00	.260	2	.			
	2002.00	.158	9	.200(*)	.920	9	.395
	2003.00	.216	4	.	.960	4	.778
	2004.00	.244	4	.	.933	4	.612
	6001.00	.220	6	.200(*)	.872	6	.234
	6002.00	.223	8	.200(*)	.892	8	.246
	6004.00	.260	2	.			
	8001.00	.205	6	.200(*)	.933	6	.605
	8002.00	.150	10	.200(*)	.947	10	.637
	8003.00	.267	4	.	.952	4	.726
	8004.00	.374	4	.	.769	4	.057
	12001.00	.193	6	.200(*)	.938	6	.642
	12002.00	.142	11	.200(*)	.965	11	.828
	12003.00	.177	3	.	1.000	3	.968
	12004.00	.254	3	.	.963	3	.632
	13001.00	.310	6	.074	.868	6	.218
	13002.00	.199	9	.200(*)	.922	9	.412
	13003.00	.260	2	.			
	13004.00	.260	2	.			
p16	1001.00	.260	2	.			
	1002.00	.159	6	.200(*)	.990	6	.989
	1003.00	.260	2	.			
	1004.00	.283	3	.	.934	3	.505
	2001.00	.260	2	.			
	2002.00	.183	9	.200(*)	.941	9	.595
	2003.00	.277	4	.	.875	4	.316
	2004.00	.239	4	.	.936	4	.631
	6001.00	.248	6	.200(*)	.891	6	.322
	6002.00	.222	8	.200(*)	.879	8	.184
	6004.00	.260	2	.			
	8001.00	.215	6	.200(*)	.918	6	.488
	8002.00	.153	10	.200(*)	.950	10	.664
	8003.00	.342	4	.	.859	4	.257
	8004.00	.236	4	.	.928	4	.582
	12001.00	.205	6	.200(*)	.940	6	.660
	12002.00	.247	11	.060	.937	11	.487
	12003.00	.268	3	.	.951	3	.573
	12004.00	.278	3	.	.940	3	.526
	13001.00	.205	6	.200(*)	.939	6	.651
	13002.00	.209	9	.200(*)	.966	9	.861
	13003.00	.260	2	.			
	13004.00	.260	2	.			
p8	1001.00	.260	2	.			
	1002.00	.218	6	.200(*)	.967	6	.872
	1003.00	.260	2	.			
	1004.00	.246	3	.	.970	3	.669
	2001.00	.260	2	.			

	2002.00	.202	9	.200(*)	.921	9	.399
	2003.00	.235	4	.	.943	4	.671
	2004.00	.265	4	.	.888	4	.372
	6001.00	.230	6	.200(*)	.900	6	.375
	6002.00	.280	8	.064	.813	8	.039
	6004.00	.260	2	.			
	8001.00	.179	6	.200(*)	.927	6	.560
	8002.00	.207	10	.200(*)	.941	10	.568
	8003.00	.342	4	.	.766	4	.054
	8004.00	.189	4	.	.980	4	.903
	12001.00	.259	6	.200(*)	.931	6	.586
	12002.00	.199	11	.200(*)	.939	11	.511
	12003.00	.360	3	.	.810	3	.137
	12004.00	.307	3	.	.902	3	.393
	13001.00	.290	6	.125	.794	6	.051
	13002.00	.183	9	.200(*)	.948	9	.669
	13003.00	.260	2	.			
	13004.00	.260	2	.			
p4	1001.00	.260	2	.			
	1002.00	.191	6	.200(*)	.923	6	.526
	1003.00	.260	2	.			
	1004.00	.269	3	.	.949	3	.565
	2001.00	.260	2	.			
	2002.00	.222	9	.200(*)	.870	9	.121
	2003.00	.293	4	.	.912	4	.491
	2004.00	.183	4	.	.969	4	.835
	6001.00	.132	6	.200(*)	.984	6	.968
	6002.00	.169	8	.200(*)	.942	8	.632
	6004.00	.260	2	.			
	8001.00	.163	6	.200(*)	.965	6	.859
	8002.00	.231	10	.140	.935	10	.497
	8003.00	.224	4	.	.955	4	.745
	8004.00	.246	4	.	.930	4	.596
	12001.00	.306	6	.082	.846	6	.146
	12002.00	.203	11	.200(*)	.884	11	.118
	12003.00	.371	3	.	.784	3	.077
	12004.00	.218	3	.	.988	3	.786
	13001.00	.308	6	.079	.839	6	.129
	13002.00	.197	9	.200(*)	.967	9	.868
	13003.00	.260	2	.			
	13004.00	.260	2	.			
p_3_8	1001.00	.260	2	.			
	1002.00	.221	6	.200(*)	.909	6	.432
	1003.00	.260	2	.			
	1004.00	.358	3	.	.813	3	.146
	2001.00	.260	2	.			
	2002.00	.253	9	.101	.852	9	.078
	2003.00	.157	4	.	.992	4	.966

	2004.00	.343	4	.	.802	4	.105
	6001.00	.231	6	.200(*)	.914	6	.461
	6002.00	.178	8	.200(*)	.939	8	.598
	6004.00	.260	2	.			
	8001.00	.221	6	.200(*)	.913	6	.459
	8002.00	.206	10	.200(*)	.927	10	.420
	8003.00	.225	4	.	.953	4	.735
	8004.00	.314	4	.	.859	4	.256
	12001.00	.173	6	.200(*)	.921	6	.515
	12002.00	.181	11	.200(*)	.862	11	.062
	12003.00	.205	3	.	.993	3	.840
	12004.00	.284	3	.	.934	3	.502
	13001.00	.296	6	.109	.854	6	.169
	13002.00	.147	9	.200(*)	.978	9	.951
	13003.00	.260	2	.			
	13004.00	.260	2	.			
p_1_2	1001.00	.260	2	.			
	1002.00	.278	6	.164	.855	6	.173
	1003.00	.260	2	.			
	1004.00	.338	3	.	.852	3	.246
	2001.00	.260	2	.			
	2002.00	.155	9	.200(*)	.951	9	.697
	2003.00	.265	4	.	.913	4	.499
	2004.00	.345	4	.	.858	4	.253
	6001.00	.172	6	.200(*)	.973	6	.910
	6002.00	.144	8	.200(*)	.965	8	.854
	6004.00	.260	2	.			
	8001.00	.318	6	.057	.880	6	.270
	8002.00	.140	10	.200(*)	.967	10	.861
	8003.00	.405	4	.	.718	4	.019
	8004.00	.277	4	.	.875	4	.319
	12001.00	.234	6	.200(*)	.962	6	.836
	12002.00	.213	11	.173	.899	11	.182
	12003.00	.230	3	.	.981	3	.736
	12004.00	.380	3	.	.763	3	.029
	13001.00	.234	6	.200(*)	.914	6	.464
	13002.00	.229	9	.191	.888	9	.191
	13003.00	.260	2	.			
	13004.00	.260	2	.			
bit	1001.00	.260	2	.			
	1002.00	.299	6	.100	.828	6	.103
	1003.00	.260	2	.			
	1004.00	.222	3	.	.986	3	.770
	2001.00	.260	2	.			
	2002.00	.106	9	.200(*)	.993	9	.999
	2003.00	.218	4	.	.920	4	.538
	2004.00	.301	4	.	.834	4	.179
	6001.00	.154	6	.200(*)	.932	6	.596

6002.00	.181	8	.200(*)	.943	8	.636
6004.00	.260	2	.			
8001.00	.249	6	.200(*)	.944	6	.691
8002.00	.293	10	.015	.715	10	.001
8003.00	.285	4	.	.899	4	.427
8004.00	.202	4	.	.961	4	.787
12001.00	.264	6	.200(*)	.880	6	.269
12002.00	.141	11	.200(*)	.955	11	.712
12003.00	.219	3	.	.987	3	.780
12004.00	.219	3	.	.987	3	.780
13001.00	.217	6	.200(*)	.870	6	.225
13002.00	.240	9	.144	.890	9	.201
13003.00	.260	2	.			
13004.00	.260	2	.			

* This is a lower bound of the true significance.
a Lilliefors Significance Correction
b p200 is constant when daygp = -1.00. It has been omitted.
c p200 is constant when daygp = 6003.00. It has been omitted.
d p100 is constant when daygp = -1.00. It has been omitted.
e p100 is constant when daygp = 6003.00. It has been omitted.
f p50 is constant when daygp = -1.00. It has been omitted.
g p50 is constant when daygp = 6003.00. It has been omitted.
h p30 is constant when daygp = -1.00. It has been omitted.
i p30 is constant when daygp = 6003.00. It has been omitted.
j p16 is constant when daygp = -1.00. It has been omitted.
k p16 is constant when daygp = 6003.00. It has been omitted.
l p8 is constant when daygp = -1.00. It has been omitted.
m p8 is constant when daygp = 6003.00. It has been omitted.
n p4 is constant when daygp = -1.00. It has been omitted.
o p4 is constant when daygp = 6003.00. It has been omitted.
p p_3_8 is constant when daygp = -1.00. It has been omitted.
q p_3_8 is constant when daygp = 6003.00. It has been omitted.
r p_1_2 is constant when daygp = -1.00. It has been omitted.
s p_1_2 is constant when daygp = 6003.00. It has been omitted.
t p_3_4 is constant when daygp = -1.00. It has been omitted.
u p_3_4 is constant when daygp = 1001.00. It has been omitted.
v p_3_4 is constant when daygp = 1002.00. It has been omitted.
w p_3_4 is constant when daygp = 1003.00. It has been omitted.
x p_3_4 is constant when daygp = 1004.00. It has been omitted.
y p_3_4 is constant when daygp = 2001.00. It has been omitted.
z p_3_4 is constant when daygp = 2002.00. It has been omitted.
aa p_3_4 is constant when daygp = 2003.00. It has been omitted.
bb p_3_4 is constant when daygp = 2004.00. It has been omitted.
cc p_3_4 is constant when daygp = 6001.00. It has been omitted.
dd p_3_4 is constant when daygp = 6002.00. It has been omitted.
ee p_3_4 is constant when daygp = 6003.00. It has been omitted.
ff p_3_4 is constant when daygp = 6004.00. It has been omitted.
gg p_3_4 is constant when daygp = 8001.00. It has been omitted.
hh p_3_4 is constant when daygp = 8002.00. It has been omitted.
ii p_3_4 is constant when daygp = 8003.00. It has been omitted.
jj p_3_4 is constant when daygp = 8004.00. It has been omitted.
kk p_3_4 is constant when daygp = 12001.00. It has been omitted.
ll p_3_4 is constant when daygp = 12002.00. It has been omitted.
mm p_3_4 is constant when daygp = 12003.00. It has been omitted.
nn p_3_4 is constant when daygp = 12004.00. It has been omitted.
oo p_3_4 is constant when daygp = 13001.00. It has been omitted.
pp p_3_4 is constant when daygp = 13002.00. It has been omitted.
qq p_3_4 is constant when daygp = 13003.00. It has been omitted.
rr p_3_4 is constant when daygp = 13004.00. It has been omitted.
ss bit is constant when daygp = -1.00. It has been omitted.

tt bit is constant when daygp = 6003.00. It has been omitted.

2003 Focus Project 2

2003 Focus Project 2
Tests of Normality
Gradation and Binder Content
(b,c,d,e,f,g,h,i,j,k,l,m,n,o,p,q,r,s,t,u,v,w,x,y,z,aa,bb,cc,dd,ee,ff,gg,hh,ii,jj,kk,ll,mm,nn,oo,pp,qq,rr,ss,tt,uu,vv,ww,xx,yy,zz,aaa,bbb,ccc,ddd,eee,fff,ggg,hhh,iii,jjj,kkk,lll,mmm,nnn,ooo,ppp,qqq,rrr)

	daygp	Kolmogorov-Smirnov(a)			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
p200	1001.00	.264	4	.	.880	4	.339
	1002.00	.322	4	.	.779	4	.069
	1004.00	.381	4	.	.736	4	.028
	5001.00	.225	4	.	.974	4	.865
	5002.00	.192	7	.200(*)	.874	7	.200
	5003.00	.332	3	.	.864	3	.278
	5004.00	.306	3	.	.904	3	.399
	6001.00	.231	5	.200(*)	.899	5	.406
	6002.00	.195	7	.200(*)	.921	7	.477
	6003.00	.260	2	.			
	6004.00	.260	2	.			
	7001.00	.212	8	.200(*)	.873	8	.162
	7003.00	.260	2	.			
	7004.00	.260	2	.			
	8001.00	.211	5	.200(*)	.888	5	.349
	8002.00	.295	4	.	.850	4	.225
	9001.00	.362	4	.	.832	4	.173
	9002.00	.262	7	.159	.894	7	.298
	12001.00	.190	6	.200(*)	.894	6	.341
	12004.00	.317	3	.	.888	3	.348
	13001.00	.207	7	.200(*)	.896	7	.310
	13003.00	.183	5	.200(*)	.985	5	.959
	13004.00	.260	2	.			
	14001.00	.175	6	.200(*)	.970	6	.895
	14002.00	.283	5	.200(*)	.906	5	.441
	14004.00	.260	2	.			
	15001.00	.311	8	.022	.874	8	.163
	15002.00	.155	6	.200(*)	.979	6	.948
	15004.00	.260	2	.			
	16001.00	.208	6	.200(*)	.959	6	.811
	16004.00	.385	3	.	.751	3	.002
	22001.00	.208	4	.	.965	4	.810
	22002.00	.320	3	.	.883	3	.333
	22004.00	.260	2	.			
	23001.00	.200	6	.200(*)	.939	6	.654
	23002.00	.322	3	.	.880	3	.323

	23003.00	.260	2	.			
	23004.00	.260	2	.			
p100	1001.00	.277	4	.	.878	4	.329
	1002.00	.273	4	.	.823	4	.150
	1004.00	.292	4	.	.919	4	.533
	5001.00	.380	4	.	.782	4	.074
	5002.00	.154	7	.200(*)	.938	7	.618
	5003.00	.285	3	.	.932	3	.497
	5004.00	.244	3	.	.972	3	.678
	6001.00	.233	5	.200(*)	.892	5	.370
	6002.00	.222	7	.200(*)	.836	7	.091
	6003.00	.260	2	.			
	6004.00	.260	2	.			
	7001.00	.211	8	.200(*)	.862	8	.127
	7003.00	.260	2	.			
	7004.00	.260	2	.			
	8001.00	.258	5	.200(*)	.882	5	.320
	8002.00	.230	4	.	.955	4	.746
	9001.00	.294	4	.	.790	4	.086
	9002.00	.176	7	.200(*)	.955	7	.773
	12001.00	.245	6	.200(*)	.853	6	.167
	12004.00	.248	3	.	.969	3	.661
	13001.00	.131	7	.200(*)	.988	7	.990
	13003.00	.323	5	.096	.823	5	.123
	13004.00	.260	2	.			
	14001.00	.165	6	.200(*)	.977	6	.938
	14002.00	.236	5	.200(*)	.945	5	.702
	14004.00	.260	2	.			
	15001.00	.146	8	.200(*)	.960	8	.813
	15002.00	.149	6	.200(*)	.986	6	.979
	15004.00	.260	2	.			
	16001.00	.135	6	.200(*)	.987	6	.979
	16004.00	.374	3	.	.777	3	.062
	22001.00	.252	4	.	.938	4	.639
	22002.00	.177	3	.	1.000	3	.972
	22004.00	.260	2	.			
	23001.00	.214	6	.200(*)	.960	6	.818
	23002.00	.324	3	.	.876	3	.314
	23003.00	.260	2	.			
	23004.00	.260	2	.			
p50	1001.00	.275	4	.	.890	4	.383
	1002.00	.288	4	.	.896	4	.411
	1004.00	.292	4	.	.932	4	.606
	5001.00	.333	4	.	.860	4	.259
	5002.00	.277	7	.112	.862	7	.159
	5003.00	.177	3	.	1.000	3	.965
	5004.00	.351	3	.	.827	3	.181
	6001.00	.251	5	.200(*)	.872	5	.274
	6002.00	.268	7	.139	.823	7	.069

	6003.00	.260	2	.			
	6004.00	.260	2	.			
	7001.00	.284	8	.056	.901	8	.295
	7003.00	.260	2	.			
	7004.00	.260	2	.			
	8001.00	.338	5	.063	.798	5	.079
	8002.00	.272	4	.	.895	4	.406
	9001.00	.320	4	.	.832	4	.174
	9002.00	.151	7	.200(*)	.980	7	.959
	12001.00	.141	6	.200(*)	.974	6	.917
	12004.00	.243	3	.	.972	3	.679
	13001.00	.165	7	.200(*)	.952	7	.748
	13003.00	.201	5	.200(*)	.974	5	.900
	13004.00	.260	2	.			
	14001.00	.136	6	.200(*)	.990	6	.989
	14002.00	.223	5	.200(*)	.920	5	.532
	14004.00	.260	2	.			
	15001.00	.172	8	.200(*)	.932	8	.536
	15002.00	.146	6	.200(*)	.964	6	.846
	15004.00	.260	2	.			
	16001.00	.144	6	.200(*)	.990	6	.990
	16004.00	.288	3	.	.929	3	.484
	22001.00	.336	4	.	.857	4	.249
	22002.00	.224	3	.	.984	3	.760
	22004.00	.260	2	.			
	23001.00	.228	6	.200(*)	.941	6	.668
	23002.00	.297	3	.	.918	3	.444
	23003.00	.260	2	.			
	23004.00	.260	2	.			
p30	1001.00	.223	4	.	.920	4	.537
	1002.00	.376	4	.	.789	4	.083
	1004.00	.352	4	.	.800	4	.102
	5001.00	.393	4	.	.772	4	.060
	5002.00	.329	7	.021	.814	7	.057
	5003.00	.345	3	.	.838	3	.210
	5004.00	.247	3	.	.969	3	.665
	6001.00	.294	5	.181	.878	5	.298
	6002.00	.324	7	.025	.831	7	.082
	6003.00	.260	2	.			
	6004.00	.260	2	.			
	7001.00	.118	8	.200(*)	.983	8	.978
	7003.00	.260	2	.			
	7004.00	.260	2	.			
	8001.00	.435	5	.002	.641	5	.002
	8002.00	.244	4	.	.897	4	.418
	9001.00	.315	4	.	.861	4	.263
	9002.00	.237	7	.200(*)	.910	7	.393
	12001.00	.220	6	.200(*)	.940	6	.659

	12004.00	.189	3	.	.998	3	.906
	13001.00	.162	7	.200(*)	.986	7	.984
	13003.00	.388	5	.013	.722	5	.016
	13004.00	.260	2	.			
	14001.00	.245	6	.200(*)	.828	6	.103
	14002.00	.312	5	.126	.796	5	.075
	14004.00	.260	2	.			
	15001.00	.166	8	.200(*)	.950	8	.710
	15002.00	.182	6	.200(*)	.950	6	.744
	15004.00	.260	2	.			
	16001.00	.191	6	.200(*)	.959	6	.814
	16004.00	.226	3	.	.983	3	.752
	22001.00	.297	4	.	.842	4	.200
	22002.00	.185	3	.	.998	3	.924
	22004.00	.260	2	.			
	23001.00	.163	6	.200(*)	.971	6	.897
	23002.00	.175	3	.	1.000	3	.998
	23003.00	.260	2	.			
	23004.00	.260	2	.			
p16	1001.00	.316	4	.	.838	4	.190
	1002.00	.271	4	.	.948	4	.705
	1004.00	.367	4	.	.753	4	.041
	5001.00	.255	4	.	.959	4	.775
	5002.00	.281	7	.100	.827	7	.076
	5003.00	.275	3	.	.944	3	.542
	5004.00	.280	3	.	.937	3	.516
	6001.00	.284	5	.200(*)	.866	5	.252
	6002.00	.333	7	.018	.809	7	.050
	6003.00	.260	2	.			
	6004.00	.260	2	.			
	7001.00	.135	8	.200(*)	.983	8	.975
	7003.00	.260	2	.			
	7004.00	.260	2	.			
	8001.00	.407	5	.007	.674	5	.005
	8002.00	.228	4	.	.911	4	.488
	9001.00	.308	4	.	.863	4	.272
	9002.00	.206	7	.200(*)	.915	7	.429
	12001.00	.238	6	.200(*)	.945	6	.699
	12004.00	.210	3	.	.991	3	.818
	13001.00	.210	7	.200(*)	.948	7	.711
	13003.00	.311	5	.129	.869	5	.262
	13004.00	.260	2	.			
	14001.00	.206	6	.200(*)	.924	6	.531
	14002.00	.174	5	.200(*)	.946	5	.709
	14004.00	.260	2	.			
	15001.00	.200	8	.200(*)	.926	8	.481
	15002.00	.137	6	.200(*)	.970	6	.891
	15004.00	.260	2	.			

	16001.00	.188	6	.200(*)	.971	6	.898
	16004.00	.177	3	.	1.000	3	.961
	22001.00	.244	4	.	.948	4	.706
	22002.00	.370	3	.	.786	3	.081
	22004.00	.260	2	.			
	23001.00	.176	6	.200(*)	.922	6	.521
	23002.00	.340	3	.	.849	3	.238
	23003.00	.260	2	.			
	23004.00	.260	2	.			
p8	1001.00	.266	4	.	.952	4	.727
	1002.00	.334	4	.	.872	4	.305
	1004.00	.380	4	.	.785	4	.078
	5001.00	.188	4	.	.980	4	.903
	5002.00	.189	7	.200(*)	.892	7	.287
	5003.00	.244	3	.	.971	3	.674
	5004.00	.244	3	.	.971	3	.676
	6001.00	.252	5	.200(*)	.851	5	.198
	6002.00	.286	7	.088	.816	7	.058
	6003.00	.260	2	.			
	6004.00	.260	2	.			
	7001.00	.180	8	.200(*)	.970	8	.901
	7003.00	.260	2	.			
	7004.00	.260	2	.			
	8001.00	.420	5	.004	.638	5	.002
	8002.00	.326	4	.	.863	4	.271
	9001.00	.334	4	.	.879	4	.335
	9002.00	.228	7	.200(*)	.881	7	.230
	12001.00	.211	6	.200(*)	.917	6	.486
	12004.00	.277	3	.	.941	3	.533
	13001.00	.148	7	.200(*)	.975	7	.935
	13003.00	.302	5	.154	.890	5	.355
	13004.00	.260	2	.			
	14001.00	.162	6	.200(*)	.965	6	.860
	14002.00	.250	5	.200(*)	.954	5	.767
	14004.00	.260	2	.			
	15001.00	.269	8	.090	.911	8	.362
	15002.00	.157	6	.200(*)	.977	6	.936
	15004.00	.260	2	.			
	16001.00	.187	6	.200(*)	.955	6	.777
	16004.00	.205	3	.	.993	3	.840
	22001.00	.237	4	.	.935	4	.627
	22002.00	.220	3	.	.987	3	.778
	22004.00	.260	2	.			
	23001.00	.149	6	.200(*)	.985	6	.973
	23002.00	.282	3	.	.936	3	.511
	23003.00	.260	2	.			
	23004.00	.260	2	.			
p4	1001.00	.328	4	.	.792	4	.089
	1002.00	.334	4	.	.805	4	.111

	1004.00	.400	4	.	.754	4	.042
	5001.00	.230	4	.	.938	4	.640
	5002.00	.180	7	.200(*)	.925	7	.510
	5003.00	.360	3	.	.810	3	.138
	5004.00	.249	3	.	.968	3	.654
	6001.00	.323	5	.097	.836	5	.155
	6002.00	.283	7	.094	.817	7	.060
	6003.00	.260	2	.			
	6004.00	.260	2	.			
	7001.00	.202	8	.200(*)	.945	8	.662
	7003.00	.260	2	.			
	7004.00	.260	2	.			
	8001.00	.397	5	.010	.753	5	.032
	8002.00	.375	4	.	.792	4	.089
	9001.00	.266	4	.	.941	4	.662
	9002.00	.221	7	.200(*)	.905	7	.361
	12001.00	.226	6	.200(*)	.909	6	.427
	12004.00	.282	3	.	.935	3	.509
	13001.00	.220	7	.200(*)	.938	7	.621
	13003.00	.301	5	.158	.897	5	.391
	13004.00	.260	2	.			
	14001.00	.294	6	.114	.870	6	.224
	14002.00	.307	5	.140	.831	5	.141
	14004.00	.260	2	.			
	15001.00	.286	8	.053	.904	8	.312
	15002.00	.332	6	.038	.767	6	.029
	15004.00	.260	2	.			
	16001.00	.189	6	.200(*)	.936	6	.631
	16004.00	.291	3	.	.925	3	.470
	22001.00	.248	4	.	.920	4	.539
	22002.00	.177	3	.	1.000	3	.969
	22004.00	.260	2	.			
	23001.00	.323	6	.050	.859	6	.185
	23002.00	.374	3	.	.777	3	.060
	23003.00	.260	2	.			
	23004.00	.260	2	.			
p3_8	1001.00	.323	4	.	.818	4	.139
	1002.00	.279	4	.	.884	4	.357
	1004.00	.267	4	.	.899	4	.427
	5001.00	.239	4	.	.937	4	.636
	5002.00	.287	7	.083	.902	7	.346
	5003.00	.362	3	.	.804	3	.125
	5004.00	.331	3	.	.864	3	.280
	6001.00	.173	5	.200(*)	.966	5	.847
	6002.00	.302	7	.052	.792	7	.034
	6003.00	.260	2	.			
	6004.00	.260	2	.			
	7001.00	.229	8	.200(*)	.909	8	.350
	7003.00	.260	2	.			

	7004.00	.260	2	.			
	8001.00	.170	5	.200(*)	.956	5	.778
	8002.00	.332	4	.	.865	4	.279
	9001.00	.287	4	.	.935	4	.625
	9002.00	.201	7	.200(*)	.938	7	.622
	12001.00	.199	6	.200(*)	.935	6	.617
	12004.00	.303	3	.	.908	3	.412
	13001.00	.245	7	.200(*)	.825	7	.072
	13003.00	.184	5	.200(*)	.949	5	.731
	13004.00	.260	2	.			
	14001.00	.236	6	.200(*)	.931	6	.591
	14002.00	.292	5	.188	.858	5	.220
	14004.00	.260	2	.			
	15001.00	.189	8	.200(*)	.955	8	.764
	15002.00	.222	6	.200(*)	.872	6	.233
	15004.00	.260	2	.			
	16001.00	.291	6	.121	.845	6	.143
	16004.00	.384	3	.	.751	3	.002
	22001.00	.224	4	.	.948	4	.704
	22002.00	.248	3	.	.968	3	.658
	22004.00	.260	2	.			
	23001.00	.289	6	.127	.769	6	.030
	23002.00	.179	3	.	.999	3	.950
	23003.00	.260	2	.			
	23004.00	.260	2	.			
p1_2	1001.00	.293	4	.	.842	4	.202
	1002.00	.271	4	.	.823	4	.150
	1004.00	.223	4	.	.978	4	.887
	5001.00	.212	4	.	.943	4	.670
	5002.00	.248	7	.200(*)	.923	7	.491
	5003.00	.268	3	.	.950	3	.570
	5004.00	.244	3	.	.972	3	.676
	6001.00	.245	5	.200(*)	.931	5	.602
	6002.00	.345	7	.012	.695	7	.003
	6003.00	.260	2	.			
	6004.00	.260	2	.			
	7001.00	.220	8	.200(*)	.919	8	.424
	7003.00	.260	2	.			
	7004.00	.260	2	.			
	8001.00	.317	5	.111	.786	5	.062
	8002.00	.336	4	.	.862	4	.267
	9001.00	.239	4	.	.935	4	.624
	9002.00	.266	7	.143	.790	7	.032
	12001.00	.208	6	.200(*)	.907	6	.419
	12004.00	.355	3	.	.818	3	.159
	13001.00	.249	7	.200(*)	.859	7	.150
	13003.00	.236	5	.200(*)	.931	5	.601
	13004.00	.260	2	.			

	14001.00	.263	6	.200(*)	.845	6	.144
	14002.00	.214	5	.200(*)	.966	5	.849
	14004.00	.260	2	.			
	15001.00	.247	8	.162	.870	8	.152
	15002.00	.241	6	.200(*)	.923	6	.530
	15004.00	.260	2	.			
	16001.00	.230	6	.200(*)	.846	6	.146
	16004.00	.193	3	.	.997	3	.893
	22001.00	.273	4	.	.895	4	.407
	22002.00	.195	3	.	.996	3	.881
	22004.00	.260	2	.			
	23001.00	.176	6	.200(*)	.934	6	.610
	23002.00	.202	3	.	.994	3	.853
	23003.00	.260	2	.			
	23004.00	.260	2	.			
p3_4	1001.00	.500	4	.	.	4	.
	5001.00	.441	4	.	.630	4	.001
	6001.00	.473	5	.001	.552	5	.000
	7001.00	.250	8	.150	.	8	.
	8001.00	.560	5	.000	.	5	.
	9001.00	.250	4	.	.	4	.
	12001.00	.199	6	.200(*)	.	6	.
	13001.00	.504	7	.000	.453	7	.000
	14001.00	.333	6	.036	.	6	.
	15001.00	.250	8	.150	.	8	.
	16001.00	.500	6	.000	.	6	.
	22001.00	.341	4	.	.	4	.
	23001.00	.333	6	.036	.	6	.
bit	1001.00	.237	4	.	.971	4	.845
	1002.00	.287	4	.	.921	4	.541
	1004.00	.291	4	.	.864	4	.276
	5001.00	.273	4	.	.842	4	.203
	5002.00	.237	7	.200(*)	.879	7	.222
	5003.00	.176	3	.	1.000	3	.975
	5004.00	.282	3	.	.936	3	.510
	6001.00	.396	5	.010	.685	5	.007
	6002.00	.152	7	.200(*)	.923	7	.496
	6003.00	.260	2	.			
	6004.00	.260	2	.			
	7001.00	.176	8	.200(*)	.945	8	.659
	7003.00	.260	2	.			
	7004.00	.260	2	.			
	8001.00	.292	5	.190	.903	5	.426
	8002.00	.358	4	.	.833	4	.175
	9001.00	.271	4	.	.931	4	.598
	9002.00	.202	7	.200(*)	.882	7	.233
	12001.00	.302	6	.093	.797	6	.055
	12004.00	.227	3	.	.983	3	.747
	13001.00	.224	7	.200(*)	.887	7	.259

13003.00	.347	5	.048	.725	5	.017
13004.00	.260	2	.			
14001.00	.198	6	.200(*)	.941	6	.663
14002.00	.234	5	.200(*)	.886	5	.335
14004.00	.260	2	.			
15001.00	.215	8	.200(*)	.874	8	.165
15002.00	.262	6	.200(*)	.860	6	.188
15004.00	.260	2	.			
16001.00	.229	6	.200(*)	.940	6	.660
16004.00	.269	3	.	.949	3	.567
22001.00	.291	4	.	.910	4	.480
22002.00	.385	3	.	.750	3	.000
22004.00	.260	2	.			
23001.00	.299	6	.100	.772	6	.032
23002.00	.292	3	.	.923	3	.463
23003.00	.260	2	.			
23004.00	.260	2	.			

* This is a lower bound of the true significance.
a Lilliefors Significance Correction
b p200 is constant when daygp = 8003.00. It has been omitted.
c p200 is constant when daygp = 8004.00. It has been omitted.
d p200 is constant when daygp = 9004.00. It has been omitted.
e p200 is constant when daygp = 22003.00. It has been omitted.
f p100 is constant when daygp = 8003.00. It has been omitted.
g p100 is constant when daygp = 8004.00. It has been omitted.
h p100 is constant when daygp = 9004.00. It has been omitted.
i p100 is constant when daygp = 22003.00. It has been omitted.
j p50 is constant when daygp = 8003.00. It has been omitted.
k p50 is constant when daygp = 8004.00. It has been omitted.
l p50 is constant when daygp = 9004.00. It has been omitted.
m p50 is constant when daygp = 22003.00. It has been omitted.
n p30 is constant when daygp = 8003.00. It has been omitted.
o p30 is constant when daygp = 8004.00. It has been omitted.
p p30 is constant when daygp = 9004.00. It has been omitted.
q p30 is constant when daygp = 22003.00. It has been omitted.
r p16 is constant when daygp = 8003.00. It has been omitted.
s p16 is constant when daygp = 8004.00. It has been omitted.
t p16 is constant when daygp = 9004.00. It has been omitted.
u p16 is constant when daygp = 22003.00. It has been omitted.
v p8 is constant when daygp = 8003.00. It has been omitted.
w p8 is constant when daygp = 8004.00. It has been omitted.
x p8 is constant when daygp = 9004.00. It has been omitted.
y p8 is constant when daygp = 22003.00. It has been omitted.
z p4 is constant when daygp = 8003.00. It has been omitted.
aa p4 is constant when daygp = 8004.00. It has been omitted.
bb p4 is constant when daygp = 9004.00. It has been omitted.
cc p4 is constant when daygp = 22003.00. It has been omitted.
dd p3_8 is constant when daygp = 8003.00. It has been omitted.
ee p3_8 is constant when daygp = 8004.00. It has been omitted.
ff p3_8 is constant when daygp = 9004.00. It has been omitted.
gg p3_8 is constant when daygp = 22003.00. It has been omitted.
hh p1_2 is constant when daygp = 8003.00. It has been omitted.
ii p1_2 is constant when daygp = 8004.00. It has been omitted.
jj p1_2 is constant when daygp = 9004.00. It has been omitted.
kk p1_2 is constant when daygp = 22003.00. It has been omitted.
ll p3_4 is constant when daygp = 1002.00. It has been omitted.
mm p3_4 is constant when daygp = 1004.00. It has been omitted.
nn p3_4 is constant when daygp = 5002.00. It has been omitted.
oo p3_4 is constant when daygp = 5003.00. It has been omitted.
pp p3_4 is constant when daygp = 5004.00. It has been omitted.
qq p3_4 is constant when daygp = 6002.00. It has been omitted.

rr p3_4 is constant when daygp = 6003.00. It has been omitted.
ss p3_4 is constant when daygp = 6004.00. It has been omitted.
tt p3_4 is constant when daygp = 7003.00. It has been omitted.
uu p3_4 is constant when daygp = 7004.00. It has been omitted.
vv p3_4 is constant when daygp = 8002.00. It has been omitted.
ww p3_4 is constant when daygp = 8003.00. It has been omitted.
xx p3_4 is constant when daygp = 8004.00. It has been omitted.
yy p3_4 is constant when daygp = 9002.00. It has been omitted.
zz p3_4 is constant when daygp = 9004.00. It has been omitted.
aaa p3_4 is constant when daygp = 12004.00. It has been omitted.
bbb p3_4 is constant when daygp = 13003.00. It has been omitted.
ccc p3_4 is constant when daygp = 13004.00. It has been omitted.
ddd p3_4 is constant when daygp = 14002.00. It has been omitted.
eee p3_4 is constant when daygp = 14004.00. It has been omitted.
fff p3_4 is constant when daygp = 15002.00. It has been omitted.
ggg p3_4 is constant when daygp = 15004.00. It has been omitted.
hhh p3_4 is constant when daygp = 16004.00. It has been omitted.
iii p3_4 is constant when daygp = 22002.00. It has been omitted.
jjj p3_4 is constant when daygp = 22003.00. It has been omitted.
kkk p3_4 is constant when daygp = 22004.00. It has been omitted.
lll p3_4 is constant when daygp = 23002.00. It has been omitted.
mmm p3_4 is constant when daygp = 23003.00. It has been omitted.
nnn p3_4 is constant when daygp = 23004.00. It has been omitted.
ooo bit is constant when daygp = 8003.00. It has been omitted.
ppp bit is constant when daygp = 8004.00. It has been omitted.
qqq bit is constant when daygp = 9004.00. It has been omitted.
rrr bit is constant when daygp = 22003.00. It has been omitted.

APPENDIX E

Paired t-test Statistics

2002 Focus Project 1

Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	p200p	3.022	20	.4504	.1007
	p200qc	3.105	20	.5206	.1164
Pair 2	p100p	6.905	20	1.1473	.2565
	p100qc	6.240	20	.7521	.1682
Pair 3	p50p	12.740	20	1.1274	.2521
	p50qc	12.530	20	1.0494	.2346
Pair 4	p30p	19.670	20	1.5321	.3426
	p30qc	19.040	20	1.2655	.2830
Pair 5	p16p	25.120	20	1.9403	.4339
	p16qc	24.880	20	1.5258	.3412
Pair 6	p8p	32.810	20	2.7328	.6111

	p8qc	31.750	20	1.8727	.4187
Pair 7	p4p	44.075	20	3.6202	.8095
	p4qc	42.900	20	2.2616	.5057
Pair 8	p38p	72.885	20	3.4449	.7703
	p38qc	73.370	20	2.3240	.5197
Pair 9	p12p	94.640	20	1.2509	.2797
	p12qc	93.715	20	1.1532	.2579
Pair 10	bitp	5.137	20	.2090	.0467
	bitqc	4.726	20	.2475	.0553
Pair 11	gsep	2.91855	20	.013663	.003055
	gseqc	2.89440	20	.013964	.003122
Pair 12	avp	4.311	20	.8124	.1817
	avqc	3.928	20	.9667	.2162
Pair 13	vmap	14.713	20	.4825	.1079
	vmaqc	14.037	20	.5516	.1233
Pair 14	vfap	70.793	20	4.7675	1.0660
	vfaqc	72.170	20	6.0167	1.3454
Pair 15	r200p	3.885	20	.8222	.1839
	r200qc	3.145	20	.2564	.0573
Pair 16	r100p	5.835	20	.9444	.2112
	r100qc	6.290	20	.3726	.0833
Pair 17	r50p	6.915	20	.5122	.1145
	r50qc	6.520	20	.3054	.0683
Pair 18	r30p	5.465	20	.4308	.0963
	r30qc	5.840	20	.3545	.0793
Pair 19	r16p	7.685	20	1.3846	.3096
	r16qc	6.855	20	.4740	.1060
Pair 20	r8p	11.280	20	1.2207	.2730
	r8qc	11.140	20	1.0404	.2327
Pair 21	r4p	28.795	20	1.0689	.2390
	r4qc	30.470	20	1.5698	.3510
Pair 22	r38p	21.750	20	2.6445	.5913
	r38qc	20.340	20	1.7512	.3916
Pair 23	r12p	5.360	20	1.2509	.2797
	r12qc	6.285	20	1.1532	.2579

Correlations

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	p200p & p200qc	20	.141	.555
Pair 2	p100p & p100qc	20	-.219	.354
Pair 3	p50p & p50qc	20	.318	.172
Pair 4	p30p & p30qc	20	.173	.465

Pair 5	p16p & p16qc	20	.047	.843
Pair 6	p8p & p8qc	20	-.099	.679
Pair 7	p4p & p4qc	20	-.021	.930
Pair 8	p38p & p38qc	20	-.197	.404
Pair 9	p12p & p12qc	20	-.181	.444
Pair 10	bitp & bitqc	20	-.109	.647
Pair 11	gsep & gseqc	20	.540	.014
Pair 12	avp & avqc	20	.596	.006
Pair 13	vmap & vmaqc	20	.471	.036
Pair 14	vfap & vfaqc	20	.564	.010
Pair 15	r200p & r200qc	20	-.289	.217
Pair 16	r100p & r100qc	20	.516	.020
Pair 17	r50p & r50qc	20	-.254	.279
Pair 18	r30p & r30qc	20	-.332	.153
Pair 19	r16p & r16qc	20	-.020	.935
Pair 20	r8p & r8qc	20	.544	.013
Pair 21	r4p & r4qc	20	-.153	.518
Pair 22	r38p & r38qc	20	-.224	.343
Pair 23	r12p & r12qc	20	-.181	.444

Tests

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	p200p - p200qc	-.0825	.6388	.1428	-.3814	.2164	-.578	19	.570
Pair 2	p100p - p100qc	.6650	1.5031	.3361	-.0385	1.3685	1.979	19	.063
Pair 3	p50p - p50qc	.2100	1.2728	.2846	-.3857	.8057	.738	19	.470
Pair 4	p30p - p30qc	.6300	1.8102	.4048	-.2172	1.4772	1.556	19	.136
Pair 5	p16p - p16qc	.2400	2.4108	.5391	-.8883	1.3683	.445	19	.661
Pair 6	p8p - p8qc	1.0600	3.4620	.7741	-.5603	2.6803	1.369	19	.187
Pair 7	p4p - p4qc	1.1750	4.3085	.9634	-.8414	3.1914	1.220	19	.238
Pair 8	p38p - p38qc	-.4850	4.5198	1.0107	-2.6003	1.6303	-.480	19	.637
Pair 9	p12p -	.9250	1.8487	.4134	.0598	1.7902	2.238	19	.037

	p12qc								
Pair 10	bitp - bitqc	.4115	.3409	.0762	.2519	.5711	5.398	19	.000
Pair 11	gsep - gseqc	.024150	.013248	.002962	.017950	.030350	8.152	19	.000
Pair 12	avp - avqc	.3830	.8114	.1814	.0032	.7627	2.111	19	.048
Pair 13	vmap - vmaqc	.6759	.5352	.1197	.4254	.9264	5.648	19	.000
Pair 14	vfap - vfaqc	-1.3772	5.1555	1.1528	-3.7900	1.0357	-1.195	19	.247
Pair 15	r200p - r200qc	.7400	.9293	.2078	.3051	1.1749	3.561	19	.002
Pair 16	r100p - r100qc	-.4550	.8172	.1827	-.8375	-.0725	-2.490	19	.022
Pair 17	r50p - r50qc	.3950	.6597	.1475	.0862	.7038	2.678	19	.015
Pair 18	r30p - r30qc	-.3750	.6423	.1436	-.6756	-.0744	-2.611	19	.017
Pair 19	r16p - r16qc	.8300	1.4722	.3292	.1410	1.5190	2.521	19	.021
Pair 20	r8p - r8qc	.1400	1.0908	.2439	-.3705	.6505	.574	19	.573
Pair 21	r4p - r4qc	-1.6750	2.0303	.4540	-2.6252	-.7248	-3.690	19	.002
Pair 22	r38p - r38qc	1.4100	3.4833	.7789	-.2202	3.0402	1.810	19	.086
Pair 23	r12p - r12qc	-.9250	1.8487	.4134	-1.7902	-.0598	-2.238	19	.037

2002 Focus Project 2

Statistics

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	p200p	4.682	11	.4117	.1241
	p200qc	4.285	11	.5752	.1734
Pair 2	p100p	9.836	11	1.0930	.3295
	p100qc	9.409	11	.8166	.2462
Pair 3	p50p	18.255	11	1.1919	.3594
	p50qc	17.582	11	1.1669	.3518
Pair 4	p30p	27.209	11	1.3141	.3962
	p30qc	26.336	11	1.4229	.4290
Pair 5	p16p	34.982	11	1.8165	.5477

	p16qc	33.927	11	1.3705	.4132
Pair 6	p8p	45.345	11	2.5704	.7750
	p8qc	44.218	11	1.3045	.3933
Pair 7	p4p	59.300	11	2.9014	.8748
	p4qc	58.191	11	1.5096	.4552
Pair 8	p38p	80.273	11	2.4565	.7406
	p38qc	79.900	11	1.6438	.4956
Pair 9	p12p	98.100	11	.8124	.2449
	p12qc	97.064	11	.8310	.2506
Pair 10	bitp	4.886	11	.1601	.0483
	bitqc	4.733	11	.1105	.0333
Pair 11	gsep	2.87382	11	.016916	.005100
	gseqc	2.86427	11	.013785	.004156
Pair 12	avp	3.545	11	.5978	.1803
	avqc	4.202	11	.5070	.1529
Pair 13	vmap	14.800	11	.4539	.1368
	vmaqc	15.418	11	.5250	.1583
Pair 14	vfap	76.100	11	3.4270	1.0333
	vfaqc	72.782	11	2.6168	.7890
Pair 15	r200p	5.145	11	.7367	.2221
	r200qc	5.118	11	.2994	.0903
Pair 16	r100p	8.409	11	1.0977	.3310
	r100qc	8.191	11	.5356	.1615
Pair 17	r50p	8.945	11	.6203	.1870
	r50qc	8.727	11	.4407	.1329
Pair 18	r30p	7.791	11	.7556	.2278
	r30qc	7.600	11	.3521	.1062
Pair 19	r16p	10.345	11	1.1067	.3337
	r16qc	10.300	11	.6557	.1977
Pair 20	r8p	13.964	11	.8970	.2704
	r8qc	13.973	11	.7185	.2166
Pair 21	r4p	21.000	11	1.9157	.5776
	r4qc	21.709	11	1.4195	.4280
Pair 22	r38p	17.818	11	2.3103	.6966
	r38qc	17.155	11	1.2356	.3725
Pair 23	r12p	1.900	11	.8124	.2449
	r12qc	2.936	11	.8310	.2506

Correlations

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	p200p & p200qc	11	.373	.258

Pair 2	p100p & p100qc	11	.403	.219
Pair 3	p50p & p50qc	11	.823	.002
Pair 4	p30p & p30qc	11	.683	.021
Pair 5	p16p & p16qc	11	.526	.097
Pair 6	p8p & p8qc	11	.425	.193
Pair 7	p4p & p4qc	11	.368	.266
Pair 8	p38p & p38qc	11	.516	.105
Pair 9	p12p & p12qc	11	.406	.216
Pair 10	bitp & bitqc	11	.565	.070
Pair 11	gsep & gseqc	11	.701	.016
Pair 12	avp & avqc	11	.571	.067
Pair 13	vmap & vmaqc	11	.785	.004
Pair 14	vfap & vfaqc	11	.456	.159
Pair 15	r200p & r200qc	11	.504	.114
Pair 16	r100p & r100qc	11	.533	.092
Pair 17	r50p & r50qc	11	.460	.155
Pair 18	r30p & r30qc	11	.560	.073
Pair 19	r16p & r16qc	11	.688	.019
Pair 20	r8p & r8qc	11	.541	.085
Pair 21	r4p & r4qc	11	.001	.998
Pair 22	r38p & r38qc	11	.353	.287
Pair 23	r12p & r12qc	11	.406	.216

Tests

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	p200p - p200qc	.3964	.5687	.1715	.0143	.7784	2.311	10	.043
Pair 2	p100p - p100qc	.4273	1.0687	.3222	-.2907	1.1453	1.326	10	.214
Pair 3	p50p - p50qc	.6727	.7016	.2115	.2014	1.1440	3.180	10	.010
Pair 4	p30p - p30qc	.8727	1.0946	.3300	.1374	1.6081	2.644	10	.025
Pair 5	p16p - p16qc	1.0545	1.6002	.4825	-.0205	2.1296	2.186	10	.054
Pair 6	p8p - p8qc	1.1273	2.3367	.7045	-.4425	2.6971	1.600	10	.141

Pair 7	p4p - p4qc	1.1091	2.7340	.8243	-.7277	2.9458	1.345	10	.208
Pair 8	p38p - p38qc	.3727	2.1383	.6447	-1.0638	1.8092	.578	10	.576
Pair 9	p12p - p12qc	1.0364	.8958	.2701	.4345	1.6382	3.837	10	.003
Pair 10	bitp - bitqc	.1536	.1336	.0403	.0639	.2434	3.814	10	.003
Pair 11	gsep - gseqc	.009545	.012226	.003686	.001332	.017759	2.589	10	.027
Pair 12	avp - avqc	-.6573	.5182	.1562	-1.0054	-.3092	-4.207	10	.002
Pair 13	vmap - vmaqc	-.6182	.3281	.0989	-.8386	-.3978	-6.249	10	.000
Pair 14	vfap - vfaqc	3.3182	3.2283	.9734	1.1494	5.4870	3.409	10	.007
Pair 15	r200p - r200qc	.0273	.6405	.1931	-.4030	.4575	.141	10	.890
Pair 16	r100p - r100qc	.2182	.9304	.2805	-.4069	.8432	.778	10	.455
Pair 17	r50p - r50qc	.2182	.5724	.1726	-.1664	.6027	1.264	10	.235
Pair 18	r30p - r30qc	.1909	.6300	.1900	-.2323	.6142	1.005	10	.339
Pair 19	r16p - r16qc	.0455	.8104	.2443	-.4990	.5899	.186	10	.856
Pair 20	r8p - r8qc	-.0091	.7892	.2380	-.5393	.5211	-.038	10	.970
Pair 21	r4p - r4qc	-.7091	2.3835	.7186	-2.3103	.8921	-.987	10	.347
Pair 22	r38p - r38qc	.6636	2.2024	.6640	-.8160	2.1432	.999	10	.341
Pair 23	r12p - r12qc	-1.0364	.8958	.2701	-1.6382	-.4345	-3.837	10	.003

2003 Focus Project 1

Statistics

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	p200p	3.484	19	.6362	.1460
	p200qc	3.521	19	.3360	.0771
Pair 2	p100p	6.874	19	1.0676	.2449
	p100qc	6.868	19	.5638	.1293
Pair 3	p50p	12.616	19	1.2180	.2794
	p50qc	12.674	19	.7156	.1642
Pair 4	p30p	19.095	19	1.5960	.3661
	p30qc	19.000	19	1.1116	.2550
Pair 5	p16p	24.784	19	2.1378	.4905
	p16qc	25.268	19	1.5420	.3538

Pair 6	p8p	32.768	19	3.0647	.7031
	p8qc	33.142	19	2.0686	.4746
Pair 7	p4p	42.979	19	4.0787	.9357
	p4qc	43.905	19	2.7559	.6322
Pair 8	p38p	75.437	19	3.2282	.7406
	p38qc	76.968	19	1.9562	.4488
Pair 9	p12p	97.000	19	1.4240	.3267
	p12qc	96.284	19	1.3124	.3011
Pair 10	bitp	4.900	19	.2309	.0530
	bitqc	4.958	19	.1539	.0353
Pair 11	gsep	2.89495	19	.021516	.004936
	gseqc	2.90542	19	.008934	.002050
Pair 12	avp	3.233	19	1.0372	.2380
	avqc	3.352	19	.5833	.1338
Pair 13	vmap	14.068	19	.5888	.1351
	vmaqc	14.074	19	.4629	.1062
Pair 14	vfap	77.205	19	6.4642	1.4830
	vfaqc	76.247	19	3.3638	.7717
Pair 15	r200p	3.389	19	.5216	.1197
	r200qc	3.347	19	.3062	.0702
Pair 16	r100p	5.742	19	.4464	.1024
	r100qc	5.805	19	.4223	.0969
Pair 17	r50p	6.479	19	.5018	.1151
	r50qc	6.326	19	.5384	.1235
Pair 18	r30p	5.689	19	.6235	.1430
	r30qc	6.268	19	.4796	.1100
Pair 19	r16p	7.984	19	1.0526	.2415
	r16qc	7.874	19	.5694	.1306
Pair 20	r8p	10.211	19	1.2653	.2903
	r8qc	10.763	19	1.0139	.2326
Pair 21	r4p	32.458	19	2.4685	.5663
	r4qc	33.063	19	2.2134	.5078
Pair 22	r38p	21.563	19	3.0682	.7039
	r38qc	19.316	19	1.8292	.4196
Pair 23	r12p	3.000	19	1.4240	.3267
	r12qc	3.716	19	1.3124	.3011

Correlations

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	p200p & p200qc	19	.662	.002
Pair 2	p100p & p100qc	19	.604	.006
Pair 3	p50p & p50qc	19	.709	.001

Pair 4	p30p & p30qc	19	.676	.001
Pair 5	p16p & p16qc	19	.621	.005
Pair 6	p8p & p8qc	19	.504	.028
Pair 7	p4p & p4qc	19	.493	.032
Pair 8	p38p & p38qc	19	-.122	.619
Pair 9	p12p & p12qc	19	.400	.090
Pair 10	bitp & bitqc	19	-.531	.019
Pair 11	gsep & gseqc	19	.056	.820
Pair 12	avp & avqc	19	.413	.079
Pair 13	vmap & vmaqc	19	.680	.001
Pair 14	vfap & vfaqc	19	.338	.157
Pair 15	r200p & r200qc	19	.306	.203
Pair 16	r100p & r100qc	19	.509	.026
Pair 17	r50p & r50qc	19	.654	.002
Pair 18	r30p & r30qc	19	.467	.044
Pair 19	r16p & r16qc	19	.193	.429
Pair 20	r8p & r8qc	19	.638	.003
Pair 21	r4p & r4qc	19	.732	.000
Pair 22	r38p & r38qc	19	.088	.720
Pair 23	r12p & r12qc	19	.400	.090

Tests

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	p200p - p200qc	-.0368	.4844	.1111	-.2703	.1966	-.332	18	.744
Pair 2	p100p - p100qc	.0053	.8547	.1961	-.4067	.4172	.027	18	.979
Pair 3	p50p - p50qc	-.0579	.8720	.2000	-.4782	.3624	-.289	18	.776
Pair 4	p30p - p30qc	.0947	1.1759	.2698	-.4720	.6615	.351	18	.730
Pair 5	p16p - p16qc	-.4842	1.6893	.3875	-1.2984	.3300	-1.249	18	.228
Pair 6	p8p - p8qc	-.3737	2.6989	.6192	-1.6745	.9272	-.604	18	.554

Pair 7	p4p - p4qc	-.9263	3.6258	.8318	-2.6739	.8213	-1.114	18	.280
Pair 8	p38p - p38qc	-1.5316	3.9737	.9116	-3.4468	.3837	-1.680	18	.110
Pair 9	p12p - p12qc	.7158	1.5016	.3445	-.0079	1.4395	2.078	18	.052
Pair 10	bitp - bitqc	-.0579	.3388	.0777	-.2212	.1054	-.745	18	.466
Pair 11	gsep - gseqc	-.010474	.022831	.005238	-.021478	.000531	-2.000	18	.061
Pair 12	avp - avqc	-.1195	.9576	.2197	-.5810	.3421	-.544	18	.593
Pair 13	vmap - vmaqc	-.0053	.4365	.1001	-.2156	.2051	-.053	18	.959
Pair 14	vfap - vfaqc	.9579	6.1973	1.4218	-2.0291	3.9449	.674	18	.509
Pair 15	r200p - r200qc	.0421	.5178	.1188	-.2075	.2917	.354	18	.727
Pair 16	r100p - r100qc	-.0632	.4310	.0989	-.2709	.1446	-.639	18	.531
Pair 17	r50p - r50qc	.1526	.4338	.0995	-.0565	.3617	1.534	18	.143
Pair 18	r30p - r30qc	-.5789	.5827	.1337	-.8598	-.2981	-4.331	18	.000
Pair 19	r16p - r16qc	.1105	1.0959	.2514	-.4177	.6387	.440	18	.665
Pair 20	r8p - r8qc	-.5526	.9958	.2284	-1.0326	-.0727	-2.419	18	.026
Pair 21	r4p - r4qc	-.6053	1.7309	.3971	-1.4395	.2290	-1.524	18	.145
Pair 22	r38p - r38qc	2.2474	3.4308	.7871	.5938	3.9010	2.855	18	.011
Pair 23	r12p - r12qc	-.7158	1.5016	.3445	-1.4395	.0079	-2.078	18	.052

2003 Focus Project 2

Statistics

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	p200p	4.625	12	.4391	.1268
	p200qc	4.262	12	.5546	.1601
Pair 2	p100p	9.683	12	1.1692	.3375
	p100qc	9.292	12	.8785	.2536
Pair 3	p50p	17.983	12	1.4745	.4257
	p50qc	17.367	12	1.3392	.3866
Pair 4	p30p	26.942	12	1.5582	.4498
	p30qc	26.142	12	1.5151	.4374
Pair 5	p16p	34.650	12	2.0787	.6001
	p16qc	33.683	12	1.5561	.4492

Pair 6	p8p	45.150	12	2.5425	.7340
	p8qc	44.117	12	1.2925	.3731
Pair 7	p4p	59.192	12	2.7917	.8059
	p4qc	58.175	12	1.4404	.4158
Pair 8	p38p	80.417	12	2.3946	.6913
	p38qc	80.075	12	1.6804	.4851
Pair 9	p12p	98.008	12	.8372	.2417
	p12qc	97.058	12	.7925	.2288
Pair 10	bitp	4.913	12	.1775	.0512
	bitqc	4.772	12	.1711	.0494
Pair 11	gsep	2.87383	12	.016129	.004656
	gseqc	2.86508	12	.013440	.003880
Pair 12	avp	3.582	12	.5850	.1689
	avqc	4.185	12	.4869	.1406
Pair 13	vmap	14.817	12	.4366	.1260
	vmaqc	15.383	12	.5149	.1486
Pair 14	vfap	75.842	12	3.3878	.9780
	vfaqc	72.800	12	2.4958	.7205
Pair 15	r200p	5.050	12	.7764	.2241
	r200qc	5.025	12	.4309	.1244
Pair 16	r100p	8.292	12	1.1229	.3241
	r100qc	8.092	12	.6156	.1777
Pair 17	r50p	8.950	12	.5916	.1708
	r50qc	8.750	12	.4275	.1234
Pair 18	r30p	7.725	12	.7557	.2182
	r30qc	7.550	12	.3778	.1091
Pair 19	r16p	10.483	12	1.1582	.3344
	r16qc	10.442	12	.7948	.2294
Pair 20	r8p	14.050	12	.9060	.2616
	r8qc	14.058	12	.7465	.2155
Pair 21	r4p	21.250	12	2.0215	.5835
	r4qc	21.900	12	1.5064	.4348
Pair 22	r38p	17.583	12	2.3482	.6779
	r38qc	16.975	12	1.3322	.3846
Pair 23	r12p	1.992	12	.8372	.2417
	r12qc	2.942	12	.7925	.2288

Correlations

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	p200p & p200qc	12	.397	.202
Pair 2	p100p &	12	.528	.077

	p100qc			
Pair 3	p50p & p50qc	12	.882	.000
Pair 4	p30p & p30qc	12	.756	.004
Pair 5	p16p & p16qc	12	.668	.018
Pair 6	p8p & p8qc	12	.466	.126
Pair 7	p4p & p4qc	12	.369	.237
Pair 8	p38p & p38qc	12	.545	.067
Pair 9	p12p & p12qc	12	.384	.218
Pair 10	bitp & bitqc	12	.701	.011
Pair 11	gsep & gseqc	12	.686	.014
Pair 12	avp & avqc	12	.525	.079
Pair 13	vmap & vmaqc	12	.725	.008
Pair 14	vfap & vfaqc	12	.433	.160
Pair 15	r200p & r200qc	12	.621	.031
Pair 16	r100p & r100qc	12	.614	.034
Pair 17	r50p & r50qc	12	.457	.136
Pair 18	r30p & r30qc	12	.613	.034
Pair 19	r16p & r16qc	12	.747	.005
Pair 20	r8p & r8qc	12	.600	.039
Pair 21	r4p & r4qc	12	.189	.557
Pair 22	r38p & r38qc	12	.454	.138
Pair 23	r12p & r12qc	12	.384	.218

Tests

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	p200p - p200qc	.3633	.5542	.1600	.0112	.7155	2.271	11	.044
Pair 2	p100p - p100qc	.3917	1.0264	.2963	-.2605	1.0438	1.322	11	.213
Pair 3	p50p - p50qc	.6167	.6965	.2011	.1741	1.0592	3.067	11	.011
Pair 4	p30p - p30qc	.8000	1.0737	.3099	.1178	1.4822	2.581	11	.026
Pair 5	p16p -	.9667	1.5558	.4491	-.0219	1.9552	2.152	11	.054

	p16qc								
Pair 6	p8p - p8qc	1.0333	2.2516	.6500	-.3973	2.4639	1.590	11	.140
Pair 7	p4p - p4qc	1.0167	2.6264	.7582	-.6521	2.6854	1.341	11	.207
Pair 8	p38p - p38qc	.3417	2.0416	.5894	-.9555	1.6388	.580	11	.574
Pair 9	p12p - p12qc	.9500	.9050	.2613	.3750	1.5250	3.636	11	.004
Pair 10	bitp - bitqc	.1408	.1349	.0389	.0551	.2265	3.617	11	.004
Pair 11	gsep - gseqc	.008750	.011978	.003458	.001139	.016361	2.531	11	.028
Pair 12	avp - avqc	-.6025	.5292	.1528	-.9388	-.2662	-3.944	11	.002
Pair 13	vmap - vmaqc	-.5667	.3601	.1040	-.7955	-.3378	-5.451	11	.000
Pair 14	vfap - vfaqc	3.0417	3.2236	.9306	.9935	5.0899	3.269	11	.007
Pair 15	r200p - r200qc	.0250	.6107	.1763	-.3630	.4130	.142	11	.890
Pair 16	r100p - r100qc	.2000	.8893	.2567	-.3651	.7651	.779	11	.452
Pair 17	r50p - r50qc	.2000	.5494	.1586	-.1491	.5491	1.261	11	.233
Pair 18	r30p - r30qc	.1750	.6032	.1741	-.2083	.5583	1.005	11	.336
Pair 19	r16p - r16qc	.0417	.7728	.2231	-.4493	.5327	.187	11	.855
Pair 20	r8p - r8qc	-.0083	.7525	.2172	-.4865	.4698	-.038	11	.970
Pair 21	r4p - r4qc	-.6500	2.2817	.6587	-2.0998	.7998	-.987	11	.345
Pair 22	r38p - r38qc	.6083	2.1086	.6087	-.7314	1.9481	.999	11	.339
Pair 23	r12p - r12qc	-.9500	.9050	.2613	-1.5250	-.3750	-3.636	11	.004

APPENDIX F

Partial Correlations

Partial correlations results are presented by focus project. These correlations were prepared while controlling for day of production as well as sampling group (POP, Plant Independent, Plant Split, and QC).

2002 Focus Project 1

Gradation

Correlations

Control Variables			p200	p100	p50	p30	p16	p8	p4	p3_8	p1_2	p3_4
dygp	p200	Correlation	1.000	.711	.656	.509	.448	.371	.306	.229	.148	.
		Significance (2-tailed)	.	.000	.000	.000	.000	.000	.000	.006	.078	.
		df	0	141	141	141	141	141	141	141	141	141
	p100	Correlation	.711	1.000	.537	.417	.312	.246	.167	.091	.132	.
		Significance (2-tailed)	.000	.	.000	.000	.000	.003	.046	.279	.117	.
		df	141	0	141	141	141	141	141	141	141	141
	p50	Correlation	.656	.537	1.000	.944	.879	.781	.680	.540	.326	.
		Significance (2-tailed)	.000	.000	.	.000	.000	.000	.000	.000	.000	.
		df	141	141	0	141	141	141	141	141	141	141
	p30	Correlation	.509	.417	.944	1.000	.973	.909	.831	.649	.373	.
		Significance (2-tailed)	.000	.000	.000	.	.000	.000	.000	.000	.000	.
		df	141	141	141	0	141	141	141	141	141	141
	p16	Correlation	.448	.312	.879	.973	1.000	.957	.898	.735	.364	.
		Significance (2-tailed)	.000	.000	.000	.000	.	.000	.000	.000	.000	.
		df	141	141	141	141	0	141	141	141	141	141
	p8	Correlation	.371	.246	.781	.909	.957	1.000	.957	.798	.429	.
		Significance (2-tailed)	.000	.003	.000	.000	.000	.	.000	.000	.000	.
		df	141	141	141	141	141	0	141	141	141	141
	p4	Correlation	.306	.167	.680	.831	.898	.957	1.000	.874	.469	.
		Significance (2-tailed)	.000	.046	.000	.000	.000	.000	.	.000	.000	.
		df	141	141	141	141	141	141	0	141	141	141
	p3_8	Correlation	.229	.091	.540	.649	.735	.798	.874	1.000	.561	.
		Significance (2-tailed)	.006	.279	.000	.000	.000	.000	.000	.	.000	.

		df	141	141	141	141	141	141	141	0	141	141
	p1_2	Correlation	.148	.132	.326	.373	.364	.429	.469	.561	1.000	.
		Significance (2-tailed)	.078	.117	.000	.000	.000	.000	.000	.000	.	.
		df	141	141	141	141	141	141	141	141	0	141
	p3_4	Correlation	.	.	.	.	.	.	.	.	.	1.000
		Significance (2-tailed)	.	.	.	.	.	.	.	.	.	.
		df	141	141	141	141	141	141	141	141	141	0

Retained

Correlations

Control Variables			p200	ret200	ret100	ret50	ret30	ret16	ret8	ret4	ret3_8	ret1_2
dygp	p200	Correlation	1.000	.364	-.081	.153	.189	.127	.089	-.154	-.199	-.148
		Significance (2-tailed)	.	.000	.337	.068	.024	.132	.290	.066	.017	.078
		df	0	141	141	141	141	141	141	141	141	141
	ret200	Correlation	.364	1.000	-.626	.080	-.139	-.003	-.103	-.111	.057	-.089
		Significance (2-tailed)	.000	.	.000	.343	.098	.973	.220	.185	.496	.292
		df	141	0	141	141	141	141	141	141	141	141
	ret100	Correlation	-.081	-.626	1.000	.512	.541	.340	.333	-.124	-.445	-.194
		Significance (2-tailed)	.337	.000	.	.000	.000	.000	.000	.139	.000	.020
		df	141	141	0	141	141	141	141	141	141	141
	ret50	Correlation	.153	.080	.512	1.000	.781	.677	.585	-.410	-.618	-.361
		Significance (2-tailed)	.068	.343	.000	.	.000	.000	.000	.000	.000	.000
		df	141	141	141	0	141	141	141	141	141	141
	ret30	Correlation	.189	-.139	.541	.781	1.000	.664	.616	-.148	-.793	-.253
		Significance (2-tailed)	.024	.098	.000	.000	.	.000	.000	.077	.000	.002
		df	141	141	141	141	0	141	141	141	141	141

	ret16	Correlation	.127	-.003	.340	.677	.664	1.000	.596	-.219	-.631	-.444
		Significance (2-tailed)	.132	.973	.000	.000	.000	.	.000	.008	.000	.000
		df	141	141	141	141	141	0	141	141	141	141
	ret8	Correlation	.089	-.103	.333	.585	.616	.596	1.000	-.044	-.727	-.421
		Significance (2-tailed)	.290	.220	.000	.000	.000	.000	.	.601	.000	.000
		df	141	141	141	141	141	141	0	141	141	141
	ret4	Correlation	-.154	-.111	-.124	-.410	-.148	-.219	-.044	1.000	-.210	-.184
		Significance (2-tailed)	.066	.185	.139	.000	.077	.008	.601	.	.012	.028
		df	141	141	141	141	141	141	141	0	141	141
	ret3_8	Correlation	-.199	.057	-.445	-.618	-.793	-.631	-.727	-.210	1.000	.173
		Significance (2-tailed)	.017	.496	.000	.000	.000	.000	.000	.012	.	.039
		df	141	141	141	141	141	141	141	141	0	141
	ret1_2	Correlation	-.148	-.089	-.194	-.361	-.253	-.444	-.421	-.184	.173	1.000
		Significance (2-tailed)	.078	.292	.020	.000	.002	.000	.000	.028	.039	.
		df	141	141	141	141	141	141	141	141	141	0

Volumetrics

Correlations

Control Variables			bit	gmm	gse	va	vma	vfa	gmb
dygp	bit	Correlation	1.000	-.459	.462	-.298	.302	.403	.064
		Significance (2-tailed)	.	.000	.000	.003	.003	.000	.535
		df	0	94	94	94	94	94	94
	gmm	Correlation	-.459	1.000	.575	.807	.266	-.870	-.423
		Significance (2-tailed)	.000	.	.000	.000	.009	.000	.000
		df	94	0	94	94	94	94	94
	gse	Correlation	.462	.575	1.000	.529	.540	-.496	-.360
		Significance (2-tailed)	.000	.000	.	.000	.000	.000	.000
		df	94	94	0	94	94	94	94
	va	Correlation	-.298	.807	.529	1.000	.743	-.987	-.873
		Significance (2-tailed)	.003	.000	.000	.	.000	.000	.000

		df	94	94	94	0	94	94	94
	vma	Correlation	.302	.266	.540	.743	1.000	-.636	-.927
		Significance (2-tailed)	.003	.009	.000	.000	.	.000	.000
		df	94	94	94	94	0	94	94
	vfa	Correlation	.403	-.870	-.496	-.987	-.636	1.000	.797
		Significance (2-tailed)	.000	.000	.000	.000	.000	.	.000
		df	94	94	94	94	94	0	94
	gmb	Correlation	.064	-.423	-.360	-.873	-.927	.797	1.000
		Significance (2-tailed)	.535	.000	.000	.000	.000	.000	.
		df	94	94	94	94	94	94	0

2002 Focus Project 2

Gradation

Correlations

Control Variables			p200	p100	p50	p30	p16	p8	p4	p_3_8	p_1_2	p_3_4
daygp	p200	Correlation	1.000	.968	.615	.051	.038	.107	.101	.105	.087	.
		Significance (2-tailed)	.	.000	.000	.595	.691	.265	.295	.273	.363	.
		df	0	108	108	108	108	108	108	108	108	108
	p100	Correlation	.968	1.000	.716	.156	.126	.170	.144	.123	.131	.
		Significance (2-tailed)	.000	.	.000	.103	.190	.075	.133	.200	.173	.
		df	108	0	108	108	108	108	108	108	108	108
	p50	Correlation	.615	.716	1.000	.546	.512	.448	.347	.252	.185	.
		Significance (2-tailed)	.000	.000	.	.000	.000	.000	.000	.008	.053	.
		df	108	108	0	108	108	108	108	108	108	108
	p30	Correlation	.051	.156	.546	1.000	.956	.827	.643	.407	.169	.
		Significance (2-tailed)	.595	.103	.000	.	.000	.000	.000	.000	.078	.
		df	108	108	108	0	108	108	108	108	108	108
	p16	Correlation	.038	.126	.512	.956	1.000	.931	.751	.491	.229	.
		Significance	.691	.190	.000	.000	.	.000	.000	.000	.016	.

		(2-tailed)										
		df	108	108	108	108	0	108	108	108	108	108
	p8	Correlation	.107	.170	.448	.827	.931	1.000	.893	.638	.300	.
		Significance (2-tailed)	.265	.075	.000	.000	.000	.	.000	.000	.001	.
		df	108	108	108	108	108	0	108	108	108	108
	p4	Correlation	.101	.144	.347	.643	.751	.893	1.000	.810	.377	.
		Significance (2-tailed)	.295	.133	.000	.000	.000	.000	.	.000	.000	.
		df	108	108	108	108	108	108	0	108	108	108
	p_3_8	Correlation	.105	.123	.252	.407	.491	.638	.810	1.000	.486	.
		Significance (2-tailed)	.273	.200	.008	.000	.000	.000	.000	.	.000	.
		df	108	108	108	108	108	108	108	0	108	108
	p_1_2	Correlation	.087	.131	.185	.169	.229	.300	.377	.486	1.000	.
		Significance (2-tailed)	.363	.173	.053	.078	.016	.001	.000	.000	.	.
		df	108	108	108	108	108	108	108	108	0	108
	p_3_4	Correlation	.	.	.	.	.	.	.	.	.	1.000
		Significance (2-tailed)	.	.	.	.	.	.	.	.	.	.
		df	108	108	108	108	108	108	108	108	108	0

Retained

Correlations

Control Variables			ret_pan	ret200	ret100	ret50	ret30	ret16	ret8	ret4	ret_3_8	ret_1_2
daygp	ret_pan	Correlation	1.000	.726	.344	.043	.425	.500	.427	.454	.305	.091
		Significance (2-tailed)	.	.000	.000	.650	.000	.000	.000	.000	.001	.344
		df	0	109	109	109	109	109	109	109	109	109
	ret200	Correlation	.726	1.000	.745	.456	.680	.674	.633	.666	.533	.149
		Significance (2-tailed)	.000	.	.000	.000	.000	.000	.000	.000	.000	.118
		df	109	0	109	109	109	109	109	109	109	109

	ret100	Correlation	.344	.745	1.000	.569	.748	.627	.602	.597	.423	.162
		Significance (2-tailed)	.000	.000	.	.000	.000	.000	.000	.000	.000	.089
		df	109	109	0	109	109	109	109	109	109	109
	ret50	Correlation	.043	.456	.569	1.000	.681	.615	.542	.435	.285	.181
		Significance (2-tailed)	.650	.000	.000	.	.000	.000	.000	.000	.002	.057
		df	109	109	109	0	109	109	109	109	109	109
	ret30	Correlation	.425	.680	.748	.681	1.000	.892	.714	.550	.328	.073
		Significance (2-tailed)	.000	.000	.000	.000	.	.000	.000	.000	.000	.446
		df	109	109	109	109	0	109	109	109	109	109
	ret16	Correlation	.500	.674	.627	.615	.892	1.000	.816	.510	.166	.008
		Significance (2-tailed)	.000	.000	.000	.000	.000	.	.000	.000	.081	.932
		df	109	109	109	109	109	0	109	109	109	109
	ret8	Correlation	.427	.633	.602	.542	.714	.816	1.000	.597	.134	-.007
		Significance (2-tailed)	.000	.000	.000	.000	.000	.000	.	.000	.160	.946
		df	109	109	109	109	109	109	0	109	109	109
	ret4	Correlation	.454	.666	.597	.435	.550	.510	.597	1.000	.428	.151
		Significance (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.	.000	.114
		df	109	109	109	109	109	109	109	0	109	109
	ret_3_8	Correlation	.305	.533	.423	.285	.328	.166	.134	.428	1.000	.171
		Significance (2-tailed)	.001	.000	.000	.002	.000	.081	.160	.000	.	.074
		df	109	109	109	109	109	109	109	109	0	109
	ret_1_2	Correlation	.091	.149	.162	.181	.073	.008	-.007	.151	.171	1.000
		Significance (2-tailed)	.344	.118	.089	.057	.446	.932	.946	.114	.074	.
		df	109	109	109	109	109	109	109	109	109	0

Volumetrics

Correlations

Control Variables			bit	gmm	gse	va	vma	vfa	gmb
daygp	bit	Correlation	1.000	-.056	.592	-.395	-.071	.465	.370
		Significance (2-tailed)	.	.677	.000	.002	.594	.000	.004

		df	0	56	56	56	56	56	56
	gmm	Correlation	-.056	1.000	.772	.216	-.288	-.347	.249
		Significance (2-tailed)	.677	.	.000	.103	.028	.008	.060
		df	56	0	56	56	56	56	56
	gse	Correlation	.592	.772	1.000	-.078	-.279	.017	.437
		Significance (2-tailed)	.000	.000	.	.560	.034	.902	.001
		df	56	56	0	56	56	56	56
	va	Correlation	-.395	.216	-.078	1.000	.819	-.985	-.887
		Significance (2-tailed)	.002	.103	.560	.	.000	.000	.000
		df	56	56	56	0	56	56	56
	vma	Correlation	-.071	-.288	-.279	.819	1.000	-.710	-.938
		Significance (2-tailed)	.594	.028	.034	.000	.	.000	.000
		df	56	56	56	56	0	56	56
	vfa	Correlation	.465	-.347	.017	-.985	-.710	1.000	.811
		Significance (2-tailed)	.000	.008	.902	.000	.000	.	.000
		df	56	56	56	56	56	0	56
	gmb	Correlation	.370	.249	.437	-.887	-.938	.811	1.000
		Significance (2-tailed)	.004	.060	.001	.000	.000	.000	.
		df	56	56	56	56	56	56	0

2003 Focus Project 1

Gradation

Correlations

Control Variables			p200	p100	p50	p30	p16	p8	p4	p3_8	p1_2	p3_4
dysg	p200	Correlation	1.000	.923	.652	.630	.612	.596	.548	.539	.336	-.088
		Significance (2-tailed)	.	.000	.000	.000	.000	.000	.000	.000	.000	.224
		df	0	190	190	190	190	190	190	190	190	190
	p100	Correlation	.923	1.000	.710	.686	.655	.618	.571	.507	.415	.022
		Significance (2-tailed)	.000	.	.000	.000	.000	.000	.000	.000	.000	.759
		df	190	0	190	190	190	190	190	190	190	190
	p50	Correlation	.652	.710	1.000	.863	.803	.751	.704	.502	.275	.038
		Significance (2-	.000	.000	.	.000	.000	.000	.000	.000	.000	.597

		tailed)										
		df	190	190	0	190	190	190	190	190	190	190
	p30	Correlation	.630	.686	.863	1.000	.964	.916	.857	.613	.330	.056
		Significance (2-tailed)	.000	.000	.000	.	.000	.000	.000	.000	.000	.439
		df	190	190	190	0	190	190	190	190	190	190
	p16	Correlation	.612	.655	.803	.964	1.000	.977	.926	.698	.295	.040
		Significance (2-tailed)	.000	.000	.000	.000	.	.000	.000	.000	.000	.586
		df	190	190	190	190	0	190	190	190	190	190
	p8	Correlation	.596	.618	.751	.916	.977	1.000	.961	.753	.310	-.007
		Significance (2-tailed)	.000	.000	.000	.000	.000	.	.000	.000	.000	.920
		df	190	190	190	190	190	0	190	190	190	190
	p4	Correlation	.548	.571	.704	.857	.926	.961	1.000	.784	.328	-.033
		Significance (2-tailed)	.000	.000	.000	.000	.000	.000	.	.000	.000	.651
		df	190	190	190	190	190	190	0	190	190	190
	p3_8	Correlation	.539	.507	.502	.613	.698	.753	.784	1.000	.523	-.091
		Significance (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.	.000	.207
		df	190	190	190	190	190	190	190	0	190	190
	p1_2	Correlation	.336	.415	.275	.330	.295	.310	.328	.523	1.000	-.071
		Significance (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.	.327
		df	190	190	190	190	190	190	190	190	0	190
	p3_4	Correlation	-.088	.022	.038	.056	.040	-.007	-.033	-.091	-.071	1.000
		Significance (2-tailed)	.224	.759	.597	.439	.586	.920	.651	.207	.327	.
		df	190	190	190	190	190	190	190	190	190	0

Retained

Correlations

Control Variable			ret200	ret100	ret50	ret30	ret16	ret8	ret4	ret38	ret12

s											
dysg	ret200	Correlation	1.000	-.140	.189	.383	.352	.304	-.181	-.219	-.427
		Significance (2-tailed)	.	.052	.009	.000	.000	.000	.012	.002	.000
		df	0	190	190	190	190	190	190	190	190
	ret100	Correlation	-.140	1.000	-.117	.197	.233	.227	-.324	-.187	.093
		Significance (2-tailed)	.052	.	.106	.006	.001	.002	.000	.009	.198
		df	190	0	190	190	190	190	190	190	190
	ret50	Correlation	.189	-.117	1.000	.525	.497	.336	-.245	-.355	-.207
		Significance (2-tailed)	.009	.106	.	.000	.000	.000	.001	.000	.004
		df	190	190	0	190	190	190	190	190	190
	ret30	Correlation	.383	.197	.525	1.000	.821	.614	-.248	-.746	-.164
		Significance (2-tailed)	.000	.006	.000	.	.000	.000	.001	.000	.023
		df	190	190	190	0	190	190	190	190	190
	ret16	Correlation	.352	.233	.497	.821	1.000	.665	-.233	-.729	-.296
		Significance (2-tailed)	.000	.001	.000	.000	.	.000	.001	.000	.000
		df	190	190	190	190	0	190	190	190	190
	ret8	Correlation	.304	.227	.336	.614	.665	1.000	-.292	-.617	-.287
		Significance (2-tailed)	.000	.002	.000	.000	.000	.	.000	.000	.000
		df	190	190	190	190	190	0	190	190	190
	ret4	Correlation	-.181	-.324	-.245	-.248	-.233	-.292	1.000	-.208	-.286
		Significance (2-tailed)	.012	.000	.001	.001	.001	.000	.	.004	.000
		df	190	190	190	190	190	190	0	190	190
	ret38	Correlation	-.219	-.187	-.355	-.746	-.729	-.617	-.208	1.000	.080
		Significance (2-tailed)	.002	.009	.000	.000	.000	.000	.004	.	.271
		df	190	190	190	190	190	190	190	0	190
	ret12	Correlation	-.427	.093	-.207	-.164	-.296	-.287	-.286	.080	1.000
		Significance (2-tailed)	.000	.198	.004	.023	.000	.000	.000	.271	.
		df	190	190	190	190	190	190	190	190	0

Volumetrics

Correlations

Control Variables			bit	gmm	gse	va	vma	vfa	gmb
dysg	bit	Correlation	1.000	-.277	.368	-.328	.134	.399	.175
		Significance (2-tailed)	.	.007	.000	.001	.199	.000	.094
		df	0	91	91	91	91	91	91
	gmm	Correlation	-.277	1.000	.790	.694	.049	-.773	-.068
		Significance (2-tailed)	.007	.	.000	.000	.643	.000	.515
		df	91	0	91	91	91	91	91
	gse	Correlation	.368	.790	1.000	.458	.125	-.489	.060
		Significance (2-tailed)	.000	.000	.	.000	.232	.000	.569
		df	91	91	0	91	91	91	91
	va	Correlation	-.328	.694	.458	1.000	.703	-.989	-.738
		Significance (2-tailed)	.001	.000	.000	.	.000	.000	.000
		df	91	91	91	0	91	91	91
	vma	Correlation	.134	.049	.125	.703	1.000	-.595	-.910
		Significance (2-tailed)	.199	.643	.232	.000	.	.000	.000
		df	91	91	91	91	0	91	91
	vfa	Correlation	.399	-.773	-.489	-.989	-.595	1.000	.654
		Significance (2-tailed)	.000	.000	.000	.000	.000	.	.000
		df	91	91	91	91	91	0	91
	gmb	Correlation	.175	-.068	.060	-.738	-.910	.654	1.000
		Significance (2-tailed)	.094	.515	.569	.000	.000	.000	.
		df	91	91	91	91	91	91	0

2003 Focus Project 2

Gradation

Correlations

Control Variables			p200	p100	p50	p30	p16	p8	p4	p3_8	p1_2	p3_4
daygp	p200	Correlation	1.000	.893	.700	.393	.201	.023	-.061	-.020	.026	-.057
		Significance (2-tailed)	.	.000	.000	.000	.010	.771	.438	.801	.738	.472
		df	0	161	161	161	161	161	161	161	161	161
	p100	Correlation	.893	1.000	.768	.497	.328	.129	.023	.040	.156	-.108
		Signific	.000	.	.000	.000	.000	.102	.772	.614	.047	.170

	ance (2-tailed)										
	df	161	0	161	161	161	161	161	161	161	161
p50	Correlation	.700	.768	1.000	.867	.694	.513	.368	.290	.201	-.025
	Significance (2-tailed)	.000	.000	.	.000	.000	.000	.000	.000	.010	.751
	df	161	161	0	161	161	161	161	161	161	161
p30	Correlation	.393	.497	.867	1.000	.947	.819	.657	.552	.268	-.021
	Significance (2-tailed)	.000	.000	.000	.	.000	.000	.000	.000	.001	.789
	df	161	161	161	0	161	161	161	161	161	161
p16	Correlation	.201	.328	.694	.947	1.000	.947	.806	.681	.308	-.026
	Significance (2-tailed)	.010	.000	.000	.000	.	.000	.000	.000	.000	.743
	df	161	161	161	161	0	161	161	161	161	161
p8	Correlation	.023	.129	.513	.819	.947	1.000	.926	.769	.332	.010
	Significance (2-tailed)	.771	.102	.000	.000	.000	.	.000	.000	.000	.900
	df	161	161	161	161	161	0	161	161	161	161
p4	Correlation	-.061	.023	.368	.657	.806	.926	1.000	.791	.318	.049
	Significance (2-tailed)	.438	.772	.000	.000	.000	.000	.	.000	.000	.533
	df	161	161	161	161	161	161	0	161	161	161
p3_8	Correlation	-.020	.040	.290	.552	.681	.769	.791	1.000	.351	.086
	Significance (2-tailed)	.801	.614	.000	.000	.000	.000	.000	.	.000	.273
	df	161	161	161	161	161	161	161	0	161	161
p1_2	Correlation	.026	.156	.201	.268	.308	.332	.318	.351	1.000	.151
	Significance (2-tailed)	.738	.047	.010	.001	.000	.000	.000	.000	.	.054
	df	161	161	161	161	161	161	161	161	0	161
p3_4	Correlation	-.057	-.108	-.025	-.021	-.026	.010	.049	.086	.151	1.000
	Significance (2-tailed)	.472	.170	.751	.789	.743	.900	.533	.273	.054	.
	df	161	161	161	161	161	161	161	161	161	0

Retained

Correlations

Control Variables			retpan	ret200	ret100	ret50	ret30	ret16	ret8	ret4	ret3_8	ret1_2
daygp	retpan	Correlation	1.000	.605	-.264	-.345	-.289	-.338	-.197	.072	.034	-.036
		Significance (2-tailed)	.	.000	.001	.000	.000	.000	.012	.363	.667	.647
		df	0	161	161	161	161	161	161	161	161	161
	ret200	Correlation	.605	1.000	-.306	-.102	-.005	-.220	-.154	-.037	.026	-.275
		Significance (2-tailed)	.000	.	.000	.193	.950	.005	.050	.636	.746	.000
		df	161	0	161	161	161	161	161	161	161	161
	ret100	Correlation	-.264	-.306	1.000	.534	.316	.422	.150	-.313	-.359	-.052
		Significance (2-tailed)	.001	.000	.	.000	.000	.000	.056	.000	.000	.507
		df	161	161	0	161	161	161	161	161	161	161
	ret50	Correlation	-.345	-.102	.534	1.000	.842	.607	.204	-.280	-.572	-.212
		Significance (2-tailed)	.000	.193	.000	.	.000	.000	.009	.000	.000	.007
		df	161	161	161	0	161	161	161	161	161	161
	ret30	Correlation	-.289	-.005	.316	.842	1.000	.820	.349	-.354	-.603	-.282
		Significance (2-tailed)	.000	.950	.000	.000	.	.000	.000	.000	.000	.000
		df	161	161	161	161	0	161	161	161	161	161
	ret16	Correlation	-.338	-.220	.422	.607	.820	1.000	.615	-.433	-.595	-.259
		Significance (2-tailed)	.000	.005	.000	.000	.000	.	.000	.000	.000	.001
		df	161	161	161	161	161	0	161	161	161	161
	ret8	Correlation	-.197	-.154	.150	.204	.349	.615	1.000	-.449	-.422	-.124
		Significance (2-tailed)	.012	.050	.056	.009	.000	.000	.	.000	.000	.114
		df	161	161	161	161	161	161	0	161	161	161
	ret4	Correlat	.072	-.037	-.313	-.280	-.354	-.433	-.449	1.00	-.129	.034

		ion								0		
		Significance (2-tailed)	.363	.636	.000	.000	.000	.000	.000	.	.102	.666
		df	161	161	161	161	161	161	161	0	161	161
	ret3_8	Correlation	.034	.026	-.359	-.572	-.603	-.595	-.422	-.129	1.000	-.116
		Significance (2-tailed)	.667	.746	.000	.000	.000	.000	.000	.102	.	.141
		df	161	161	161	161	161	161	161	161	0	161
	ret1_2	Correlation	-.036	-.275	-.052	-.212	-.282	-.259	-.124	.034	-.116	1.000
		Significance (2-tailed)	.647	.000	.507	.007	.000	.001	.114	.666	.141	.
		df	161	161	161	161	161	161	161	161	161	0

Volumetrics

Correlations

Control Variables			bit	gmm	gse	va	vma	vfa	gmb
daygp	bit	Correlation	1.000	-.177	.414	-.402	-.171	.435	.365
		Significance (2-tailed)	.	.084	.000	.000	.096	.000	.000
		df	0	94	94	94	94	94	94
	gmm	Correlation	-.177	1.000	.823	.412	-.099	-.517	.090
		Significance (2-tailed)	.084	.	.000	.000	.335	.000	.385
		df	94	0	94	94	94	94	94
	gse	Correlation	.414	.823	1.000	.150	-.190	-.227	.293
		Significance (2-tailed)	.000	.000	.	.145	.064	.026	.004
		df	94	94	0	94	94	94	94
	va	Correlation	-.402	.412	.150	1.000	.848	-.989	-.859
		Significance (2-tailed)	.000	.000	.145	.	.000	.000	.000
		df	94	94	94	0	94	94	94
	vma	Correlation	-.171	-.099	-.190	.848	1.000	-.771	-.964
		Significance (2-tailed)	.096	.335	.064	.000	.	.000	.000
		df	94	94	94	94	0	94	94
	vfa	Correlation	.435	-.517	-.227	-.989	-.771	1.000	.787
		Significance (2-tailed)	.000	.000	.026	.000	.000	.	.000
		df	94	94	94	94	94	0	94
	gmb	Correlation	.365	.090	.293	-.859	-.964	.787	1.000
		Significance (2-tailed)	.000	.385	.004	.000	.000	.000	.
		df	94	94	94	94	94	94	0

APPENDIX G

Segregation Data

2002 Focus Project 1 – No MTV

GLM

Multivariate Tests(d)

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power(a)
Intercept	Pillai's Trace	1.000	28954.922(b)	10.000	49.000	.000	1.000	289549.219	1.000
	Wilks' Lambda	.000	28954.922(b)	10.000	49.000	.000	1.000	289549.219	1.000
	Hotelling's Trace	5909.168	28954.922(b)	10.000	49.000	.000	1.000	289549.219	1.000
	Roy's Largest Root	5909.168	28954.922(b)	10.000	49.000	.000	1.000	289549.219	1.000
weeklot	Pillai's Trace	.221	1.389(b)	10.000	49.000	.213	.221	13.895	.624
	Wilks' Lambda	.779	1.389(b)	10.000	49.000	.213	.221	13.895	.624
	Hotelling's Trace	.284	1.389(b)	10.000	49.000	.213	.221	13.895	.624
	Roy's Largest Root	.284	1.389(b)	10.000	49.000	.213	.221	13.895	.624
smgp	Pillai's Trace	1.006	5.062	20.000	100.000	.000	.503	101.246	1.000
	Wilks' Lambda	.144	8.014(b)	20.000	98.000	.000	.621	160.288	1.000
	Hotelling's Trace	4.903	11.768	20.000	96.000	.000	.710	235.359	1.000
	Roy's Largest Root	4.680	23.402(c)	10.000	50.000	.000	.824	234.023	1.000
weeklot * smgp	Pillai's Trace	.419	1.324	20.000	100.000	.182	.209	26.483	.843
	Wilks' Lambda	.617	1.338(b)	20.000	98.000	.174	.214	26.757	.847
	Hotelling's Trace	.563	1.350	20.000	96.000	.168	.220	27.003	.850
	Roy's Largest Root	.426	2.132(c)	10.000	50.000	.039	.299	21.324	.846

a Computed using alpha = .05
b Exact statistic
c The statistic is an upper bound on F that yields a lower bound on the significance level.
d Design: Intercept+weeklot+smgp+weeklot * smgp

Between-Subjects Effects:

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power(a)
Corrected Model	p200	3.347(b)	5	.669	4.031	.003	.258	20.157	.932
	p100	16.439(c)	5	3.288	4.674	.001	.287	23.371	.964
	p50	6.462(d)	5	1.292	1.532	.194	.117	7.660	.499
	p30	13.468(e)	5	2.694	1.314	.271	.102	6.570	.432
	p16	19.487(f)	5	3.897	1.066	.389	.084	5.330	.352
	p8	41.764(g)	5	8.353	1.140	.350	.090	5.701	.376
	p4	104.268(h)	5	20.854	1.520	.198	.116	7.598	.495
	p3_8	139.164(i)	5	27.833	2.462	.043	.175	12.310	.735
	p1_2	23.411(j)	5	4.682	2.528	.039	.179	12.638	.748
	p3_4	.000(k)	5	.000	.	.	.	.	.
	bit	.716(l)	5	.143	1.660	.159	.125	8.302	.537
Intercept	p200	465.762	1	465.762	2805.231	.000	.980	2805.231	1.000
	p100	2115.940	1	2115.940	3008.247	.000	.981	3008.247	1.000
	p50	7540.507	1	7540.507	8937.720	.000	.994	8937.720	1.000
	p30	17726.291	1	17726.291	8647.226	.000	.993	8647.226	1.000
	p16	29186.906	1	29186.906	7983.004	.000	.993	7983.004	1.000
	p8	47849.710	1	47849.710	6532.208	.000	.991	6532.208	1.000
	p4	88468.658	1	88468.658	6446.784	.000	.991	6446.784	1.000
	p3_8	252194.657	1	252194.657	22308.392	.000	.997	22308.392	1.000
	p1_2	435213.015	1	435213.015	234930.656	.000	1.000	234930.656	1.000
	p3_4	490909.091	1	490909.091	.	.	1.000	.	.
	bit	1154.351	1	1154.351	13378.295	.000	.996	13378.295	1.000
weeklot	p200	.107	1	.107	.643	.426	.011	.643	.124
	p100	.048	1	.048	.068	.794	.001	.068	.058
	p50	3.980	1	3.980	4.718	.034	.075	4.718	.570
	p30	9.777	1	9.777	4.770	.033	.076	4.770	.574
	p16	15.523	1	15.523	4.246	.044	.068	4.246	.526
	p8	28.377	1	28.377	3.874	.054	.063	3.874	.490
	p4	56.582	1	56.582	4.123	.047	.066	4.123	.515
	p3_8	33.670	1	33.670	2.978	.090	.049	2.978	.396
	p1_2	7.321	1	7.321	3.952	.052	.064	3.952	.498
	p3_4	.000	1	.000	.	.	.	.	.

	bit	.006	1	.006	.070	.793	.001	.070	.058
smgp	p200	.128	2	.064	.387	.681	.013	.774	.109
	p100	5.061	2	2.531	3.598	.034	.110	7.195	.644
	p50	.224	2	.112	.133	.876	.005	.265	.069
	p30	1.050	2	.525	.256	.775	.009	.512	.088
	p16	.522	2	.261	.071	.931	.002	.143	.060
	p8	.416	2	.208	.028	.972	.001	.057	.054
	p4	4.122	2	2.061	.150	.861	.005	.300	.072
	p3_8	62.174	2	31.087	2.750	.072	.087	5.500	.522
	p1_2	5.057	2	2.528	1.365	.264	.045	2.730	.282
	p3_4	.000	2	.000	.	.	.	.	.
	bit	.593	2	.296	3.435	.039	.106	6.869	.622
weeklot * smgp	p200	2.742	2	1.371	8.256	.001	.222	16.513	.953
	p100	11.326	2	5.663	8.051	.001	.217	16.102	.948
	p50	4.032	2	2.016	2.390	.101	.076	4.779	.464
	p30	2.867	2	1.433	.699	.501	.024	1.398	.162
	p16	2.474	2	1.237	.338	.714	.012	.677	.102
	p8	5.987	2	2.993	.409	.666	.014	.817	.113
	p4	21.107	2	10.553	.769	.468	.026	1.538	.175
	p3_8	40.347	2	20.173	1.784	.177	.058	3.569	.359
	p1_2	4.465	2	2.232	1.205	.307	.040	2.410	.253
	p3_4	.000	2	.000	.	.	.	.	.
	bit	.059	2	.030	.343	.711	.012	.685	.102
Error	p200	9.630	58	.166					
	p100	40.796	58	.703					
	p50	48.933	58	.844					
	p30	118.896	58	2.050					
	p16	212.056	58	3.656					
	p8	424.861	58	7.325					
	p4	795.929	58	13.723					
	p3_8	655.686	58	11.305					
	p1_2	107.446	58	1.853					
	p3_4	.000	58	.000					
	bit	5.005	58	.086					
Total	p200	621.418	64						
	p100	2906.169	64						
	p50	10012.964	64						
	p30	23647.280	64						
	p16	38679.142	64						
	p8	63925.777	64						
	p4	118172.096	64						
	p3_8	329902.452	64						
	p1_2	570984.174	64						

	p3_4	640000.000	64						
	bit	1540.059	64						
Corrected Total	p200	12.977	63						
	p100	57.235	63						
	p50	55.395	63						
	p30	132.364	63						
	p16	231.543	63						
	p8	466.625	63						
	p4	900.197	63						
	p3_8	794.850	63						
	p1_2	130.857	63						
	p3_4	.000	63						
	bit	5.721	63						

a Computed using alpha = .05
b R Squared = .258 (Adjusted R Squared = .194)
c R Squared = .287 (Adjusted R Squared = .226)
d R Squared = .117 (Adjusted R Squared = .041)
e R Squared = .102 (Adjusted R Squared = .024)
f R Squared = .084 (Adjusted R Squared = .005)
g R Squared = .090 (Adjusted R Squared = .011)
h R Squared = .116 (Adjusted R Squared = .040)
i R Squared = .175 (Adjusted R Squared = .104)
j R Squared = .179 (Adjusted R Squared = .108)
k R Squared = . (Adjusted R Squared = .)
l R Squared = .125 (Adjusted R Squared = .050)

t-test

Group Statistics

	location	N	Mean	Std. Deviation	Std. Error Mean
p200	P	43	3.0209	.44274	.06752
	F	21	3.2112	.46005	.10039
p100	P	43	6.589	1.0132	.1545
	F	21	6.841	.8131	.1774
p50	P	43	12.411	1.0433	.1591
	F	21	12.601	.6769	.1477
p30	P	43	19.047	1.5571	.2375
	F	21	19.417	1.1958	.2610
p16	P	43	24.427	2.0406	.3112
	F	21	24.680	1.6695	.3643
p8	P	43	31.416	2.7847	.4247
	F	21	31.638	2.6480	.5778
p4	P	43	42.767	3.6614	.5584
	F	21	42.887	4.1046	.8957
p3_8	P	43	71.924	3.4606	.5277
	F	21	71.272	3.7809	.8251
p1_2	P	43	94.328	1.4843	.2264

	F	21	94.679	1.3526	.2952
p3_4	P	43	100.00	.000(a)	.000
	F	21	100.00	.000(a)	.000
bit	P	43	4.8934	.32770	.04997
	F	21	4.9024	.24590	.05366

a t cannot be computed because the standard deviations of both groups are 0.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
p200	Equal variances assumed	.016	.899	-1.594	62	.116	-.19032	.11937	-.42895	.04830
	Equal variances not assumed			-1.573	38.439	.124	-.19032	.12098	-.43515	.05450
p100	Equal variances assumed	.328	.569	-.993	62	.324	-.2521	.2538	-.7594	.2552
	Equal variances not assumed			-1.072	48.543	.289	-.2521	.2353	-.7250	.2208
p50	Equal variances assumed	2.527	.117	-.761	62	.450	-.1906	.2505	-.6913	.3101
	Equal variances not assumed			-.878	56.873	.384	-.1906	.2171	-.6253	.2442
p30	Equal variances assumed	1.140	.290	-.959	62	.341	-.3702	.3861	-1.1420	.4017
	Equal variances not assumed			-1.049	50.384	.299	-.3702	.3528	-1.0787	.3384
p16	Equal varianc	.924	.340	-.493	62	.624	-.2531	.5135	-1.2795	.7734

	es assumed									
	Equal variances not assumed			-.528	47.733	.600	-.2531	.4791	-1.2165	.7104
p8	Equal variances assumed	.014	.905	-.304	62	.762	-.2217	.7298	-1.6806	1.2372
	Equal variances not assumed			-.309	41.653	.759	-.2217	.7171	-1.6692	1.2258
p4	Equal variances assumed	.622	.433	-.119	62	.906	-.1207	1.0143	-2.1483	1.9069
	Equal variances not assumed			-.114	35.977	.910	-.1207	1.0555	-2.2613	2.0200
p3_8	Equal variances assumed	.442	.508	.686	62	.496	.6511	.9496	-1.2472	2.5494
	Equal variances not assumed			.665	36.781	.510	.6511	.9794	-1.3337	2.6359
p1_2	Equal variances assumed	1.072	.304	-.913	62	.365	-.3508	.3842	-1.1188	.4172
	Equal variances not assumed			-.943	43.309	.351	-.3508	.3720	-1.1008	.3991
bit	Equal variances assumed	2.933	.092	-.111	62	.912	-.00901	.08086	-.17065	.15263
	Equal variances not assumed			-.123	51.345	.903	-.00901	.07333	-.15620	.13818

GLM

Multivariate Tests(d)

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power(a)
Intercept	Pillai's Trace	1.000	26543.155(b)	10.000	45.000	.000	1.000	265431.550	1.000
	Wilks' Lambda	.000	26543.155(b)	10.000	45.000	.000	1.000	265431.550	1.000
	Hotelling's Trace	5898.479	26543.155(b)	10.000	45.000	.000	1.000	265431.550	1.000
	Roy's Largest Root	5898.479	26543.155(b)	10.000	45.000	.000	1.000	265431.550	1.000
weeklot	Pillai's Trace	.558	5.691(b)	10.000	45.000	.000	.558	56.908	1.000
	Wilks' Lambda	.442	5.691(b)	10.000	45.000	.000	.558	56.908	1.000
	Hotelling's Trace	1.265	5.691(b)	10.000	45.000	.000	.558	56.908	1.000
	Roy's Largest Root	1.265	5.691(b)	10.000	45.000	.000	.558	56.908	1.000
smgp	Pillai's Trace	1.215	7.115	20.000	92.000	.000	.607	142.305	1.000
	Wilks' Lambda	.045	16.617(b)	20.000	90.000	.000	.787	332.341	1.000
	Hotelling's Trace	15.293	33.645	20.000	88.000	.000	.884	672.902	1.000
	Roy's Largest Root	14.909	68.582(c)	10.000	46.000	.000	.937	685.816	1.000
weeklot * smgp	Pillai's Trace	.152	.808(b)	10.000	45.000	.622	.152	8.083	.362
	Wilks' Lambda	.848	.808(b)	10.000	45.000	.622	.152	8.083	.362
	Hotelling's Trace	.180	.808(b)	10.000	45.000	.622	.152	8.083	.362
	Roy's Largest Root	.180	.808(b)	10.000	45.000	.622	.152	8.083	.362

a Computed using alpha = .05
b Exact statistic
c The statistic is an upper bound on F that yields a lower bound on the significance level.
d Design: Intercept+weeklot+smgp+weeklot * smgp

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power(a)
Corrected Model	p200	.287(b)	4	.072	.661	.622	.047	2.642	.202
	p100	8.144(c)	4	2.036	3.195	.020	.191	12.782	.791
	p50	1.678(d)	4	.420	1.086	.373	.074	4.342	.319
	p30	3.430(e)	4	.857	.996	.418	.069	3.983	.294

	p16	18.870(f)	4	4.718	3.259	.018	.194	13.036	.800
	p8	39.431(g)	4	9.858	4.102	.006	.233	16.408	.892
	p4	105.429(h)	4	26.357	5.274	.001	.281	21.097	.958
	p3_8	176.732(i)	4	44.183	5.771	.001	.299	23.084	.972
	p1_2	46.032(j)	4	11.508	6.752	.000	.333	27.010	.989
	p3_4	.000(k)	4	.000	.	.	.	.	.
	bit	.638(l)	4	.159	3.980	.007	.228	15.922	.881
Intercept	p200	534.054	1	534.054	4910.989	.000	.989	4910.989	1.000
	p100	2390.401	1	2390.401	3751.848	.000	.986	3751.848	1.000
	p50	8081.041	1	8081.041	20907.840	.000	.997	20907.840	1.000
	p30	17982.024	1	17982.024	20884.124	.000	.997	20884.124	1.000
	p16	28976.072	1	28976.072	20016.885	.000	.997	20016.885	1.000
	p8	46959.020	1	46959.020	19541.092	.000	.997	19541.092	1.000
	p4	82157.694	1	82157.694	16440.142	.000	.997	16440.142	1.000
	p3_8	244626.960	1	244626.960	31951.918	.000	.998	31951.918	1.000
	p1_2	433891.219	1	433891.219	254587.781	.000	1.000	254587.781	1.000
	p3_4	495670.218	1	495670.218	.	.	1.000	.	.
	bit	1196.472	1	1196.472	29868.800	.000	.998	29868.800	1.000
weeklot	p200	.196	1	.196	1.805	.185	.032	1.805	.262
	p100	.007	1	.007	.011	.918	.000	.011	.051
	p50	.550	1	.550	1.422	.238	.026	1.422	.216
	p30	.063	1	.063	.073	.789	.001	.073	.058
	p16	.449	1	.449	.310	.580	.006	.310	.085
	p8	2.823	1	2.823	1.175	.283	.021	1.175	.187
	p4	2.212	1	2.212	.443	.509	.008	.443	.100
	p3_8	30.229	1	30.229	3.948	.052	.068	3.948	.497
	p1_2	7.207	1	7.207	4.228	.045	.073	4.228	.524
	p3_4	.000	1	.000	.	.	.	.	.
	bit	.076	1	.076	1.890	.175	.034	1.890	.272
smgp	p200	.225	2	.112	1.033	.363	.037	2.065	.221
	p100	7.466	2	3.733	5.859	.005	.178	11.719	.855
	p50	.234	2	.117	.303	.740	.011	.606	.096
	p30	.659	2	.329	.382	.684	.014	.765	.109
	p16	12.366	2	6.183	4.271	.019	.137	8.542	.722
	p8	22.994	2	11.497	4.784	.012	.151	9.568	.773
	p4	67.177	2	33.588	6.721	.002	.199	13.442	.901
	p3_8	105.206	2	52.603	6.871	.002	.203	13.742	.908
	p1_2	18.890	2	9.445	5.542	.006	.170	11.084	.834
	p3_4	.000	2	.000	.	.	.	.	.

	bit	.526	2	.263	6.560	.003	.195	13.121	.894
weeklot * smgp	p200	.029	1	.029	.263	.610	.005	.263	.080
	p100	.126	1	.126	.197	.659	.004	.197	.072
	p50	.674	1	.674	1.743	.192	.031	1.743	.254
	p30	2.296	1	2.296	2.666	.108	.047	2.666	.361
	p16	4.371	1	4.371	3.019	.088	.053	3.019	.400
	p8	8.464	1	8.464	3.522	.066	.061	3.522	.454
	p4	21.144	1	21.144	4.231	.045	.073	4.231	.524
	p3_8	10.688	1	10.688	1.396	.243	.025	1.396	.213
	p1_2	6.075	1	6.075	3.565	.064	.062	3.565	.458
	p3_4	.000	1	.000	.	.	.	.	.
	bit	.064	1	.064	1.602	.211	.029	1.602	.237
Error	p200	5.872	54	.109					
	p100	34.405	54	.637					
	p50	20.871	54	.387					
	p30	46.496	54	.861					
	p16	78.169	54	1.448					
	p8	129.767	54	2.403					
	p4	269.859	54	4.997					
	p3_8	413.429	54	7.656					
	p1_2	92.032	54	1.704					
	p3_4	.000	54	.000					
	bit	2.163	54	.040					
Total	p200	634.515	59						
	p100	2961.973	59						
	p50	9618.031	59						
	p30	21455.963	59						
	p16	34428.981	59						
	p8	55966.581	59						
	p4	97746.387	59						
	p3_8	291641.284	59						
	p1_2	519672.142	59						
	p3_4	590000.000	59						
	bit	1436.593	59						
Corrected Total	p200	6.160	58						
	p100	42.548	58						
	p50	22.550	58						
	p30	49.926	58						
	p16	97.039	58						
	p8	169.198	58						
	p4	375.287	58						
	p3_8	590.161	58						

	p1_2	138.064	58							
	p3_4	.000	58							
	bit	2.801	58							

a Computed using alpha = .05
b R Squared = .047 (Adjusted R Squared = -.024)
c R Squared = .191 (Adjusted R Squared = .131)
d R Squared = .074 (Adjusted R Squared = .006)
e R Squared = .069 (Adjusted R Squared = .000)
f R Squared = .194 (Adjusted R Squared = .135)
g R Squared = .233 (Adjusted R Squared = .176)
h R Squared = .281 (Adjusted R Squared = .228)
i R Squared = .299 (Adjusted R Squared = .248)
j R Squared = .333 (Adjusted R Squared = .284)
k R Squared = . (Adjusted R Squared = .)
l R Squared = .228 (Adjusted R Squared = .171)

t-test

Group Statistics

	location	N	Mean	Std. Deviation	Std. Error Mean
p200	P	34	3.2934	.32444	.05564
	F	25	3.2227	.33001	.06600
p100	P	34	6.967	.8804	.1510
	F	25	7.126	.8318	.1664
p50	P	34	12.761	.7327	.1257
	F	25	12.742	.4485	.0897
p30	P	34	19.139	1.0796	.1851
	F	25	18.923	.6707	.1341
p16	P	34	24.477	1.4354	.2462
	F	25	23.641	.8893	.1779
p8	P	34	31.325	1.7773	.3048
	F	25	29.974	1.2696	.2539
p4	P	34	41.599	2.3557	.4040
	F	25	39.300	2.1986	.4397
p3_8	P	34	71.509	2.7900	.4785
	F	25	68.504	2.9094	.5819
p1_2	P	34	94.128	1.5831	.2715
	F	25	93.445	1.4234	.2847
p3_4	P	34	100.00	.000(a)	.000
	F	25	100.00	.000(a)	.000
bit	P	34	4.8907	.24399	.04184
	F	25	4.9826	.17259	.03452

a t cannot be computed because the standard deviations of both groups are 0.

Independent Samples Test

		Levene's Test for Equality of Variances	t-test for Equality of Means

		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
p200	Equal variances assumed	1.640	.205	.822	57	.415	.07076	.08610	-.10165	.24317
	Equal variances not assumed			.820	51.367	.416	.07076	.08633	-.10252	.24404
p100	Equal variances assumed	.023	.881	-.702	57	.486	-.1591	.2266	-.6130	.2947
	Equal variances not assumed			-.708	53.448	.482	-.1591	.2247	-.6096	.2914
p50	Equal variances assumed	3.287	.075	.118	57	.907	.0195	.1657	-.3123	.3513
	Equal variances not assumed			.126	55.416	.900	.0195	.1544	-.2899	.3289
p30	Equal variances assumed	3.284	.075	.880	57	.383	.2155	.2449	-.2749	.7059
	Equal variances not assumed			.943	55.651	.350	.2155	.2286	-.2426	.6736
p16	Equal variances assumed	5.145	.027	2.569	57	.013	.8360	.3254	.1843	1.4877
	Equal variances not assumed			2.753	55.609	.008	.8360	.3037	.2275	1.4445
p8	Equal variances assumed	3.635	.062	3.237	57	.002	1.3505	.4172	.5151	2.1859

	Equal variances not assumed			3.404	56.970	.001	1.3505	.3967	.5561	2.1449
p4	Equal variances assumed	.374	.543	3.809	57	.000	2.2992	.6035	1.0906	3.5077
	Equal variances not assumed			3.850	53.760	.000	2.2992	.5971	1.1019	3.4964
p3_8	Equal variances assumed	.143	.706	4.016	57	.000	3.0055	.7485	1.5067	4.5043
	Equal variances not assumed			3.990	50.602	.000	3.0055	.7533	1.4928	4.5182
p1_2	Equal variances assumed	.061	.806	1.709	57	.093	.6833	.3999	-.1175	1.4842
	Equal variances not assumed			1.737	54.639	.088	.6833	.3934	-.1052	1.4718
bit	Equal variances assumed	2.396	.127	-1.608	57	.113	-.09186	.05712	-.20625	.02252
	Equal variances not assumed			-1.694	56.939	.096	-.09186	.05424	-.20049	.01676

2002 Focus Project 2

GLM

Multivariate Tests (d)

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power(a)

Intercept	Pillai's Trace	1.000	46949.829(b)	10.000	78.000	.000	1.000	469498.286	1.000
	Wilks' Lambda	.000	46949.829(b)	10.000	78.000	.000	1.000	469498.286	1.000
	Hotelling's Trace	6019.209	46949.829(b)	10.000	78.000	.000	1.000	469498.286	1.000
	Roy's Largest Root	6019.209	46949.829(b)	10.000	78.000	.000	1.000	469498.286	1.000
weeklot	Pillai's Trace	.532	2.866	20.000	158.000	.000	.266	57.326	.999
	Wilks' Lambda	.526	2.956(b)	20.000	156.000	.000	.275	59.125	.999
	Hotelling's Trace	.791	3.044	20.000	154.000	.000	.283	60.889	1.000
	Roy's Largest Root	.609	4.807(c)	10.000	79.000	.000	.378	48.075	.999
sgp	Pillai's Trace	.644	3.756	20.000	158.000	.000	.322	75.115	1.000
	Wilks' Lambda	.425	4.161(b)	20.000	156.000	.000	.348	83.221	1.000
	Hotelling's Trace	1.188	4.572	20.000	154.000	.000	.373	91.448	1.000
	Roy's Largest Root	1.028	8.123(c)	10.000	79.000	.000	.507	81.231	1.000
weeklot * sgp	Pillai's Trace	.271	.794	30.000	240.000	.772	.090	23.815	.734
	Wilks' Lambda	.750	.790	30.000	229.621	.777	.092	23.149	.715
	Hotelling's Trace	.307	.785	30.000	230.000	.782	.093	23.557	.726
	Roy's Largest Root	.184	1.471(c)	10.000	80.000	.166	.155	14.709	.691

a Computed using alpha = .05
b Exact statistic
c The statistic is an upper bound on F that yields a lower bound on the significance level.
d Design: Intercept+weeklot+sgp+weeklot * sgp

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power(a)
Corrected Model	p200	1.305(b)	7	.186	.978	.453	.073	6.843	.398
	p100	2.983(c)	7	.426	1.341	.241	.097	9.384	.541
	p50	4.876(d)	7	.697	1.174	.326	.086	8.221	.477
	p30	3.685(e)	7	.526	.573	.776	.044	4.013	.234
	p16	5.302(f)	7	.757	.517	.819	.040	3.619	.213
	p8	18.351(g)	7	2.622	.775	.610	.059	5.427	.316
	p4	12.133(h)	7	1.733	.229	.977	.018	1.601	.112
	p_3_8	30.497(i)	7	4.357	.594	.759	.046	4.161	.243
	p_1_2	22.738(j)	7	3.248	1.954	.071	.136	13.678	.737

	p_3_4	.000(k)	7	.000	.	.	.	.	.
	bit	.538(l)	7	.077	2.950	.008	.192	20.651	.914
Intercept	p200	662.610	1	662.610	3473.535	.000	.976	3473.535	1.000
	p100	2563.325	1	2563.325	8063.616	.000	.989	8063.616	1.000
	p50	12852.012	1	12852.012	21667.212	.000	.996	21667.212	1.000
	p30	32697.002	1	32697.002	35604.220	.000	.998	35604.220	1.000
	p16	52675.416	1	52675.416	35957.809	.000	.998	35957.809	1.000
	p8	95450.156	1	95450.156	28227.076	.000	.997	28227.076	1.000
	p4	187887.087	1	187887.087	24785.795	.000	.997	24785.795	1.000
	p_3_8	428132.156	1	428132.156	58409.146	.000	.999	58409.146	1.000
	p_1_2	688960.417	1	688960.417	414439.754	.000	1.000	414439.754	1.000
	p_3_4	758350.888	1	758350.888	.	.	1.000	.	.
	bit	1730.032	1	1730.032	66392.207	.000	.999	66392.207	1.000
weeklot	p200	.647	2	.324	1.696	.189	.038	3.393	.348
	p100	.799	2	.400	1.257	.290	.028	2.514	.267
	p50	1.211	2	.605	1.021	.365	.023	2.041	.223
	p30	1.007	2	.503	.548	.580	.012	1.096	.138
	p16	.849	2	.425	.290	.749	.007	.580	.095
	p8	7.450	2	3.725	1.102	.337	.025	2.203	.238
	p4	2.640	2	1.320	.174	.840	.004	.348	.076
	p_3_8	3.840	2	1.920	.262	.770	.006	.524	.090
	p_1_2	.937	2	.468	.282	.755	.006	.563	.093
	p_3_4	.000	2	.000	.	.	.	.	.
	bit	.001	2	.001	.023	.977	.001	.046	.053
sgp	p200	.260	2	.130	.683	.508	.015	1.365	.162
	p100	1.137	2	.569	1.788	.173	.039	3.577	.365
	p50	2.415	2	1.207	2.035	.137	.045	4.071	.409
	p30	1.333	2	.667	.726	.487	.016	1.452	.169
	p16	.639	2	.319	.218	.805	.005	.436	.083
	p8	.182	2	.091	.027	.974	.001	.054	.054
	p4	7.060	2	3.530	.466	.629	.011	.931	.124
	p_3_8	15.235	2	7.617	1.039	.358	.023	2.078	.226
	p_1_2	13.380	2	6.690	4.024	.021	.085	8.049	.704
	p_3_4	.000	2	.000	.	.	.	.	.
	bit	.424	2	.212	8.135	.001	.158	16.271	.953
weeklot * sgp	p200	.706	3	.235	1.233	.303	.041	3.700	.320
	p100	1.396	3	.465	1.464	.230	.048	4.392	.375
	p50	.900	3	.300	.506	.679	.017	1.517	.149
	p30	.890	3	.297	.323	.809	.011	.969	.110
	p16	2.232	3	.744	.508	.678	.017	1.524	.150
	p8	2.988	3	.996	.295	.829	.010	.884	.105
	p4	1.205	3	.402	.053	.984	.002	.159	.059

	p_3_8	7.240	3	2.413	.329	.804	.011	.988	.112
	p_1_2	7.057	3	2.352	1.415	.244	.047	4.245	.363
	p_3_4	.000	3	.000	.	.	.	.	.
	bit	.079	3	.026	1.011	.392	.034	3.034	.266
Error	p200	16.596	87	.191					
	p100	27.656	87	.318					
	p50	51.604	87	.593					
	p30	79.896	87	.918					
	p16	127.448	87	1.465					
	p8	294.191	87	3.382					
	p4	659.498	87	7.580					
	p_3_8	637.700	87	7.330					
	p_1_2	144.628	87	1.662					
	p_3_4	.000	87	.000					
	bit	2.267	87	.026					
Total	p200	853.487	95						
	p100	3287.889	95						
	p50	16253.269	95						
	p30	41090.659	95						
	p16	65957.536	95						
	p8	119371.408	95						
	p4	234740.696	95						
	p_3_8	534281.308	95						
	p_1_2	865969.114	95						
	p_3_4	950000.000	95						
	bit	2142.265	95						
Corrected Total	p200	17.901	94						
	p100	30.639	94						
	p50	56.481	94						
	p30	83.581	94						
	p16	132.750	94						
	p8	312.543	94						
	p4	671.631	94						
	p_3_8	668.197	94						
	p_1_2	167.366	94						
	p_3_4	.000	94						
	bit	2.805	94						

a Computed using alpha = .05
b R Squared = .073 (Adjusted R Squared = -.002)
c R Squared = .097 (Adjusted R Squared = .025)
d R Squared = .086 (Adjusted R Squared = .013)
e R Squared = .044 (Adjusted R Squared = -.033)
f R Squared = .040 (Adjusted R Squared = -.037)
g R Squared = .059 (Adjusted R Squared = -.017)

h R Squared = .018 (Adjusted R Squared = -.061)
i R Squared = .046 (Adjusted R Squared = -.031)
j R Squared = .136 (Adjusted R Squared = .066)
k R Squared = . (Adjusted R Squared = .)
l R Squared = .192 (Adjusted R Squared = .127)

t-test

Group Statistics

	smlc	N	Mean	Std. Deviation	Std. Error Mean
p200	P	71	2.949677	.4550350	.0540027
	F	24	3.013276	.3807837	.0777272
p100	P	71	5.834636	.5794395	.0687668
	F	24	5.917207	.5522422	.1127260
p50	P	71	13.050550	.7898302	.0937356
	F	24	13.077183	.7460019	.1522770
p30	P	71	20.742185	.9878639	.1172379
	F	24	20.877110	.8060450	.1645332
p16	P	71	26.287116	1.2424552	.1474523
	F	24	26.428567	1.0285567	.2099533
p8	P	71	35.426742	1.8506458	.2196313
	F	24	35.325987	1.7768842	.3627050
p4	P	71	49.532242	2.5749962	.3055958
	F	24	49.949028	2.9808986	.6084734
p_3_8	P	71	74.788262	2.6851540	.3186692
	F	24	75.414681	2.6081405	.5323844
p_1_2	P	71	95.389141	1.2964673	.1538624
	F	24	95.692242	1.4455288	.2950673
p_3_4	P	71	100.00	.000(a)	.000
	F	24	100.00	.000(a)	.000
bit	P	72	4.7592	.18244	.02150
	F	24	4.7117	.13643	.02785

a t cannot be computed because the standard deviations of both groups are 0.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
p200	Equal variances assumed	.940	.335	-.615	93	.540	-.0635991	.1033827	-.2688966	.1416984

	Equal variances not assumed			-.672	46.968	.505	-.0635991	.0946457	-.2540051	.1268069
p100	Equal variances assumed	.123	.726	-.610	93	.543	-.0825713	.1352556	-.3511622	.1860196
	Equal variances not assumed			-.625	41.419	.535	-.0825713	.1320455	-.3491607	.1840181
p50	Equal variances assumed	.020	.887	-.145	93	.885	-.0266330	.1839871	-.3919949	.3387289
	Equal variances not assumed			-.149	41.762	.882	-.0266330	.1788146	-.3875563	.3342903
p30	Equal variances assumed	.849	.359	-.604	93	.547	-.1349249	.2234033	-.5785595	.3087097
	Equal variances not assumed			-.668	48.202	.507	-.1349249	.2020295	-.5410885	.2712386
p16	Equal variances assumed	.813	.370	-.502	93	.617	-.1414506	.2817181	-.7008870	.4179857
	Equal variances not assumed			-.551	47.489	.584	-.1414506	.2565591	-.6574408	.3745395
p8	Equal variances assumed	.021	.886	.233	93	.816	.1007551	.4327267	-.7585543	.9600645
	Equal variances not assumed			.238	41.142	.813	.1007551	.4240198	-.7554806	.9569907
p4	Equal variances assumed	1.271	.263	-.658	93	.512	-.4167855	.6330544	-1.6739061	.8403351
	Equal variances not			-.612	35.328	.544	-.4167855	.6809028	-1.7986334	.9650624

	assumed									
p_3_8	Equal variances assumed	.012	.912	-.995	93	.322	-.6264188	.6295619	-1.8766039	.6237663
	Equal variances not assumed			-1.010	40.716	.319	-.6264188	.6204702	-1.8797489	.6269114
p_1_2	Equal variances assumed	.099	.754	-.962	93	.339	-.3031010	.3151882	-.9290023	.3228003
	Equal variances not assumed			-.911	36.326	.368	-.3031010	.3327737	-.9777873	.3715853
bit	Equal variances assumed	5.140	.026	1.170	94	.245	.04752	.04062	-.03313	.12816
	Equal variances not assumed			1.351	52.541	.183	.04752	.03518	-.02307	.11810

2003 Focus Project 1

GLM

Multivariate Tests(d)

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power(a)
Intercept	Pillai's Trace	1.000	80700.260(b)	10.000	142.000	.000	1.000	807002.601	1.000
	Wilks' Lambda	.000	80700.260(b)	10.000	142.000	.000	1.000	807002.601	1.000
	Hotelling's Trace	5683.117	80700.260(b)	10.000	142.000	.000	1.000	807002.601	1.000
	Roy's Largest Root	5683.117	80700.260(b)	10.000	142.000	.000	1.000	807002.601	1.000
weeklot	Pillai's Trace	.870	5.886	30.000	432.000	.000	.290	176.589	1.000
	Wilks' Lambda	.279	7.569	30.000	417.474	.000	.346	221.057	1.000
	Hotelling's Trace	2.057	9.644	30.000	422.000	.000	.407	289.318	1.000

	Roy's Largest Root	1.777	25.584(c)	10.000	144.000	.000	.640	255.838	1.000
Sgp	Pillai's Trace	1.049	15.778	20.000	286.000	.000	.525	315.552	1.000
	Wilks' Lambda	.123	26.319(b)	20.000	284.000	.000	.650	526.375	1.000
	Hotelling's Trace	5.742	40.482	20.000	282.000	.000	.742	809.635	1.000
	Roy's Largest Root	5.487	78.463(c)	10.000	143.000	.000	.846	784.633	1.000
weeklot * Sgp	Pillai's Trace	.562	1.847	50.000	730.000	.000	.112	92.351	1.000
	Wilks' Lambda	.529	1.951	50.000	650.984	.000	.120	88.403	1.000
	Hotelling's Trace	.731	2.053	50.000	702.000	.000	.128	102.671	1.000
	Roy's Largest Root	.465	6.796(c)	10.000	146.000	.000	.318	67.958	1.000

a Computed using alpha = .05
b Exact statistic
c The statistic is an upper bound on F that yields a lower bound on the significance level.
d Design: Intercept+weeklot+Sgp+weeklot * Sgp

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power(a)
Corrected Model	p200	2.968(b)	10	.297	2.280	.016	.131	22.796	.915
	p100	10.590(c)	10	1.059	2.647	.005	.149	26.470	.955
	p50	17.025(d)	10	1.703	2.458	.009	.140	24.579	.937
	p30	87.594(e)	10	8.759	8.881	.000	.370	88.813	1.000
	p16	203.111(f)	10	20.311	10.981	.000	.421	109.805	1.000
	p8	370.006(g)	10	37.001	9.705	.000	.391	97.049	1.000
	p4	777.255(h)	10	77.725	11.377	.000	.430	113.772	1.000
	p3_8	453.238(i)	10	45.324	6.945	.000	.315	69.446	1.000
	p1_2	41.041(j)	10	4.104	2.533	.008	.144	25.328	.945
	p3_4	5.014E-27(k)	10	5.014E-28	.	.	1.000	.	.
	bit	.620(l)	10	.062	1.619	.106	.097	16.188	.768
Intercept	p200	1382.640	1	1382.640	10620.074	.000	.986	10620.074	1.000
	p100	5271.359	1	5271.359	13175.193	.000	.989	13175.193	1.000
	p50	17952.330	1	17952.330	25917.821	.000	.994	25917.821	1.000
	p30	40255.559	1	40255.559	40815.820	.000	.996	40815.820	1.000
	p16	68087.284	1	68087.284	36809.124	.000	.996	36809.124	1.000

	p8	117075.415	1	117075.415	30707.618	.000	.995	30707.618	1.000
	p4	199703.324	1	199703.324	29232.025	.000	.995	29232.025	1.000
	p3_8	668451.987	1	668451.987	102421.475	.000	.999	102421.475	1.000
	p1_2	1117667.491	1	1117667.491	689762.071	.000	1.000	689762.071	1.000
	p3_4	1204784.963	1	1204784.963	.	.	1.000	.	.
	bit	2845.266	1	2845.266	74234.296	.000	.998	74234.296	1.000
weeklot	p200	.103	3	.034	.263	.852	.005	.790	.099
	p100	.568	3	.189	.473	.702	.009	1.419	.144
	p50	10.287	3	3.429	4.951	.003	.090	14.852	.906
	p30	75.003	3	25.001	25.349	.000	.335	76.047	1.000
	p16	145.249	3	48.416	26.175	.000	.342	78.524	1.000
	p8	232.263	3	77.421	20.307	.000	.287	60.920	1.000
	p4	458.140	3	152.713	22.354	.000	.308	67.061	1.000
	p3_8	44.647	3	14.882	2.280	.082	.043	6.841	.566
	p1_2	4.724	3	1.575	.972	.408	.019	2.916	.261
	p3_4	.000	3	.000	.	.	.	.	.
	bit	.096	3	.032	.837	.476	.016	2.511	.229
Sgp	p200	1.107	2	.553	4.250	.016	.053	8.500	.736
	p100	3.149	2	1.574	3.935	.022	.050	7.870	.701
	p50	2.728	2	1.364	1.969	.143	.025	3.938	.403
	p30	3.416	2	1.708	1.732	.180	.022	3.464	.359
	p16	38.879	2	19.440	10.509	.000	.122	21.019	.988
	p8	82.193	2	41.097	10.779	.000	.125	21.558	.989
	p4	209.824	2	104.912	15.357	.000	.169	30.713	.999
	p3_8	309.818	2	154.909	23.735	.000	.239	47.471	1.000
	p1_2	17.034	2	8.517	5.256	.006	.065	10.512	.828
	p3_4	.000	2	.000	.	.	.	.	.
	bit	.239	2	.119	3.117	.047	.040	6.234	.592
weeklot * Sgp	p200	1.458	5	.292	2.240	.053	.069	11.201	.717
	p100	5.779	5	1.156	2.889	.016	.087	14.444	.836
	p50	1.361	5	.272	.393	.853	.013	1.966	.151
	p30	.355	5	.071	.072	.996	.002	.360	.066
	p16	.702	5	.140	.076	.996	.003	.380	.066
	p8	2.060	5	.412	.108	.990	.004	.540	.074
	p4	4.644	5	.929	.136	.984	.004	.680	.081
	p3_8	44.603	5	8.921	1.367	.240	.043	6.834	.473
	p1_2	6.900	5	1.380	.852	.515	.027	4.259	.299
	p3_4	.000	5	.000	.	.	.	.	.
	bit	.176	5	.035	.916	.472	.029	4.580	.321
Error	p200	19.659	151	.130					

	p100	60.415	151	.400					
	p50	104.592	151	.693					
	p30	148.927	151	.986					
	p16	279.311	151	1.850					
	p8	575.700	151	3.813					
	p4	1031.581	151	6.832					
	p3_8	985.499	151	6.526					
	p1_2	244.675	151	1.620					
	p3_4	.000	151	.000					
	bit	5.788	151	.038					
Total	p200	1878.522	162						
	p100	7176.537	162						
	p50	24444.752	162						
	p30	54853.427	162						
	p16	92218.170	162						
	p8	159233.771	162						
	p4	272766.682	162						
	p3_8	903682.340	162						
	p1_2	1509027.380	162						
	p3_4	1620000.000	162						
	bit	3824.065	162						
Corrected Total	p200	22.627	161						
	p100	71.005	161						
	p50	121.617	161						
	p30	236.521	161						
	p16	482.421	161						
	p8	945.706	161						
	p4	1808.836	161						
	p3_8	1438.737	161						
	p1_2	285.716	161						
	p3_4	5.014E-27	161						
	bit	6.408	161						

a Computed using alpha = .05
b R Squared = .131 (Adjusted R Squared = .074)
c R Squared = .149 (Adjusted R Squared = .093)
d R Squared = .140 (Adjusted R Squared = .083)
e R Squared = .370 (Adjusted R Squared = .329)
f R Squared = .421 (Adjusted R Squared = .383)
g R Squared = .391 (Adjusted R Squared = .351)
h R Squared = .430 (Adjusted R Squared = .392)
i R Squared = .315 (Adjusted R Squared = .270)
j R Squared = .144 (Adjusted R Squared = .087)

k R Squared = 1.000 (Adjusted R Squared = 1.000)
l R Squared = .097 (Adjusted R Squared = .037)

t-test

Group Statistics

	LocSam	N	Mean	Std. Deviation	Std. Error Mean
p200	P	122	3.431	.3474	.0315
	F	40	3.245	.4231	.0669
p100	P	122	6.685	.6038	.0547
	F	40	6.432	.8000	.1265
p50	P	122	12.319	.9078	.0822
	F	40	12.054	.7122	.1126
p30	P	122	18.471	1.2034	.1089
	F	40	18.027	1.1916	.1884
p16	P	122	24.013	1.7352	.1571
	F	40	23.135	1.5594	.2466
p8	P	122	31.647	2.4072	.2179
	F	40	30.072	2.0865	.3299
p4	P	122	41.474	3.2652	.2956
	F	40	39.138	3.0141	.4766
p3_8	P	122	75.299	2.6701	.2417
	F	40	72.583	3.0122	.4763
p1_2	P	122	96.681	1.2815	.1160
	F	40	95.969	1.3562	.2144
p3_4	P	122	100.000	.0000(a)	.0000
	F	40	100.000	.0000(a)	.0000
bit	P	122	4.876	.1952	.0177
	F	40	4.788	.2003	.0317

a t cannot be computed because the standard deviations of both groups are 0.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
p200	Equal variances assumed	2.294	.132	2.774	160	.006	.1857	.0669	.0535	.3179
	Equal variances not assume			2.512	57.252	.015	.1857	.0739	.0377	.3337

	d									
p100	Equal variances assumed	6.146	.014	2.112	160	.036	.2529	.1197	.0164	.4893
	Equal variances not assumed			1.835	54.320	.072	.2529	.1378	-.0234	.5291
p50	Equal variances assumed	1.073	.302	1.683	160	.094	.2650	.1575	-.0459	.5760
	Equal variances not assumed			1.901	83.946	.061	.2650	.1394	-.0122	.5423
p30	Equal variances assumed	.040	.842	2.028	160	.044	.4436	.2187	.0117	.8756
	Equal variances not assumed			2.038	67.029	.045	.4436	.2176	.0092	.8780
p16	Equal variances assumed	1.244	.266	2.847	160	.005	.8787	.3087	.2691	1.4882
	Equal variances not assumed			3.005	73.204	.004	.8787	.2924	.2960	1.4613
p8	Equal variances assumed	2.191	.141	3.707	160	.000	1.5757	.4251	.7362	2.4152
	Equal variances not assumed			3.985	75.813	.000	1.5757	.3954	.7882	2.3632
p4	Equal variances assumed	.804	.371	4.000	160	.000	2.3365	.5841	1.1829	3.4900
	Equal variances not assumed			4.166	71.381	.000	2.3365	.5608	1.2184	3.4546

p3_8	Equal variances assumed	.077	.782	5.406	160	.000	2.7161	.5024	1.7239	3.7083
	Equal variances not assumed			5.085	60.390	.000	2.7161	.5341	1.6479	3.7844
p1_2	Equal variances assumed	.814	.368	3.006	160	.003	.7121	.2369	.2443	1.1799
	Equal variances not assumed			2.921	63.423	.005	.7121	.2438	.2250	1.1993
bit	Equal variances assumed	.071	.790	2.466	160	.015	.0883	.0358	.0176	.1589
	Equal variances not assumed			2.433	65.015	.018	.0883	.0363	.0158	.1607

2003 Focus Project 2

GLM

Multivariate Tests (d)

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power(a)
Intercept	Pillai's Trace	1.000	1643146.488(b)	11.000	126.000	.000	1.000	18074611.364	1.000
	Wilks' Lambda	.000	1643146.488(b)	11.000	126.000	.000	1.000	18074611.364	1.000
	Hotelling's Trace	143449.297	1643146.488(b)	11.000	126.000	.000	1.000	18074611.364	1.000
	Roy's Largest Root	143449.297	1643146.488(b)	11.000	126.000	.000	1.000	18074611.364	1.000
smgp	Pillai's Trace	.517	4.023	22.000	254.000	.000	.258	88.512	1.000
	Wilks' Lambda	.522	4.392(b)	22.000	252.000	.000	.277	96.631	1.000
	Hotelling's Trace	.839	4.765	22.000	250.000	.000	.295	104.836	1.000

	Roy's Largest Root	.736	8.503(c)	11.000	127.000	.000	.424	93.535	1.000
wk	Pillai's Trace	1.146	7.193	33.000	384.000	.000	.382	237.359	1.000
	Wilks' Lambda	.207	7.958	33.000	371.923	.000	.408	256.546	1.000
	Hotelling's Trace	2.318	8.757	33.000	374.000	.000	.436	288.973	1.000
	Roy's Largest Root	1.559	18.146 (c)	11.000	128.000	.000	.609	199.601	1.000
smgp * wk	Pillai's Trace	.542	1.182	66.000	786.000	.160	.090	77.998	.998
	Wilks' Lambda	.557	1.189	66.000	679.663	.153	.093	69.574	.994
	Hotelling's Trace	.633	1.193	66.000	746.000	.148	.095	78.753	.999
	Roy's Largest Root	.246	2.928(c)	11.000	131.000	.002	.197	32.213	.980

a Computed using alpha = .05
b Exact statistic
c The statistic is an upper bound on F that yields a lower bound on the significance level.
d Design: Intercept+smgp+wk+smgp * wk

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power(a)
Corrected Model	p200	11.780(b)	11	1.071	2.988	.001	.195	32.872	.983
	p100	20.656(c)	11	1.878	1.582	.111	.113	17.399	.782
	p50	38.660(d)	11	3.515	3.292	.000	.210	36.209	.991
	p30	94.545(e)	11	8.595	4.826	.000	.281	53.087	1.000
	p16	142.848 (f)	11	12.986	4.219	.000	.254	46.409	.999
	p8	218.314 (g)	11	19.847	3.694	.000	.230	40.639	.996
	p4	351.779 (h)	11	31.980	3.772	.000	.234	41.496	.997
	p3_8	207.897 (i)	11	18.900	2.856	.002	.188	31.413	.977
	p1_2	109.742 (j)	11	9.977	9.785	.000	.442	107.631	1.000
	p3_4	.066(k)	11	.006	.124	1.000	.010	1.367	.090
	bit	1.884(l)	11	.171	5.275	.000	.299	58.026	1.000
Intercept	p200	1625.737	1	1625.737	4536.780	.000	.971	4536.780	1.000
	p100	7239.562	1	7239.562	6097.933	.000	.978	6097.933	1.000
	p50	25005.537	1	25005.537	23420.697	.000	.994	23420.697	1.000
	p30	56375.310	1	56375.310	31654.670	.000	.996	31654.670	1.000
	p16	94657.493	1	94657.493	30752.491	.000	.996	30752.491	1.000

	p8	162388.535	1	162388.535	30228.552	.000	.996	30228.552	1.000
	p4	283988.216	1	283988.216	33499.412	.000	.996	33499.412	1.000
	p3_8	541411.497	1	541411.497	81805.766	.000	.998	81805.766	1.000
	p1_2	814398.416	1	814398.416	798728.697	.000	1.000	798728.697	1.000
	p3_4	867015.323	1	867015.323	17994761.238	.000	1.000	17994761.238	1.000
	bit	2010.773	1	2010.773	61937.198	.000	.998	61937.198	1.000
smgp	p200	2.262	2	1.131	3.156	.046	.044	6.311	.597
	p100	5.191	2	2.596	2.186	.116	.031	4.373	.441
	p50	3.769	2	1.885	1.765	.175	.025	3.530	.365
	p30	4.187	2	2.093	1.175	.312	.017	2.351	.254
	p16	4.499	2	2.250	.731	.483	.011	1.462	.172
	p8	4.472	2	2.236	.416	.660	.006	.832	.116
	p4	25.883	2	12.941	1.527	.221	.022	3.053	.320
	p3_8	42.624	2	21.312	3.220	.043	.045	6.440	.606
	p1_2	25.760	2	12.880	12.632	.000	.157	25.264	.996
	p3_4	.001	2	.001	.014	.986	.000	.027	.052
	bit	.149	2	.074	2.292	.105	.033	4.584	.459
wk	p200	5.744	3	1.915	5.343	.002	.105	16.028	.927
	p100	10.452	3	3.484	2.935	.036	.061	8.804	.687
	p50	25.613	3	8.538	7.996	.000	.150	23.989	.989
	p30	75.864	3	25.288	14.199	.000	.239	42.598	1.000
	p16	113.139	3	37.713	12.252	.000	.213	36.757	1.000
	p8	174.580	3	58.193	10.833	.000	.193	32.498	.999
	p4	247.964	3	82.655	9.750	.000	.177	29.250	.997
	p3_8	111.354	3	37.118	5.608	.001	.110	16.825	.939
	p1_2	72.502	3	24.167	23.702	.000	.343	71.107	1.000
	p3_4	.010	3	.003	.068	.977	.001	.203	.062
	bit	.609	3	.203	6.253	.001	.121	18.758	.961
smgp * wk	p200	3.541	6	.590	1.647	.139	.068	9.882	.614
	p100	7.253	6	1.209	1.018	.416	.043	6.110	.392
	p50	12.885	6	2.147	2.011	.068	.082	12.068	.718
	p30	15.097	6	2.516	1.413	.214	.059	8.477	.537
	p16	18.096	6	3.016	.980	.441	.041	5.879	.377
	p8	25.846	6	4.308	.802	.570	.034	4.811	.309
	p4	49.748	6	8.291	.978	.443	.041	5.868	.377
	p3_8	35.644	6	5.941	.898	.499	.038	5.386	.346
	p1_2	10.648	6	1.775	1.740	.116	.071	10.443	.643
	p3_4	.026	6	.004	.091	.997	.004	.546	.071
	bit	.488	6	.081	2.503	.025	.099	15.017	.823
Error	p200	48.735	136	.358					
	p100	161.461	136	1.187					

	p50	145.203	136	1.068					
	p30	242.209	136	1.781					
	p16	418.614	136	3.078					
	p8	730.595	136	5.372					
	p4	1152.928	136	8.477					
	p3_8	900.083	136	6.618					
	p1_2	138.668	136	1.020					
	p3_4	6.553	136	.048					
	bit	4.415	136	.032					
Total	p200	2829.857	148						
	p100	12641.984	148						
	p50	43626.991	148						
	p30	98187.345	148						
	p16	165009.458	148						
	p8	283834.774	148						
	p4	494297.360	148						
	p3_8	930908.734	148						
	p1_2	1404592.870	148						
	p3_4	1479782.057	148						
	bit	3415.835	148						
Corrected Total	p200	60.515	147						
	p100	182.117	147						
	p50	183.863	147						
	p30	336.754	147						
	p16	561.462	147						
	p8	948.910	147						
	p4	1504.707	147						
	p3_8	1107.980	147						
	p1_2	248.410	147						
	p3_4	6.619	147						
	bit	6.299	147						

a Computed using alpha = .05
b R Squared = .195 (Adjusted R Squared = .130)
c R Squared = .113 (Adjusted R Squared = .042)
d R Squared = .210 (Adjusted R Squared = .146)
e R Squared = .281 (Adjusted R Squared = .223)
f R Squared = .254 (Adjusted R Squared = .194)
g R Squared = .230 (Adjusted R Squared = .168)
h R Squared = .234 (Adjusted R Squared = .172)
i R Squared = .188 (Adjusted R Squared = .122)
j R Squared = .442 (Adjusted R Squared = .397)
k R Squared = .010 (Adjusted R Squared = -.070)
l R Squared = .299 (Adjusted R Squared = .242)

t-test

Group Statistics

	smlc	N	Mean	Std. Deviation	Std. Error Mean
p200	P	75	4.1649	.62965	.07271
	F	73	4.4909	.61514	.07200
p100	P	75	8.967	1.0254	.1184
	F	73	9.390	1.1649	.1363
p50	P	75	16.934	1.1461	.1323
	F	73	17.337	1.0585	.1239
p30	P	75	25.540	1.5769	.1821
	F	73	25.890	1.4348	.1679
p16	P	75	33.203	1.9866	.2294
	F	73	33.468	1.9251	.2253
p8	P	75	43.697	2.5633	.2960
	F	73	43.742	2.5348	.2967
p4	P	75	57.878	3.2316	.3732
	F	73	57.524	3.1782	.3720
p3_8	P	75	79.354	2.9090	.3359
	F	73	79.167	2.5833	.3023
p1_2	P	75	97.176	1.4163	.1635
	F	73	97.651	1.1281	.1320
p3_4	P	75	100.000	.0000	.0000
	F	73	99.985	.3030	.0355
bit	P	75	4.7547	.21012	.02426
	F	73	4.8460	.19447	.02276

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
p200	Equal variances assumed	.066	.798	-3.186	146	.002	-.32605	.10235	-.52833	-.12376
	Equal variances not assume			-3.187	145.998	.002	-.32605	.10232	-.52827	-.12383

	d									
p100	Equal variances assumed	1.496	.223	-2.344	146	.020	-.4225	.1803	-.7788	-.0662
	Equal variances not assumed			-2.340	142.624	.021	-.4225	.1806	-.7794	-.0655
p50	Equal variances assumed	.408	.524	-2.217	146	.028	-.4022	.1815	-.7609	-.0436
	Equal variances not assumed			-2.219	145.604	.028	-.4022	.1813	-.7605	-.0440
p30	Equal variances assumed	.536	.465	-1.410	146	.161	-.3497	.2480	-.8399	.1404
	Equal variances not assumed			-1.412	145.347	.160	-.3497	.2477	-.8393	.1398
p16	Equal variances assumed	.049	.825	-.822	146	.412	-.2644	.3217	-.9002	.3713
	Equal variances not assumed			-.822	145.997	.412	-.2644	.3215	-.8999	.3710
p8	Equal variances assumed	.054	.817	-.107	146	.915	-.0450	.4191	-.8734	.7833
	Equal variances not assumed			-.107	145.962	.915	-.0450	.4191	-.8733	.7832
p4	Equal variances assumed	1.159	.283	.672	146	.502	.3544	.5270	-.6872	1.3959
	Equal variances not assumed			.673	145.984	.502	.3544	.5269	-.6869	1.3957

p3_8	Equal variances assumed	.165	.686	.414	146	.679	.1874	.4527	-.7072	1.0820
	Equal variances not assumed			.415	144.797	.679	.1874	.4519	-.7058	1.0807
p1_2	Equal variances assumed	.279	.598	-2.253	146	.026	-.4750	.2108	-.8917	-.0583
	Equal variances not assumed			-2.260	140.543	.025	-.4750	.2102	-.8905	-.0595
p3_4	Equal variances assumed	4.939	.028	.440	146	.661	.0154	.0350	-.0538	.0845
	Equal variances not assumed			.434	72.000	.666	.0154	.0355	-.0553	.0861
Bit	Equal variances assumed	.651	.421	-2.743	146	.007	-.09136	.03330	-.15718	-.02554
	Equal variances not assumed			-2.746	145.634	.007	-.09136	.03327	-.15711	-.02561

APPENDIX G

Reheating Data

Gmb

TIME (HOURS)	Troxler	Troxler Reheat	Pine	Pine Reheat
0.25	2.580	2.553	2.574	2.558
0.75	2.564	2.562	2.567	2.554
1.5	2.55	2.573	2.568	2.573

	8			
3	2.560	2.557	2.573	2.561
5	2.556	2.538	2.560	2.534

Gmm

TIME (HOURS)	Troxler	Troxler Reheat	Pine	Pine Reheat
0.25	2.650	2.661	2.650	2.661
0.75	2.673	2.655	2.673	2.655
1.5	2.670	2.682	2.670	2.682
3	2.664	2.661	2.664	2.661
5	2.657	2.655	2.657	2.655

Va

TIME (HOURS)	Troxler	Troxler Reheat	Pine	Pine Reheat
0.25	4.06	5.42	4.24	5.25
0.75	5.42	4.90	5.31	5.27
1.5	5.66	5.38	5.18	5.45
3	5.20	5.13	4.79	5.09
5	5.05	5.64	5.07	5.88

APPENDIX H

Paired Samples Data

2002 Focus Project 1

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	p200p	3.022	20	.4504	.1007
	p200qc	3.105	20	.5206	.1164
Pair 2	p100p	6.905	20	1.1473	.2565
	p100qc	6.240	20	.7521	.1682
Pair 3	p50p	12.740	20	1.1274	.2521
	p50qc	12.530	20	1.0494	.2346
Pair 4	p30p	19.670	20	1.5321	.3426
	p30qc	19.040	20	1.2655	.2830
Pair 5	p16p	25.120	20	1.9403	.4339
	p16qc	24.880	20	1.5258	.3412
Pair 6	p8p	32.810	20	2.7328	.6111
	p8qc	31.750	20	1.8727	.4187
Pair 7	p4p	44.075	20	3.6202	.8095
	p4qc	42.900	20	2.2616	.5057
Pair 8	p38p	72.885	20	3.4449	.7703
	p38qc	73.370	20	2.3240	.5197
Pair 9	p12p	94.640	20	1.2509	.2797
	p12qc	93.715	20	1.1532	.2579
Pair 10	bitp	5.137	20	.2090	.0467
	bitqc	4.726	20	.2475	.0553
Pair 11	gsep	2.91855	20	.013663	.003055
	gseqc	2.89440	20	.013964	.003122
Pair 12	avp	4.311	20	.8124	.1817
	avqc	3.928	20	.9667	.2162
Pair 13	vmap	14.713	20	.4825	.1079
	vmaqc	14.037	20	.5516	.1233
Pair 14	vfap	70.793	20	4.7675	1.0660
	vfaqc	72.170	20	6.0167	1.3454
Pair 15	r200p	3.885	20	.8222	.1839
	r200qc	3.145	20	.2564	.0573
Pair 16	r100p	5.835	20	.9444	.2112
	r100qc	6.290	20	.3726	.0833
Pair 17	r50p	6.915	20	.5122	.1145
	r50qc	6.520	20	.3054	.0683
Pair 18	r30p	5.465	20	.4308	.0963
	r30qc	5.840	20	.3545	.0793
Pair 19	r16p	7.685	20	1.3846	.3096

	r16qc	6.855	20	.4740	.1060
Pair 20	r8p	11.280	20	1.2207	.2730
	r8qc	11.140	20	1.0404	.2327
Pair 21	r4p	28.795	20	1.0689	.2390
	r4qc	30.470	20	1.5698	.3510
Pair 22	r38p	21.750	20	2.6445	.5913
	r38qc	20.340	20	1.7512	.3916
Pair 23	r12p	5.360	20	1.2509	.2797
	r12qc	6.285	20	1.1532	.2579

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	p200p & p200qc	20	.141	.555
Pair 2	p100p & p100qc	20	-.219	.354
Pair 3	p50p & p50qc	20	.318	.172
Pair 4	p30p & p30qc	20	.173	.465
Pair 5	p16p & p16qc	20	.047	.843
Pair 6	p8p & p8qc	20	-.099	.679
Pair 7	p4p & p4qc	20	-.021	.930
Pair 8	p38p & p38qc	20	-.197	.404
Pair 9	p12p & p12qc	20	-.181	.444
Pair 10	bitp & bitqc	20	-.109	.647
Pair 11	gsep & gseqc	20	.540	.014
Pair 12	avp & avqc	20	.596	.006
Pair 13	vmap & vmaqc	20	.471	.036
Pair 14	vfap & vfaqc	20	.564	.010
Pair 15	r200p & r200qc	20	-.289	.217
Pair 16	r100p & r100qc	20	.516	.020
Pair 17	r50p & r50qc	20	-.254	.279
Pair 18	r30p & r30qc	20	-.332	.153
Pair 19	r16p & r16qc	20	-.020	.935
Pair 20	r8p & r8qc	20	.544	.013
Pair 21	r4p & r4qc	20	-.153	.518
Pair 22	r38p & r38qc	20	-.224	.343
Pair 23	r12p & r12qc	20	-.181	.444

Paired Samples Test

	Paired Differences				t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error	95% Confidence Interval of the			

					Difference				
				Mean	Lower	Upper			
Pair 1	p200p - p200qc	-.0825	.6388	.1428	-.3814	.2164	-.578	19	.570
Pair 2	p100p - p100qc	.6650	1.5031	.3361	-.0385	1.3685	1.979	19	.063
Pair 3	p50p - p50qc	.2100	1.2728	.2846	-.3857	.8057	.738	19	.470
Pair 4	p30p - p30qc	.6300	1.8102	.4048	-.2172	1.4772	1.556	19	.136
Pair 5	p16p - p16qc	.2400	2.4108	.5391	-.8883	1.3683	.445	19	.661
Pair 6	p8p - p8qc	1.0600	3.4620	.7741	-.5603	2.6803	1.369	19	.187
Pair 7	p4p - p4qc	1.1750	4.3085	.9634	-.8414	3.1914	1.220	19	.238
Pair 8	p38p - p38qc	-.4850	4.5198	1.0107	-2.6003	1.6303	-.480	19	.637
Pair 9	p12p - p12qc	.9250	1.8487	.4134	.0598	1.7902	2.238	19	.037
Pair 10	bitp - bitqc	.4115	.3409	.0762	.2519	.5711	5.398	19	.000
Pair 11	gsep - gseqc	.024150	.013248	.002962	.017950	.030350	8.152	19	.000
Pair 12	avp - avqc	.3830	.8114	.1814	.0032	.7627	2.111	19	.048
Pair 13	vmap - vmaqc	.6759	.5352	.1197	.4254	.9264	5.648	19	.000
Pair 14	vfap - vfaqc	-1.3772	5.1555	1.1528	-3.7900	1.0357	-1.195	19	.247
Pair 15	r200p - r200qc	.7400	.9293	.2078	.3051	1.1749	3.561	19	.002
Pair 16	r100p - r100qc	-.4550	.8172	.1827	-.8375	-.0725	-2.490	19	.022
Pair 17	r50p - r50qc	.3950	.6597	.1475	.0862	.7038	2.678	19	.015
Pair 18	r30p - r30qc	-.3750	.6423	.1436	-.6756	-.0744	-2.611	19	.017
Pair 19	r16p - r16qc	.8300	1.4722	.3292	.1410	1.5190	2.521	19	.021
Pair 20	r8p - r8qc	.1400	1.0908	.2439	-.3705	.6505	.574	19	.573
Pair 21	r4p - r4qc	-1.6750	2.0303	.4540	-2.6252	-.7248	-3.690	19	.002
Pair 22	r38p - r38qc	1.4100	3.4833	.7789	-.2202	3.0402	1.810	19	.086
Pair 23	r12p - r12qc	-.9250	1.8487	.4134	-1.7902	-.0598	-2.238	19	.037

2002 Focus Project 2

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	p200p	2.769	13	.4385	.1216
	p200qc	3.008	13	.4941	.1370
Pair 2	p100p	5.692	13	.5204	.1443

	p100qc	5.808	13	.6370	.1767
Pair 3	p50p	13.269	13	.6047	.1677
	p50qc	12.923	13	.7440	.2064
Pair 4	p30p	21.131	13	.9647	.2676
	p30qc	20.531	13	.9970	.2765
Pair 5	p16p	26.908	13	1.0579	.2934
	p16qc	26.231	13	1.2912	.3581
Pair 6	p8p	36.538	13	1.1155	.3094
	p8qc	35.523	13	1.9967	.5538
Pair 7	p4p	51.385	13	1.0335	.2866
	p4qc	50.162	13	2.7082	.7511
Pair 8	p38p	76.577	13	1.4249	.3952
	p38qc	76.023	13	2.5447	.7058
Pair 9	p12p	96.046	13	1.2177	.3377
	p12qc	94.885	13	1.3843	.3839
Pair 10	bitp	4.800	13	.1155	.0320
	bitqc	4.877	13	.1235	.0343
Pair 11	gsep	2.87823	13	.008671	.002405
	gseqc	2.89046	13	.011956	.003316
Pair 12	avp	3.992	13	.6500	.1803
	avqc	3.400	13	.5831	.1617
Pair 13	vmap	13.977	13	.4622	.1282
	vmaqc	13.531	13	.5360	.1487
Pair 14	vfap	71.577	13	3.8239	1.0605
	vfaqc	74.946	13	3.3788	.9371
Pair 15	retpanp	2.769	13	.4385	.1216
	retpanqc	3.008	13	.4941	.1370
Pair 16	r200p	2.915	13	.1144	.0317
	r200qc	2.777	13	.2088	.0579
Pair 17	r100p	7.562	13	.6653	.1845
	r100qc	7.146	13	.3799	.1054
Pair 18	r50p	7.885	13	.7347	.2038
	r50qc	7.600	13	.5972	.1656
Pair 19	r30p	5.762	13	.2844	.0789
	r30qc	5.685	13	.4356	.1208
Pair 20	r16p	9.654	13	.5651	.1567
	r16qc	9.323	13	.9593	.2661
Pair 21	r8p	14.846	13	.8903	.2469
	r8qc	14.646	13	1.0309	.2859
Pair 22	r4p	25.192	13	1.5047	.4173
	r4qc	25.862	13	1.4586	.4045
Pair 23	r38p	19.469	13	1.5824	.4389
	r38qc	18.846	13	1.9479	.5403
Pair 24	r12p	3.954	13	1.2177	.3377
	r12qc	5.115	13	1.3843	.3839

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	p200p & p200qc	13	.694	.009
Pair 2	p100p & p100qc	13	.674	.012
Pair 3	p50p & p50qc	13	-.289	.338
Pair 4	p30p & p30qc	13	-.265	.381
Pair 5	p16p & p16qc	13	-.114	.710
Pair 6	p8p & p8qc	13	.098	.750
Pair 7	p4p & p4qc	13	.200	.513
Pair 8	p38p & p38qc	13	.149	.626
Pair 9	p12p & p12qc	13	.666	.013
Pair 10	bitp & bitqc	13	-.351	.240
Pair 11	gsep & gseqc	13	.125	.684
Pair 12	avp & avqc	13	.732	.004
Pair 13	vmap & vmaqc	13	.669	.012
Pair 14	vfap & vfaqc	13	.728	.005
Pair 15	retpanp & retpanqc	13	.694	.009
Pair 16	r200p & r200qc	13	.260	.390
Pair 17	r100p & r100qc	13	-.292	.332
Pair 18	r50p & r50qc	13	.196	.522
Pair 19	r30p & r30qc	13	.129	.674
Pair 20	r16p & r16qc	13	.606	.028
Pair 21	r8p & r8qc	13	.267	.378
Pair 22	r4p & r4qc	13	.475	.101
Pair 23	r38p & r38qc	13	.271	.371
Pair 24	r12p & r12qc	13	.666	.013

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	p200p - p200qc	-.2385	.3686	.1022	-.4612	-.0157	-2.332	12	.038
Pair 2	p100p - p100qc	-.1154	.4793	.1329	-.4050	.1743	-.868	12	.402
Pair 3	p50p - p50qc	.3462	1.0860	.3012	-.3101	1.0024	1.149	12	.273
Pair 4	p30p - p30qc	.6000	1.5604	.4328	-.3430	1.5430	1.386	12	.191
Pair 5	p16p - p16qc	.6769	1.7603	.4882	-.3868	1.7407	1.387	12	.191
Pair 6	p8p - p8qc	1.0154	2.1897	.6073	-.3078	2.3386	1.672	12	.120
Pair 7	p4p - p4qc	1.2231	2.6991	.7486	-.4080	2.8541	1.634	12	.128

Pair 8	p38p - p38qc	.5538	2.7245	.7556	-1.0925	2.2002	.733	12	.478
Pair 9	p12p - p12qc	1.1615	1.0736	.2978	.5128	1.8103	3.901	12	.002
Pair 10	bitp - bitqc	-.0769	.1964	.0545	-.1956	.0418	-1.412	12	.183
Pair 11	gsep - gseqc	-.012231	.013863	.003845	-.020608	-.003853	-3.181	12	.008
Pair 12	avp - avqc	.5923	.4555	.1263	.3171	.8675	4.689	12	.001
Pair 13	vmap - vmaqc	.4462	.4115	.1141	.1975	.6948	3.909	12	.002
Pair 14	vfap - vfaqc	-3.3692	2.6896	.7460	-4.9945	-1.7439	-4.517	12	.001
Pair 15	retpanp - retpanqc	-.2385	.3686	.1022	-.4612	-.0157	-2.332	12	.038
Pair 16	r200p - r200qc	.1385	.2103	.0583	.0114	.2656	2.374	12	.035
Pair 17	r100p - r100qc	.4154	.8572	.2377	-.1026	.9334	1.747	12	.106
Pair 18	r50p - r50qc	.2846	.8513	.2361	-.2298	.7991	1.205	12	.251
Pair 19	r30p - r30qc	.0769	.4885	.1355	-.2182	.3721	.568	12	.581
Pair 20	r16p - r16qc	.3308	.7631	.2116	-.1304	.7919	1.563	12	.144
Pair 21	r8p - r8qc	.2000	1.1683	.3240	-.5060	.9060	.617	12	.549
Pair 22	r4p - r4qc	-.6692	1.5190	.4213	-1.5871	.2487	-1.589	12	.138
Pair 23	r38p - r38qc	.6231	2.1514	.5967	-.6770	1.9232	1.044	12	.317
Pair 24	r12p - r12qc	-1.1615	1.0736	.2978	-1.8103	-.5128	-3.901	12	.002

2003 Focus Project 1

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	p200p	3.484	19	.6362	.1460
	p200qc	3.521	19	.3360	.0771
Pair 2	p100p	6.874	19	1.0676	.2449
	p100qc	6.868	19	.5638	.1293
Pair 3	p50p	12.616	19	1.2180	.2794
	p50qc	12.674	19	.7156	.1642
Pair 4	p30p	19.095	19	1.5960	.3661
	p30qc	19.000	19	1.1116	.2550
Pair 5	p16p	24.784	19	2.1378	.4905
	p16qc	25.268	19	1.5420	.3538
Pair 6	p8p	32.768	19	3.0647	.7031
	p8qc	33.142	19	2.0686	.4746

Pair 7	p4p	42.979	19	4.0787	.9357
	p4qc	43.905	19	2.7559	.6322
Pair 8	p38p	75.437	19	3.2282	.7406
	p38qc	76.968	19	1.9562	.4488
Pair 9	p12p	97.000	19	1.4240	.3267
	p12qc	96.284	19	1.3124	.3011
Pair 10	bitp	4.900	19	.2309	.0530
	bitqc	4.958	19	.1539	.0353
Pair 11	gsep	2.89495	19	.021516	.004936
	gseqc	2.90542	19	.008934	.002050
Pair 12	avp	3.233	19	1.0372	.2380
	avqc	3.352	19	.5833	.1338
Pair 13	vmap	14.068	19	.5888	.1351
	vmaqc	14.074	19	.4629	.1062
Pair 14	vfap	77.205	19	6.4642	1.4830
	vfaqc	76.247	19	3.3638	.7717
Pair 15	r200p	3.389	19	.5216	.1197
	r200qc	3.347	19	.3062	.0702
Pair 16	r100p	5.742	19	.4464	.1024
	r100qc	5.805	19	.4223	.0969
Pair 17	r50p	6.479	19	.5018	.1151
	r50qc	6.326	19	.5384	.1235
Pair 18	r30p	5.689	19	.6235	.1430
	r30qc	6.268	19	.4796	.1100
Pair 19	r16p	7.984	19	1.0526	.2415
	r16qc	7.874	19	.5694	.1306
Pair 20	r8p	10.211	19	1.2653	.2903
	r8qc	10.763	19	1.0139	.2326
Pair 21	r4p	32.458	19	2.4685	.5663
	r4qc	33.063	19	2.2134	.5078
Pair 22	r38p	21.563	19	3.0682	.7039
	r38qc	19.316	19	1.8292	.4196
Pair 23	r12p	3.000	19	1.4240	.3267
	r12qc	3.716	19	1.3124	.3011

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	p200p & p200qc	19	.662	.002
Pair 2	p100p & p100qc	19	.604	.006
Pair 3	p50p & p50qc	19	.709	.001
Pair 4	p30p & p30qc	19	.676	.001
Pair 5	p16p & p16qc	19	.621	.005
Pair 6	p8p & p8qc	19	.504	.028
Pair 7	p4p & p4qc	19	.493	.032

Pair 8	p38p & p38qc	19	-.122	.619
Pair 9	p12p & p12qc	19	.400	.090
Pair 10	bitp & bitqc	19	-.531	.019
Pair 11	gsep & gseqc	19	.056	.820
Pair 12	avp & avqc	19	.413	.079
Pair 13	vmap & vmaqc	19	.680	.001
Pair 14	vfap & vfaqc	19	.338	.157
Pair 15	r200p & r200qc	19	.306	.203
Pair 16	r100p & r100qc	19	.509	.026
Pair 17	r50p & r50qc	19	.654	.002
Pair 18	r30p & r30qc	19	.467	.044
Pair 19	r16p & r16qc	19	.193	.429
Pair 20	r8p & r8qc	19	.638	.003
Pair 21	r4p & r4qc	19	.732	.000
Pair 22	r38p & r38qc	19	.088	.720
Pair 23	r12p & r12qc	19	.400	.090

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper			
Pair 1	p200p - p200qc	-.0368	.4844	.1111	-.2703	.1966	-.332	18	.744
Pair 2	p100p - p100qc	.0053	.8547	.1961	-.4067	.4172	.027	18	.979
Pair 3	p50p - p50qc	-.0579	.8720	.2000	-.4782	.3624	-.289	18	.776
Pair 4	p30p - p30qc	.0947	1.1759	.2698	-.4720	.6615	.351	18	.730
Pair 5	p16p - p16qc	-.4842	1.6893	.3875	-1.2984	.3300	-1.249	18	.228
Pair 6	p8p - p8qc	-.3737	2.6989	.6192	-1.6745	.9272	-.604	18	.554
Pair 7	p4p - p4qc	-.9263	3.6258	.8318	-2.6739	.8213	-1.114	18	.280
Pair 8	p38p - p38qc	-1.5316	3.9737	.9116	-3.4468	.3837	-1.680	18	.110
Pair 9	p12p - p12qc	.7158	1.5016	.3445	-.0079	1.4395	2.078	18	.052
Pair 10	bitp - bitqc	-.0579	.3388	.0777	-.2212	.1054	-.745	18	.466
Pair 11	gsep - gseqc	-.010474	.022831	.005238	-.021478	.000531	-2.000	18	.061
Pair 12	avp - avqc	-.1195	.9576	.2197	-.5810	.3421	-.544	18	.593
Pair 13	vmap - vmaqc	-.0053	.4365	.1001	-.2156	.2051	-.053	18	.959

Pair 14	vfap - vfaqc	.9579	6.1973	1.4218	-2.0291	3.9449	.674	18	.509
Pair 15	r200p - r200qc	.0421	.5178	.1188	-.2075	.2917	.354	18	.727
Pair 16	r100p - r100qc	-.0632	.4310	.0989	-.2709	.1446	-.639	18	.531
Pair 17	r50p - r50qc	.1526	.4338	.0995	-.0565	.3617	1.534	18	.143
Pair 18	r30p - r30qc	-.5789	.5827	.1337	-.8598	-.2981	-4.331	18	.000
Pair 19	r16p - r16qc	.1105	1.0959	.2514	-.4177	.6387	.440	18	.665
Pair 20	r8p - r8qc	-.5526	.9958	.2284	-1.0326	-.0727	-2.419	18	.026
Pair 21	r4p - r4qc	-.6053	1.7309	.3971	-1.4395	.2290	-1.524	18	.145
Pair 22	r38p - r38qc	2.2474	3.4308	.7871	.5938	3.9010	2.855	18	.011
Pair 23	r12p - r12qc	-.7158	1.5016	.3445	-1.4395	.0079	-2.078	18	.052

2003 Focus Project 2

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	p200p	4.625	12	.4391	.1268
	p200qc	4.262	12	.5546	.1601
Pair 2	p100p	9.683	12	1.1692	.3375
	p100qc	9.292	12	.8785	.2536
Pair 3	p50p	17.983	12	1.4745	.4257
	p50qc	17.367	12	1.3392	.3866
Pair 4	p30p	26.942	12	1.5582	.4498
	p30qc	26.142	12	1.5151	.4374
Pair 5	p16p	34.650	12	2.0787	.6001
	p16qc	33.683	12	1.5561	.4492
Pair 6	p8p	45.150	12	2.5425	.7340
	p8qc	44.117	12	1.2925	.3731
Pair 7	p4p	59.192	12	2.7917	.8059
	p4qc	58.175	12	1.4404	.4158
Pair 8	p38p	80.417	12	2.3946	.6913
	p38qc	80.075	12	1.6804	.4851
Pair 9	p12p	98.008	12	.8372	.2417
	p12qc	97.058	12	.7925	.2288
Pair 10	bitp	4.913	12	.1775	.0512
	bitqc	4.772	12	.1711	.0494
Pair 11	gsep	2.87383	12	.016129	.004656
	gseqc	2.86508	12	.013440	.003880
Pair 12	avp	3.582	12	.5850	.1689
	avqc	4.185	12	.4869	.1406
Pair 13	vmap	14.817	12	.4366	.1260
	vmaqc	15.383	12	.5149	.1486

Pair 14	vfap	75.842	12	3.3878	.9780
	vfaqc	72.800	12	2.4958	.7205
Pair 15	r200p	5.050	12	.7764	.2241
	r200qc	5.025	12	.4309	.1244
Pair 16	r100p	8.292	12	1.1229	.3241
	r100qc	8.092	12	.6156	.1777
Pair 17	r50p	8.950	12	.5916	.1708
	r50qc	8.750	12	.4275	.1234
Pair 18	r30p	7.725	12	.7557	.2182
	r30qc	7.550	12	.3778	.1091
Pair 19	r16p	10.483	12	1.1582	.3344
	r16qc	10.442	12	.7948	.2294
Pair 20	r8p	14.050	12	.9060	.2616
	r8qc	14.058	12	.7465	.2155
Pair 21	r4p	21.250	12	2.0215	.5835
	r4qc	21.900	12	1.5064	.4348
Pair 22	r38p	17.583	12	2.3482	.6779
	r38qc	16.975	12	1.3322	.3846
Pair 23	r12p	1.992	12	.8372	.2417
	r12qc	2.942	12	.7925	.2288

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	p200p & p200qc	12	.397	.202
Pair 2	p100p & p100qc	12	.528	.077
Pair 3	p50p & p50qc	12	.882	.000
Pair 4	p30p & p30qc	12	.756	.004
Pair 5	p16p & p16qc	12	.668	.018
Pair 6	p8p & p8qc	12	.466	.126
Pair 7	p4p & p4qc	12	.369	.237
Pair 8	p38p & p38qc	12	.545	.067
Pair 9	p12p & p12qc	12	.384	.218
Pair 10	bitp & bitqc	12	.701	.011
Pair 11	gsep & gseqc	12	.686	.014
Pair 12	avp & avqc	12	.525	.079
Pair 13	vmap & vmaqc	12	.725	.008
Pair 14	vfap & vfaqc	12	.433	.160
Pair 15	r200p & r200qc	12	.621	.031
Pair 16	r100p & r100qc	12	.614	.034
Pair 17	r50p & r50qc	12	.457	.136
Pair 18	r30p & r30qc	12	.613	.034

Pair 19	r16p & r16qc	12	.747	.005
Pair 20	r8p & r8qc	12	.600	.039
Pair 21	r4p & r4qc	12	.189	.557
Pair 22	r38p & r38qc	12	.454	.138
Pair 23	r12p & r12qc	12	.384	.218

Paired Samples Test
Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	p200p - p200qc	.3633	.5542	.1600	.0112	.7155	2.271	11	.044
Pair 2	p100p - p100qc	.3917	1.0264	.2963	-.2605	1.0438	1.322	11	.213
Pair 3	p50p - p50qc	.6167	.6965	.2011	.1741	1.0592	3.067	11	.011
Pair 4	p30p - p30qc	.8000	1.0737	.3099	.1178	1.4822	2.581	11	.026
Pair 5	p16p - p16qc	.9667	1.5558	.4491	-.0219	1.9552	2.152	11	.054
Pair 6	p8p - p8qc	1.0333	2.2516	.6500	-.3973	2.4639	1.590	11	.140
Pair 7	p4p - p4qc	1.0167	2.6264	.7582	-.6521	2.6854	1.341	11	.207
Pair 8	p38p - p38qc	.3417	2.0416	.5894	-.9555	1.6388	.580	11	.574
Pair 9	p12p - p12qc	.9500	.9050	.2613	.3750	1.5250	3.636	11	.004
Pair 10	bitp - bitqc	.1408	.1349	.0389	.0551	.2265	3.617	11	.004
Pair 11	gsep - gseqc	.008750	.011978	.003458	.001139	.016361	2.531	11	.028
Pair 12	avp - avqc	-.6025	.5292	.1528	-.9388	-.2662	-3.944	11	.002
Pair 13	vmap - vmaqc	-.5667	.3601	.1040	-.7955	-.3378	-5.451	11	.000
Pair 14	vfap - vfaqc	3.0417	3.2236	.9306	.9935	5.0899	3.269	11	.007
Pair 15	r200p - r200qc	.0250	.6107	.1763	-.3630	.4130	.142	11	.890
Pair 16	r100p - r100qc	.2000	.8893	.2567	-.3651	.7651	.779	11	.452
Pair 17	r50p - r50qc	.2000	.5494	.1586	-.1491	.5491	1.261	11	.233
Pair 18	r30p - r30qc	.1750	.6032	.1741	-.2083	.5583	1.005	11	.336
Pair 19	r16p - r16qc	.0417	.7728	.2231	-.4493	.5327	.187	11	.855
Pair 20	r8p - r8qc	-.0083	.7525	.2172	-.4865	.4698	-.038	11	.970
Pair 21	r4p - r4qc	-.6500	2.2817	.6587	-2.0998	.7998	-.987	11	.345
Pair 22	r38p - r38qc	.6083	2.1086	.6087	-.7314	1.9481	.999	11	.339

Pair 23	r12p - r12qc	-.9500	.9050	.2613	-1.5250	-.3750	-3.636	11	.004

APPENDIX I

PWL data

2002 Focus Project 1

2002 Focus Project 2

2003 Focus Project 1

2003 Focus Project 2

APPENDIX J

Other Project Notes

2002 Focus Project 2 – Route I-95, Darien – Norwalk

Dates of project execution:

Project characteristics:
Location: Interstate Route 95
Town(s): Darien, Norwalk
Termini:
Length:
When paved: November 2002
Paving shift: Night
Number of lanes: 3
Access: Limited
Road Configuration: Divided
Functional Classification:
Average Daily Traffic (ADT):
Superpave mix: ½″ Superpave Level 4
Paving thickness: single 2″ lift

Selection criteria: This project provided an opportunity to test sampling methods at what were expected to be difficult conditions (a high-volume highway with a lot of construction equipment, being paved at night. In addition to these factors, this project was being paved late in the year, though this was not a selection criterion but rather the result of the project execution progress.

Notes:

Material Transfer Vehicle (MTV)

A Material Transfer Vehicle (MTV) was used at all times when project personnel were at the paving locations. The MTV did not have substantial storage capacity, but rather provided separation between the paver and the mix-hauling trucks, thus avoiding bumping and reducing the need for paving-train stops.

Sampling Space Requirements

Surprisingly, the paving location and lane-closure patterns provided ample space for a staging area and for movement among sample locations. In particular, the median area provided a convenient “corridor” for staying out of the way of construction equipment, and when the paving was switched to the outside lanes, there was sufficient space in the shoulder and (subsequently) on the paved mat to avoid conflicts and crossings with the hauling trucks and paving equipment.

Segregation

Segregation was not visually observed on this project, though night paving did not provide a particularly advantageous perspective.

Material Replacement

At night, the illumination from traffic highlights any imperfections in elevation on the newly paved mat. The first POP sample location appeared higher than the surrounding pavement, but subsequent samples did not present this appearance. During daytime, these differences were not visible. On very cold nights (temperatures around the freezing point), cooling of replacement material around the bucket edges caused the material to stick to the buckets more than on warmer nights (even five degrees warmer). If POP samples are to be obtained on cold-weather-paving conditions, it is advisable to insulate the buckets. Otherwise, replacement-material cooling was not observed to be more than 5-15 degrees in the first 10-15 minutes. Regardless, if material is observed to be cooler than 20 degrees from the time it was obtained, it should be discarded (placed back in front of the paver auger) and replaced. Cooling of material was not a problem with proper sample planning.

Independent Assurance

The volumetric data from this focus project presented statistically significant differences based on where the tests were actually run. Plant Split and POP samples composed one group of data while QC results composed another. This was demonstrated in post-hoc tests run under the General Linear Model (GLM) analysis (also known as MANOVA) for volumetrics. In particular, the volumetrics that presented the greatest data comparison challenges were those that involved the use of a gyratory compactor (VMA and related properties).

The main contribution of this focus project was to demonstrate that the sampling technique could be performed in the harshest sampling environment (at night, in the cold, on a high-volume roadway). In addition, the differences in volumetric data highlight the importance of calibrating and monitoring equipment behavior (as part of an IA program).

2003 Focus Project 1 – Interstate Route 384, Manchester

Selection Criteria:
This project presented the opportunity to observe a large quantity of material being placed on a leveled surface, with echelon paving and two (2) pavers and MTVs. Although the PI was absent for the later portion of the project due to a back injury, data from the project suggests a similar finding to that in Glastonbury regarding segregation. Plant Independent and QC data presented differences in the coarse sieves with respect to POP samples.

2003 Focus Project 2 – Route 6, Windham

Selection Criteria:
This project involved a plant that had not been included, the use of an MTV, sufficient space for sampling, and an opportunity to use all lessons learned in previous projects to improve POP sampling techniques. On two days of production, POP sampling was performed with one (1) person instead of two, and no adverse effects on the ability to collect the amount required for a complete data set were observed.