Construction Aggregates Manual

State Materials Office

Gainesville, Florida

December 1, 2004

CONSTRUCTION AGGREGATES MANUAL

TABLE OF CONTENTS

APPENDICES
(1 to 18 for Minimum Sampling & Testing Frequency)

APPENDICES (cont)

CONSTRUCTION AGGREGATES MANUAL

PURPOSE

To assign sampling and testing requirements to Aggregate Producers, and to establish compliance with the requirements of ***Chapter 14-103, Florida Administrative Code***.

AUTHORITY

Section 334.044(10)(a) and (b), Florida Statutes (F.S.)
Section 334.24(2) and (4), Florida Statutes (F.S.)
Chapter 14-103, Florida Administrative Code (F.A.C.)

SCOPE

Principal users are the Aggregate Producers, State, State Materials Office, and the District Materials Offices.

1. SAMPLING, TESTING AND REPORTING

1.1. REQUIREMENTS FOR INITIAL SOURCE APPROVAL AND NEW-PRODUCTS APPROVAL

The producer must supply test data to the Department that indicates that each product from each process meets the quality and uniformity requirements of Section II of this Manual. Coarse and fine aggregate data submitted for Department evaluation with a request for initial source approval must represent 30 calendar days of production. Coarse and fine aggregate data submitted when seeking to add a product to an approved source's products list must represent a production period spread over a week (for Redistribution Terminals the data shall represent one shipment. If the quantity of material shipped is such that testing at Department-assigned frequencies does not yield sufficient data for approval, the material may be certified through a Conditional certification system). The following sections set forth the testing requirements for coarse and fine aggregate, base materials, and rip-rap. These data must have been produced within 90 days of an approval request. Approved test methods are listed in Appendix 20.

1.1.1. COARSE AGGREGATE

The minimum number of producer tests results per aggregate code, grade, or stone size from a single process required to establish quality and control of aggregates are given in ***Table 1*** below.

Table 1. Required Tests for Coarse Aggregate Approval

Test Type	No. of Tests For:		Test Method
	Initial Source Approval	Additional Product	
Gradation	30	15	AASHTO T-27
Passing #200 Sieve	30	15	FM 1-T011
Los Angeles (LA) Abrasion	15	5	FM 1-T096
Bulk Specific Gravity (Dry)* And Absorption*	15	15	FM 1-T085
Acid Insoluble for FC	5	5	FM 5-510

* = For aggregates to be used in bituminous asphalt mixes

In addition, depending upon type of aggregate, specific properties and characteristics, usage, and contract specifications, tests for the following will be required: dry-rodded weight (AASHTO T-19), soundness (AASHTO T-104), sulphur, phosphate, extraneous substances (AASHTO T-112) (i.e. sticks, friable particles, pyrite, limonite, goethite and other iron compounds, and other deleterious substances).

Single production runs of aggregate intended for Asphalt Rubber Membrane Interlayer on a single project may be approved by the Department on the basis of representative test data submitted by the producer. The Department will determine the appropriate number and type of samples to be submitted per stockpile or shipment.

1.1.2. FINE AGGREGATE

A. The minimum number of tests per aggregate code, grade, or stone size from a single process required to establish quality and control of aggregates are given in ***Table 2*** (for Silica Sand) and ***Table 3*** (for screenings) below.

Table 2. Required Tests for Fine Aggregate Approval – Silica Sand

Test Type	No. of Tests For		Test Method
	Initial Mine Approval	Additional Product	
Gradation	30	15	AASHTO T 27
Passing #200 Sieve	30	15	FM 1-T011
Bulk Specific Gravity (Dry)* And Absorption*	15	15	FM 1-T084
Fineness Modulus	30	15	AASHTO T 27
Color	30	15	AASHTO T 21

* = For aggregates to be used in bituminous asphalt mixes

Table 3. Required Tests for Fine Aggregate Approval – Screenings

Test Type	No. of Tests For		Test Method
	Initial Mine Approval	Additional Product	
Gradation	30	15	AASHTO T 27
Passing #200 Sieve	30	15	FM 1-T011
Modified LA Abrasion	15	5	FM 1-T096
Bulk Specific Gravity (Dry)* And Absorption*	15	15	FM 1-T084

* = For aggregates to be used in bituminous asphalt mixes

B. General Additional Requirements

In addition, depending upon type of aggregate, specific properties and characteristics, usage, and contract specifications, tests for the following will be required: fineness modulus (AASHTO T 27), specific gravity (AASHTO T 84), absorption (AASHTO T 84), soundness (AASHTO T 104), sulphur, phosphate, extraneous substances (i.e. pyrite, limonite, goethite and other iron compounds, deleterious substances not specifically named).

1.1.3. BASE AGGREGATE

A. General Requirements

The minimum number of tests per aggregate code, grade, or stone size from a single process required to establish quality and control of materials over at least a three-week period are given in ***Table 4*** below.

Table 4. Required Tests for Base Aggregate Approval

Test Type	No. of Tests	Test Method
Limerock Bearing Ratio Values	3	FM 5-515
Carbonate Content	6	FM 5-514
Gradation	6	AASHTO T-27
Liquid Limits, Plasticity	6	AASHTO T-89, AASHTO T-90
Soundness*	2	AASHTO T-104

* = for Graded Aggregate Base

B. Additional Requirements

In addition, depending upon type of aggregate, specific properties and characteristics, usage, and contract specifications, tests for the following will be required: sand, clay content and identification, organic content, and other deleterious substances (i.e. by Petrographic analysis).

1.1.4. RIPRAP MATERIALS (BANK AND SHORE, DITCH LINING, BEDDING STONE, OR OTHER)

A. General Requirements

Department approval of producer quality and control of these materials are on a pretested stockpile basis. Minimum number of tests per aggregate code, grade, or stone size to establish quality and control during processing of a single stockpile **up to 5,000 tons** are given in ***Table 5*** below.

Table 5. Required Tests for Riprap Approval

Tests As Required By Specific Project Specifications	No. of Tests for Stockpile Maximum Size		Test Method
	2,500 tons	5,000 tons	
Gradation	1	1	FM 5-538
Specific Gravity	2	3	FM 1 T-085
L.A. Abrasion	2	3	FM 3-C 535
Soundness	2	3	AASHTO T104
Absorption	2	3	FM 1 T-085

B. Additional Requirements

Depending upon type of aggregate, production process, specific properties and characteristics, and contract specifications, tests for Flat and Elongated Pieces (ASTM D 4791-99), Dirt and Fines, and/or other controls required by the specifications will be required. The number of tests will be determined by the Department on an as needed basis.

1.2. MINIMUM REQUIREMENTS FOR CONTINUED APPROVAL

Once a source is approved, the producer is to maintain an ongoing sampling and testing program to verify the quality and uniformity of the day-to-day production for each aggregate code, grade or stone size. The type and minimum number of tests required are derived statistically from the quality and uniformity of the product and are as follows:

1.2.1. MINES

A. COARSE AGGREGATE

(1) Gradation

(a) Set Sieve Limits

Minimum sampling and testing frequencies for gradation will be set in accordance with ***Appendices 1 through 11***, as applicable, with the maximum frequency of any one required sieve determining the minimum required for entire gradation. For sieve ranges not specified in the appendices, the Department will determine the minimum frequency by criteria on which appendices were derived.

(b) Non-Set Sieve Limits For Asphalt Aggregate Gradations

Based on the following required sieves given in ***Table 6*** below.

Table 6. Gradation Control Bands and Frequency

		Sieve Size								
		1 1/2	1	3/4	1/2	3/8	No.4	No.8	No.16	No.30
Coarse	Control Band	-5	+/-5	+/-10	+/-15	+/-10	+/-5	+/-5	Not Required (N.R.)	
	Appendix	1	2 or 4	4a	6	4a	2 or 4	2 or 4	N.R.	
Intermediate	Control Band	Not Required			+/-5	+/-10	+/-15	+/-10	+/-5	+/-5
	Appendix	Not Required			2 or 4	4A	6	4A	2 or 4	2 or 4

(2) L.A. Abrasion

Minimum sampling and testing frequencies for L.A. Abrasion will be set in accordance with ***Appendix 12***.

(3) Acid Insoluble Test For Friction Course

Minimum sampling and testing frequencies for acid insolubles will be set in accordance with ***Appendices 17 and 18***.

(4) Bulk Specific Gravity (Dry)

Minimum sampling and testing frequencies for Bulk Specific Gravity (Dry) will be set in accordance with ***Appendix 12A***.

(5) Other Properties

Sampling and testing frequencies for other aggregate properties will be established by the Department at the time of approval, based on the characteristics of the aggregate and contract specifications.

B. FINE AGGREGATE

(1) Silica Sand

(a) Standard Gradation & Percent Passing #200 Sieve

Minimum sampling and testing frequencies for gradation will be set in accordance with ***Appendices 1, 1A, 3, 6, 6A, 8, and 13***, as applicable, with the maximum frequency of any one required sieve determining the minimum required for entire gradation. For sieve ranges not specified in the appendices, the Department will determine the minimum frequency by criteria on which appendices were derived.

Fineness Modulus is required on all gradation samples.

(b) Color

Minimum sampling and testing frequency for color is one per week and increases to the minimum will be set by the Department on a mine by mine basis.

(2) Screenings

(a) Non-Set Sieve Limits (for asphalt screenings gradation)

Based on the following required sieves given in ***Table 7*** below.

Table 7. Screenings Gradation Control Bands and Frequency

	Sieve Size						
	3/8”	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100
Control Band	*	*	+/- 10	+/- 15	+/- 10	+/- 10	+/- 5
Appendix	N.A.	3A	4A	6	4A	4A	2 or 4

* = Per Specification 902-5.1

Note: Gradation tests for screenings shall include a report for the total amount of material finer than the No. 200 sieve.

(3) Bulk Specific Gravity (Dry)

Minimum sampling and testing frequencies for Bulk Specific Gravity (Dry) for all fine aggregates will be set in accordance with ***Appendix 12A***.

(4) Other Properties

Sampling and testing frequencies for other material properties will be established by the Department at the time of approval, based on the characteristics of the aggregate and contract specifications.

C. BASE AGGREGATE

(1) Limerock Bearing Ratio

Minimum sampling and testing frequencies will be set by the Department in accordance with ***Appendix 16***. If carbonate content falls outside a range of ±10% of the target set at approval and the LBR average falls below 140, LBR testing frequencies will be set at twice the normal frequency given in ***Appendix 16***. Testing frequency will return to normal after three consecutive passing LBR results.

(2) Gradation and Plasticity

Minimum sampling and testing frequencies will be at the same frequency of the LBR test and samples may be derived from LBR sample.

(3) Carbonate Content

The Department will sample and test for carbonate content.

(4) Other Properties

Sampling and testing frequencies for other material properties will be established by the Department at the time of approval, based on the characteristics of the aggregate and contract specifications.

1.2.2. REDISTRIBUTION TERMINALS

The Department shall set the sampling and testing frequency for all outgoing aggregates leaving Redistribution Terminals on an as shipped basis in accordance with ***Appendices 1 through 18*** of this manual, with the exception of those sources on Full Approval listed in ***Table 8*** below.

Table 8. Sampling and Testing Frequencies for Incoming Aggregate Shipments at Redistribution Terminals:

Rail Redistribution Terminals:	**Compliance Level, %**	
	> 95	**90 - 95**
Gradation	1 per 10 rail cars	2 per 10 rail cars
Minus 200	1 per product per shipment	2 per product per shipment
Ship Redistribution Terminals:		
Gradation	1 per 3,000 tons offloaded	2 per 3,000 tons offloaded
Minus 200	1 per 3,000 tons offloaded	2 per 3,000 tons offloaded
Los Angeles Abrasion.	1 per product per shipment	2 per product per shipment
LBR, Liquid Limits, Plasticity, and Grade for Aggregate Base	3 each per shipment	6 each per shipment
Acid Insoluble	1 per product per shipment	2 per product per shipment
Barge Redistribution Terminals:		
Gradation	3 per barge	6 per barge
Minus 200	3 per barge	6 per barge
Los Angeles Abrasion.	1 per product per shipment	2 per product per shipment
LBR, Liquid Limits, Plasticity, and Grade for Aggregate Base	2 each per shipment	4 each per shipment
Acid Insoluble	1 per product per shipment	2 per product per shipment

A. For non-statistical evaluation and frequency setting :

(1) No failure in last 30 results is considered >95%

(2) One or more failures in last 30 is considered 90-95%

B. For aggregate shipments received at Redistribution Terminals from Type I and II mines, aggregate certification from the mine will be used in lieu of retesting at the Terminal for L.A. Abrasion (all types), limerock bearing ratio, acid insoluble, Atterberg tests, bulk specific gravity, absorption, and color. However, QC tests for gradation and passing #200 sieve will be required at the terminal.

C. For Riprap materials, the minimum number tests will be one for each type established in Section (I) (A) 4 of this manual, per shipment received from Type III mines.

D. In addition, depending upon type of aggregate, size, usage and specific properties and characteristics, additional tests and frequencies will be set by the Department according to contract specification requirements.

1.3. REPORTING AND RECORDING

Data submitted electronically will not require codesheets. All data including worksheets and Department standardized computer codesheets will be available to the Department mine inspector at the mine and transmitted to the Department within the limits set for each variety of test given below and are partly dependent on the sampling and testing frequency. Availability at the mine may be considered the test results received verbally from the producer's QC laboratory to be followed by codesheets (where applicable) and worksheets, as per ***Table 9*** below.

Table 9. Availability of Test Results and Department Receipt

Type of Test	Testing Frequency	Availability (work days)	Received by the Department (work days)
Gradation (including -200)	all	1 (one)	5 (five)
LBR	1 per week	10 (ten)	10 (ten)
	>1 per week	7 (seven)	10 (ten)
LA Abrasion	all	4 (four)	7 (seven)

Type of Test	Testing Frequency	Availability (work days)	Received by the Department (work days)
Color	all	3 (three)	7 (seven)
Soundness	all	10 (ten)	14 (fourteen)
Fineness Modulus	all	1 (one)	5 (five)
Specific Gravity	all	3 (three)	6(six)
Atterberg Limits	If no failing result in last 30 If failing result in last 30	7 (seven) 3 (three)	10 (ten) 10 (ten)
Other tests	------set by the Department-----		

2. AGGREGATE COMPLIANCE LIMITS AND STANDARDS

Standard statistical analysis shall be performed on the most recent thirty (30) QC test results of each aggregate code, grade, or type of aggregate from each operation when available. When the quality or uniformity of the aggregate is such that there is low testing frequency or a producer's QC program is inactive resulting in a smaller number of test results, all QC results less than one (1) year old from date sampled will be analyzed to verify an existing frequency or establish a new frequency even if the total numbers used in the analysis is less than thirty (30). The Department will perform Verification tests to evaluate the effectiveness of the producer's Quality Control Program. Standards of evaluation shall be as set forth in the Department's ***"Quality Assurance Monitoring of Mineral Aggregates"*** Procedure.

2.1. INITIAL DATA SUBMITTAL

Data must have greater than 95.0% probability of complying with all pertinent specifications, control bands and Department standards. (Exception - Limerock Bearing Ratio Test - all values greater than 100). (Exception - Cemented Coquina Base - average carbonate percentage shall be equal to or greater than 45%).

2.2. FULL CERTIFICATION

Most recent data must have greater than 95.0% probability of complying with all pertinent specifications, control bands and Department standards (30 most recent data). (Exception - Limerock Bearing Ratio Test - lot averages greater than 100 and all individual test values above 90.

The average asphalt aggregate bulk specific gravity analysis for the most recent data for a specific material code cannot differ from the initial (as determined by the Department or from that data submitted for approval) data analysis average by more than 0.05.

The quality and uniformity of aggregate shipped from the mine and the effectiveness of the Quality Control Program for a mine will be monitored at the following location:

Mine	Location
Type I, Type IV	**Mine**
Type II	Point-of-use or Redistribution terminal
Type III	Redistribution terminal

2.3. CONDITIONAL CERTIFICATION

A 90-95% probability of complying with all pertinent specifications, control bands and Department standards (30 most recent data). (Exception - Limerock Bearing Ratio Test - lot averages below 100 but no two (2) consecutive lot averages less than 100, or an individual test value below 90 but no two (2) individual test values below 90 in the same lot and no individual test values below 90 on consecutive lots.)

Average asphalt aggregate bulk specific gravity for the most recent data for a specific material code differs from the initial data analysis by more than 0.05. (Producer may elect to apply for approval of material under a different material code number for average data less than initial data).

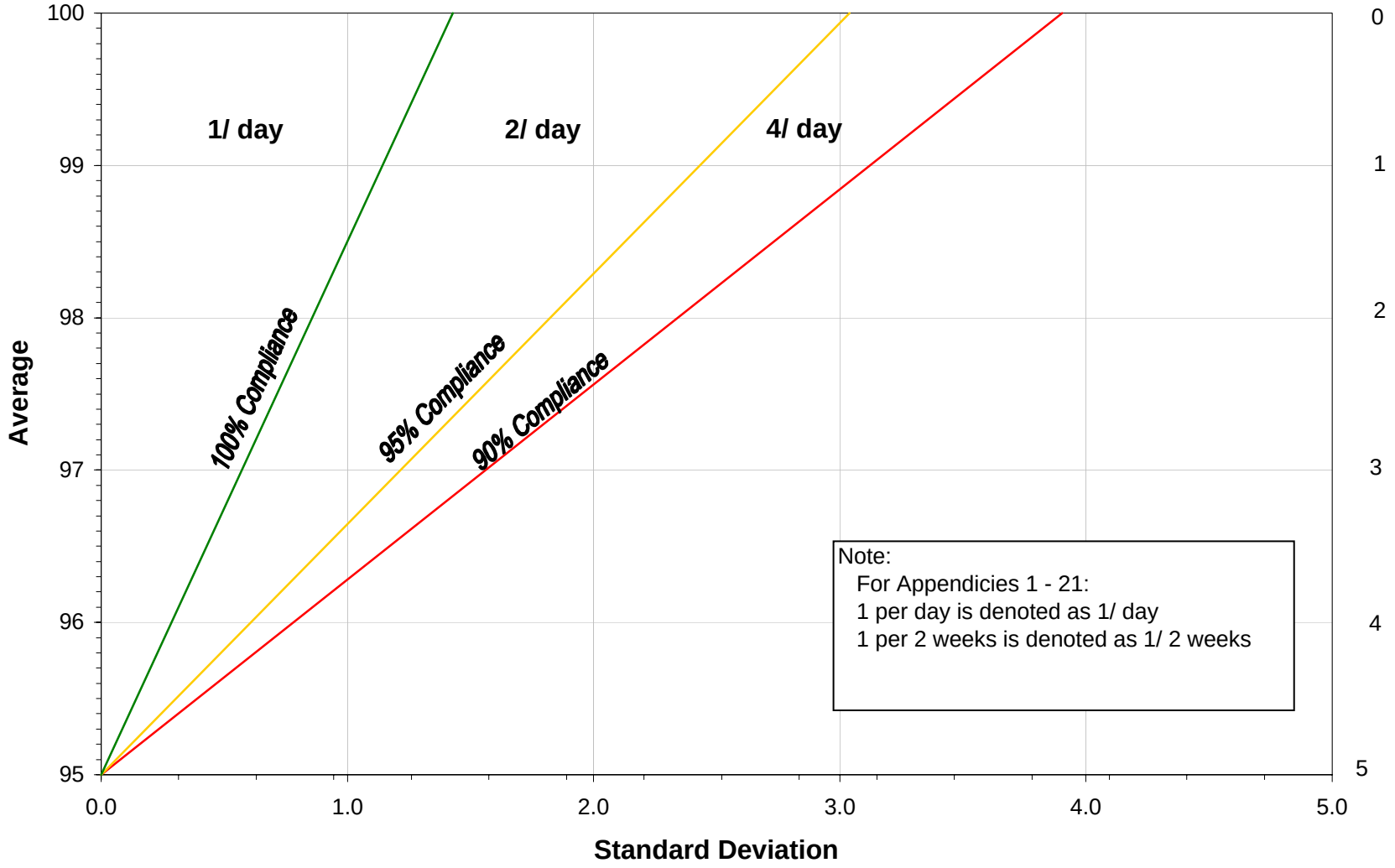
2.4. SUSPENDED APPROVAL

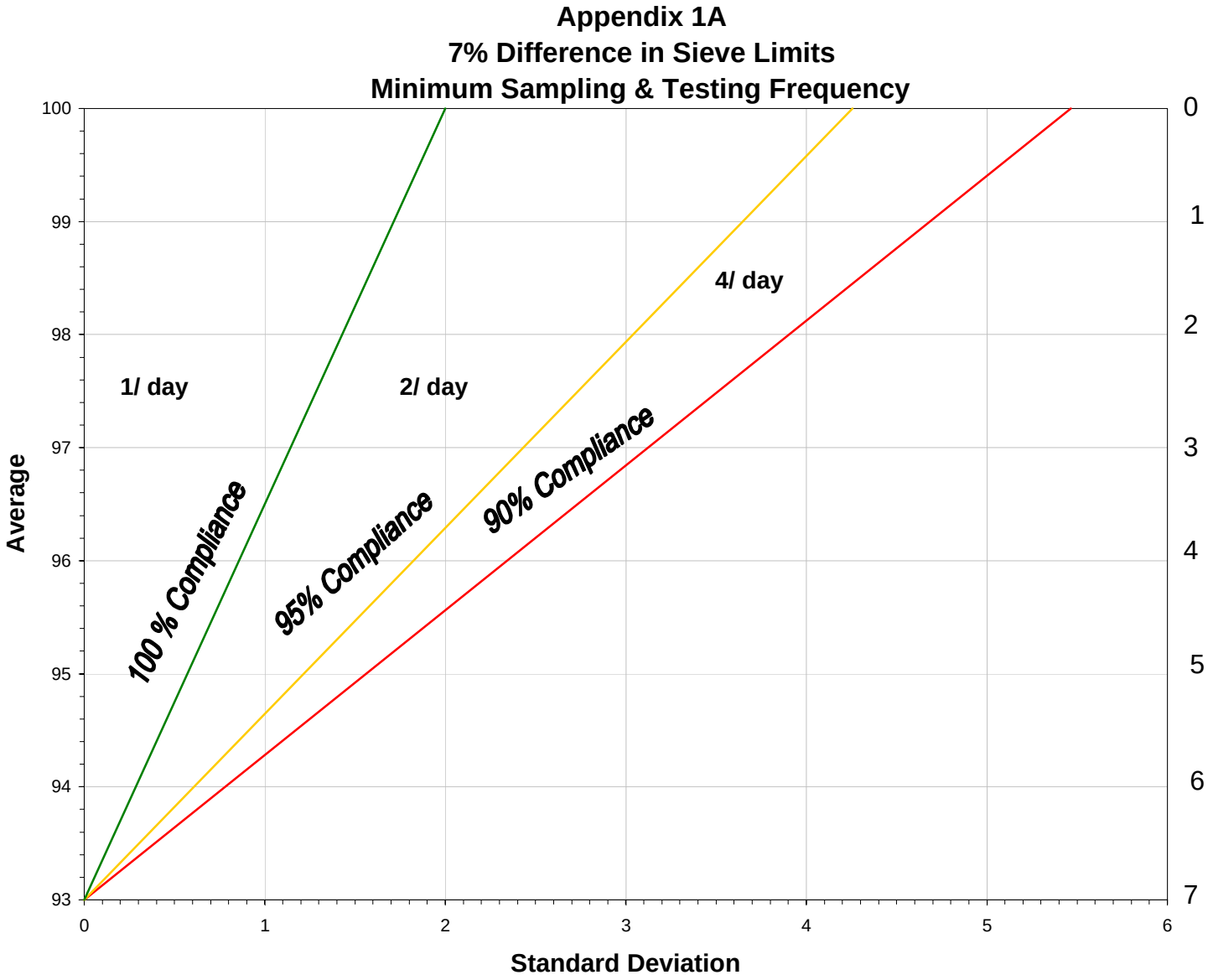
Below 90% probability of complying with all pertinent specifications, control bands and Department standards.(30 most recent data) (Exception - Limerock Bearing Ratio Test - two(2) consecutive lot averages less than 100 and/or two(2) individual test values below 90 in the same lot and/or individual test values below 90 in consecutive lots.)

3. GENERALIZED AGGREGATE FLOW

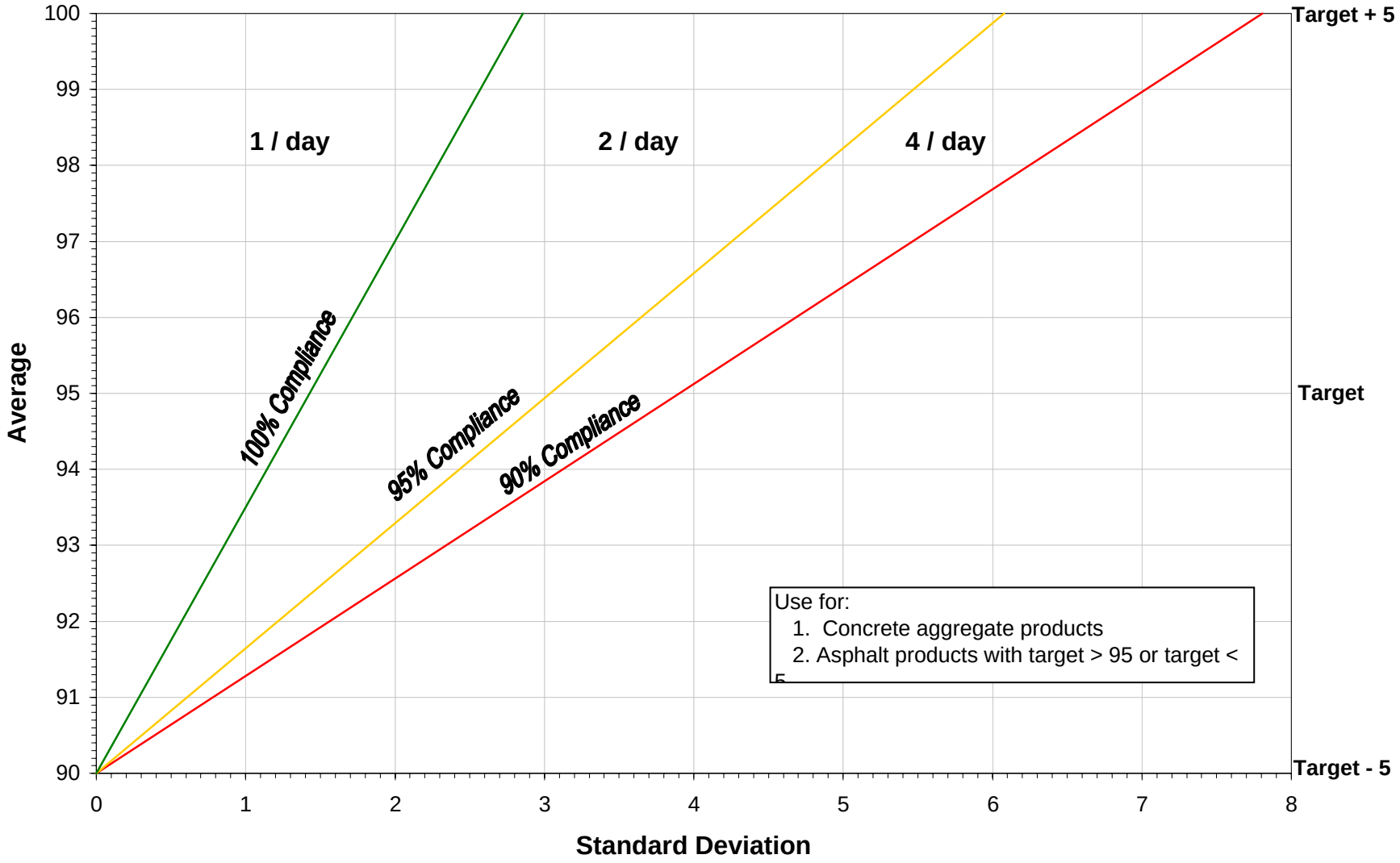
The relationship between mines and terminals, acceptance of aggregate at point-of-use, and points of sampling and testing responsibilities are given in ***Appendix 19*** for coarse aggregate as a general pattern.

Appendix 1
5% Difference in Sieve Limits
Minimum Sampling & Testing Frequency

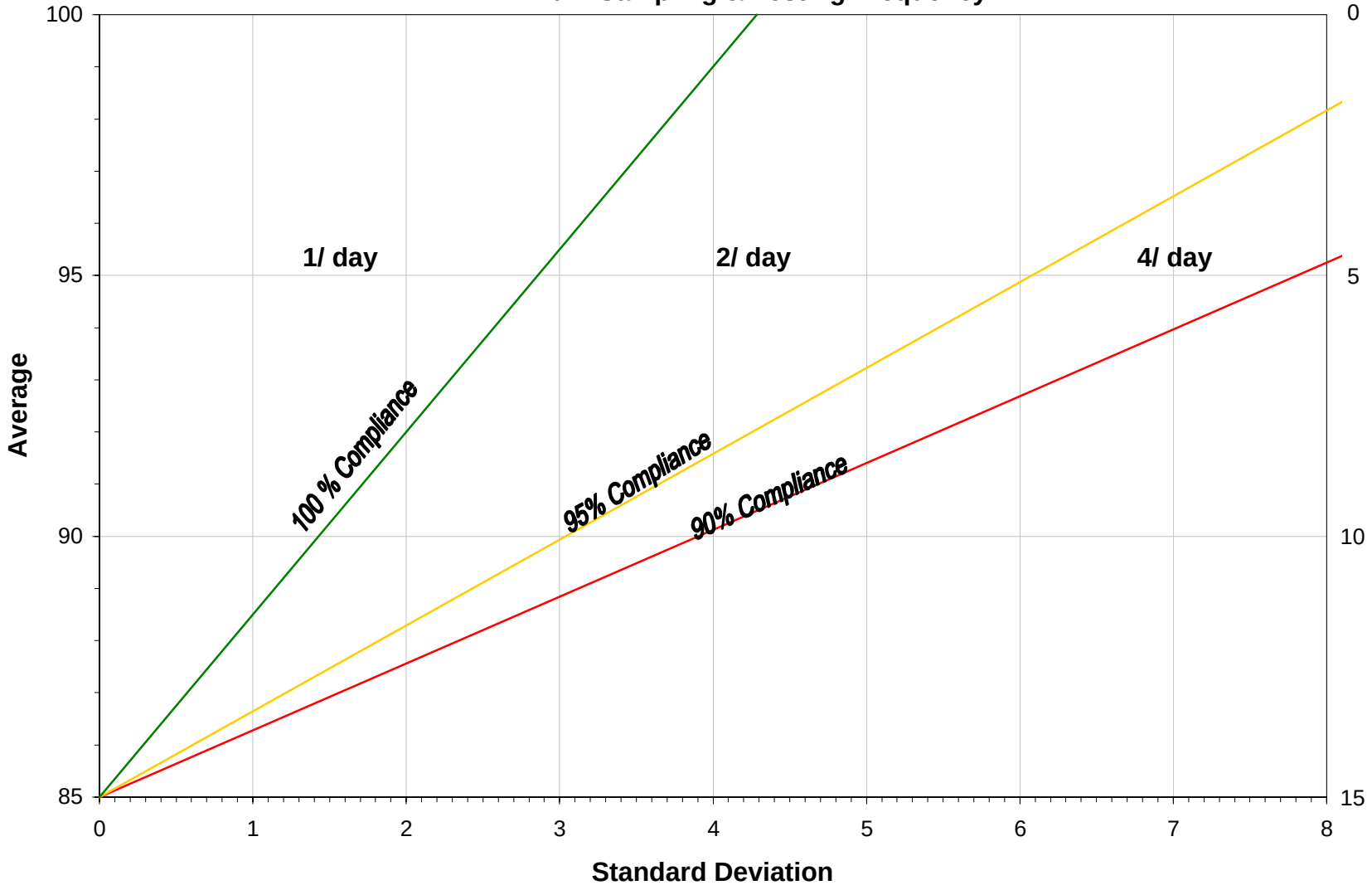



Appendix 1A
7% Difference in Sieve Limits
Minimum Sampling & Testing Frequency
Average
Standard Deviation
100
99
98
97
96
95
94
93
0
1
2
3
4
5
6
0
1
2
3
4
5
6
7
1/ day
2/ day
4/ day
100 % Compliance
95% Compliance
90% Compliance

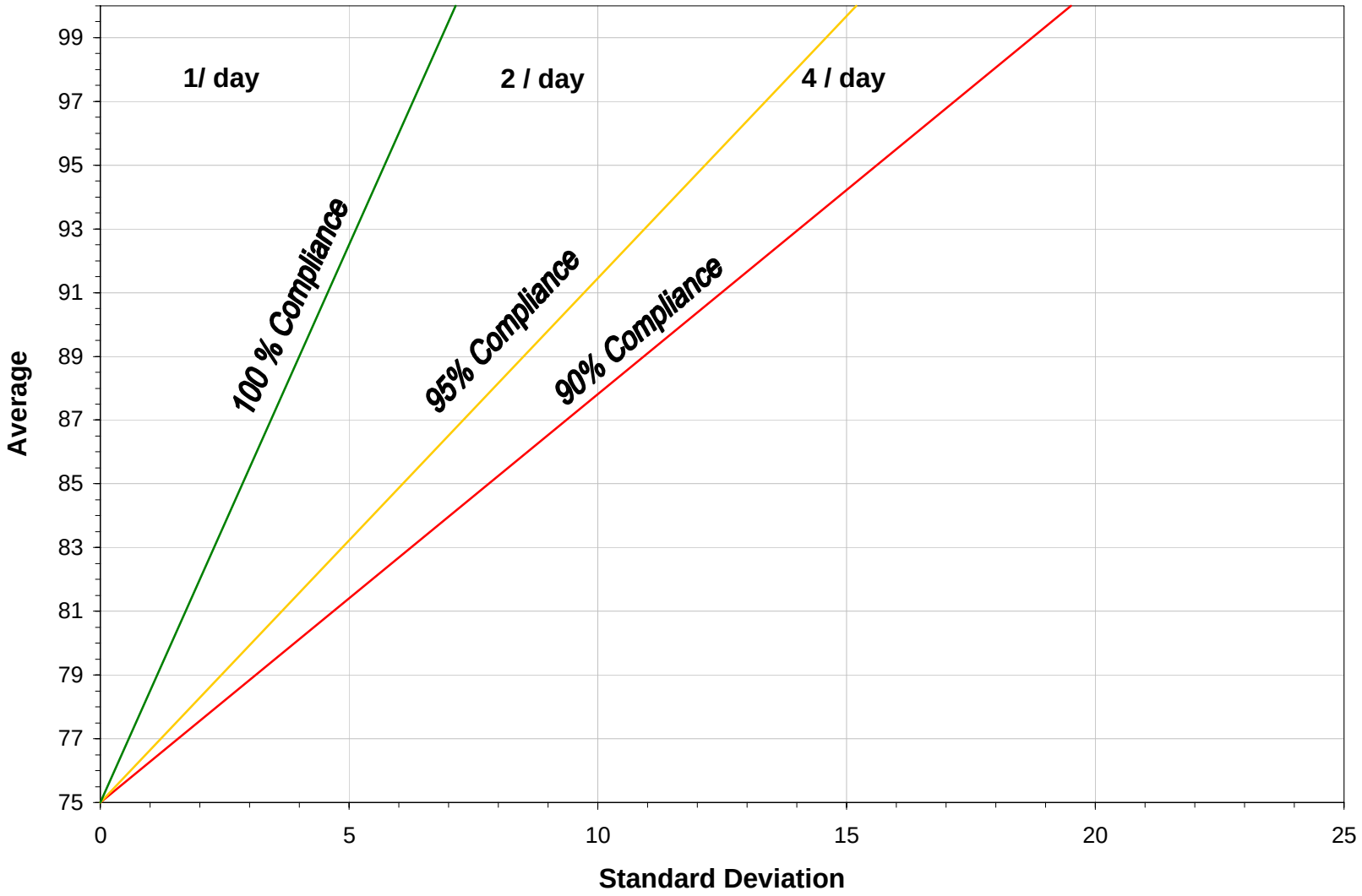
Appendix 2
10% Difference in Sieve Limits
Minimum Sampling & Testing Frequency



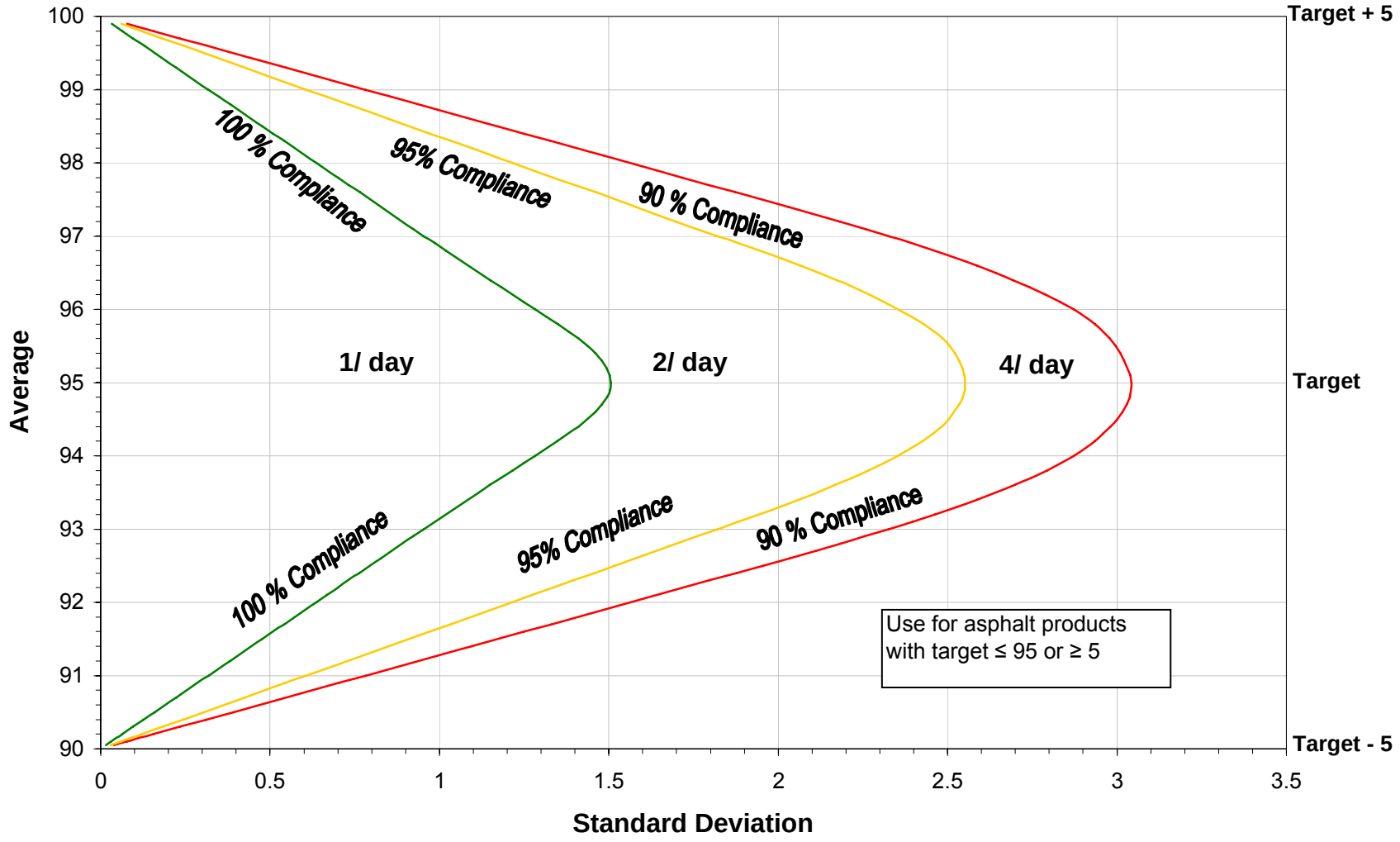
Appendix 3
15% Difference in Sieve Limits
Minimum Sampling & Testing Frequency



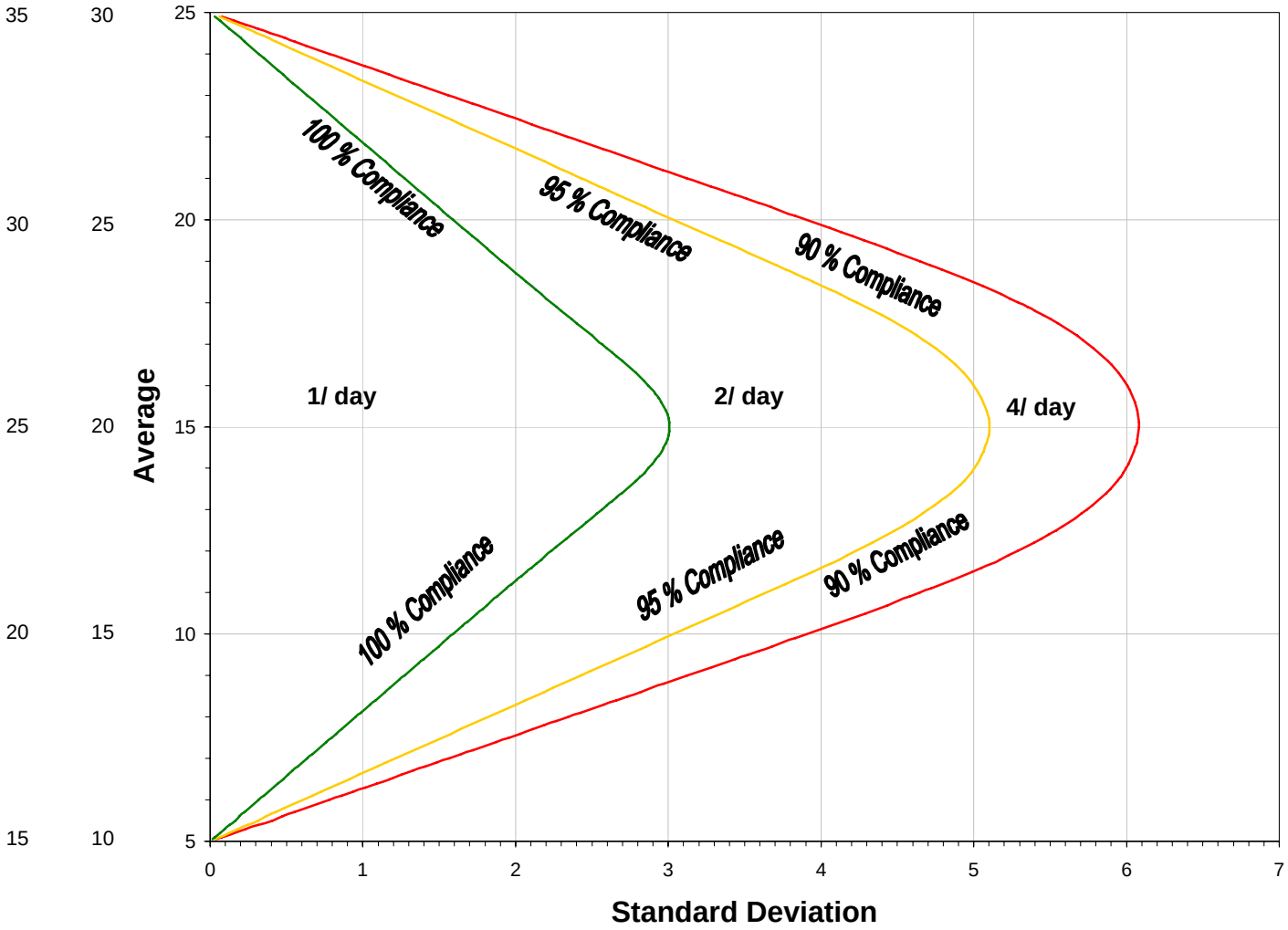
Appendix 3A
25% Difference in Sieve Limits
Minimum Sampling & Testing Frequency



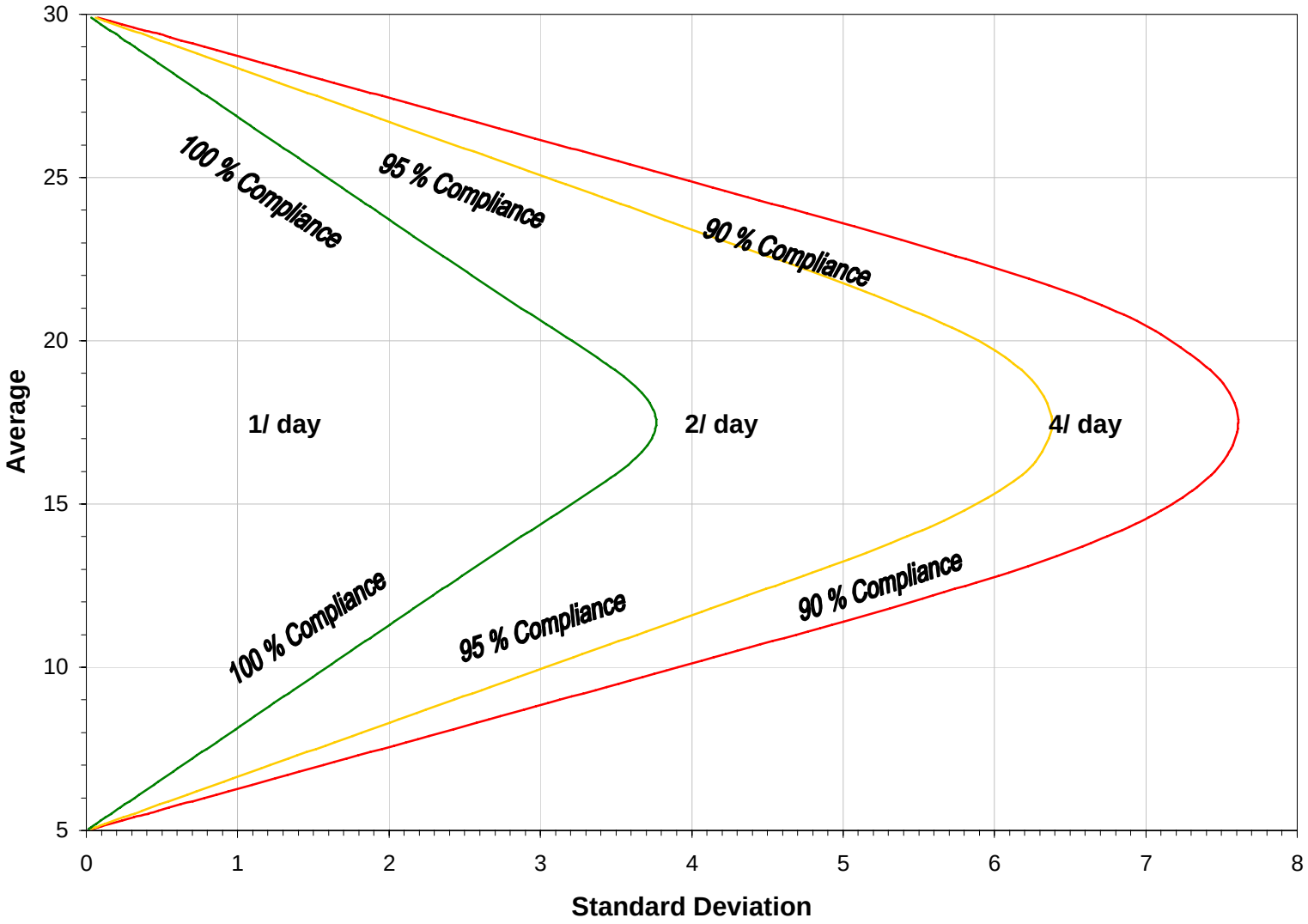
Appendix 4
10% Differrence in Sieve Limits (Curves)
Minimum Sampling & Testing Frequency



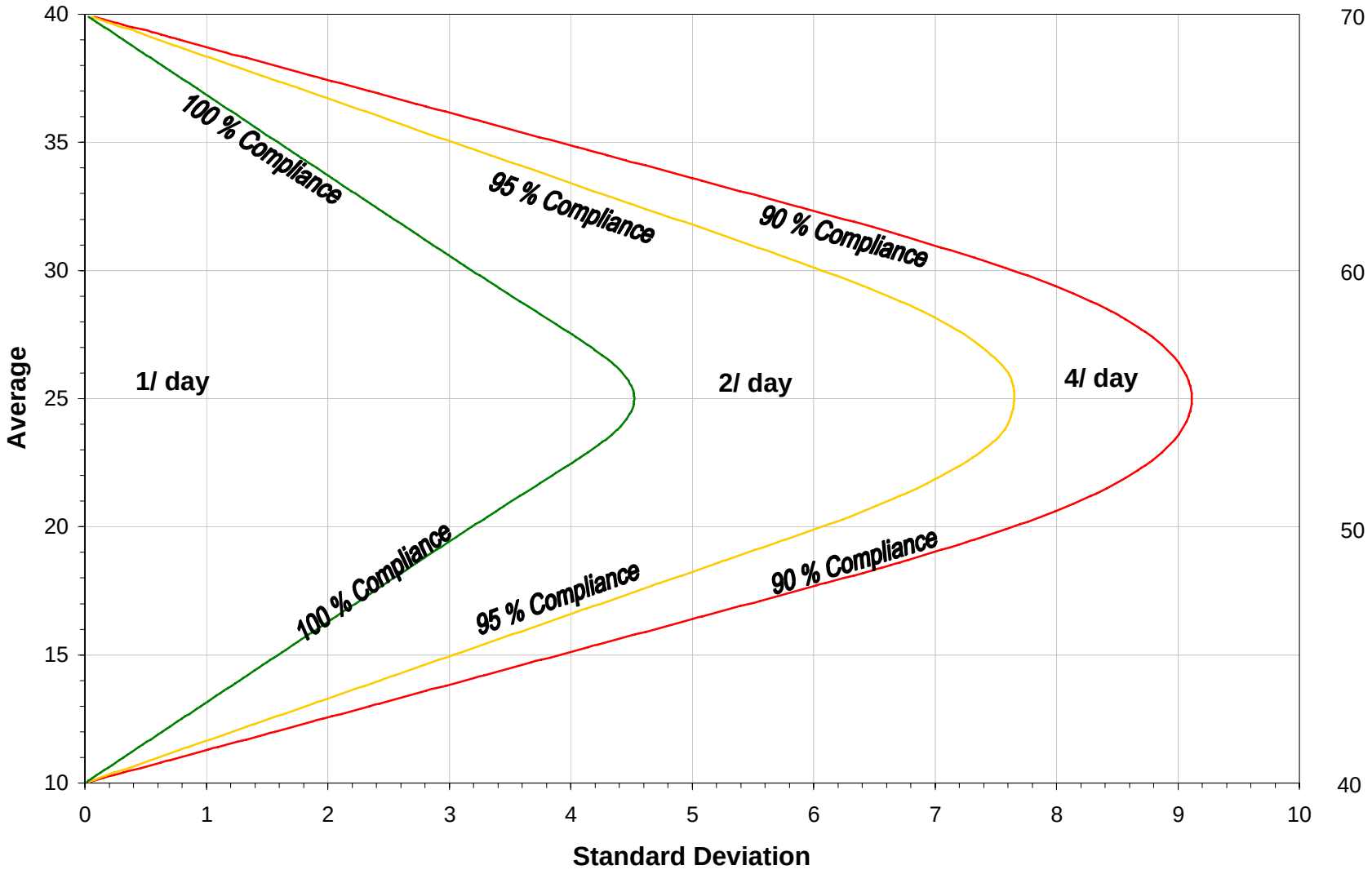
Appendix 4A
20% Difference in Sieve Limits
Minimum Sampling & Testing Frequency



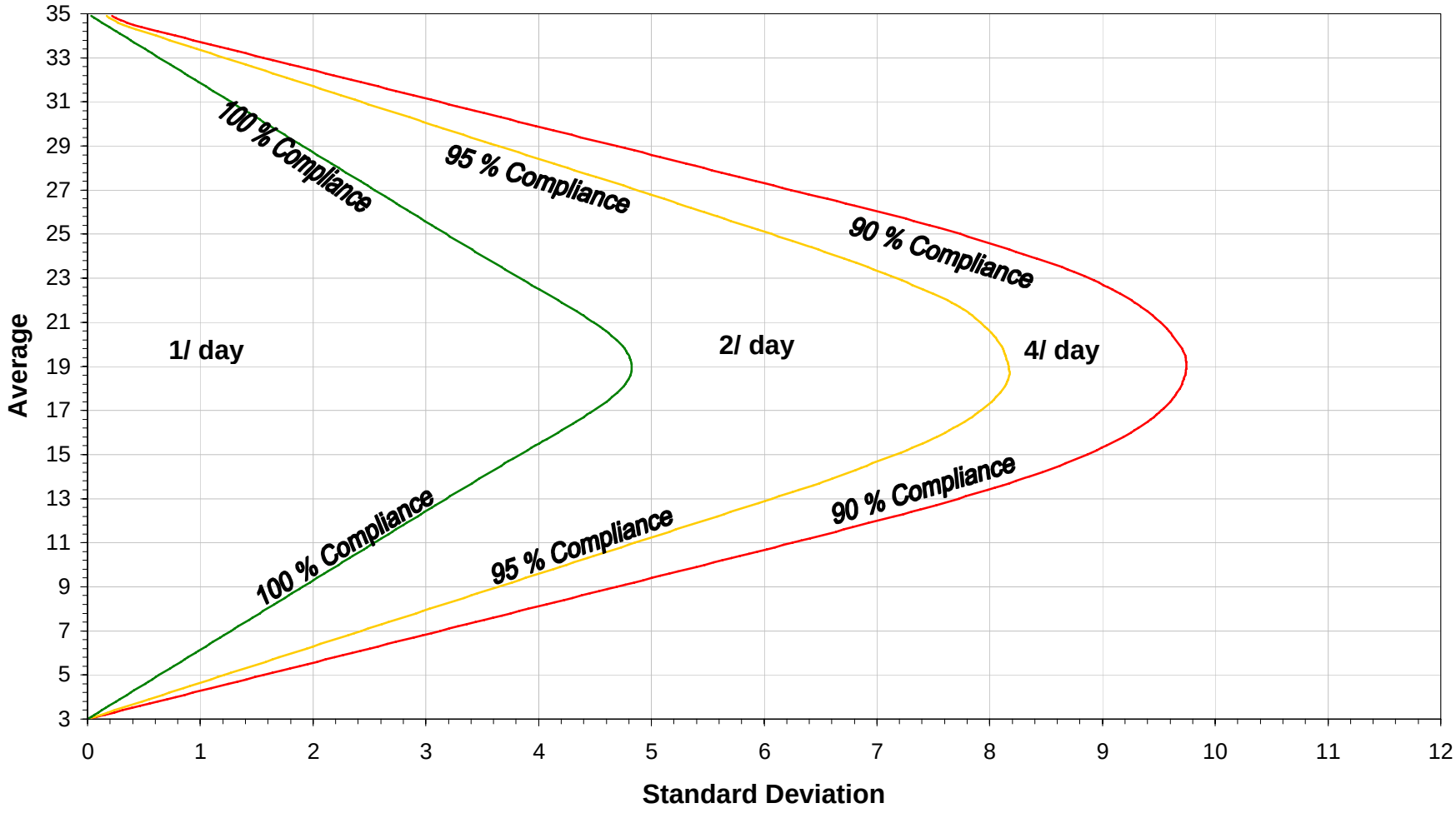
Appendix 5
25% Difference in Sieve Limits
Minimum Sampling & Testing Frequency



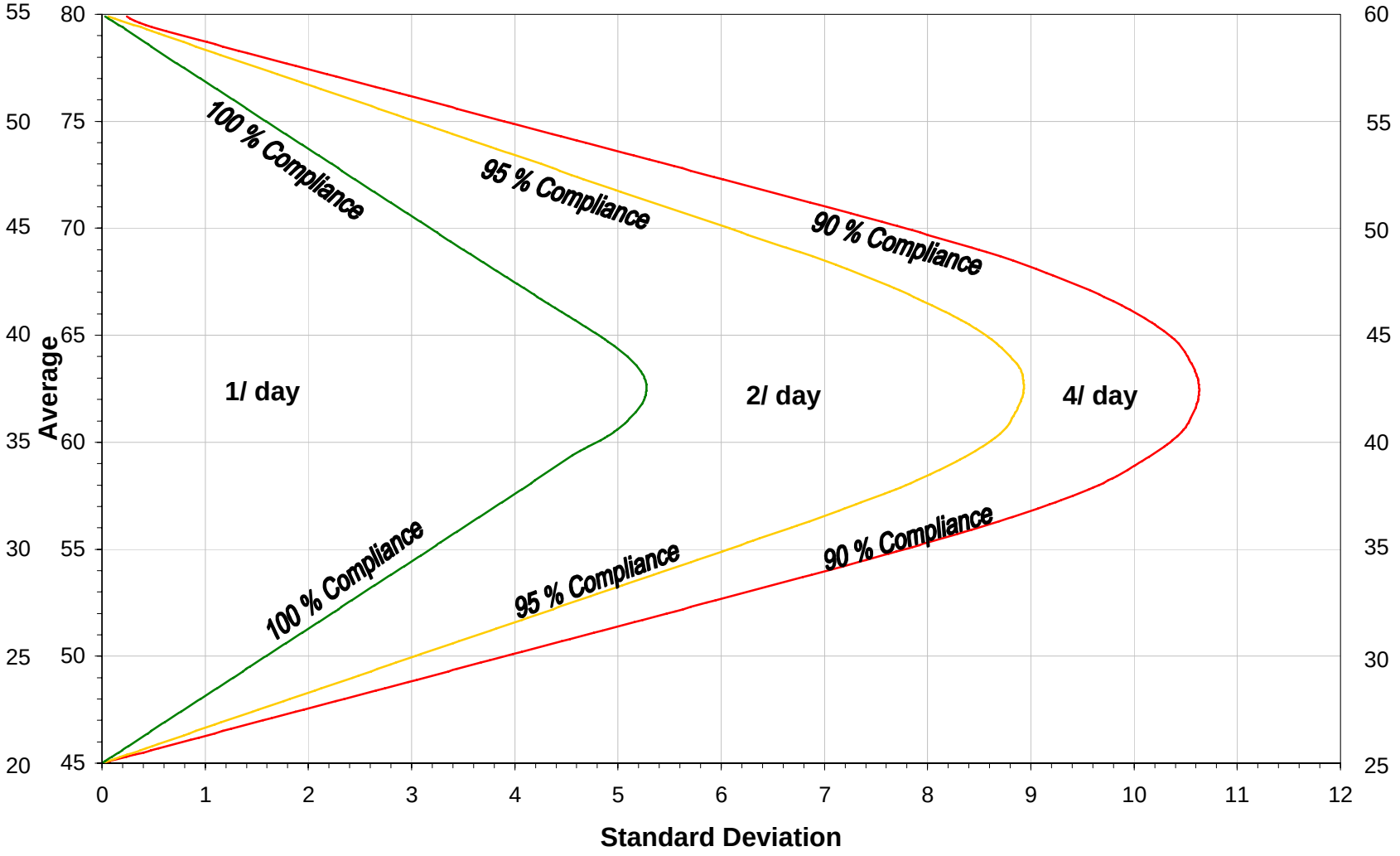
Appendix 6
30% Difference in Sieve Limits
Minimum Sampling & Testing Frequency



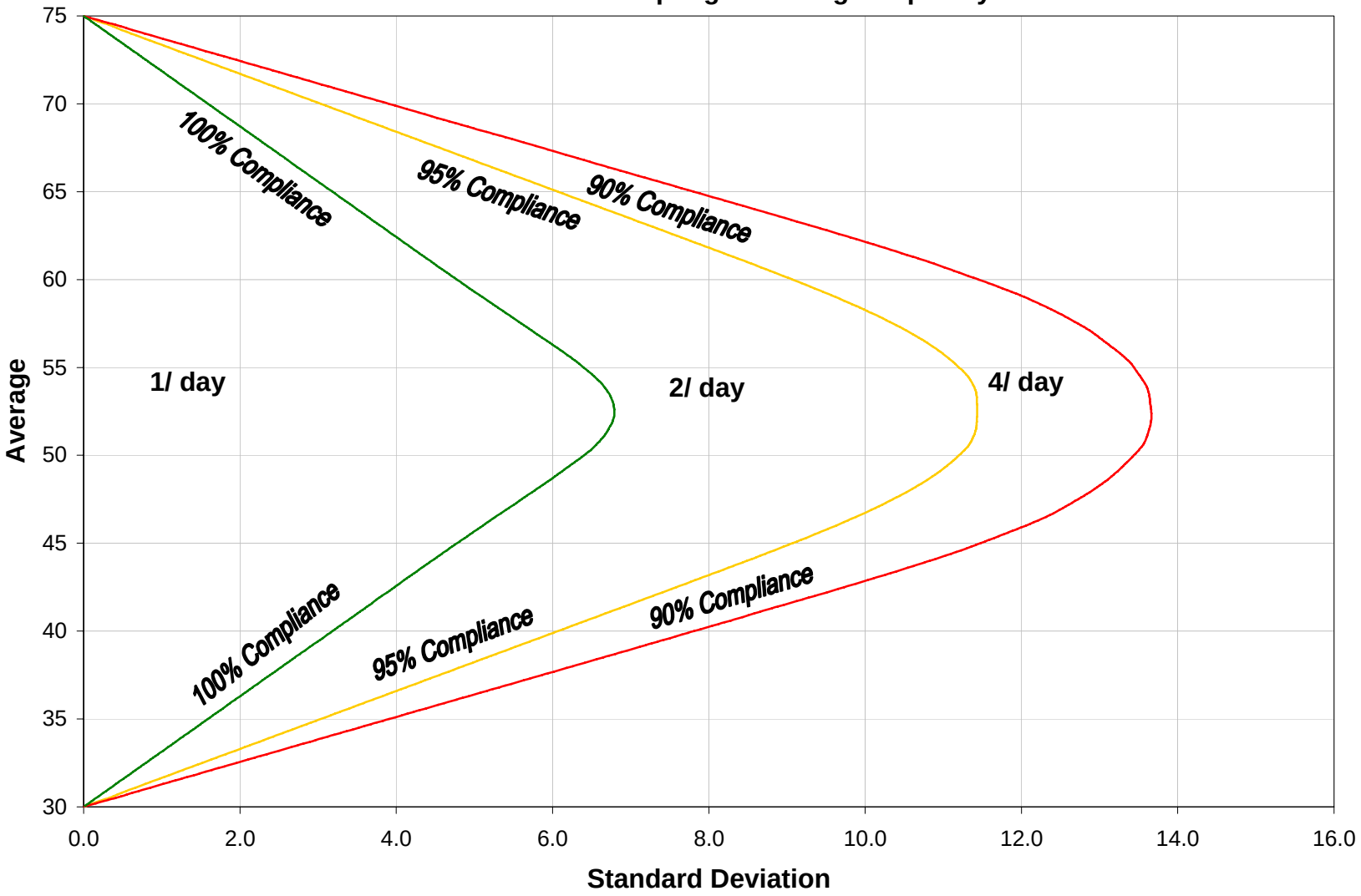
Appendix 6A
32% Difference in Sieve Limits
Minimum Sampling & Testing Frequency



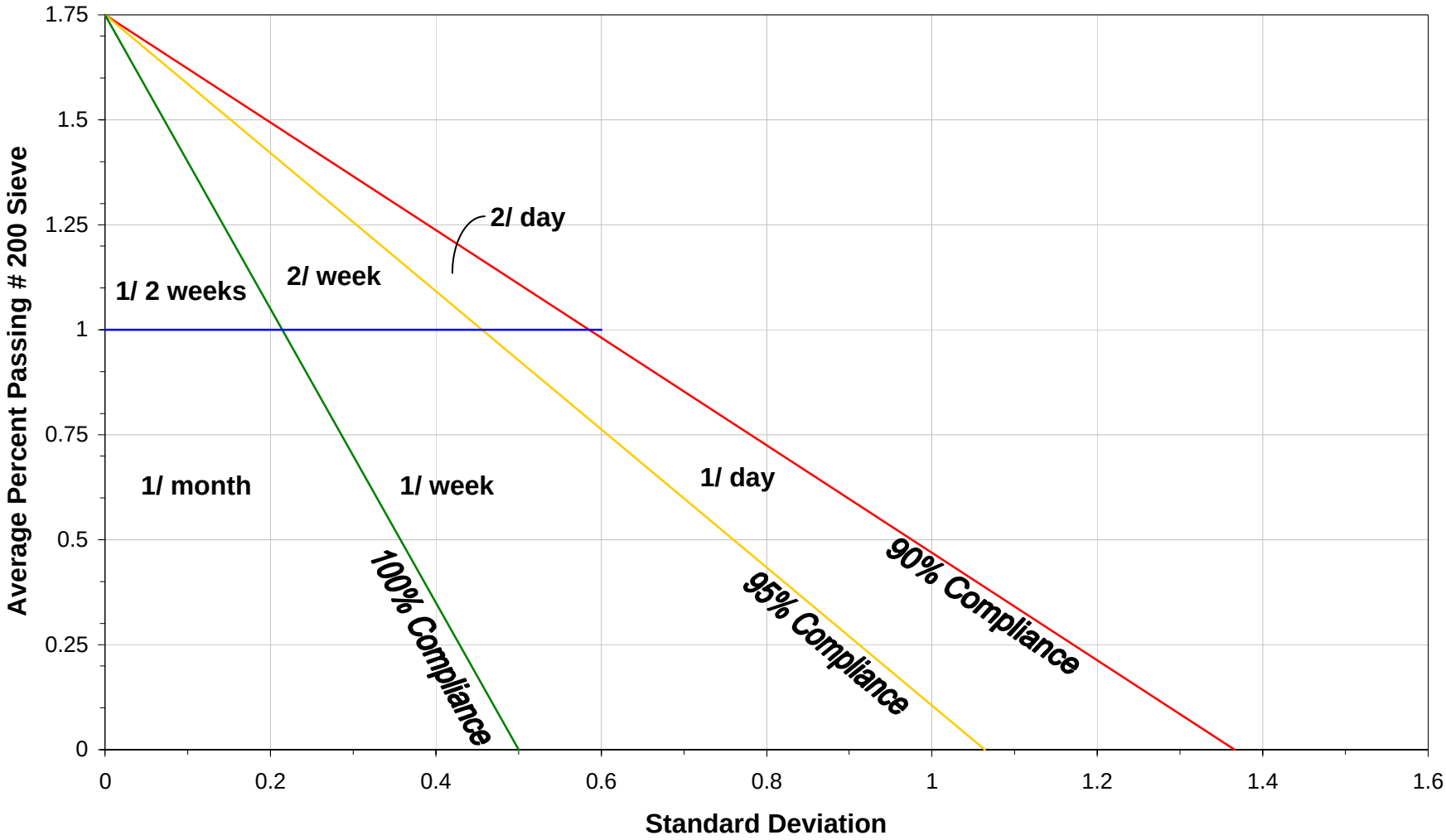
Appendix 7
35% Difference in Sieve Limits
Minimum Sampling & Testing Frequency



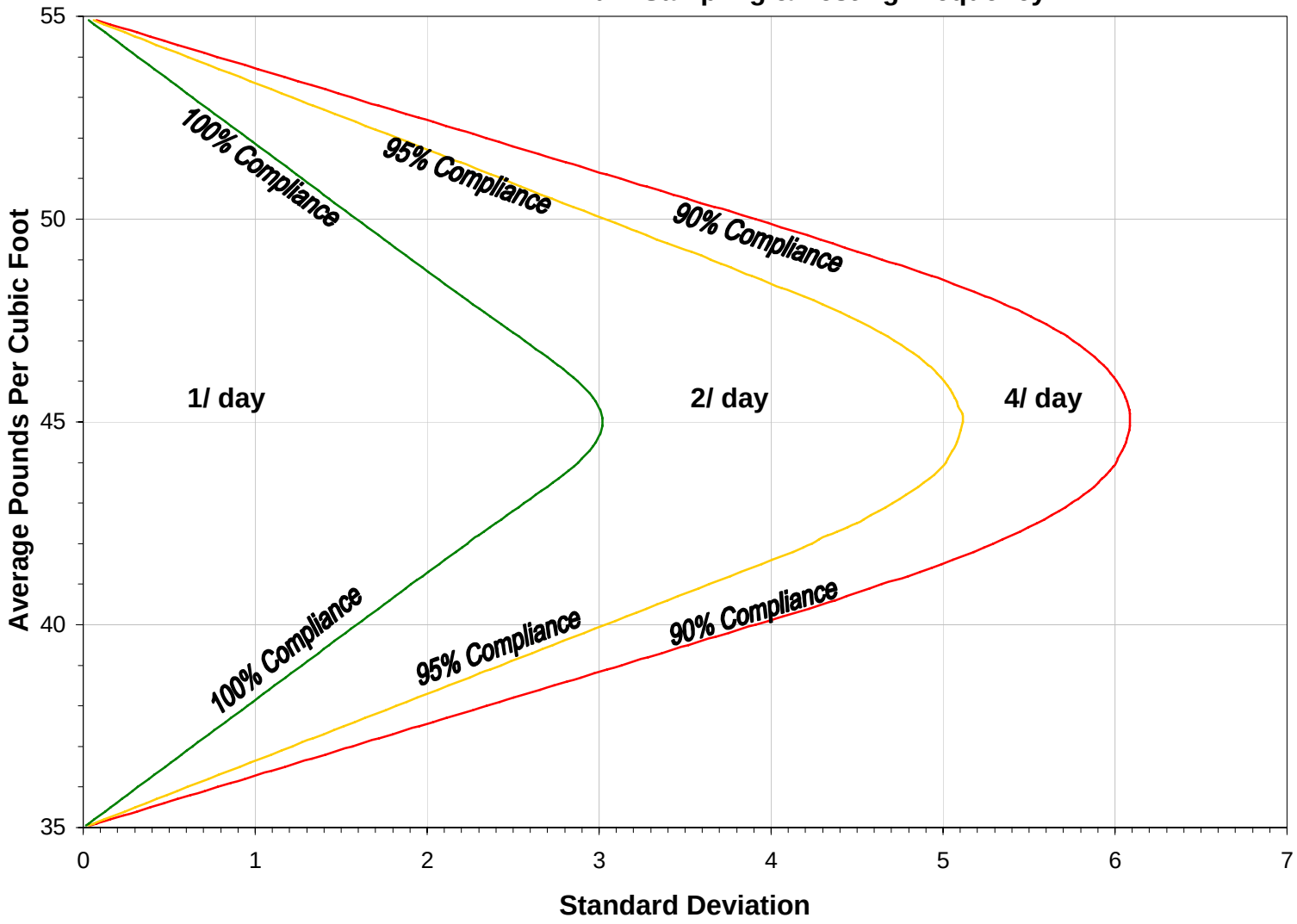
Appendix 8
45% Difference in Sieve Limits
Minimum Sampling & Testing Frequency



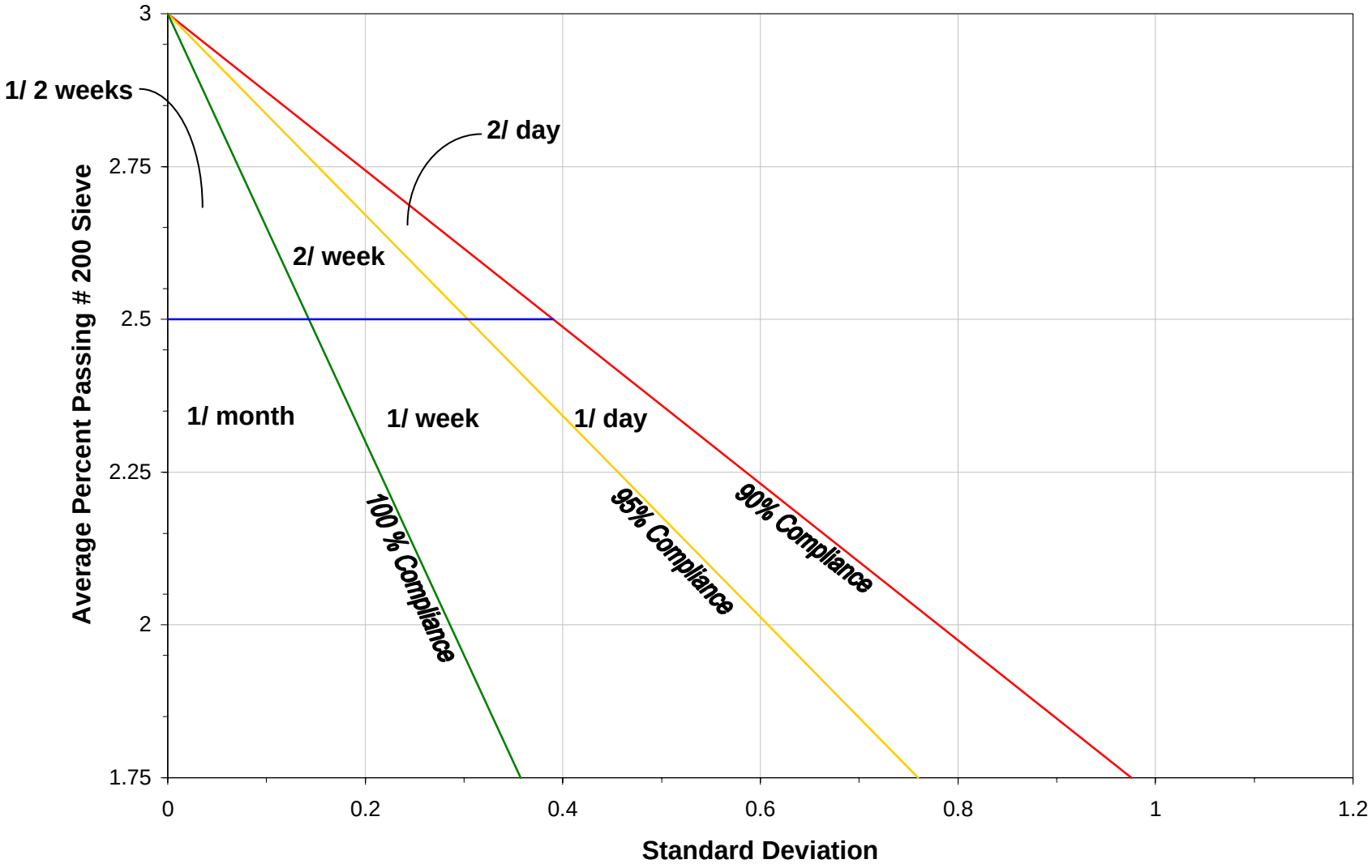
Appendix 9
Coarse Aggregate Minus #200 Sieve
Minimum Sampling & Testing Frequency



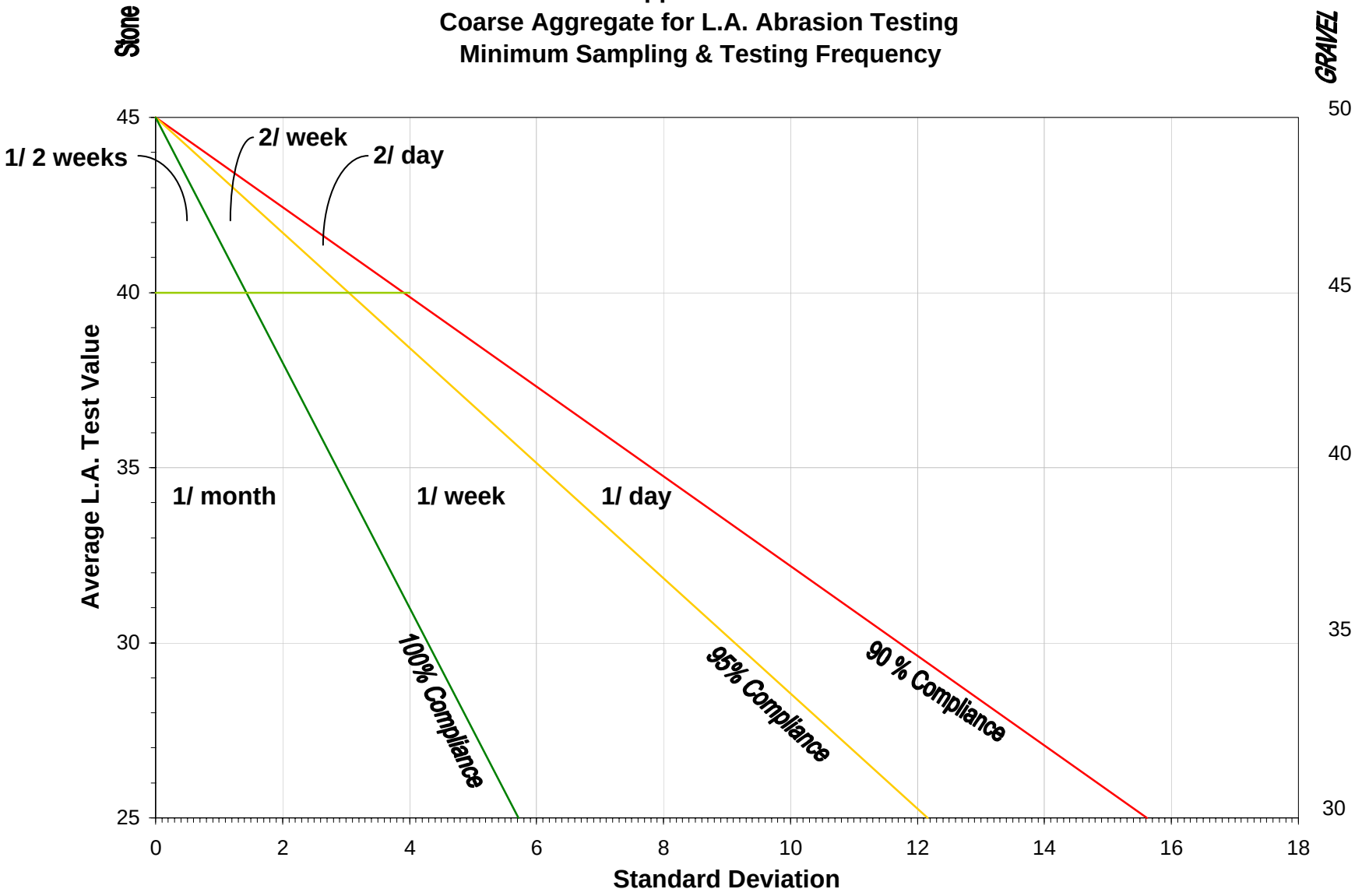
Appendix 10
Lightweight Coarse Aggregate Dry Loose Weight
Minimum Sampling & Testing Frequency



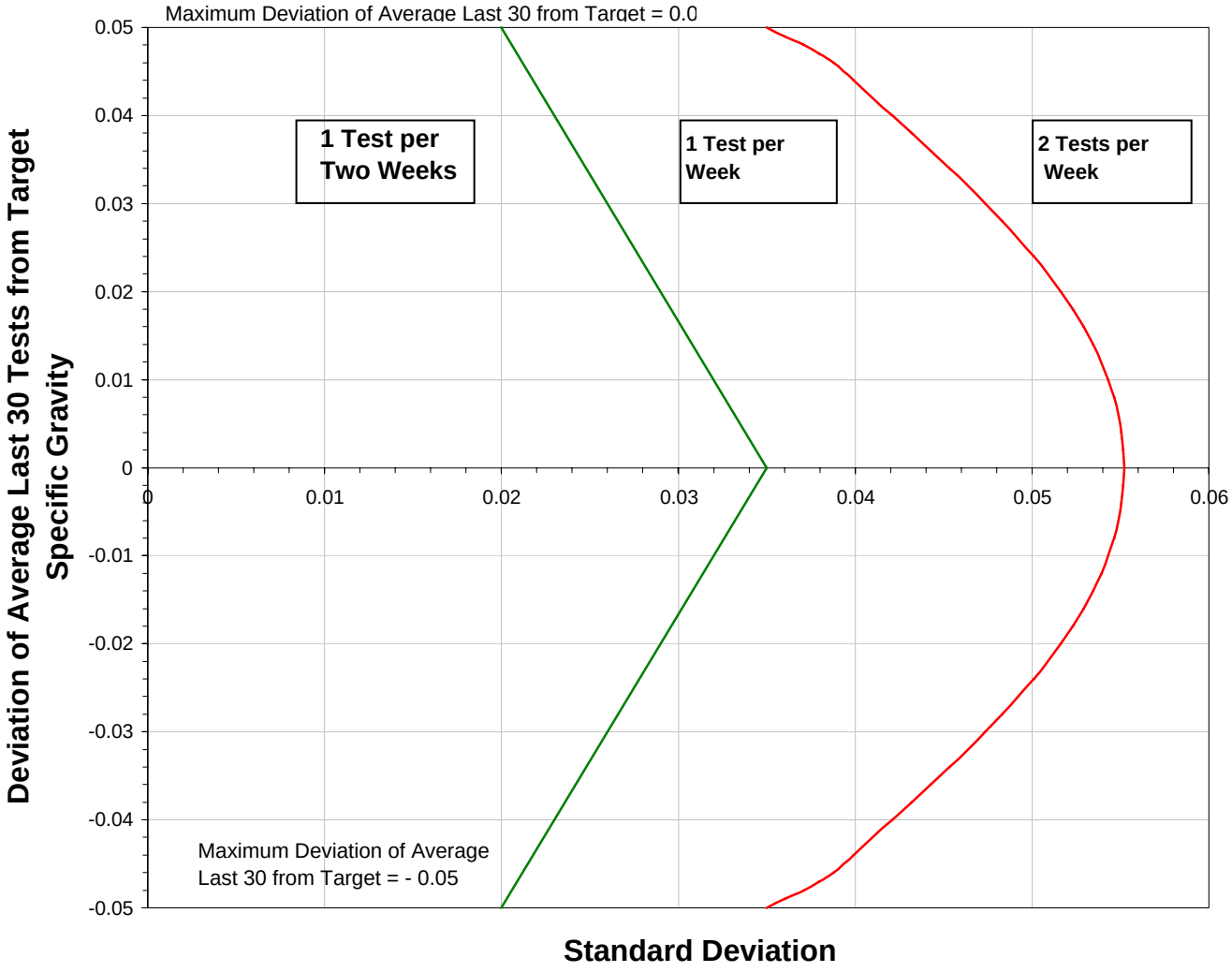
Appendix 11
Lightweight Coarse Aggregate Minus #200 Sieve
Minimum Sampling & Testing Frequency



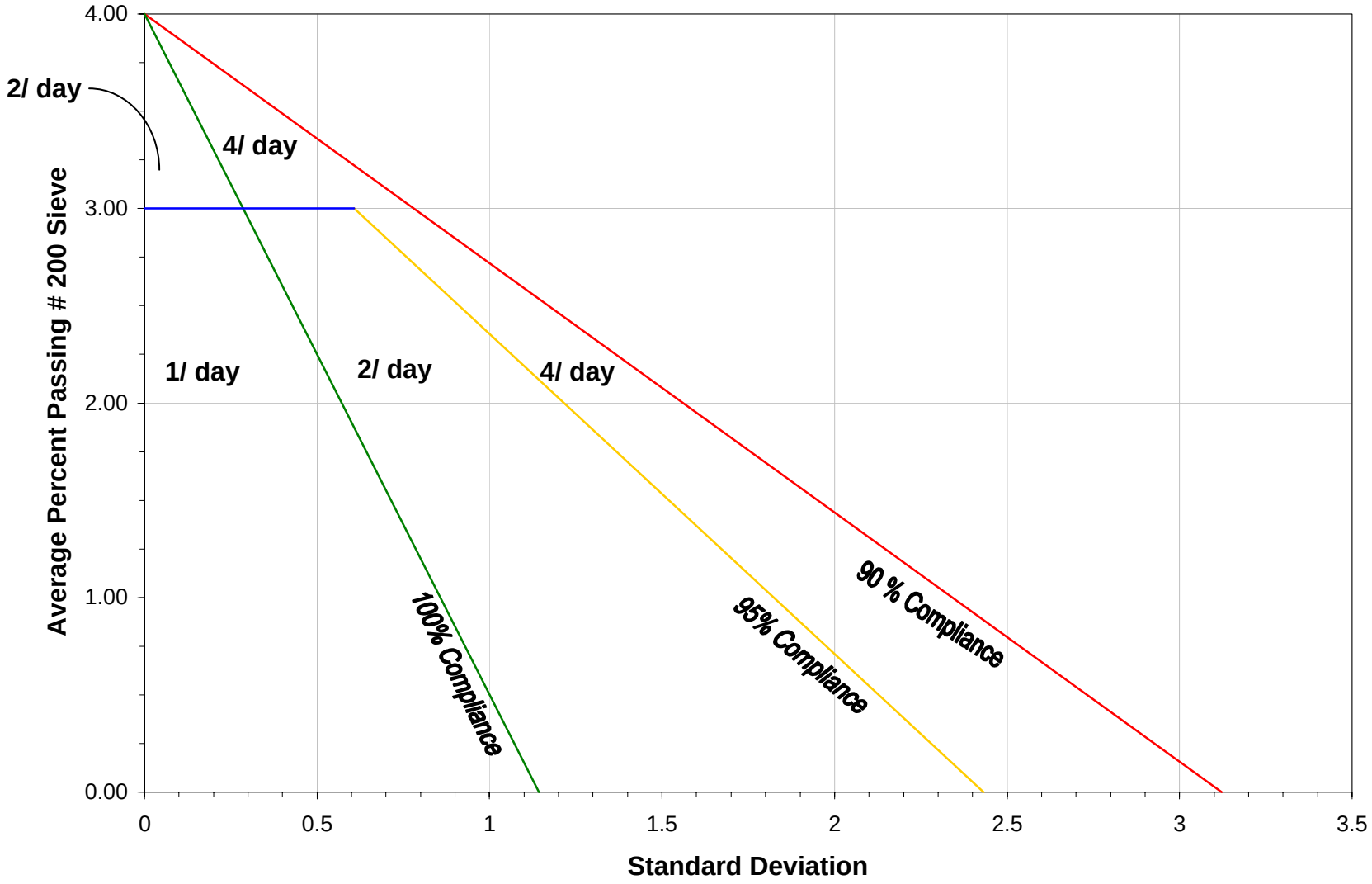
Appendix 12
Coarse Aggregate for L.A. Abrasion Testing
Minimum Sampling & Testing Frequency



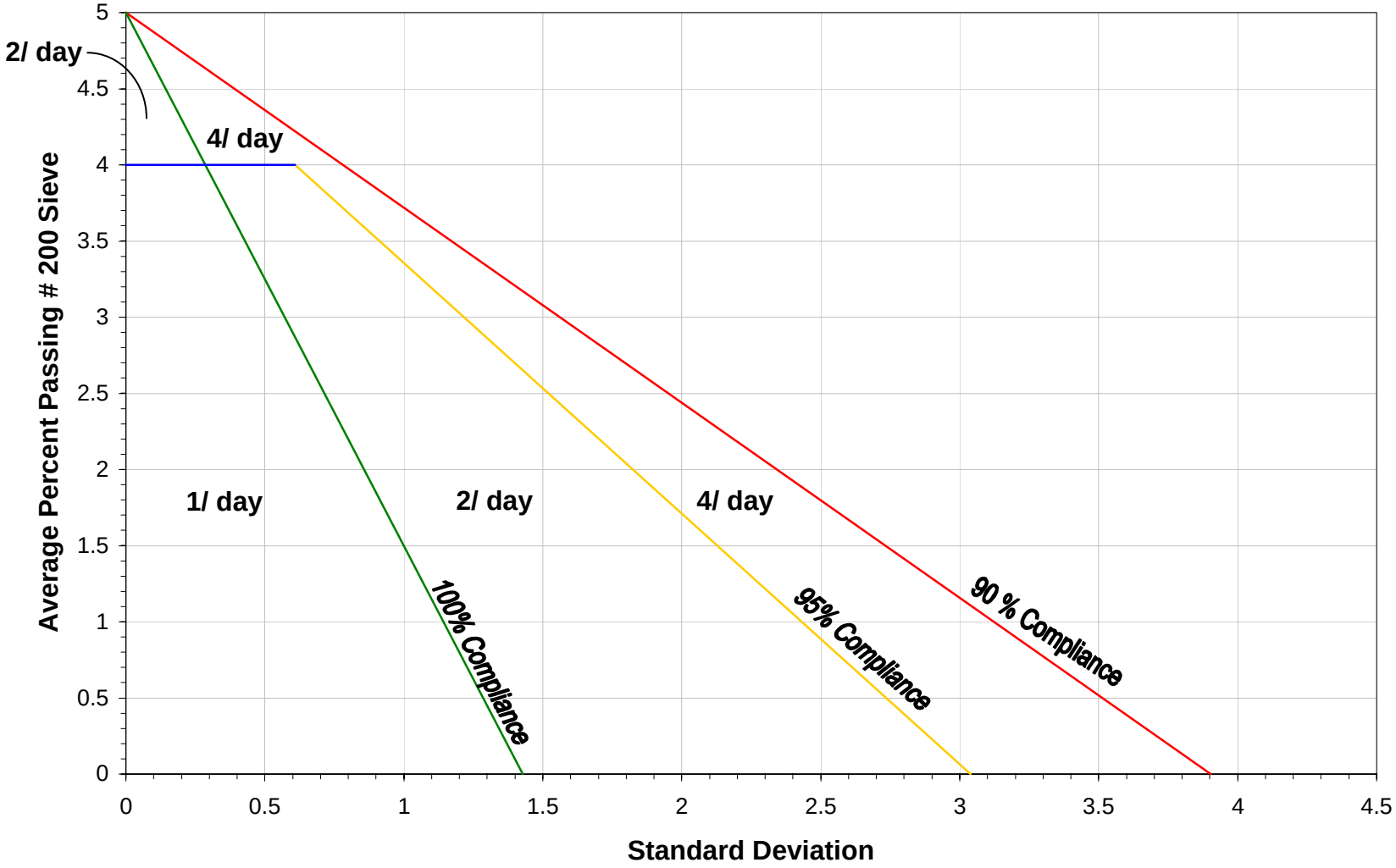
Appendix 12A
Bulk Specific Gravity
Minimum Sampling & Testing Frequency



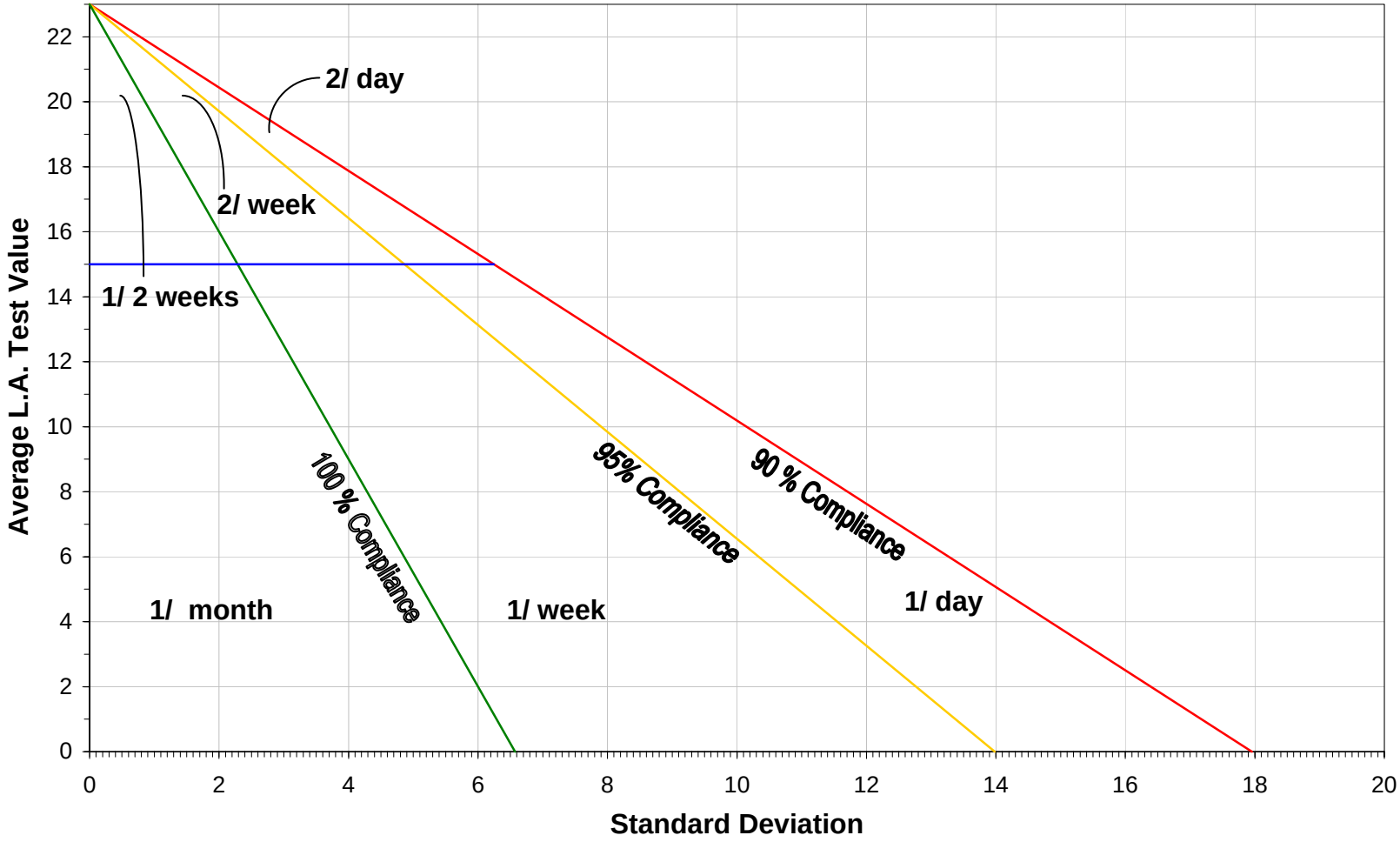
Appendix 13
Minus #200 Sieve for Silica Sand in Concrete
Minimum Sampling & Testing Frequency



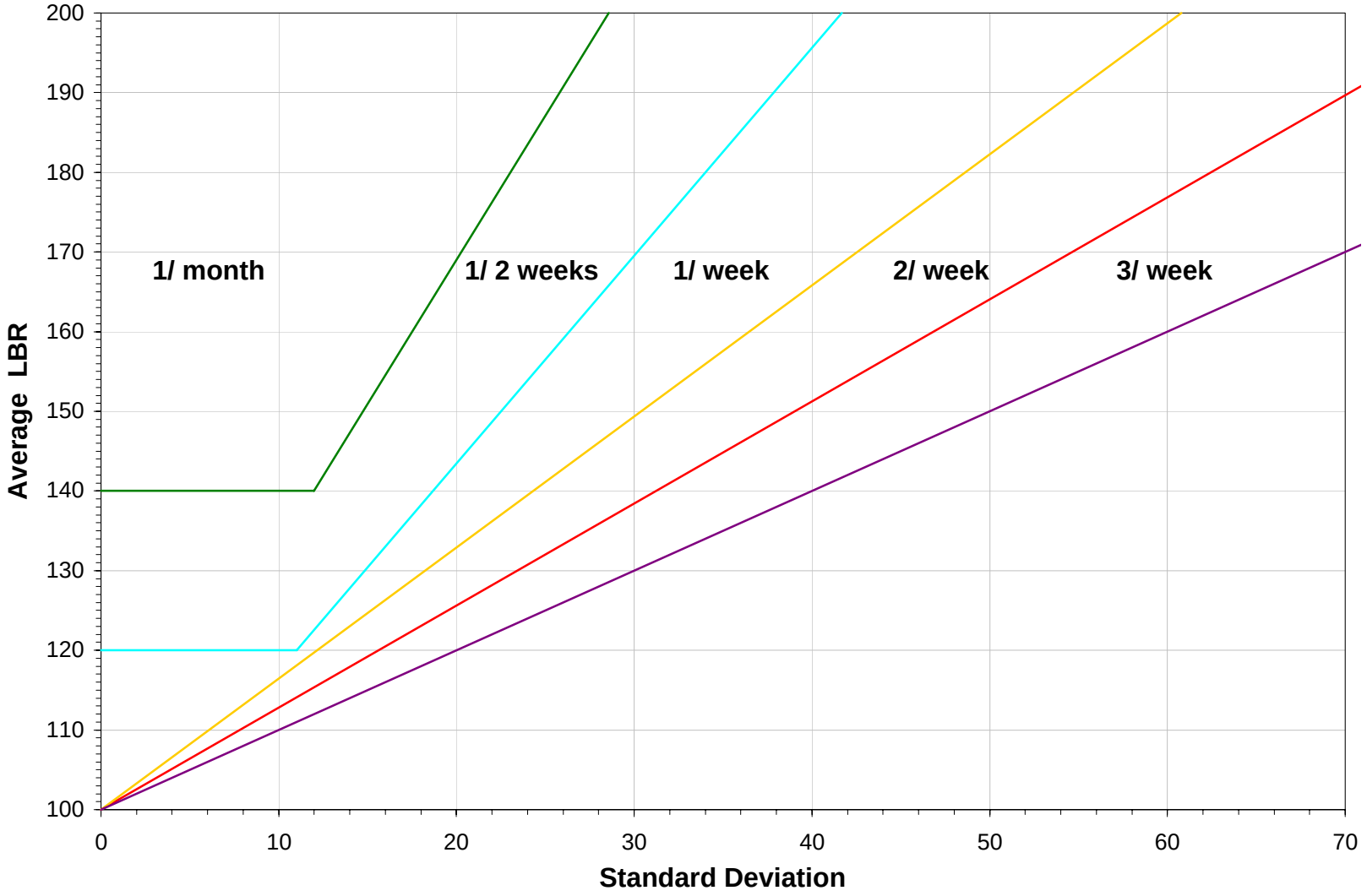
Appendix 14
Minus #200 Sieve for Silica Sand In Sand-Cement
Minimum Sampling & Testing Frequency



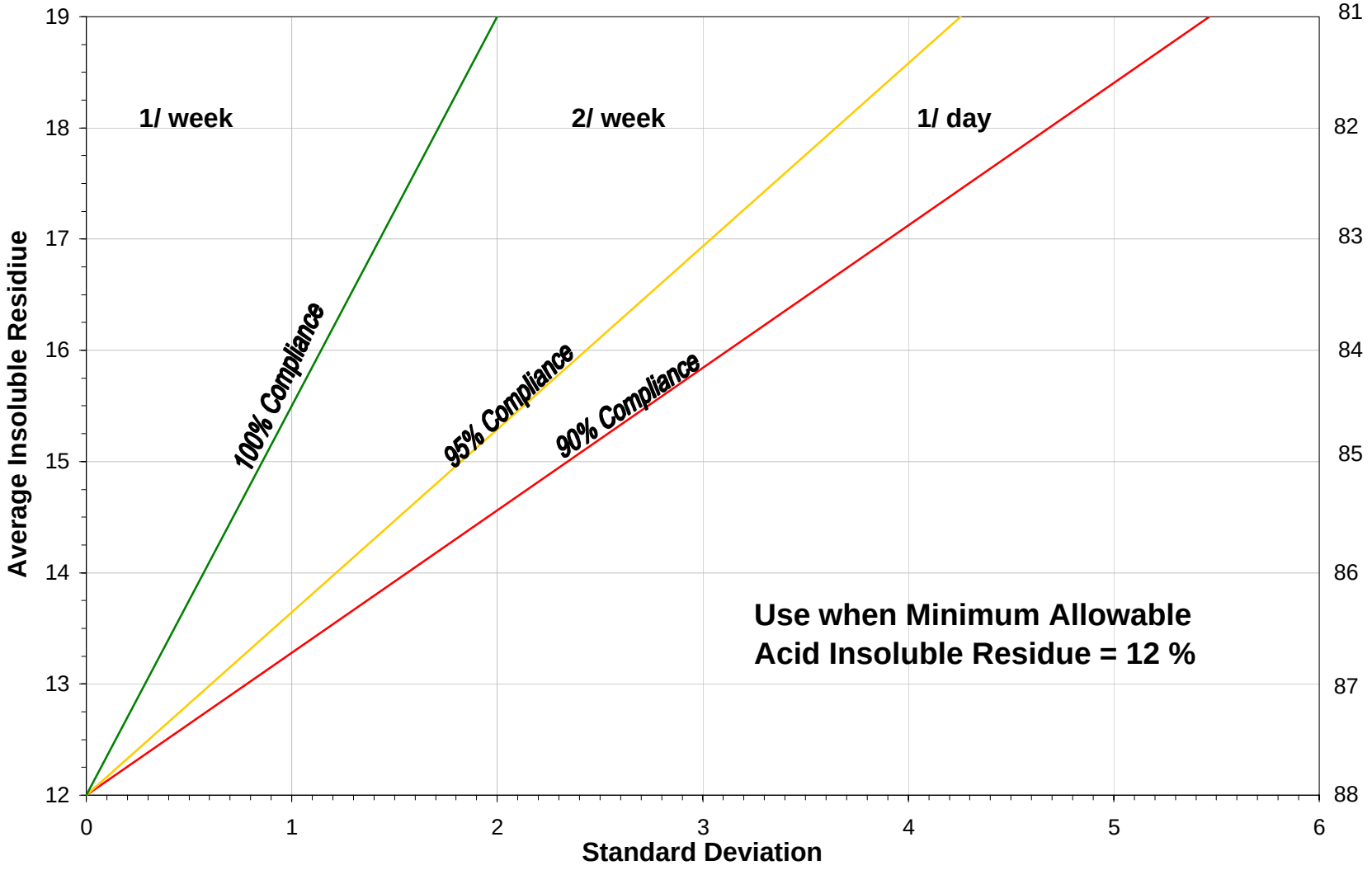
Appendix 15
Modified L.A. Abrasion for Fine Aggregate
Minimum Sampling & Testing Frequency



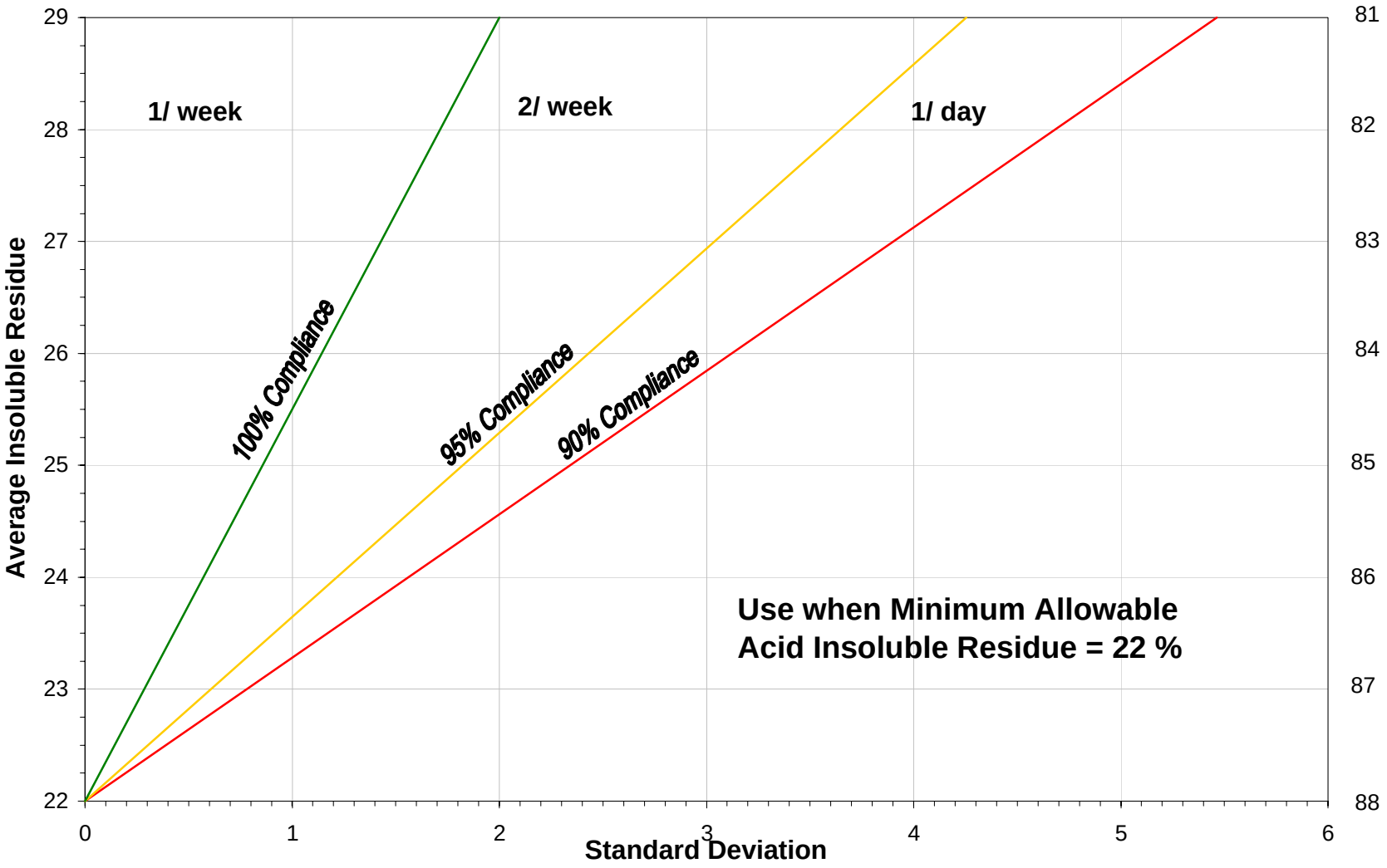
Appendix 16
Limerock Bearing Ratio for Base Material
Minimum Sampling & Testing Frequency



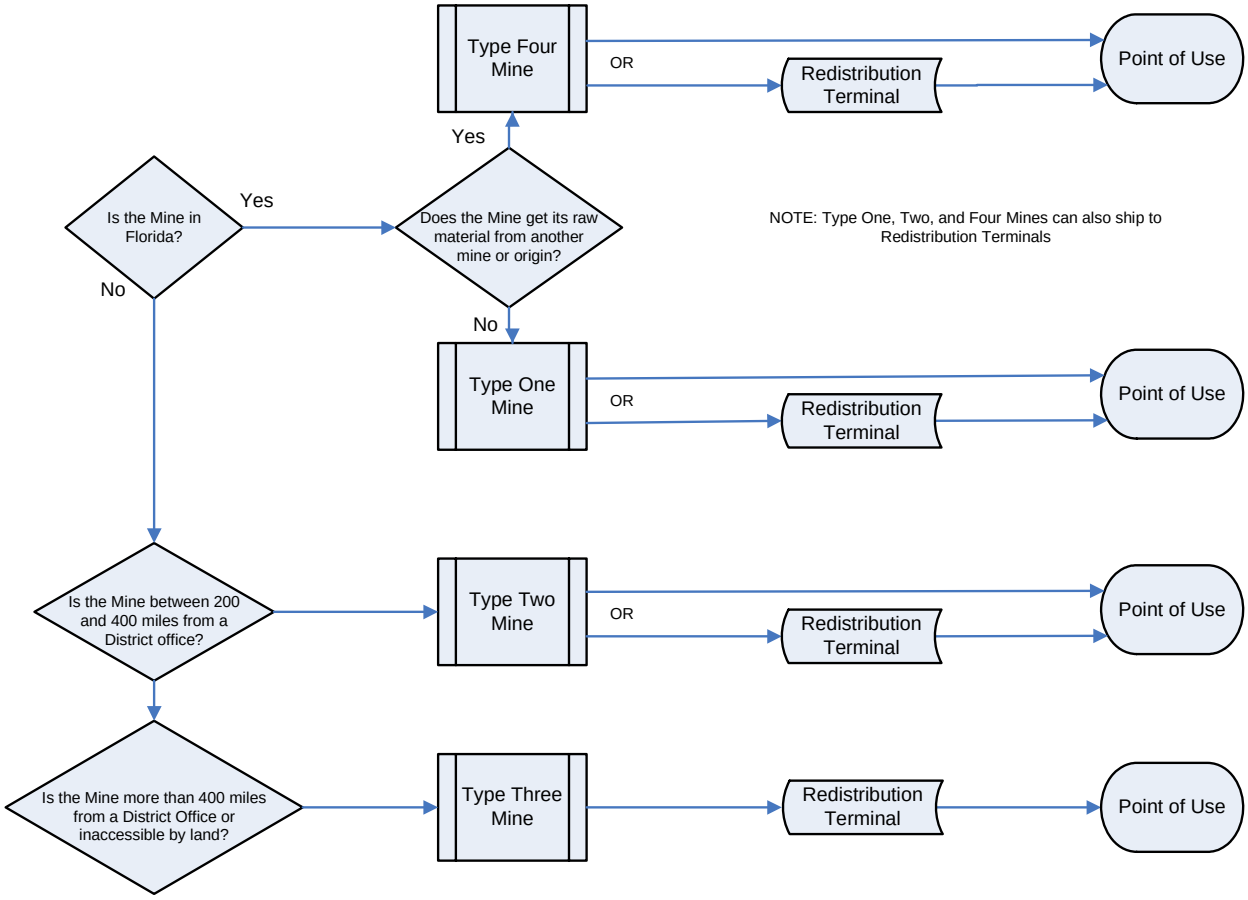
Appendix 17
Acid Insoluble Residue Content for Friction Course Aggregate
Minimum Sampling & Testing Frequency



Appendix 18
Acid Insoluble Residue Content for Friction Course Aggregates
Minimum Sampling & Testing Frequency



Appendix 19 General Aggregate Flow Chart



Appendix 20. Sampling and Testing Methods for Aggregate Sources

TEST METHOD	TITLE
AASHTO T 19/T 19M-00	Standard Method of Test for Bulk Density (“Unit Weight”) and Voids in Aggregate
AASHTO T 21-00	Standard Method of Test for Organic Impurities in Fine Aggregates for Concrete
AASHTO T 27-99	Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates
AASHTO T 87-86 (2000)	Standard Method of Test for Dry Preparation of Disturbed Soil and Aggregate Samples for Test
AASHTO T 89-02	Standard Method of Test for Determining the Liquid Limit of Soils
AASHTO T 90-00	Standard Method of Test for Determining the Plastic Limit and Plasticity Index of Soils
AASHTO T 104-99 (2003)	Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
AASHTO T 112-00	Standard Method of Test for Clay Lumps and Friable Particles in Aggregate
AASHTO T 113-02	Standard Method of Test for Lightweight Pieces in Aggregate
AASHTO T 255-00	Standard Method of Test for Total Moisture Content of Aggregate by Drying
ASTM D 4643-00	Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Heating
ASTM D 4791-99	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D 5821-01	Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM E 274-97	Standard Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire
FM 1-T 002	Florida Method of Test for Sampling Aggregates
FM 1-T 011	Florida Method of Test for Materials Finer Than 75-µm (No. 200)Sieve in Aggregates by Washing
FM 1-T 084	Florida Method of Test for Specific Gravity and Absorption of Fine Aggregate
FM 1-T 085	Florida Method of Test for Specific Gravity and Absorption of Coarse Aggregate
FM 1-T 096	Florida Method of Test for Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine
FM 1-T 248	Florida Method of Test for Reducing Samples of Aggregate to Testing Size
FM 3-C 535	Florida Method of Test for Resistance to Degradation of Large-Size Coarse Aggregates by Abrasion and Impact in the Los Angles Machine
FM 5-510	Florida Method of Test for Determination of Acid Insoluble Material Retained on the 0.075 mm (No. 200) Mesh Sieve
FM 5-514	Florida Method of Test for Carbonates and Organic Matter in Base Materials
FM 5-515	Florida Method of Test for Limerock Bearing Ratio
FM 5-555	Florida Method of Test for Shell Content of Coarse Aggregate
FM 5-538	Florida Method of Test for Sampling and Testing Rip-Rap Material