



Specifications Comparison NDOT vs. Washoe RTC

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Nevada Department of Transportation

FEBRUARY 15 & 16, 2023

NDOT:

- 3 Districts/6 Operational Areas
- 1750 staff (20% vacancies)
- 13,774 lane miles/5378 centerline miles
- Annual Budget - \$600 Million (+/-)
- 65% goes to projects
- Transportation Board (chaired by Governor)
- FHWA and Federal Funding



NDOT Advertised Pavement Repair Work for Fiscal Year 2022

Fiscal Year	Contract Maintenance Repair Work Expenditure and Mileage	Contract Preservation Repair Work and Expenditure and Mileage	Contract Maintenance and Preservation Repair Work Expenditure and Mileage
2022	\$25,295,520	\$121,555,624	\$146,851,144
	290 Centerline Miles	140 Centerline Miles	430 Centerline Miles



Standard Specifications
for
Road and Bridge
Construction



NEVADA DEPARTMENT OF TRANSPORTATION

2014

NDOT “Silver Book” (2014)

- DIVISION 1
 - GENERAL REQUIREMENTS
- DIVISION 2
 - CONSTRUCTION DETAILS
- DIVISION 3
 - MATERIALS DETAILS



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Special Provisions (NDOT)

NEVADA DEPARTMENT OF TRANSPORTATION



SPECIAL PROVISIONS

For Constructing a Portion of the State Highway System

On US 50, Lyon County, from Roy's Road to the Junction with US 95A.

County: Lyon

Route Section: 050-2

Milepost: LY 19.90 to 29.44

Project: NHP-050-2(016)

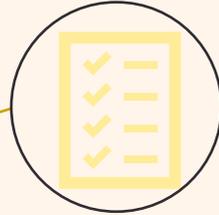
Contract: 3745

General description of work covered by this contract

Widen roadway to a 4-lane divided highway with lighting and drainage improvements and construct a new roundabout.

These Special Provisions shall be used with, and as a component part of the Standard Specifications for Road and Bridge Construction, 2014 Edition

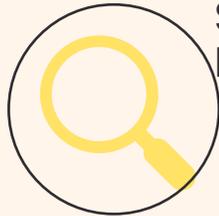
Rudy Malfabon, P.E.
NDOT Director



CHANGES TO
THE STANDARD
SPECIFICATIONS



PULLSHEETS
ADDITIONAL
INFORMATION



NON-
STANDARD/NEW
BID ITEMS



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**STANDARD
SPECIFICATIONS
FOR
PUBLIC WORKS
CONSTRUCTION**

Sponsored and Distributed by:

**Regional Transportation Commission
of Washoe County
Carson City
Churchill County
City of Reno
City of Sparks
City of Yerington
Washoe County**

RTC Orange Book (2012)

- PART 1
 - GENERAL PROVISIONS
- PART 2
 - CONSTRUCTION MATERIALS
- PART 3
 - CONSTRUCTION METHODS



Uniform Standard Specifications

for

Public Works

Construction of

Off-Site Improvements

Clark County Area

Nevada

RTC Blue USSCC Book (2023)

- PART 1
 - STANDARD SPECIFICATIONS
- PART 2
 - CONSTRUCTION STANDARD DRAWINGS



100.01 ABBREVIATIONS AND TERMS. Conflicting Provisions Order of Precedence (RTC 2016)

B Plans and Specifications

- Addendum
- Plans
- Technical Report (s) (including Special Provisions/Technical Specifications?)
- Standard Specifications and Details (Washoe County Standard Details for Public Works Construction)



105.04 Coordination of Plans, Specifications, Supplemental Specifications, and Special Provisions. (NDOT 2014)

- Plans will govern over specifications
- Special Provisions will govern over both specifications and plans
- Hierarchy on Standard Plans vs. Standard Specifications?



105.04 Coordination of Plans, Specifications, Supplemental Specifications, and Special Provisions. (2022)

Dimensions	Information
1. Plan	1. Special Provisions
2. Calculated	2. Plans
3. Scaled	3. Standard Specifications
	4. Standard Plans
	5. Information received at mandatory prebid meetings



Plantmix Bituminous Surface Aggregates, NDOT vs. RTC

Sieve Size	Percentage by Weight Passing Sieve		
	Type 2	Type 2C ⁽¹⁾	Type 3
1 inch	100	100	
3/4 inch	90 - 100	88 - 95	
1/2 inch		70 - 85	100
3/8 inch	63 - 85	60 - 78	85 - 100
No. 4	45 - 65	43 - 60	50 - 75
No. 10	30 - 44	30 - 44	32 - 52
No. 16			
No. 40	12 - 22	12 - 22	12 - 26
No. 200	3 - 8	3 - 8	3 - 8

1. Unless directed by Agency or Engineer, Type 2C shall not be used as the final (top) lift of the structural section.

TABLE 1 – PLANTMIX AND ROADMIX AGGREGATE GRADATION

Sieve Sizes	Percent By Weight Passing Sieve		
	Type 2 Coarse Arterials	Type 2 Fine Residential/Collector	Type 3
1-Inch	100	100	--
3/4-Inch	84-97	90-100	--
1/2-Inch	66-82	78-94	100
3/8-Inch	56-72	68-84	90-100
No. 4	35-50	50-65	55-85
No. 8	23-38	30-49	32-67
No. 50	5-19	7-25	7-27
No. 200	2-7	2-9	2-10

75 µm (No. 200) 3-8 3-8 3-8



Plantmix Bituminous Surface Aggregates

(NDOT: Individual Stockpile, RTC: Combined Grading)

PROJECT CONTROL TESTS	TEST METHOD (NDOT/RTC)	REQUIREMENTS (NDOT/RTC)
Sieve Analysis	Nev. T206 / ASTM C136,137	Above
Sampling Aggregate	Nev. T200 / ASTM D75	—
Fractured Faces (Type 3 Plantmix)	Nev. T230 / ASTM D5821	35% Min., 1 Fracture Min. / 35 Min.
Fractured Faces (Type 2 or 2C Plantmix)	Nev. T230 / ASTM D5821	80% Min., 2 Fractures Min. / 50 Min.
Plasticity Index	Nev. T212 / ASTM D4318	10 Max. / 4 to 6 Max.
Liquid Limit	Nev. T210 ASTM D4318	35 Max. /35 Max.
Absorption of Coarse Aggregate	Nev. T111 / ASTM C127	4% Max. / 4% Max.



Asphalt Cement (NDOT/RTC)

NDOT

- PG64-22
- PG64-28NV/NVTR
- (Ductility, T&T)
- PG70-34NV
(MSCR)

RTC Orange

- PG64-22
- PG64-28NV/NVTR
- (Ductility, T&T)
- PG58-34NV
(Ductility, ER)
- PG70-22TR
(Ductility, ER)

RTC Blue

- PG70-22CC
- PG76-22CC
- (Elastic Recovery)
- PG64-34CC for
elevations above
5000 ft. elevation
- (Elastic Recovery)



Asphalt Cement, PG 70-34NV (NDOT)

Tests on Residue from R.T.F.O., Nev. T728:	Test Method	Requirements
Mass Loss, %	Nev. T728	1.00 Max.
Creep Recovery, $R_{3.2}$, Test Temp 70 °C @ 3.2 kPa, % (a)	AASHTO T350	90.0 Min.
Non-Recoverable Creep Compliance, $J_{nr3.2}$, Test Temp 70 °C @ 3.2 kPa, kPa-1 (b)	AASHTO T350	0.1 Max.
Non-Recoverable Creep Compliance Difference, $J_{nr diff}$, % (b)	AASHTO T350	Report
Residue from Pressure Aging Vessel, AASHTO R28 @ 100 °C:	Test Method	Requirements
Dynamic Shear, $G^* \sin \delta$, Test Temp 22 °C @ 10 rad/s, kPa	AASHTO T315	4000 Max.
Creep Stiffness, S, Test Temp \square 24 °C @ 60 sec, MPa	AASHTO T313	300 Max.
Creep Stiffness, m-value, Test Temp \square 24 °C @ 60 sec	AASHTO T313	0.300 Min.

Bituminous Mix Design

NDOT Section 401.02.02

- Inhouse Hveem (NEV T760)
- Stability & Air voids (4% north)
- AASHTO T283 and Hydrated Lime (Marination method)
- Same Mixing and Compaction Temperature
- Mineral Filler (ASTM C1097)

RTC Orange 337.04

- Asphalt Institute MS-2
- Marshall Method (3% or 4%)
- AASHTO T283 or Hydrated Lime
- 337.04.02.01.01 Ignition Oven (NEV T761)
- Mineral Filler (ASTM D242)

RTC Blue 401.02.01

- IQAC entry (good for 12 months)
- Asphalt Institute MS-2
- Marshall Method (4%)
- AASHTO T283 or Hydrated Lime
- Chemical Extraction
- Mineral Filler (ASTM D242)



Sampling & Testing

MINIMUM REQUIRED SAMPLES AND TESTS: PROJECT JANUARY 2021

MATERIAL OR PRODUCT	TEST NO.*	TEST	SAMPLE FREQUENCY**	LOCATION OR TIME OF SAMPLING	
Borrow / Embankment	115	Resistance "R" value	One per 50,000 yd ³ or 26,500 tons or fraction thereof for qualifying the materials.	Source Requirement Test	Sample large c
	108	Proctor	108 and 104 (when rock correction is required) to be run every 25 compaction tests, minimum or one per 125,000 yd ³ or one per 66,250 tons.	Material obtained from Nev. T200	
	104	Specific Gravity			
	102 or 103	Density	One per 5,000 yd ³ or 2,650 tons of embankment, but not less than one per day, per lift	After final compaction	
Select Borrow	115	Resistance "R" Value	One per 50,000 yd ³ or fraction thereof for qualifying the materials.	Source Requirement Test	Sample large c
	108	Proctor	108 and 104 (when rock correction is required) to be run every 25 compaction tests, minimum or one per 125,000 yd ³ or one per 66,250 tons.	Material obtained from Nev. T200	
	104	Specific Gravity			
	102 or 103	Density	One per 1,000 yd ³ of embankment, but not less than one per day, per lift.	After final compaction	
	206	Sieve Analysis	One per day		Refer t
Foundation Material	115	Resistance "R" Value	One per 50,000 yd ³ or 26,500 tons or fraction thereof for qualifying the materials.	Source Requirement Test	Sample large c
	108	Proctor	108 and 104 (when rock correction is required) to be run every 25 compaction tests, minimum or one per 125,000 yd ³ or one per 66,250 tons.	Material obtained from Nev. T200	
	104	Specific Gravity			

* -- Assumes a Nevada test method (Nev. T) unless otherwise noted.
 ** -- Discuss any changes from the frequencies shown with the Quality Assurance Engineer.

State of Nevada Department of Transportation Minimum Required Samples and Tests: Project January 2021

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION
CONSTRUCTION DIVISION

FIELD TESTING GUIDE

NEVADA DOT
SAFE AND CONNECTED

NEVADA ALLIANCE FOR QUALITY
NAQTC
TRANSPORTATION CONSTRUCTION

R-18 approved
labs

Agency, AASHTO, NDOT Inhouse

Third Party Lab, AASHTO/ASTM, NAQTC



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Final Acceptance (NDOT/RTC)

NDOT

- Subsection 106.04 Samples and Tests.
- Contractor performs informational testing
- All acceptance testing will be performed by the Engineer
- All NDOT field test procedures, AASHTO/ASTM/NEV/Cal in HQ

RTC Orange

- Section 336.00 Inspection and Testing
- Can contractor take samples & provide test results?
- All sampling and testing perform by AASHTO accredited Lab and NAQTC personnel
- All ASTM methods (two NEV Test)

RTC Blue

- IQAC Table 1
- Field test requirements
- Contractor hires R-18 accredited lab for acceptance testing
- County hires Quality Assurance lab for validation
- County lab performs Independent Assurance for dispute resolution



HMA Paving Acceptance (NDOT/RTC)

NDOT Section 401

206	Sieve Analysis	One per 1,000 tons or one per day minimum	Section 106
112	Moisture	One per day	From coldfeed belt at plant during production
761	Bitumen Ratio	One per 1,000 tons or one per day minimum. NOTE: Immediately test another sample to verify the results before making plant adjustment	Composite sample from behind the paver, prior to rolling
306	Moisture Content		Composite sample from behind the paver, prior to rolling
325	Theoretical Maximum Specific Gravity (Rice)	One for each one-half day of production (a.m. and p.m.)	Composite sample from behind the paver, prior to rolling
AASHTO T269	Percent Air Voids of Compacted Mixture	Sample first three days of paving; then one per 10,000 tons or twice per week, whichever is less	
303	Stabilometer	One per 10,000 tons or twice per week, whichever is less; sample first three days of paving	
341	Indirect Tensile Strength and Retained Strength	One per 10,000 tons or twice per week, whichever is less; sample first three days of paving	

RTC Section 336.03.04

- Asphalt Content, Gradations, Air Voids, Thickness
- 1 per 500 tons (48 hours)
- Marshall Stability and Flow, lab compacted air voids (24 hours)
- 1 per 2,000 tons or 1 per day whichever is more

Reclaimed Asphalt Pavement(RAP)

NDOT Section 402

- One Extraction/Gradation every 500 tons
- 100% passing ½" sieve
- Minimum 2 samples for mix design
- No more than 2% Bitumen Ratio difference
- May replace 5 to 15% aggregate, Type 2/2C only

RTC Section 322/336

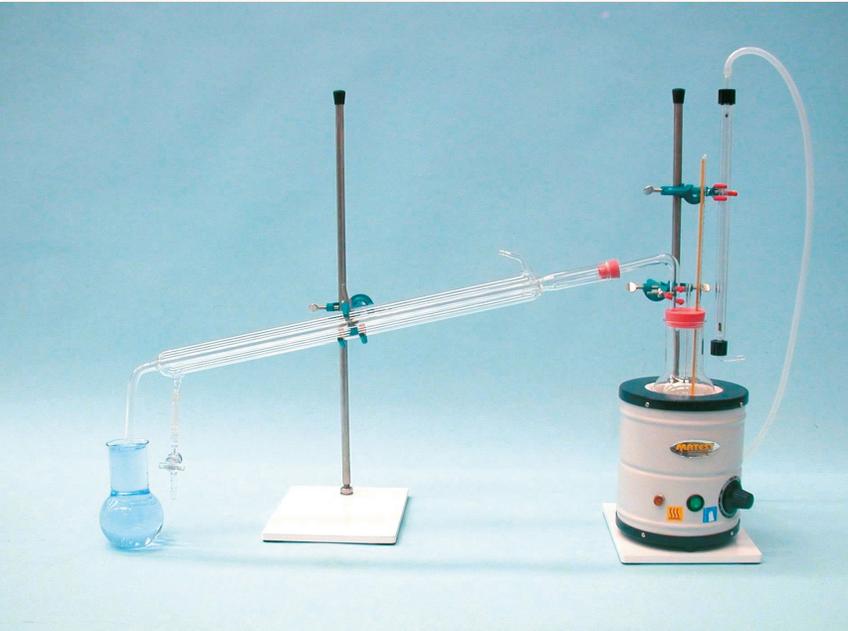
- One Extraction/Gradation every 1000 tons
- 100% passing ¾" sieve for Type 2
- 100% passing ½" sieve for Type 3
- Minimum 3 samples
- No more than 2% Bitumen Ratio difference
- One Specific Gravity /5,000 tons
- Minimum 2.470 combined Gsb

RTC CC 404.02.02

- Recycling agent required
- 15% maximum
- Minimum 2 samples for mix design
- No more than 2% Bitumen Ratio difference



RTC 336.03.04.06.02 Greater than 15% RAP



Abson Recovery



AASHTO M320

Determine the allowable RAP per

$$\% \text{RAP} = \frac{T_{\text{blend}} - T_{\text{virgin}}}{T_{\text{RAP}} - T_{\text{virgin}}}$$

where:

T_{virgin} = critical temperature of virgin

T_{blend} = critical temperature of blend

T_{RAP} = critical temperature of RAP

AASHTO M323



Functional Classification	Layer	Applicability								
		3	3	3	3	2	1	0	0	0
<i>Local / Residential</i>	Surface Course (0-15% RAP)	3	3	3	3	2	1	0	0	0
	Base Course (0-30% RAP)	3	3	3	3	2	1	0	0	0
<i>Collector</i>	Surface Course (0-15% RAP)	0	0	2	2	3	3	0	0	0
	Base Course (0-30% RAP)	0	0	2	2	3	3	1	1	0
<i>Arterial / Industrial</i>	Surface Course (0-15% RAP)	0	0	0	0	2	3	2	2	2
	Base Course (0-30% RAP)	0	0	0	0	2	3	3	3	0
Mixture Design Types Options	Mixture Type	Dense Graded Type 3		Dense Graded Type 3C		Dense Graded Type 2		Dense Graded Type 2C		OGF (non-structural layer)
	NMAS (inch)	3/8, 1/2		1/2		3/4		3/4, 1		3/8, 1/2
	Percent Lab Voids	3, 4		3, 4		4		4		n/a
	Marshall Blows	50	75	50	75	50	75	50	75	n/a
Note: The lower the number (0 through 3) the less applicable the mixture design. The color-coding in the cells also indicates applicability: 0 = red, 1 = yellow, 2 = light green, and 3 = dark green.										

Dense-graded Type 2. 3/4 inch NMAS. 4% air void design. 75 blow compaction. Up to 15% RAP. Surface course mixture.

Dense-graded Type 2C. 3/4 inch NMAS. 4% air void design. 75 blow compaction. Up to 30% RAP. Base course mixture.



After “Webinar on RTC Structural Design Guide for Flexible Pavements, Page 38” UNR April 1,2022

BITUMINOUS PLANTMIX (Production)

NDOT Section 401

- Mixing Temperature: 350°F Max.
- Temperature @ Paver: 300°F Min.
- Department provide mix design for **each calendar year**
- No more than 0.4% Bitumen Ratio difference
- **Possible revised Job-mix formula**

RTC Orange 320.02/337.01

- Mixing and Compaction Temperature (Mix Design)
- Contractor submit mix design
- no older than **12 months** prior to the date of the submittal
- No more than 0.5% Asphalt Cement difference
- **Job control grading band**

RTC Blue 401.02.01

- Mixing and Compaction Temperature (Mix Design)
- Contractor submit mix design
- Cycle renews every January 31
- No more than 0.4% Asphalt Cement difference
- **Job control grading band**



BITUMINOUS PLANTMIX (Acceptance)

NDOT Section 401/402

- 401.02.02, Final project control requirement on material
- Field trial mixture acceptance, 401.02.02 & JMF & 402.03.06
- 402.03.06, Density test section (6,600 SQYD)
- 5 nuclear tests, 92% to 96%
- Joint compactions, 90% min.

RTC Orange Section 320.06

- 320.06.02, Density
- 500 tons per lot
- 92% min. (Rice), 96% min. (Marshall)
- 3 to 8% (Air Voids)
- 302.06.03, Thickness, average equal to design thickness, all cores less than ½" thinner
- Mitigation Tables on density & air voids (slurry, chip seal & overlay)

RTC Blue 401.03.12

- 5 sublots per day.
- Density requirements vary based on roadway type 92% to 93% minimum
- Thickness requirements based on average density core height.
- No core less than 10% below requirement
- Cost recovery if deficient or excessive



BITUMINOUS PLANTMIX (Acceptance) cont.

NDOT Section 402

- 402.03.05, Surface Tolerances
- Straightedge (0.3") & Profile
- Inertial profiling system
- MRI for 0.100-mile section
- Localized IRI for any 25-foot section
- 402.05.02 Progress Payment Adjustment (PWL) on JMF & Density
- 402.05.02 Ride Pay adjustment, IRI Incentive (Interstate only)

RTC Orange 320.06

- 320.06.01, Surface Tolerances
- Straightedge unless otherwise specified
- 1/8" longitudinally,
- 1/4" transversely
- 302.07.01, Unacceptable surface tolerance shall be corrected by either overlaying or grinding with a Type III slurry

RTC Blue Mix Specific 402 or 403

- Profilograph
- Nev. Test Method No. T446
- Grinding, overlay, or removal and replacement permitted to correct profile deficiencies



Marshall Density (ASTM vs. RTC 2012)

ASTM D6926 Section 8.1

- Use specimens Gsb within 0.020 of the mean
- Note 11, ASTM D6927 single operator
 - $1s = 0.007$, $d2s = 0.020$
- ASTM D6927 Table 1 Height Correction
- **ASTM D2726 Single Operator**
 - $1s = 0.013$, $d2s = 0.037$

RTC Orange 336.03.04.04

- The Gsb range of three Specimens shall not exceed 0.020
- **Section 336.03.04.03 Compacting Field Sample**
- **Specimens outside 509 – 522 cubic centimeters are invalid for density and air void analysis**



ASTM D2726-00 Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures

equipment.

In a report⁶ dated March 22, 1988, The University of Nevada-Reno concluded that “The ASTM D2726 precision statement accurately reflects variances caused by either method of compaction (Marshall or Hveem), or by aggregate type (rounded or angular).”

NDOT: Hveem

RTC: Marshall

Superpave????



FINAL THOUGHTS

- Specification wording: Use active voice and imperative mood
- Enforcement: Set realistic limits for specifications
- Coordination of documents: Define order of precedence



You Get What you
Inspect, not What
you Expect



Louis Vincent Gerstner Jr. Former Chairman and CEO, IBM



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Thank you

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Nevada Asphalt Conference – February 15, 2023

Asphalt Concrete Specifications for Quality and Profit





USE
CAUTION



Pavement Quality

- **Contractor problem?**
- **Design problem?**
 - **NMAS and allowable / design lift thicknesses**
 - **Mix properties vs. application**
 - **Compaction requirements**
 - **Number of lifts for ride versus thick lifts for density**
 - **Cold planing for depth, or for ride quality**
 - **Work zone / traffic control restrictions**
 - **Night work**
 - **Marginal conditions due to advertisement delays**

What do you want?

“Usually, the most accurate, direct way to state a requirement is affirmatively. This is because the exclusion of one possibility may still leave open an infinite number of unmentioned, other possibilities, and because the affirmative statement requires the writer to consider and state exactly what is meant. Say what you want, not what you don't want. ”

Tim Murphy, Murphy Pavement Technology

What do you want?

- Durability?
- Rut resistance?
- Aesthetics?
- Ride quality?
- Yield and budget control?
- Cheap and temporary?

Appropriate Level of Quality

Avoid the “if some is good, more must be better” trap.

High-Bank Racetrack

- Ring-and-ball softening point: 180° F
- Minimum or target?
- Minimum, so supplier:
 - Added polymer to allow for R&B decrease in tank
 - Added polymer to allow for variability between labs
- Actual R&B in excess of 200° F

Shuttle Buggy



Shuttle Buggy







Borrowing Specs

- Do they ask for what you want?
- Read them
- Modify if necessary.
- Make sure the sampling and testing (both QA and QC) are something you want to commit to.

Large Agency Specs

- **Specs address issues**
 - **Sometimes effectively, sometimes not**
- **The larger the jurisdiction, the lower the common denominator**
- **Example:**
 - **NDOT has a stripping problem in Elko, and makes adjustments.**
 - **NDOT has an absorption problem near Reno, and makes adjustments**

NDOT vs. Ivanpah

Those changes may or may not make sense for Ivanpah

- May limit available sources
- May unnecessarily increase costs
- Ivanpah may want to consider specs from
 - ADOT
 - Clark, Mohave, or San Bernardino County



Keep in Mind

- Larger Agencies tend to drive the market
- Local agencies will usually benefit from understanding local market
 - Available materials and equipment
 - Producer / contractor capabilities, experience, capacity, limitations



Language Used

- **Succinct, clear, concise – get rid of contradictions, ambiguities, everything that doesn't pertain**
- **Special Provisions / Special Technical Specifications - revisions or edits to Revised or Standard Special Provisions - revisions and edits to the Standard Specifications**



Language Used

- *Delete the third sentence in the fourth paragraph and replace with “No additional compensation will be provided therefor.”*
- If you have to look in multiple places, or even multiple documents, to get an answer, your specs could probably be improved.



Complexity

**If you have eight sublevels in your spec,
it could probably be simplified:**

CalTrans example:

**Section 39-2.01A(4)(i)(iii)(A)(i) Corrective
Actions (for smoothness)**

Complexity

- **Another example:**

Over 100 pages between the specified gradation and the specified binder grade.

You want bidders focused on how to build your project as efficiently as possible and to innovate if they can. You don't want them spending the two-week advertise period trying to figure out what you want built.

Contract Administration

Bidding is only the first step. You want contract administration to be as easy as possible.

- **Focus on quality**
- **Focus on what's best for the project**
- **Provide a reasonable return on the work.**
- **Avoid misunderstandings, confusion, disputes, claims, lawsuits.**



Don't forget addenda

- It can be very easy to miss the “ripple effect” when making last-minute changes.
- Incorporate all pertinent language and information into a final conformed “for construction” document if necessary.

Quality Starts With Design

- **Mixture properties – ease of compaction (consider substrate), appropriate properties for the project**
- **Gradation / NMAS – lift thickness, segregation potential, permeability, etc.**

Quality Starts With Design

Section thickness / lift thickness / number of lifts required or allowed

- Thicker lifts – more time available to compact, likely to get better density
- More lifts – more opportunity for ride quality improvements

Quality Starts With Design

Ride Quality

- Initial Roughness
- Number of Opportunities for Improvement
- Types of Opportunities
 - Each lift can reduce roughness, but not eliminate it
 - Consider yield and minimum / average thickness
 - Profile milling can be very effective if existing section allows it

Quality Starts With Design

Prep work

- Cold planing for depth
- Profile planing for ride

Uniform smooth substrate allows for uniform thickness

- More mat uniformity
- More uniform performance
- Easier to administer quantities and budget

Quality Starts With Design

Traffic Control

- Larger areas provide more opportunity to improve quality and efficiency and lower cost.

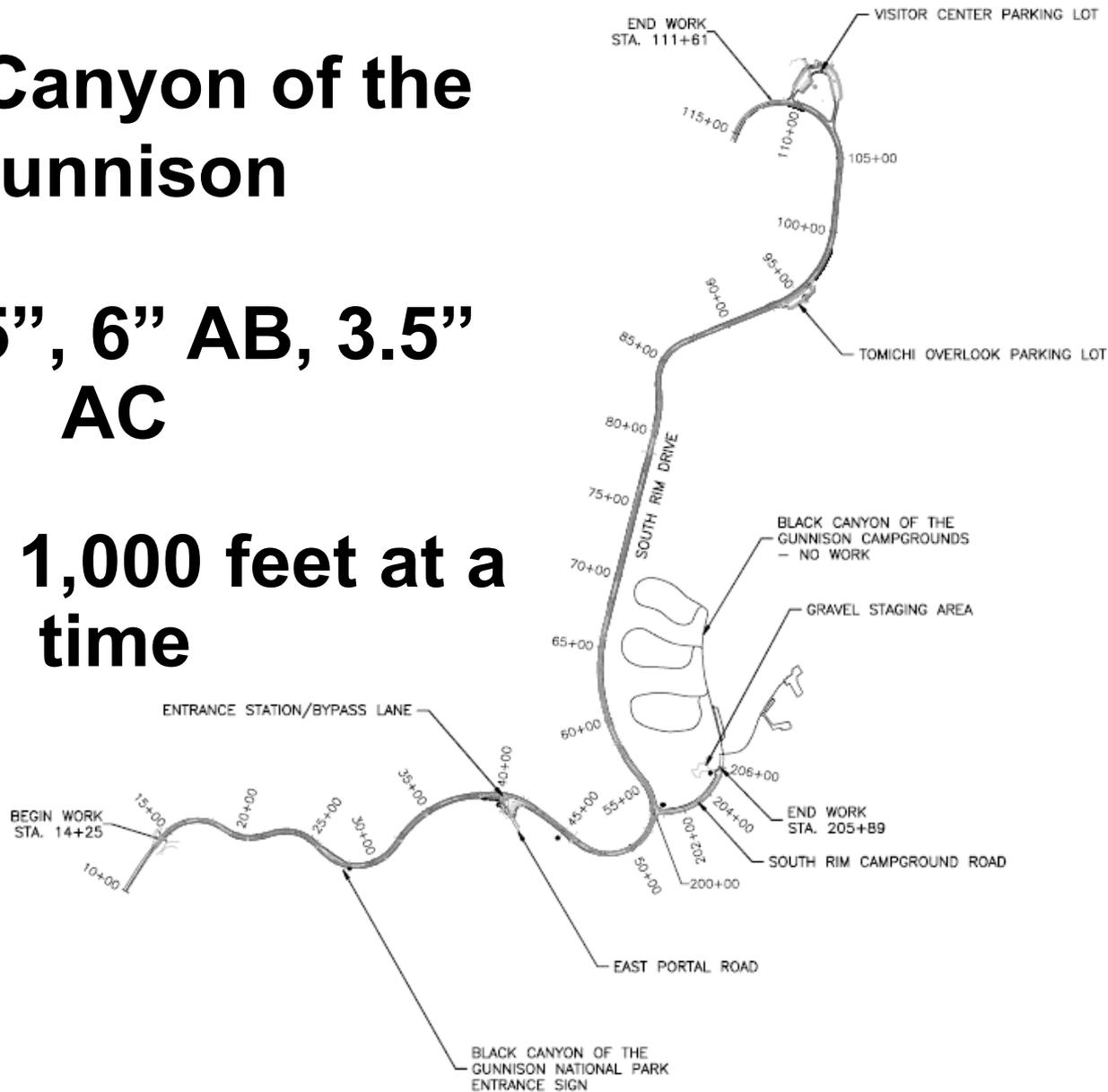
- Night work
 - Quality challenges
 - Ambient conditions

Think this through

Black Canyon of the Gunnison

**Exc 9.5", 6" AB, 3.5"
AC**

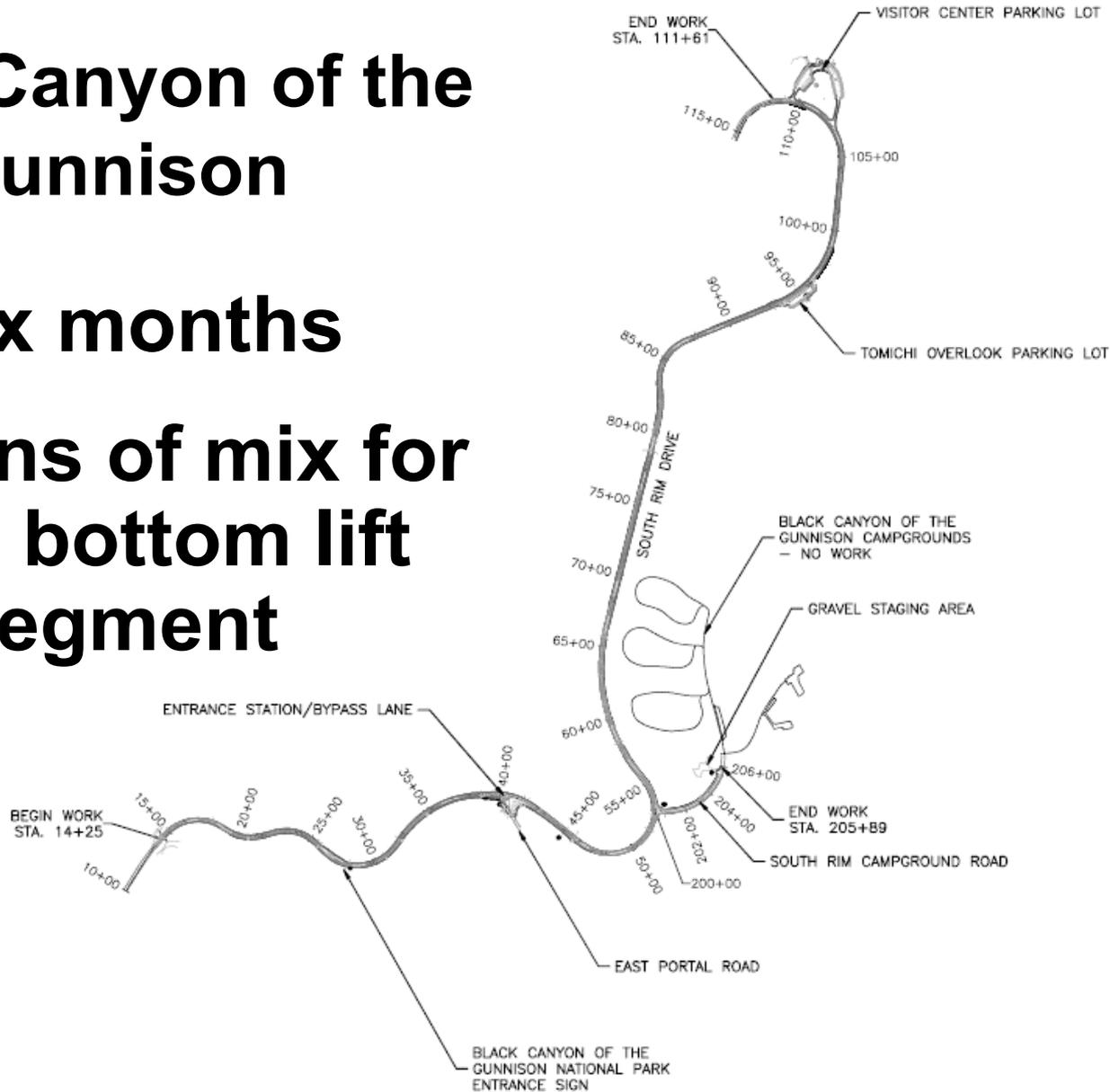
**2 miles, 1,000 feet at a
time**



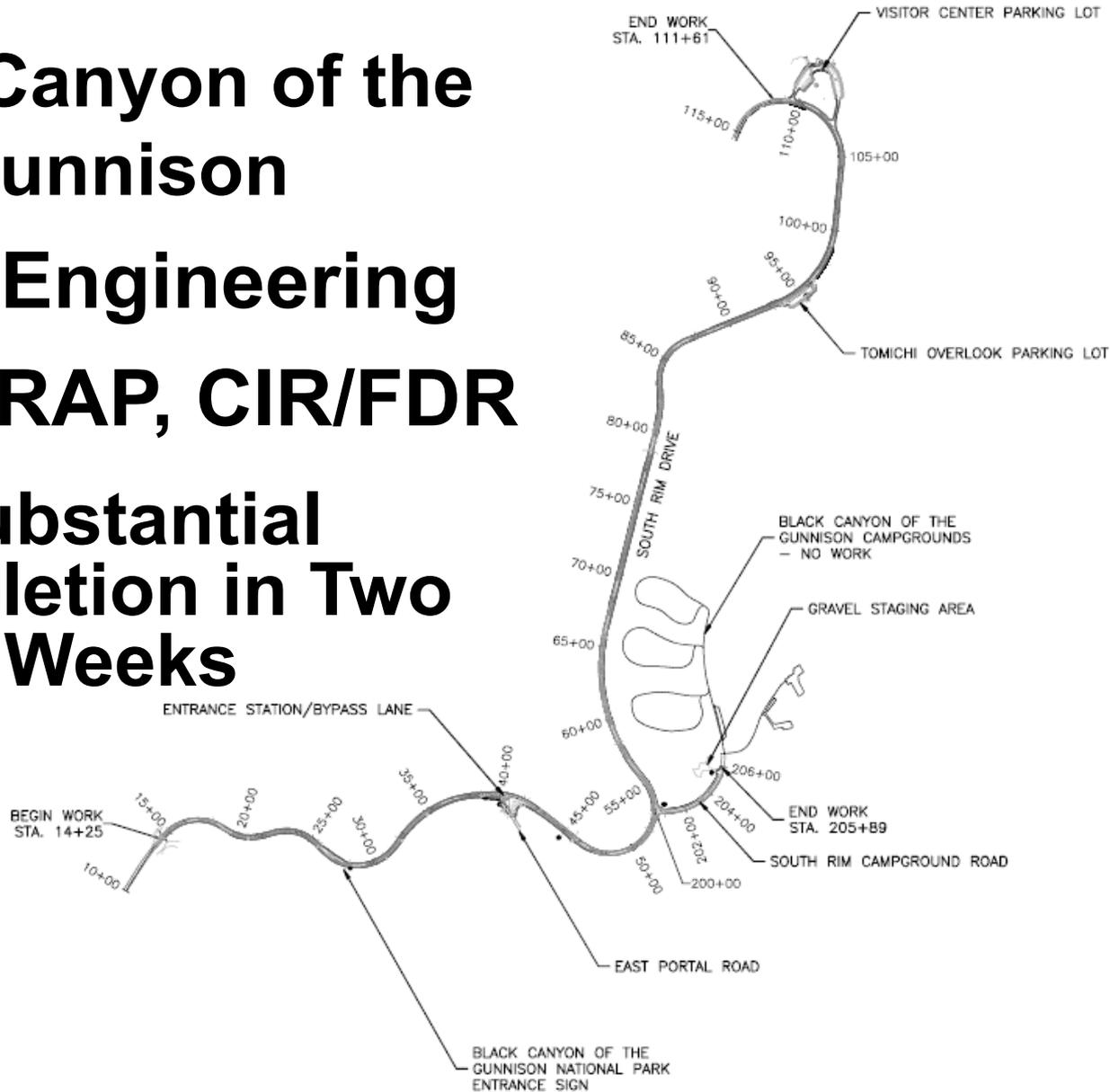
Black Canyon of the Gunnison

Six months

145 tons of mix for each bottom lift segment



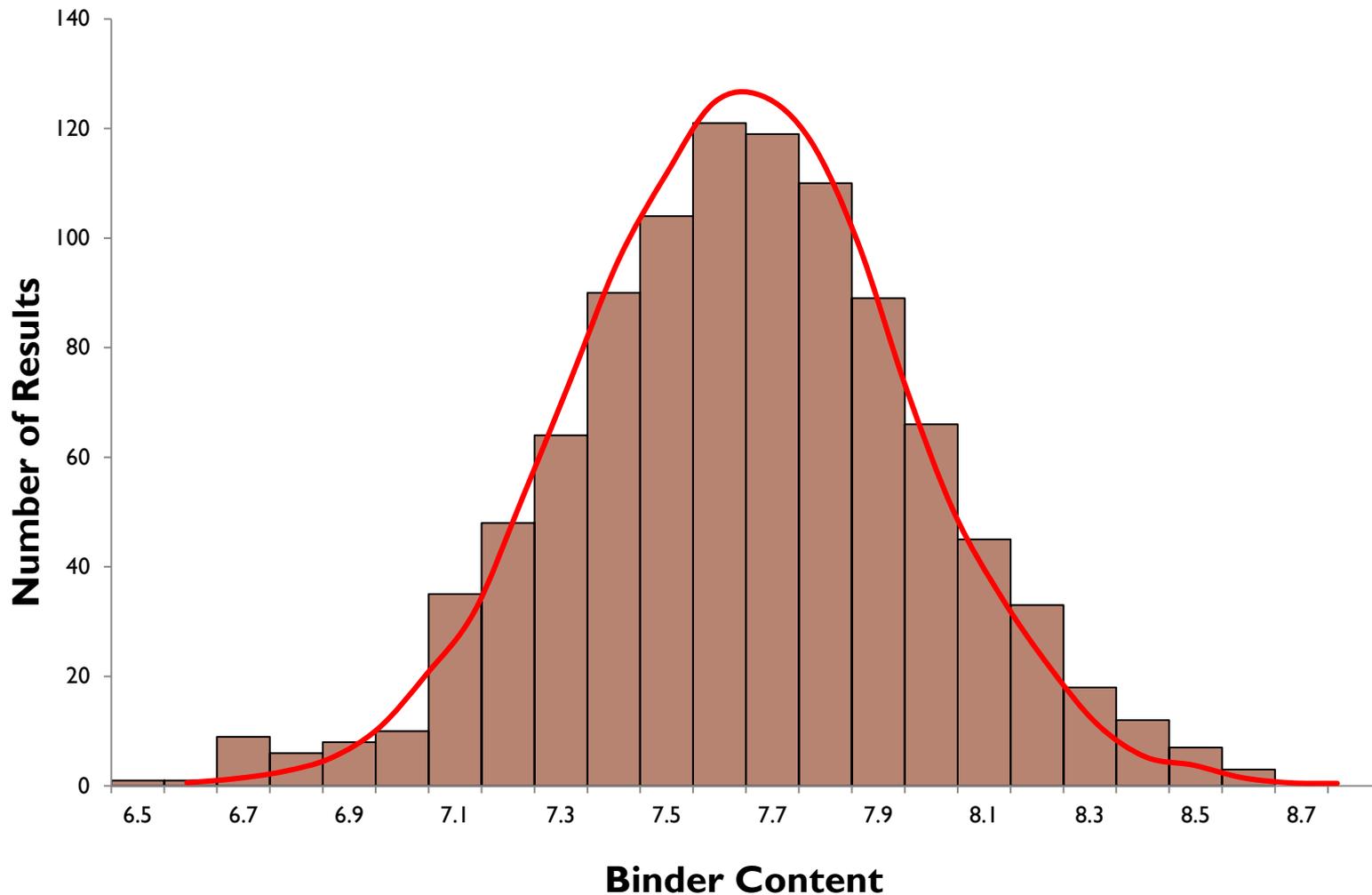
Black Canyon of the Gunnison Value Engineering Import RAP, CIR/FDR Substantial Completion in Two Weeks



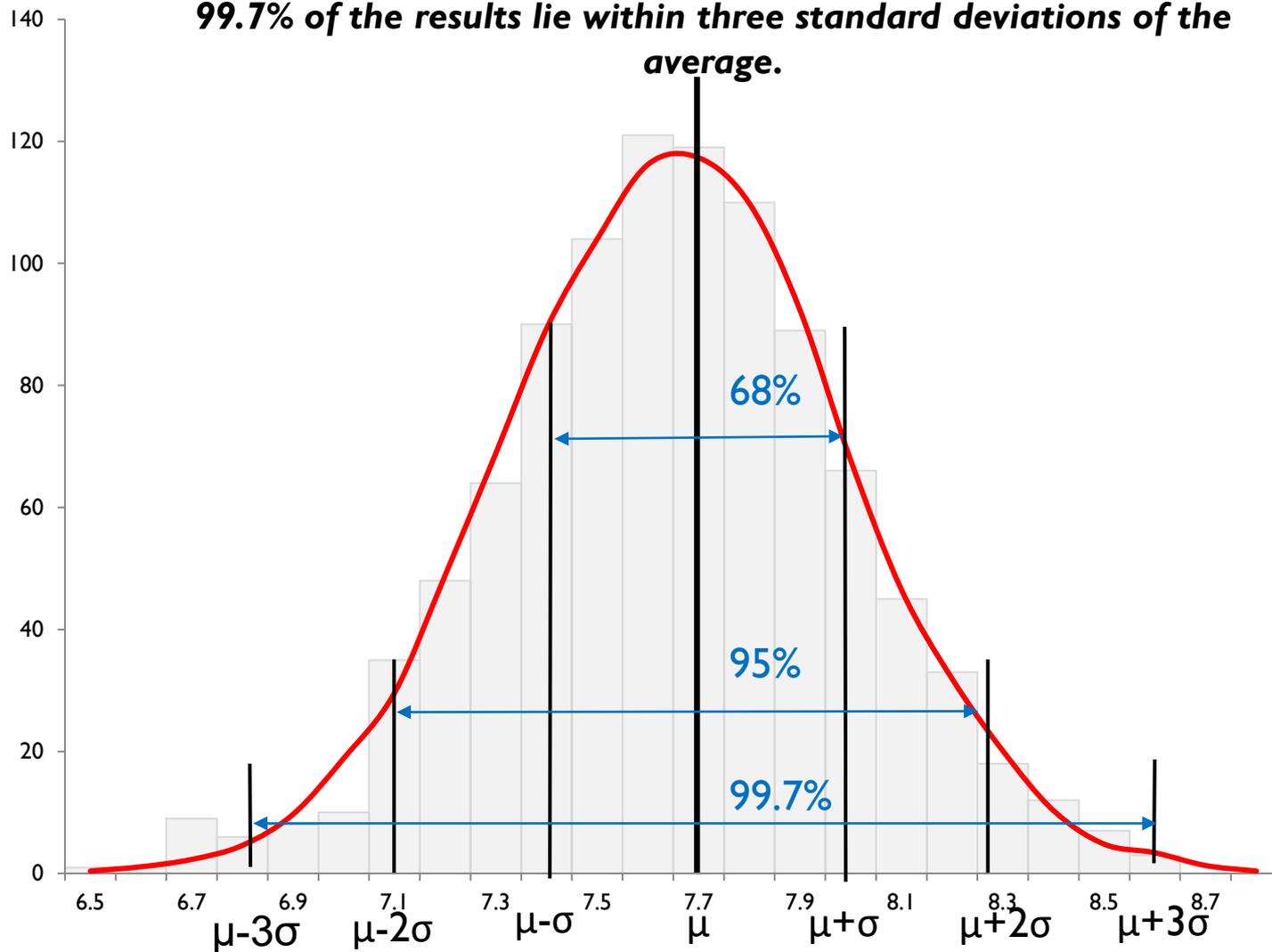
Evaluating the Results



Evaluating the Results



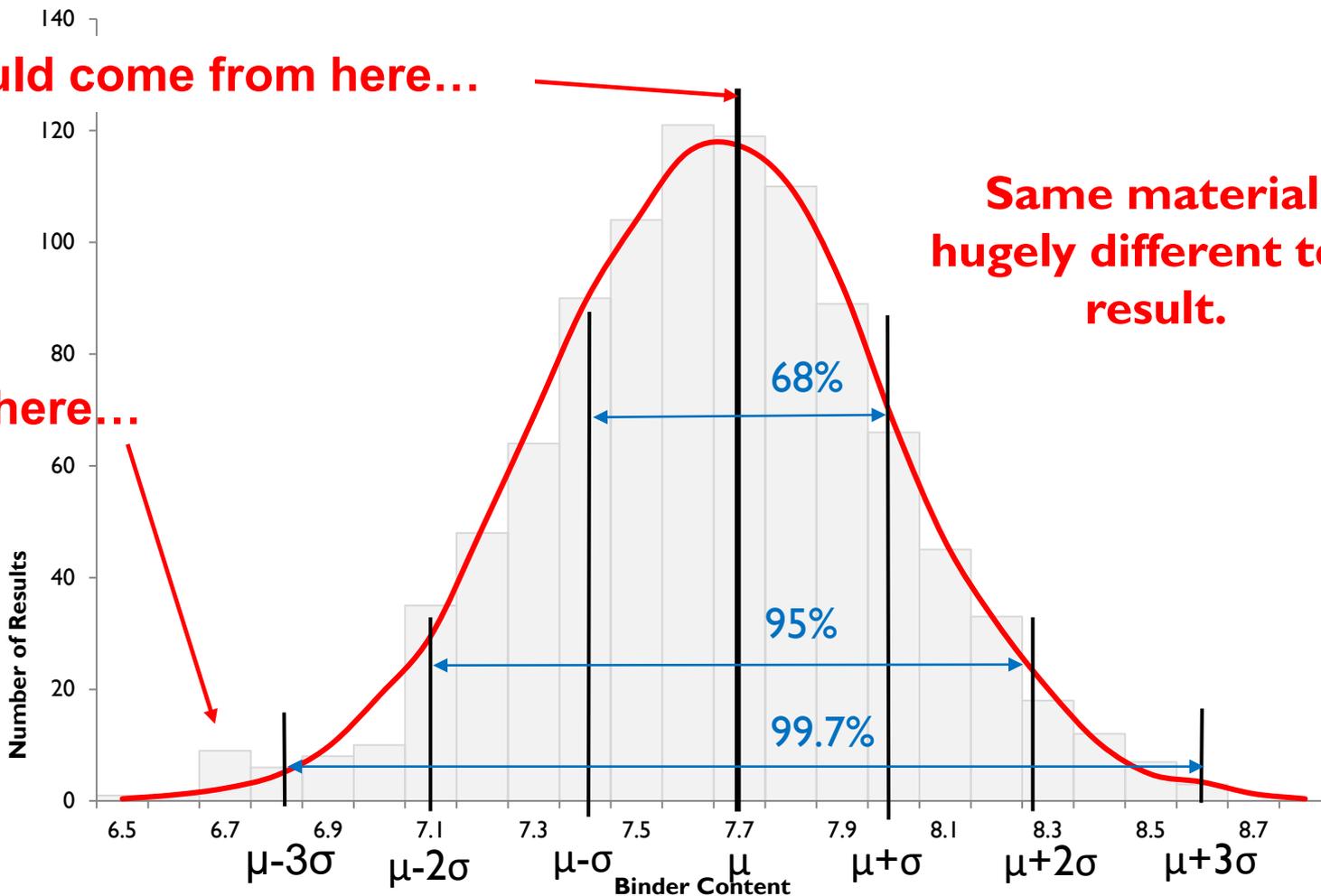
**68% of the results lie within one standard deviation of the average.
 95% of the results lie within two standard deviations of the average.
 99.7% of the results lie within three standard deviations of the average.**



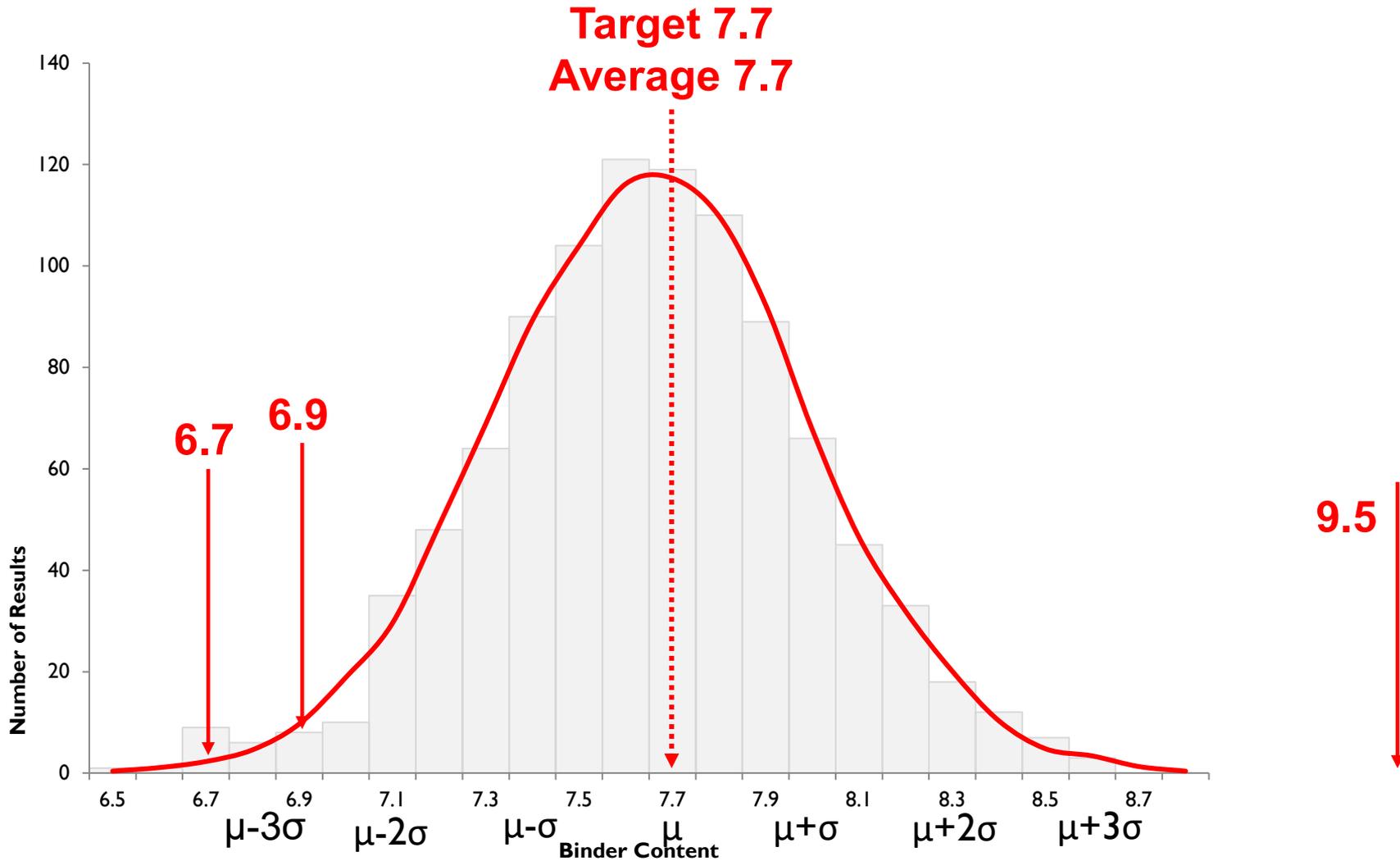
The risk of making decisions based on a single sample

It could come from here...

Or here...

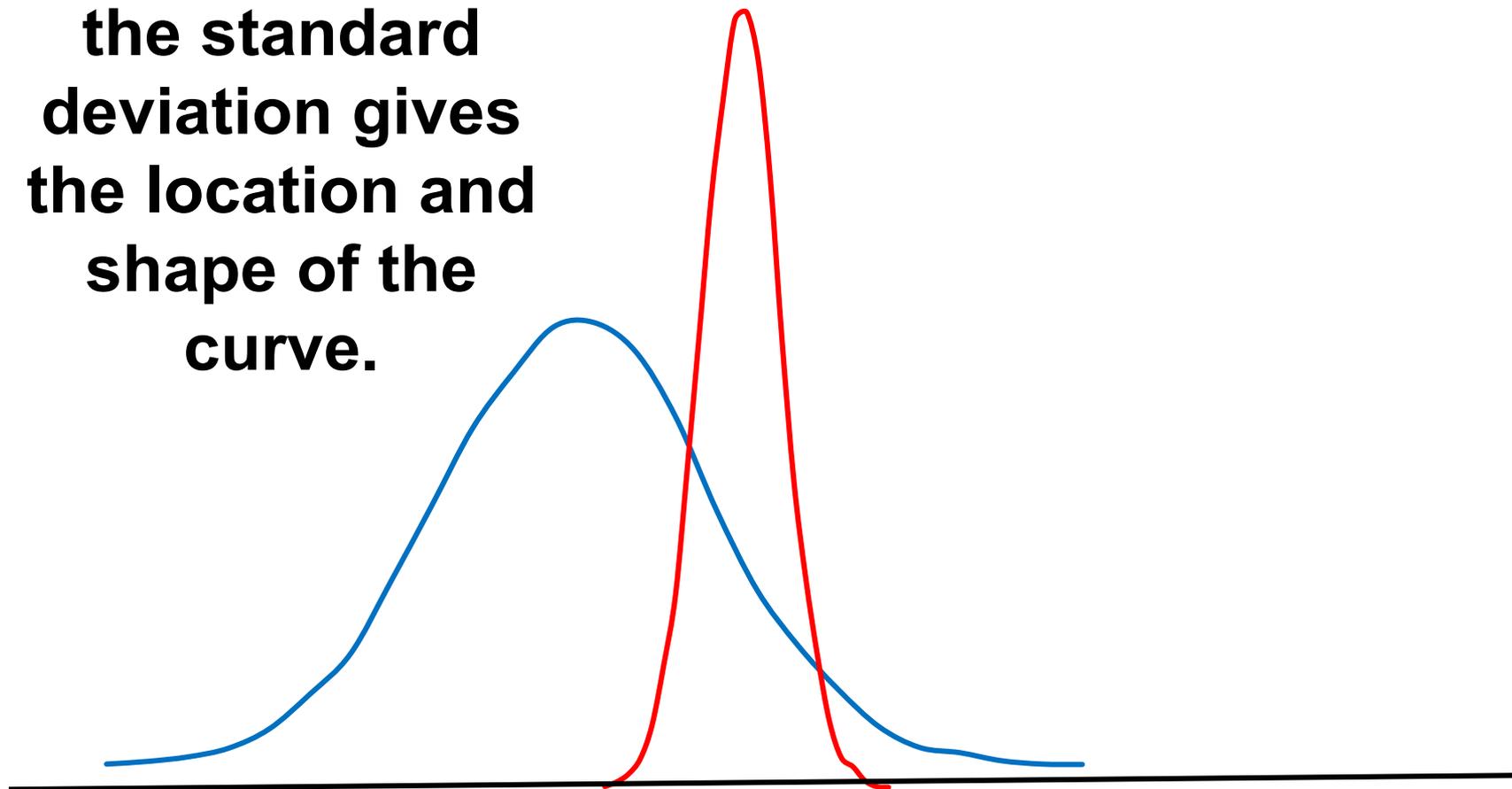


The risk of making decisions based on an average

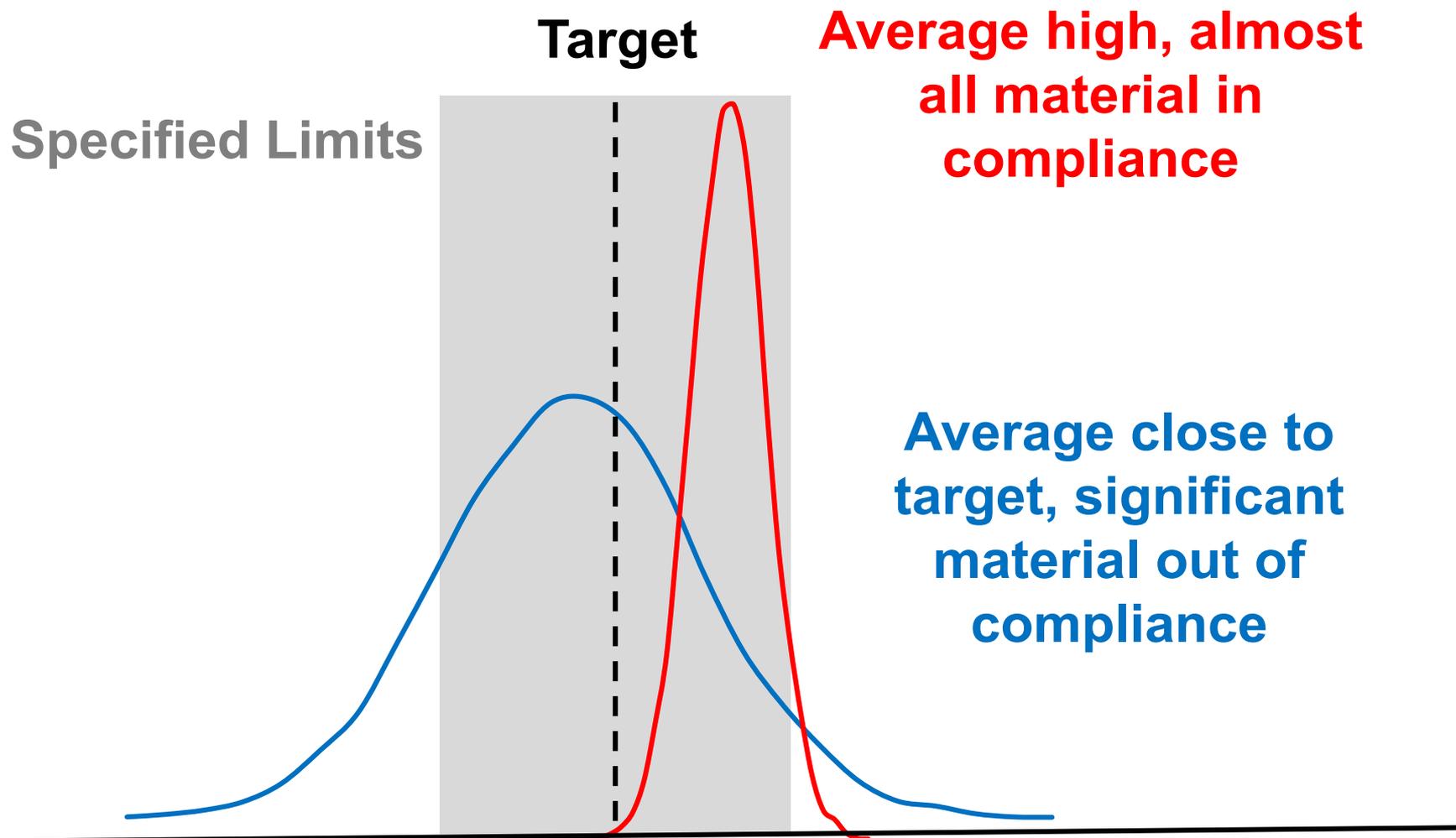


Using Statistics

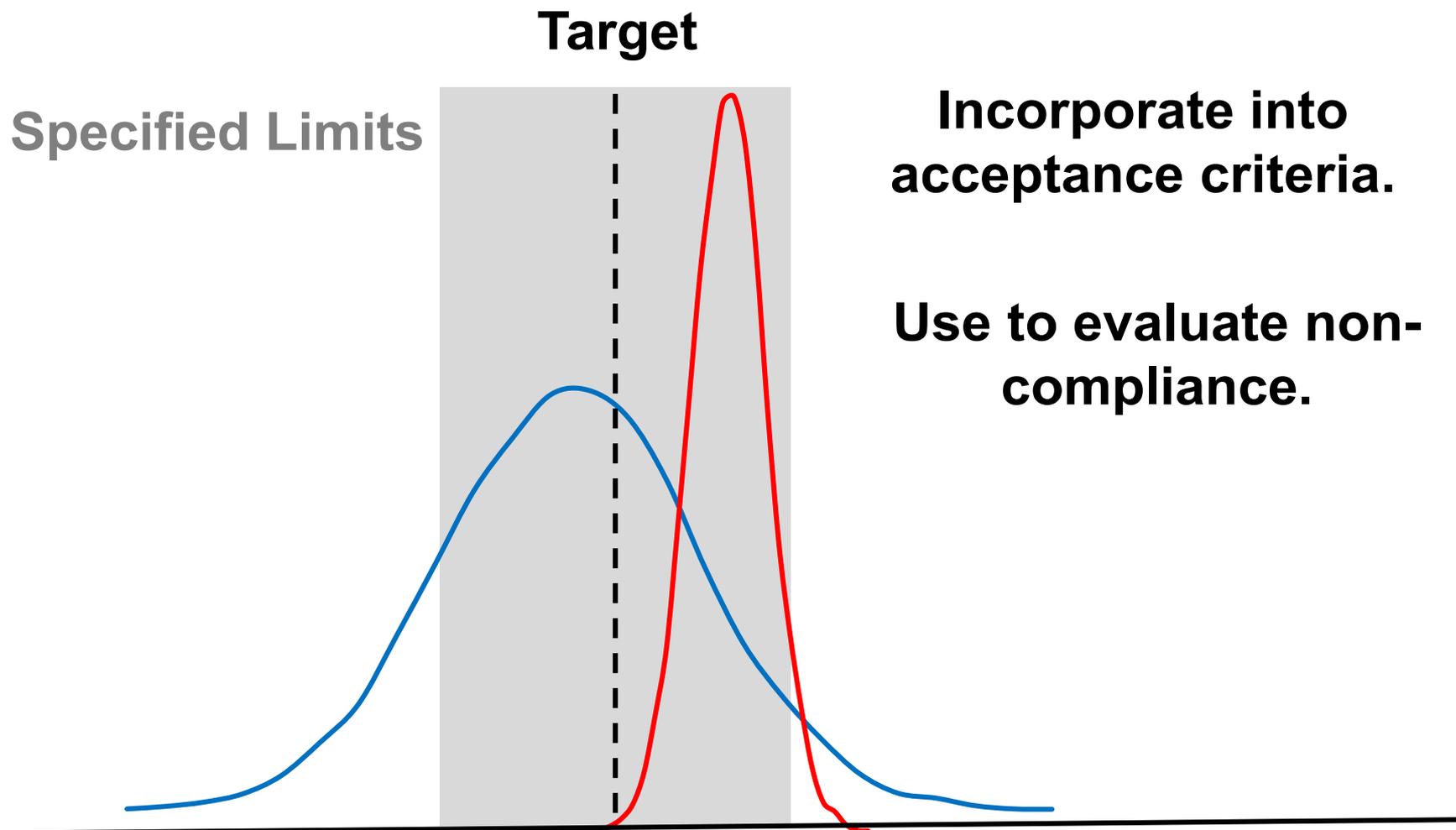
The average and
the standard
deviation gives
the location and
shape of the
curve.



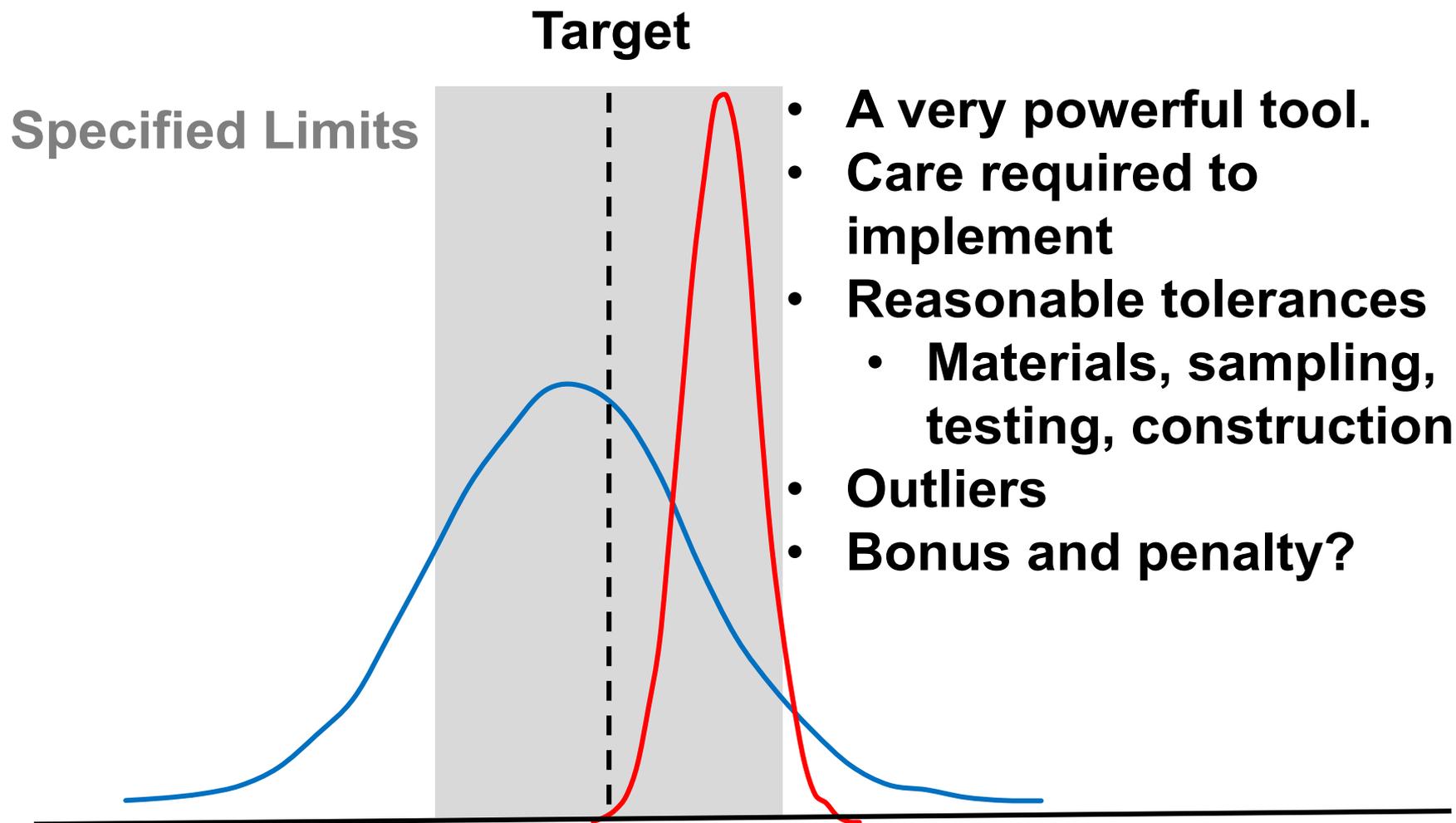
Using Statistics



Percent Within Limits



Percent Within Limits



Summary

- **Quality starts with design**
- **Quality depends on more than just material requirements**
- **Well-written specs are**
 - **Easier to bid, less risk**
 - **Easier to administer**
 - **More likely to result in good quality work**
 - **More likely to reward good contractors**
- **Consider Percent Within Limits**



Questions / Discussion

Mike Robinson LLC
101 Upper Canyon Loop
Ten Sleep, WY 82442





Nevada Asphalt
Conference

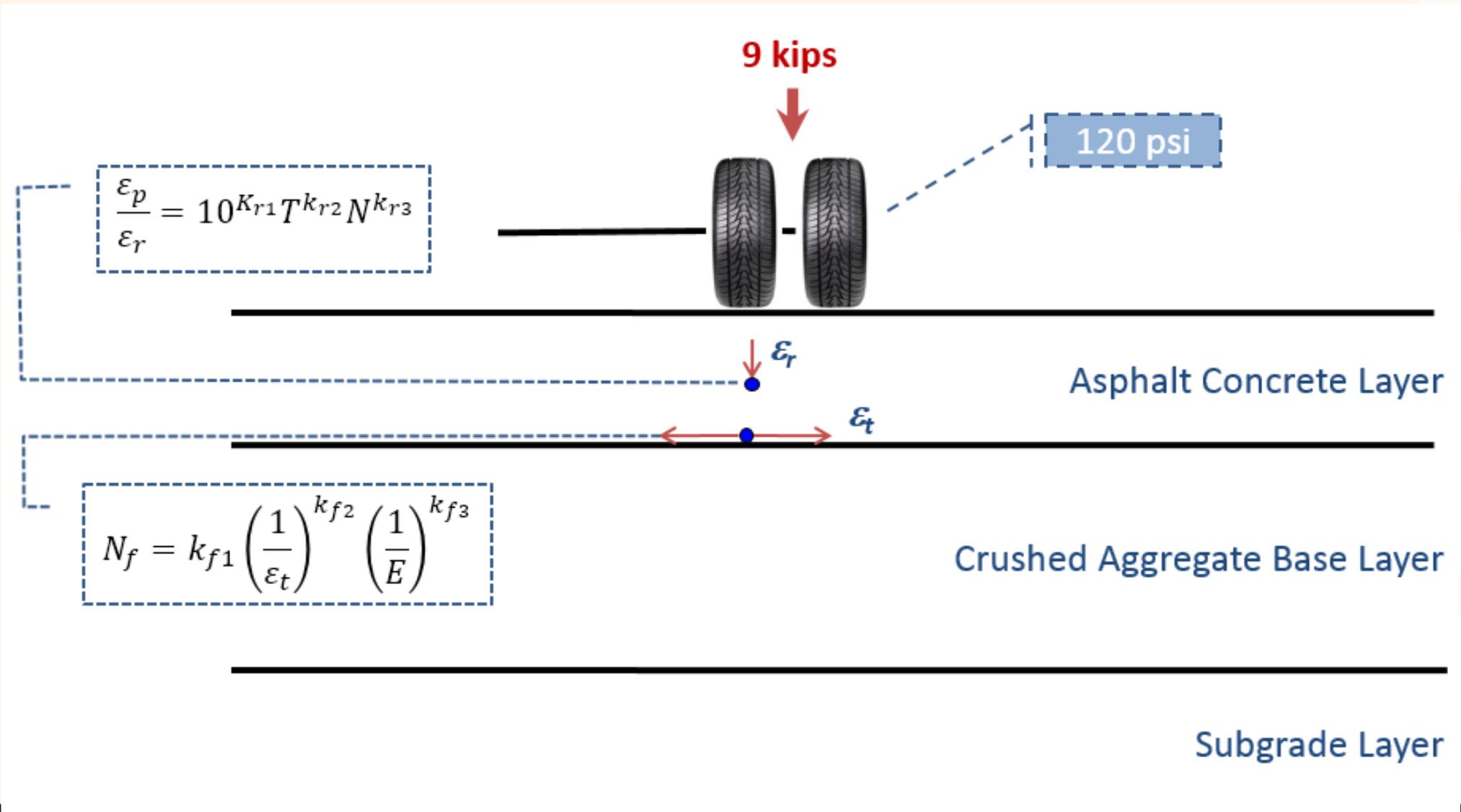
Achieving Balanced Mix Design

Peter E. Sebaaly, PhD, PE
Director of WRSC
University of Nevada

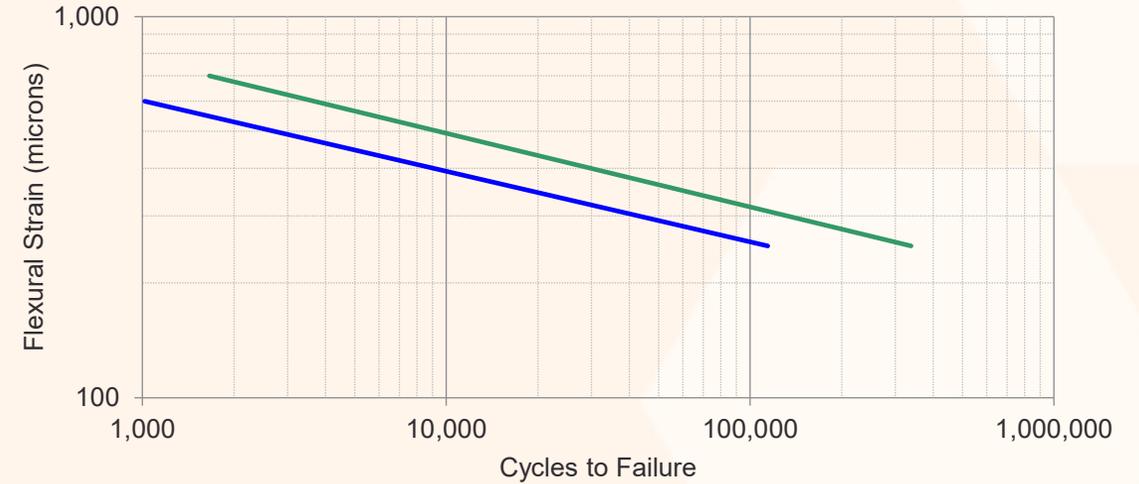
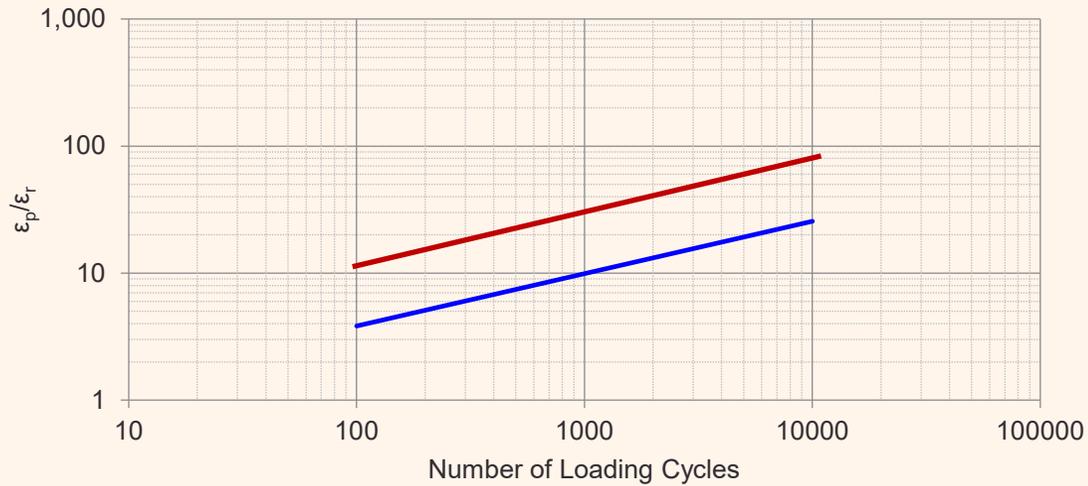
FEBRUARY 15 & 16, 2023



Pavement Engineering



Impact of Binder Content



More Binder:
Lower resistance to rutting and **higher resistance to cracking**



Balanced Mix Design

- Marshall Design
- Hveem Design
- Superpave

**ALL THREE DESIGNS STOP AT VOLUMETRICS +
MOISTURE SENSITIVITY**



Balanced Mix Design

(AASHTO) PP 105-20 defines Balanced Mix Design (BMD) of asphalt mixtures as:

“asphalt mix design using performance tests on appropriately conditioned specimens that address multiple modes of distress taking into consideration mix aging, traffic, climate, and location within the pavement structure.”



BMD: Four Approaches

BMD Approach	Volumetric Requirements	Performance Requirements	Flexibility	Innovation Potential
A—Volumetric Design with Performance Verification	Full compliance	Full compliance	Most conservative	Lowest
B—Volumetric Design with Performance Optimization	Full compliance at preliminary optimum of bitumen content (OBC)	Performance optimization through moderate changes in asphalt binder content	Slightly more flexible than Approach A	Limited
C—Performance-Modified Volumetric Design	Some requirements relaxed or eliminated	Performance optimization by adjusting preliminary asphalt binder content or mixture component properties or proportions	Less conservative than Approach A and Approach B	Medium degree
D—Performance Design	Limited or no requirements	Performance optimization by adjusting mixture components and proportions ^a	Least conservative	Highest degree



BMD Implementation Process

Task	Sub Task	Description	Years									
			-1	1	2	3	4	5	6	7		
1	Understanding the why and benefits of Performance Specifications		●									
2	Overall Planning	2.1 Identification of Champions		●								
		2.2 Establishing a Stakeholders Partnership		●								
		2.3 Doing Your Homework		●								
		2.4 Establishing Goals		●								
		2.5 Mapping the Tasks		●								
		2.6 Identifying Available External Technical Information and Support (periodically)		●	—	—	—	—	—	●		
		2.7 Developing an Implementation Timeline		●	—	—	—	—	—	—	●	
3	Selecting Performance Tests	3.1 Identifying Primary Modes of Distress.		●	—							
		3.2 Identifying and Assessing Performance Test Appropriateness.		●	—							
		3.3 Validating the Performance Tests			●	—	—	—	●			
4	Performance Testing Equipment: Acquiring, Managing Resources, Training, and Evaluating	4.1 Acquiring Equipment			●	—	—	—	●			
		4.2 Managing Resources				●	—	—	—	●		
		4.3 Conducting Initial Training			●	—						
		4.4 Evaluating Performance Tests				●	—	—	●			
		4.5 Conducting Inter-Laboratory Studies					●	—	●			
5	Establishing Baseline Data	5.1 Reviewing Historical Data & Information Management System			●	—	—					
		5.2 Conducting Benchmarking studies				●	—	—				
		5.3 Conducting Shadow Projects					●	—	—			
		5.4 Analyzing Production Data						●	—			
		5.5 Determining How to Adjust Asphalt Mixtures Containing Local Materials						●	—	—	●	
6	Specifications and Program Development	6.1 Sampling and Testing Plans							●	—	●	
		6.2 Pay Adjustment Factors (If Part of the Goals)							●	—	●	
		6.3 Developing Pilot Specifications and Policies							●	—	●	
		6.4 Conducting Pilot Projects							●	—	●	
		6.5 Final Analysis and Specification Revisions									●	—
7	Training, Certifications, and Accreditations	7.1 Developing and/or Updating Training and Certification Programs							●	—	●	
		7.2 Establishing or Updating Laboratory Accreditation Program Requirements						●	—	—	●	
8	Initial Implementation										●	



WHY BMD?

More RAP



Some RAS



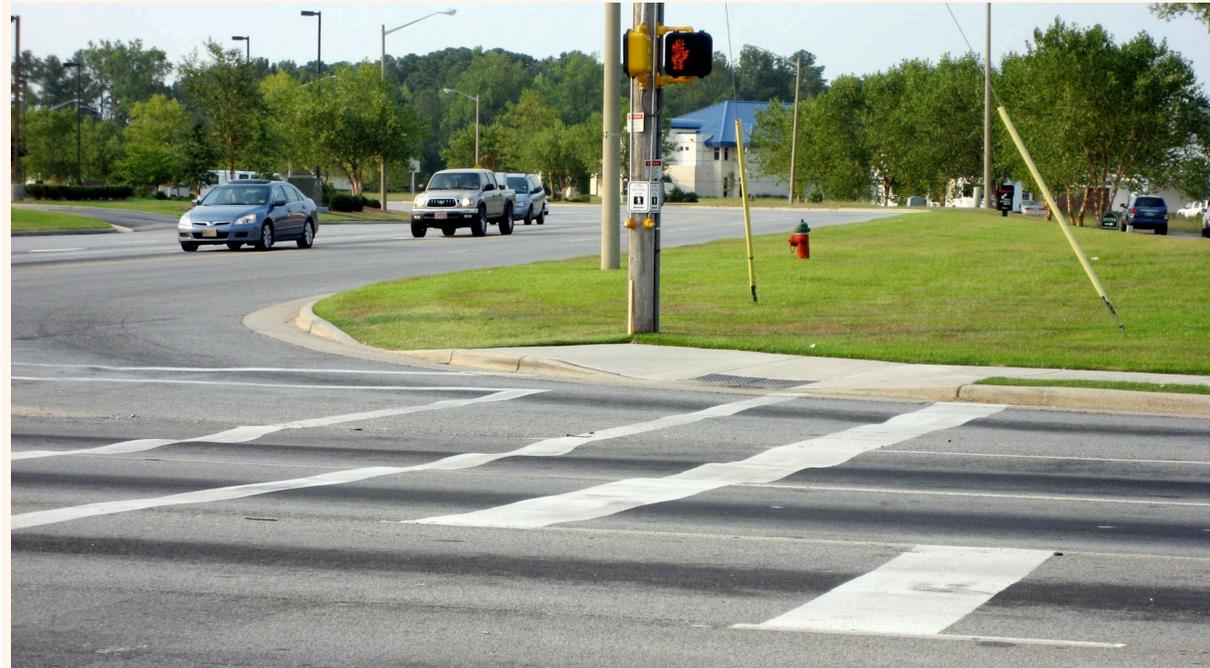
Some Plastic



Some Cracking Issues



Some Rutting Issues



HOW BMD?

- Practical
- Reasonable cost
- Mix design
- QC/QA
- Pay Factors

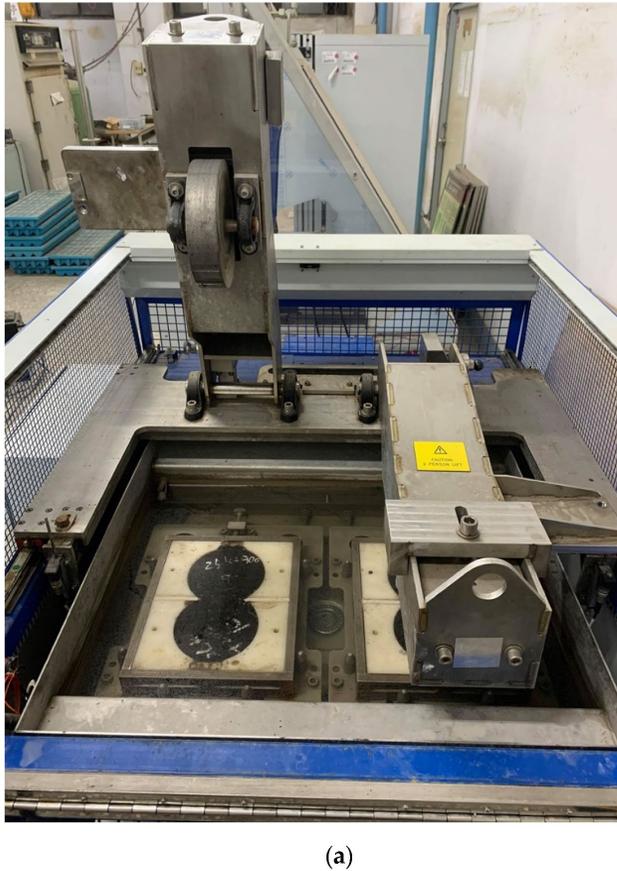


Repeated Load Triaxial



Wheel Tracking Devices

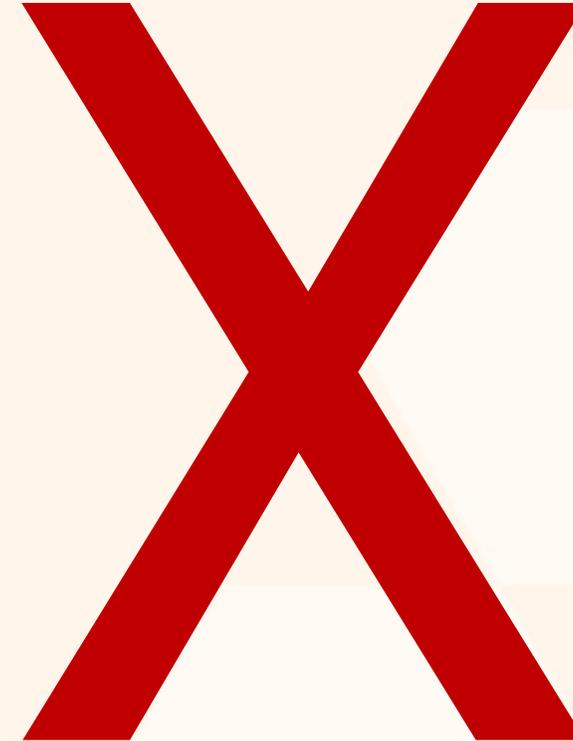
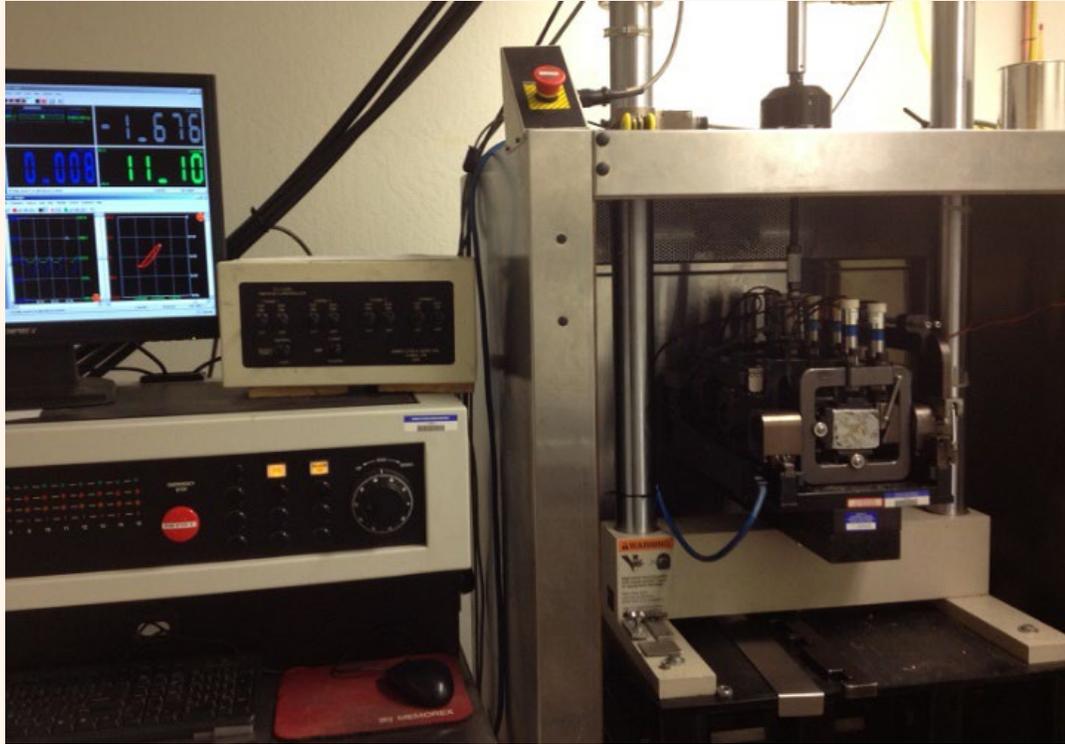
HAMBURG



APA



Flexural Beam Fatigue

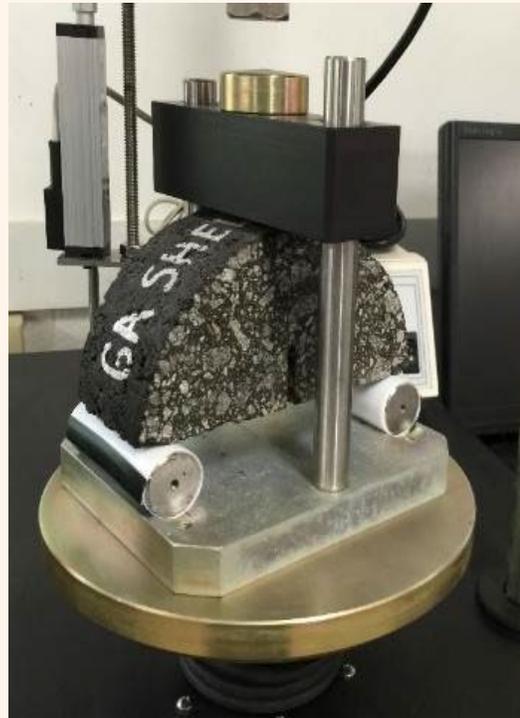


Comparison of Cracking Index tests

SCB: Three notch depths



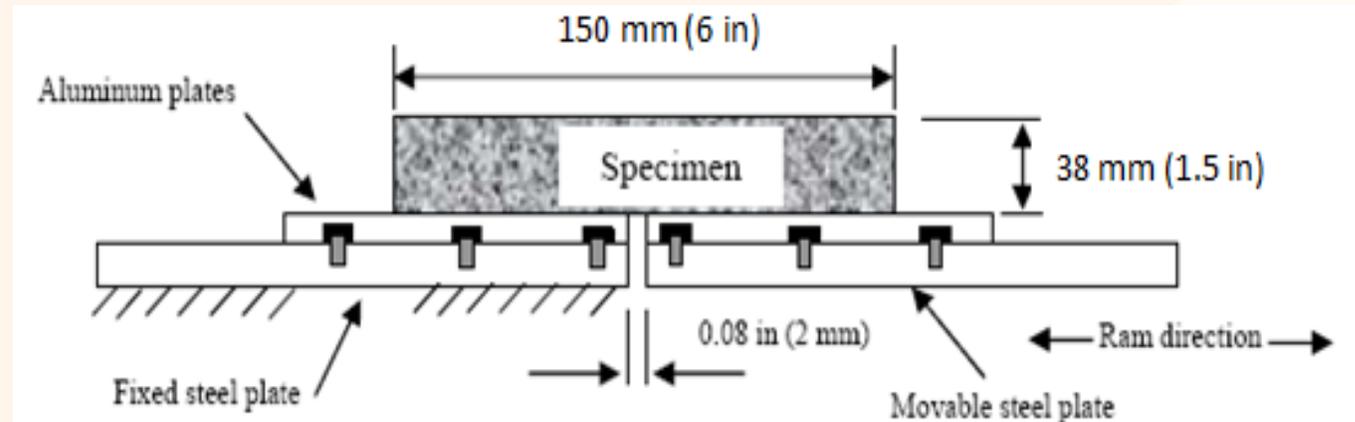
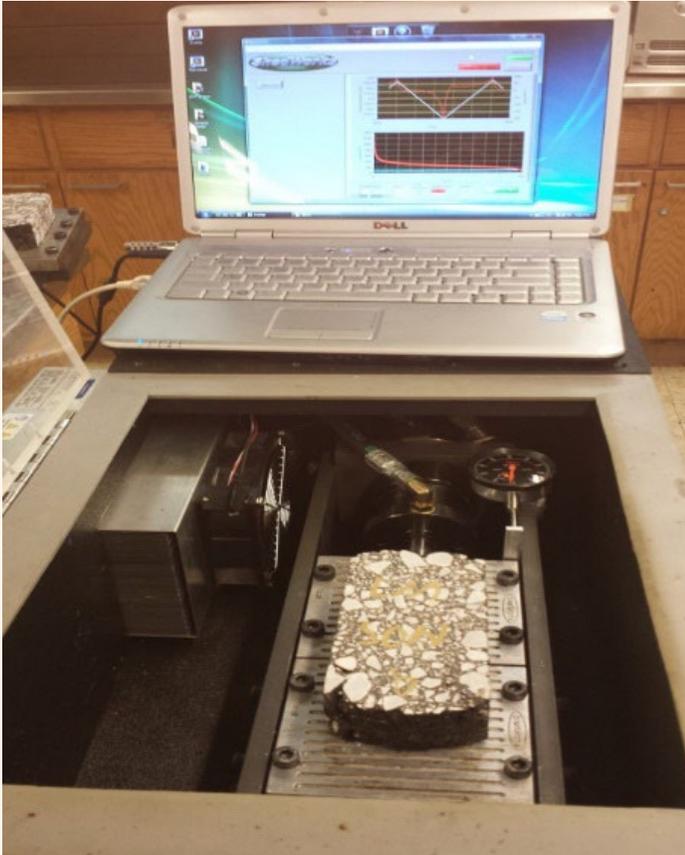
I-FIT: One notch



IDEAL-CT



Overlay Tester: **MAYBE**



How Well They DO?

Study	Data	Mix Type	APA	HWTT		AMPT		RLPD	SPST
			RD ¹	RD ¹	RR ²	FN	E*		
Williams & Prowell - 1999	Westrack Sections	PMLC	0.81		0.91				
NCAT - 2009	Test Track-2006	PMLC	0.80 ³			0.88 ³			
Goh et al. - 2011	Michigan Sections	PMLC					0.26		
NCAT - 2012	Test Track-2009	PMLC	0.13/ 0.70 ⁴	0.75	0.74	0.15/ 0.54 ⁴			
Walubita et al. – 2019	TxDOT Sections	PMLC		Good		Poor	Good	Poor	Good
Walubita at al. - 2020	TxDOT Sections	PMLC		0.81					



How Well They DO?

Study	Data	Mix Type/Aging	Overlay Test			IDEAL-CT	I-FIT	SCB	UoF-IDT	BBF
			Cycles	CFE	CPR (β)	CT _{index}	FI	J _c	ER	N _f
NCAT	FHWA ALF 2013	PMLC/ Reheat	0.47 (NCAT)					0.23		
LSU			0.82	0.30	0.77			0.57	0.48	
FHWA				0.40	0.60	0.60	0.50			
NCAT	Test Track 2009-GE	PMLC/ None	0.86							0.58
UTEP	TxDOT 2017	LMLC/ Cores	Moderate	Good	Excellent					
Range			0.82-0.86	0.30-0.40	0.60-0.77	0.60	0.50	0.23-0.57	0.48	0.58



How Repeatable?

Study	Data	Mix Type	Texas OT COV (%)			CT _{index} COV (%)		I-FIT COV (%)		HWTT COV (%)	
			CFE	CPR	Cycles	Single	Multi	Single	Multi	Single	Multi
Garcia et al. (2017)	UTEP – 30 mixes	LMLC	13	25	73						
	TxDOT – 30 mixes	LMLC	12	21	68						
	TxDOT – 120 mixes	LMLC	10	8	27						
Perez et al. (2021)	11 Labs	PMLC								14	24
Habbouche et al. (2022)	50 labs – 2 mixes 40 set/mix	LMLC				21 ¹	29 ¹				
						11 ²	25 ²				
Romero & VanFrank (2022)	3 Labs – 3 mixes 167 tests	PMLC				15 ³	20 ³				
Taylor et al. (2022)	9-29 labs 1 mix	PMLC				20 ⁵ 19	35 ⁵ 20	30 ⁵ 47	48 ⁵ 53	9 ⁴ 9	21 ⁴ 26



Other Issues to Consider

- Aging or No Aging
 - Rutting is early life distress
 - Cracking is later life distress

WHAT TEMPERATURE AND HOW LONG?



Other Issues to Consider

- Who Conducts the Mix Design
 - Equipment availability
 - Technician training
 - Repeatability



Other Issues to Consider

- How to set design Criteria
 - Benchmark testing
 - Shadow testing
 - Pilot Projects



Other Issues to Consider

- QC/QA Testing
 - Same tests as mix design
 - Simpler tests than mix design
 - Correlations

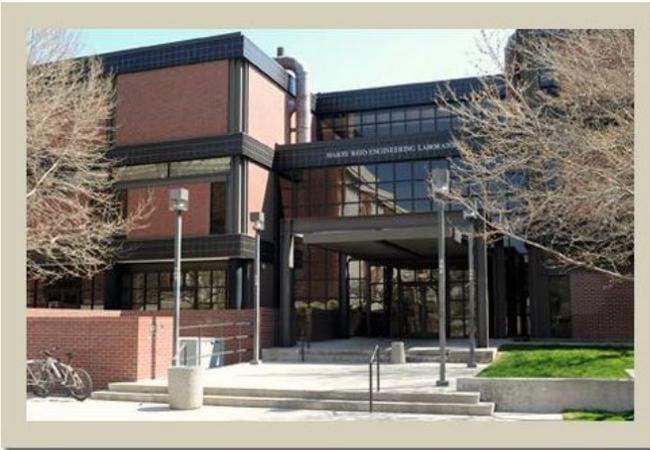


Is it All Worth It?

**YES
For
Sustainability**



Thank You



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