“Goldilocks” ABR in HMA

Applying the Concept of “Just the Right Amount” to Balanced Mix Design

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HOW DID WE GET HERE?

- Superpave
  - Strategic Highway Research Program (SHRP)
    - 1987 to 1993
- Performance-based asphalt binder specification
- Performance-based asphalt mixture specification
- Mix design system

RUTTING

Measuring Tool:
Hamburg Wheel

Solution?

CRACKING

Potential Causes:

- AC grade
- Construction quality
- Underlying distresses

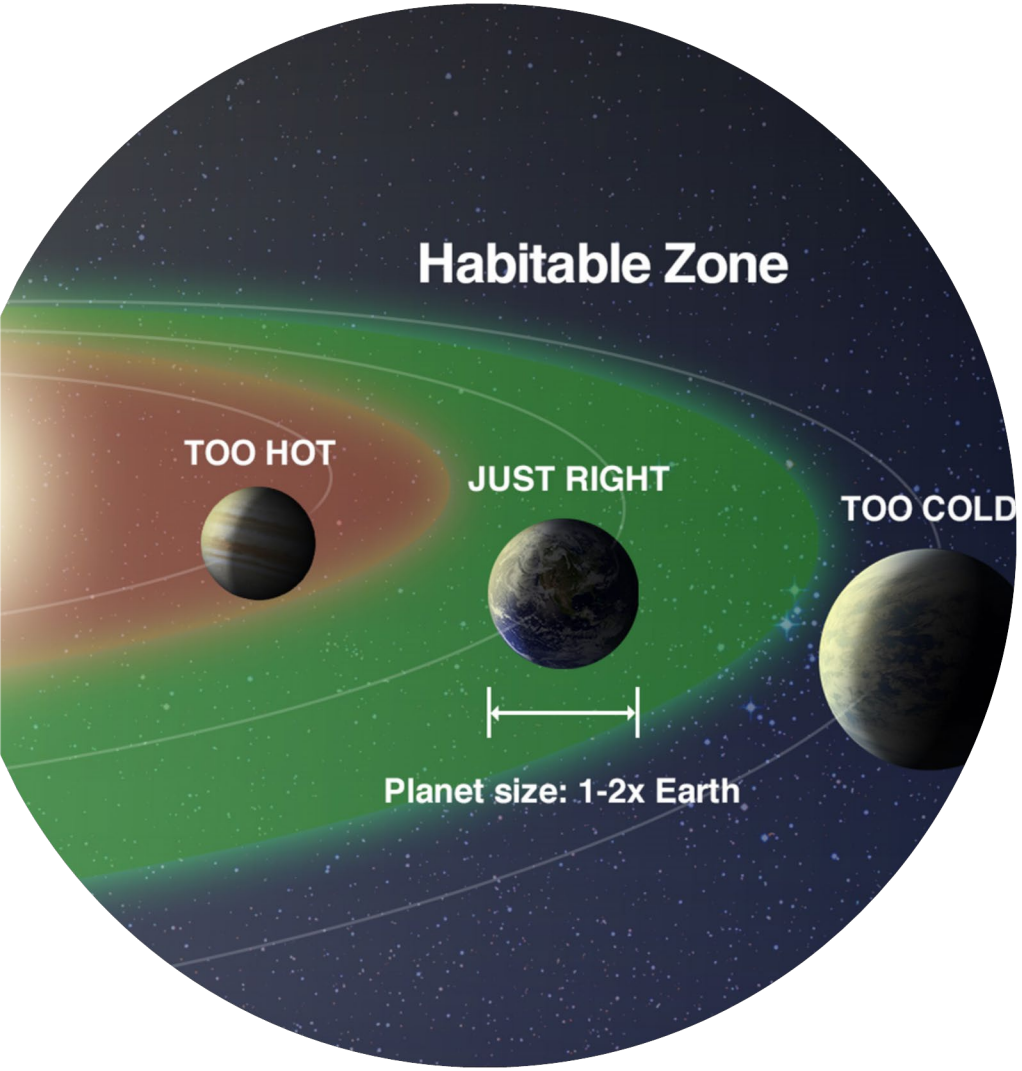
Too much of a good thing?

What is a “Goldilocks” Zone ?

GOLDILOCKS ZONE

- Familiar

GOLDILOCKS ZONE



- Familiar
- Science

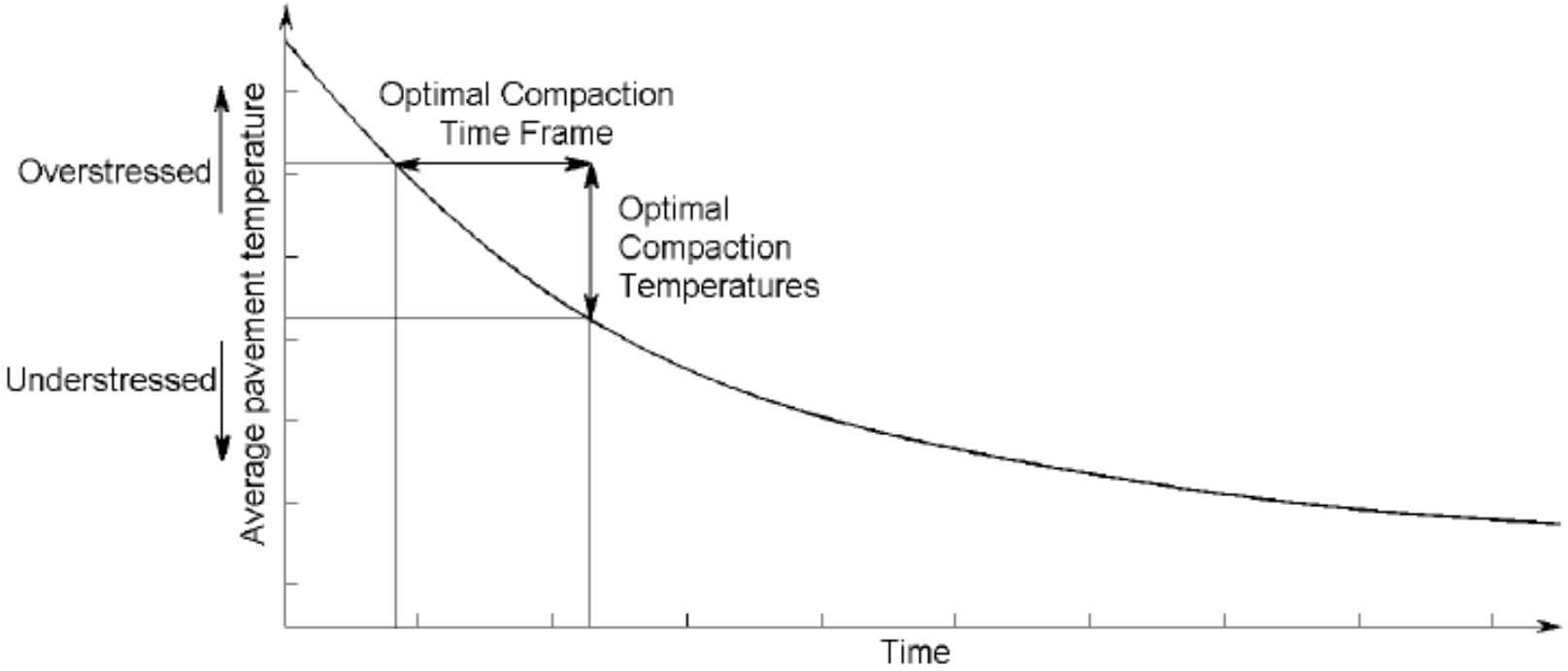
GOLDILOCKS ZONE

- Familiar
- Science
- Sports

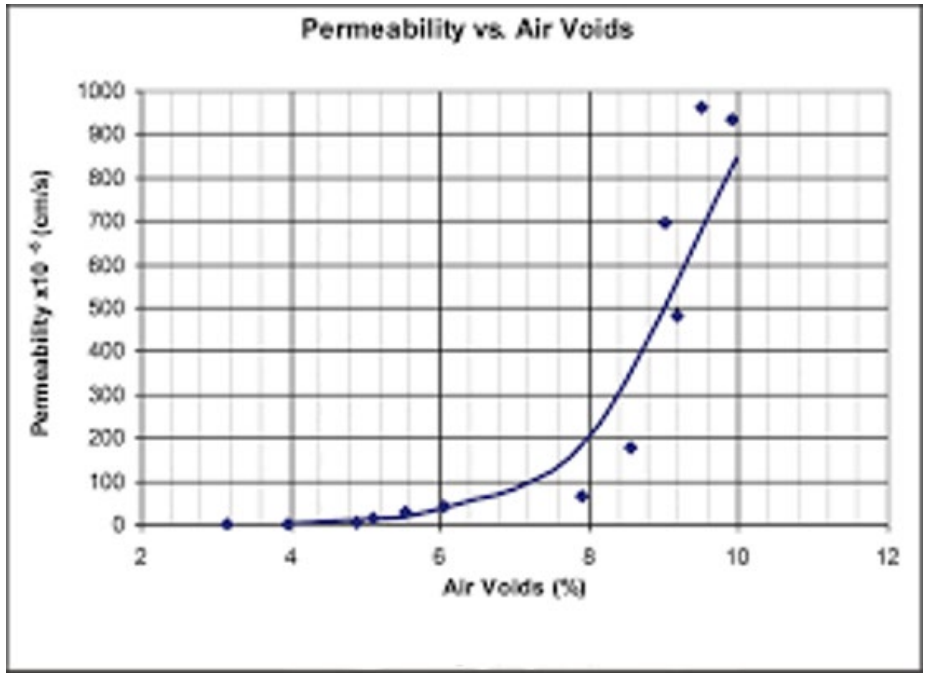
GOLDILOCKS ZONE

- Familiar
- Science
- Sports
- Celebration

COMPACTABILITY VS. TEMPERATURE



PERMEABILITY VS. AIR VOIDS



"Accepted knowledge says that for every 1% increase in air voids, about 10% of the pavement life may be lost."

-Jim Scherocman, P.E.

"If air voids fall below 3%, there will be inadequate room for expansion of the asphalt binder in hot weather. When the void content drops to 2% or less, the mix becomes plastic and unstable.

-Asphalt Institute's website

TESTING EQUIPMENT

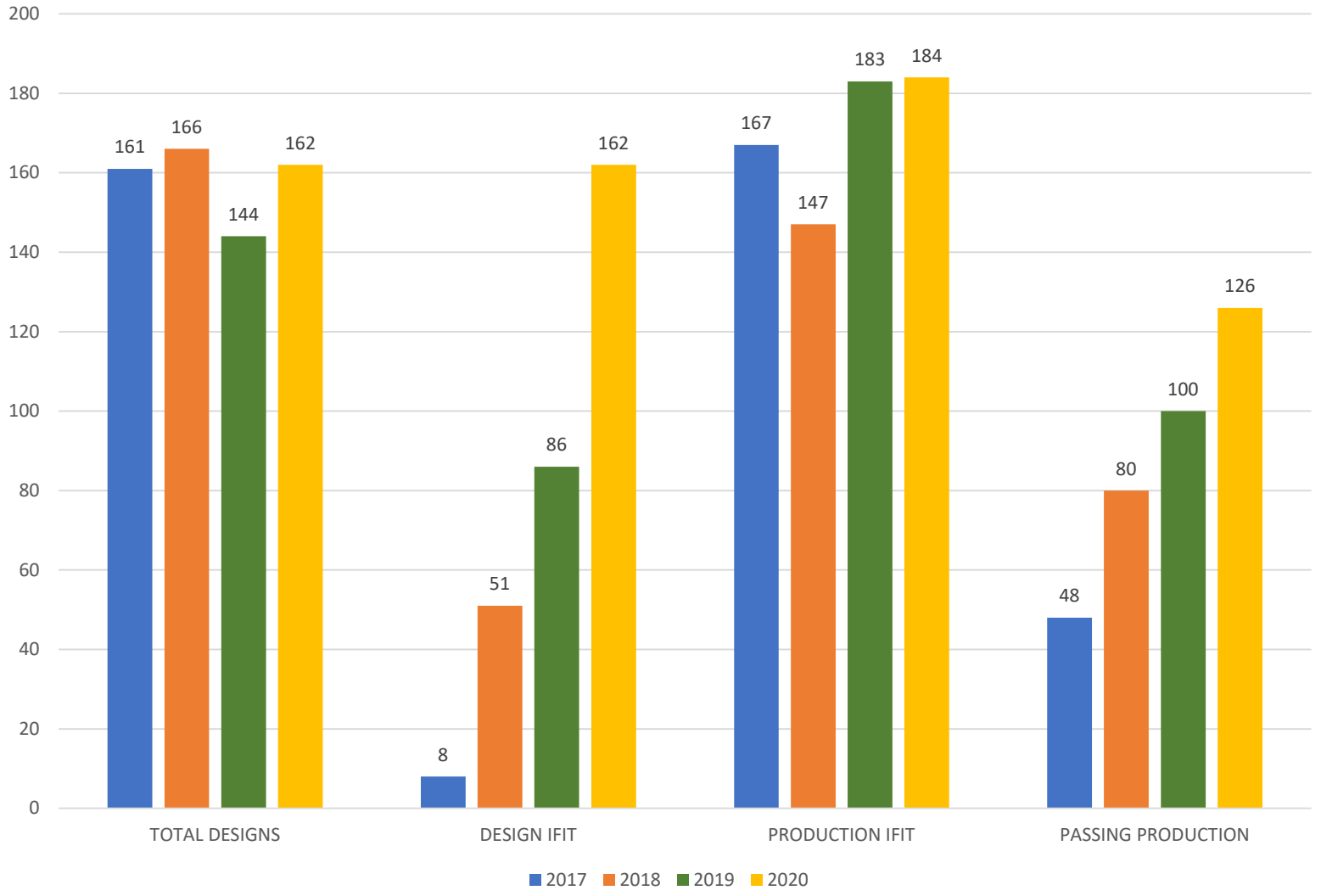
IFIT

Hamburg Wheel

BRITTLE ⟵ Goldilocks Zone ⟶ PLASTIC

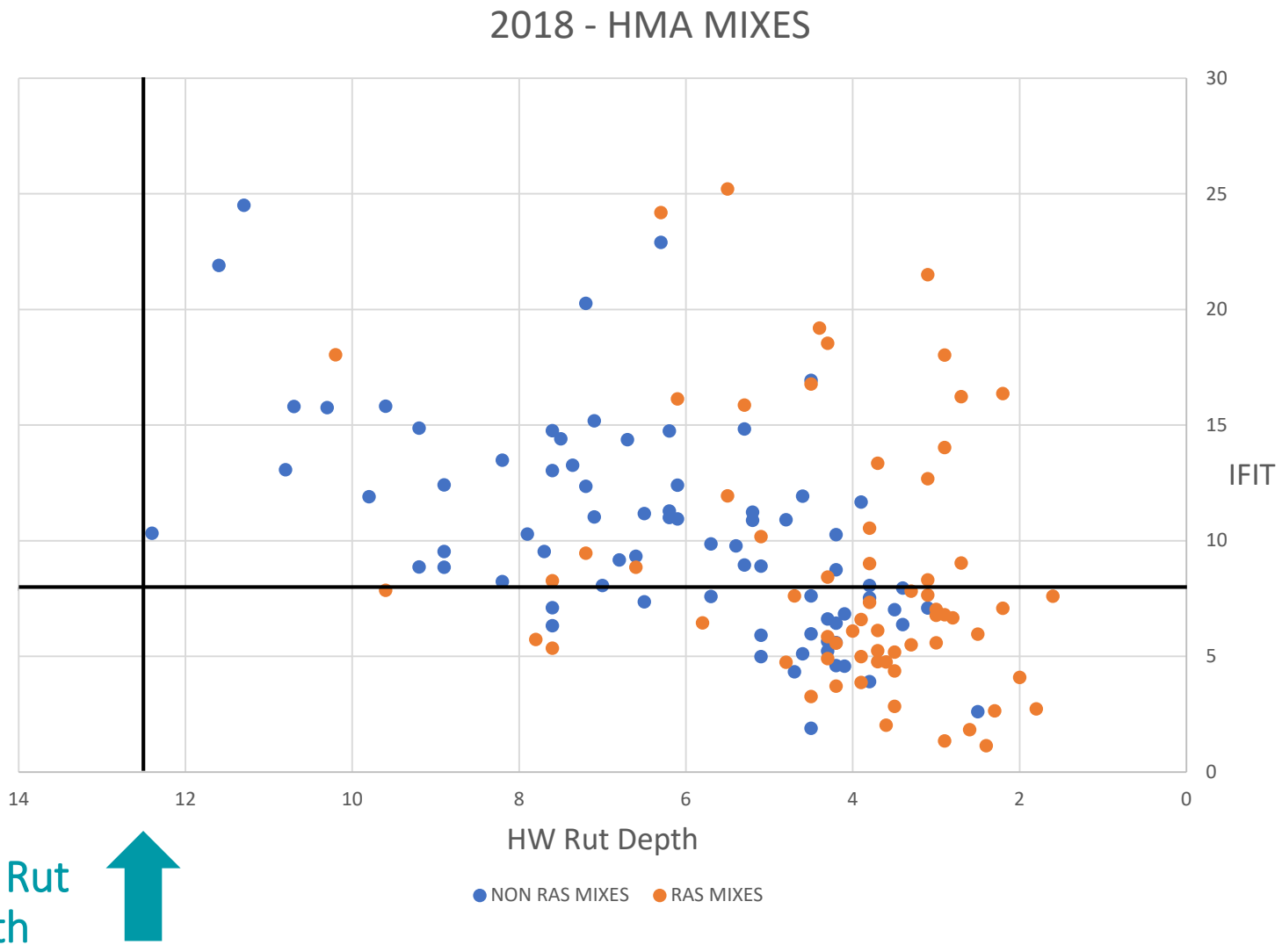
- Over expected temperature and loading conditions
- Life of HMA
  - Production
  - Placement
  - Aging and ….

THREE PLUS YEARS OF RESULTS



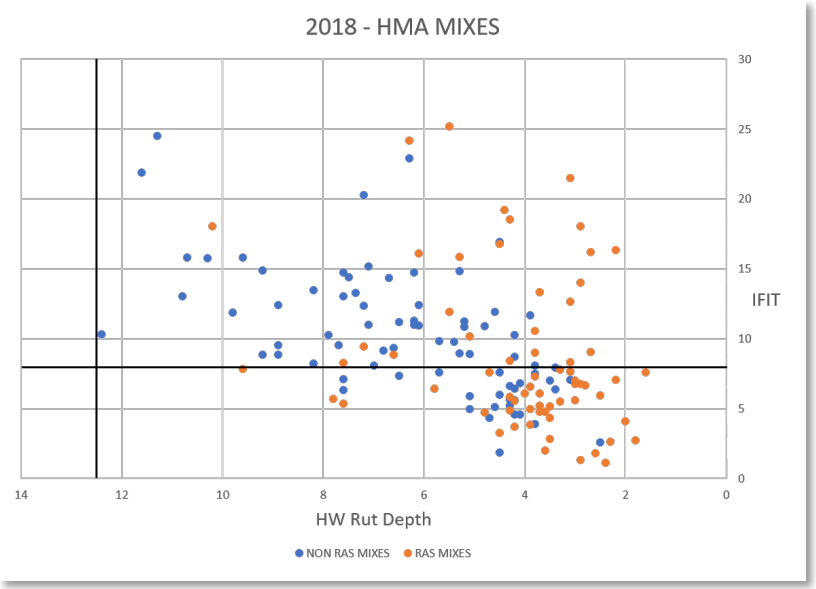
2018 – HMA MIXES

IFIT Minimum Value



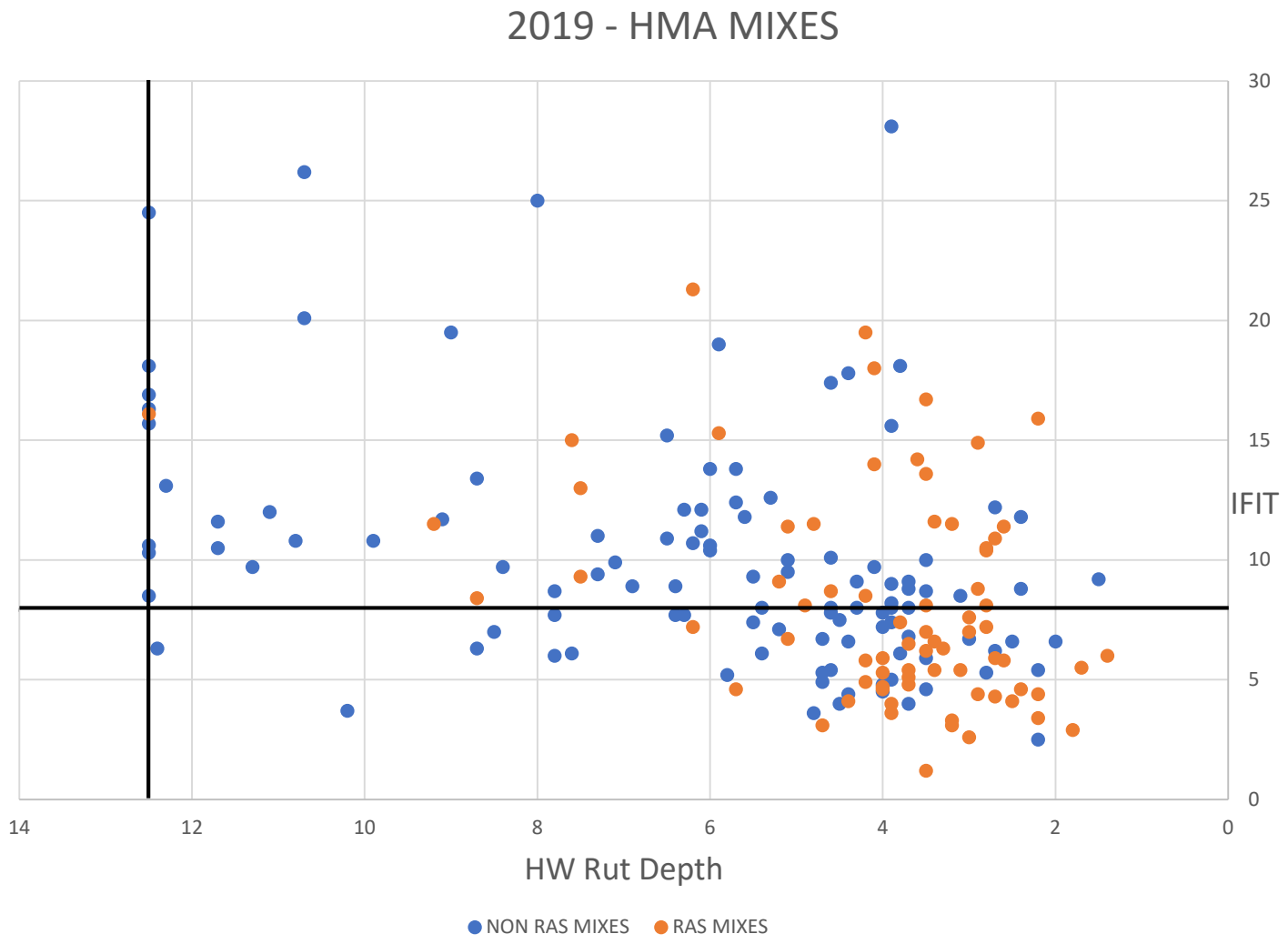
Max Rut Depth

2018 – IFIT BREAKDOWN

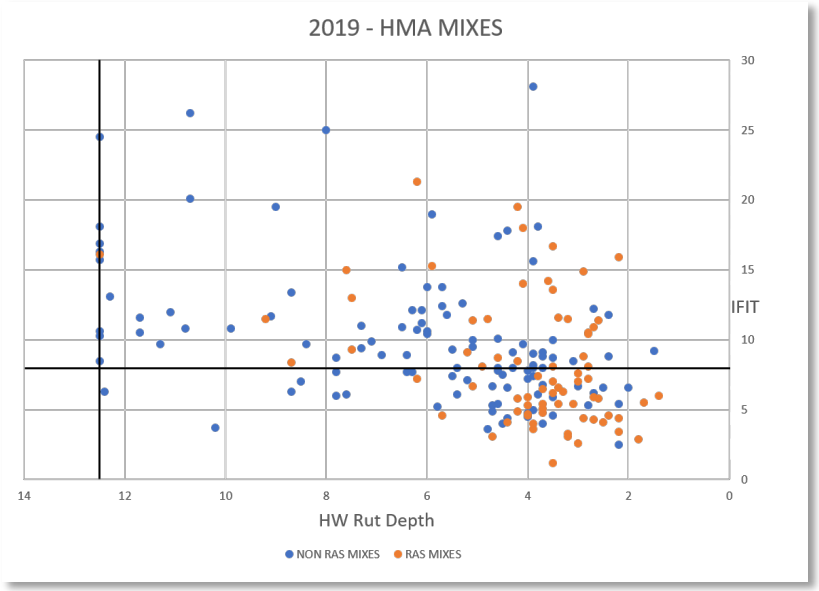


	TOTAL SAMPLES	w/RAS	w/o RAS
	146	68	78
PASSING FI	80	27	53
% PASSING	54.80%	39.70%	67.90%
HW RUT DEPTH >5.0 mm	10	4	6
NOT PASSING	6.80%	5.80%	7.60%

2019 – HMA MIXES

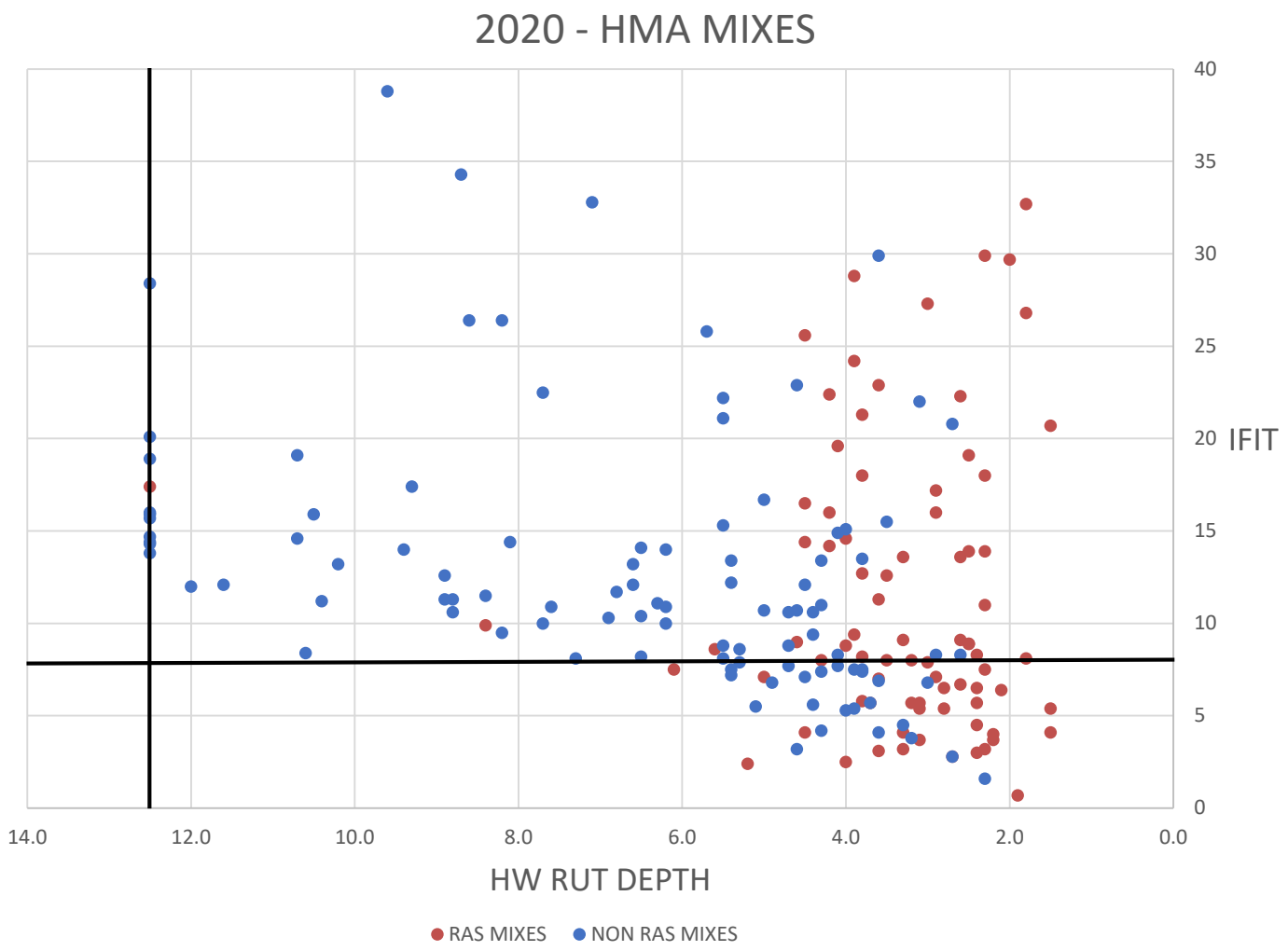


2019 – IFIT BREAKDOWN

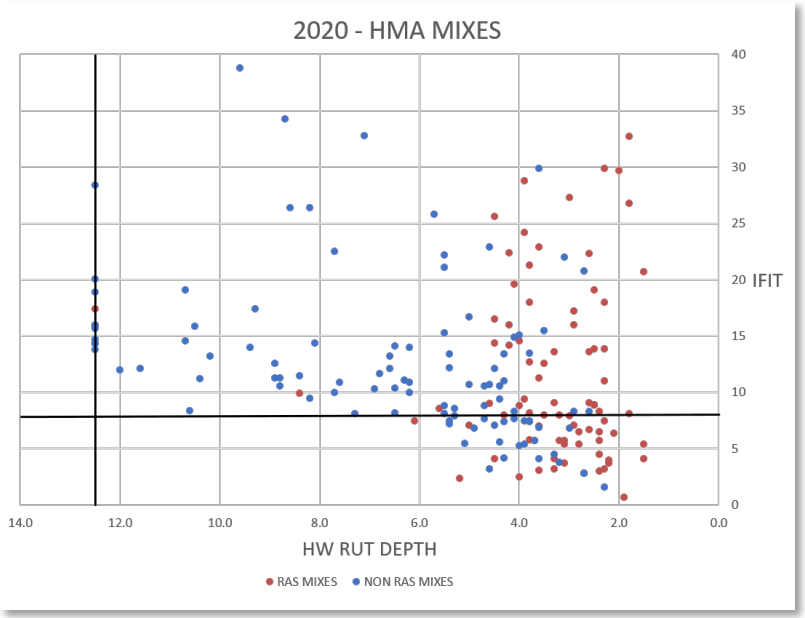


	TOTAL SAMPLES	w/RAS	w/o RAS
	183	73	110
PASSING FI	100	31	69
% PASSING	54.60%	42.50%	62.70%
HW RUT DEPTH >5.0 mm	15	3	12
NOT PASSING	8.20%	4.10%	10.90%

2020 – HMA MIXES

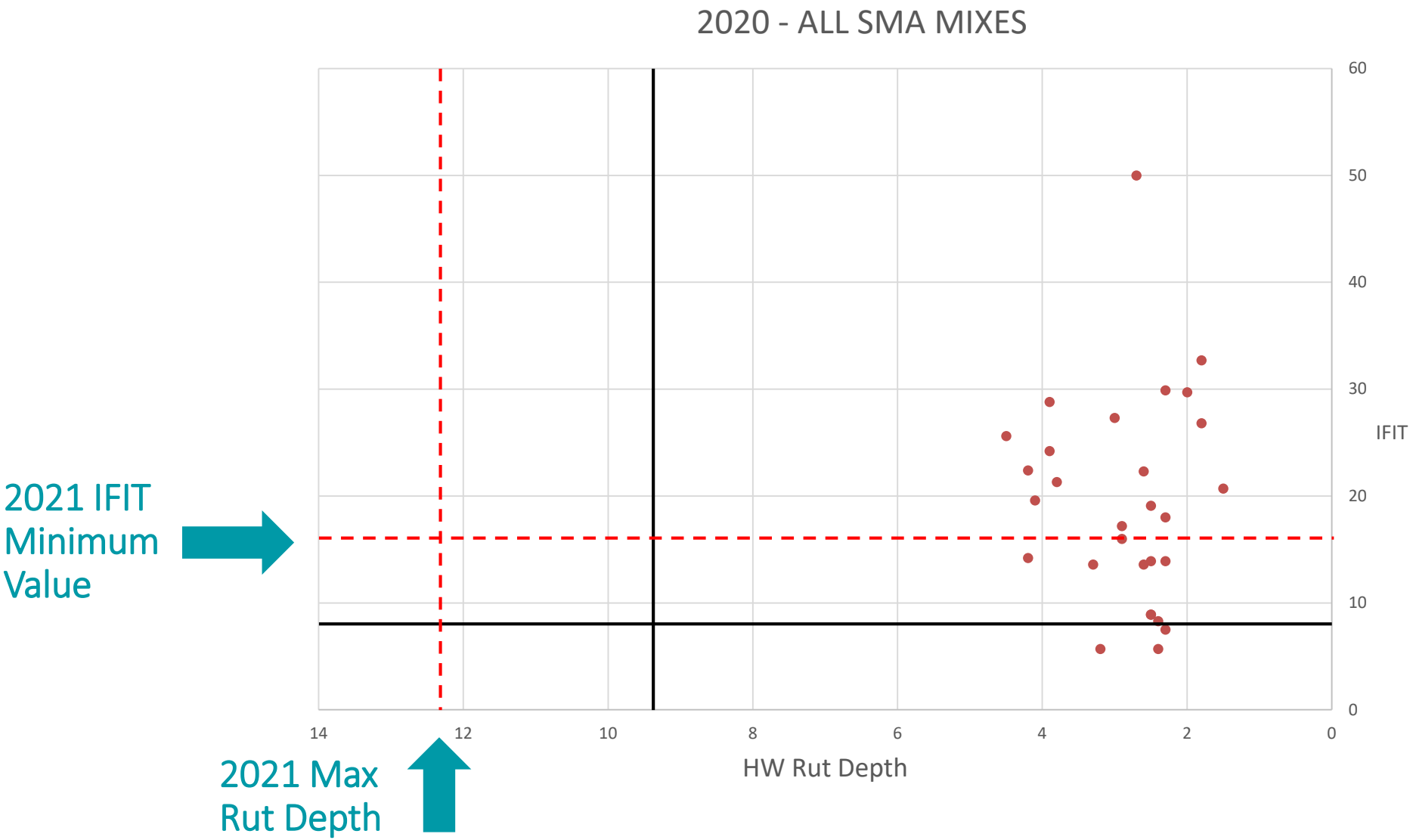


2020 – IFIT BREAKDOWN

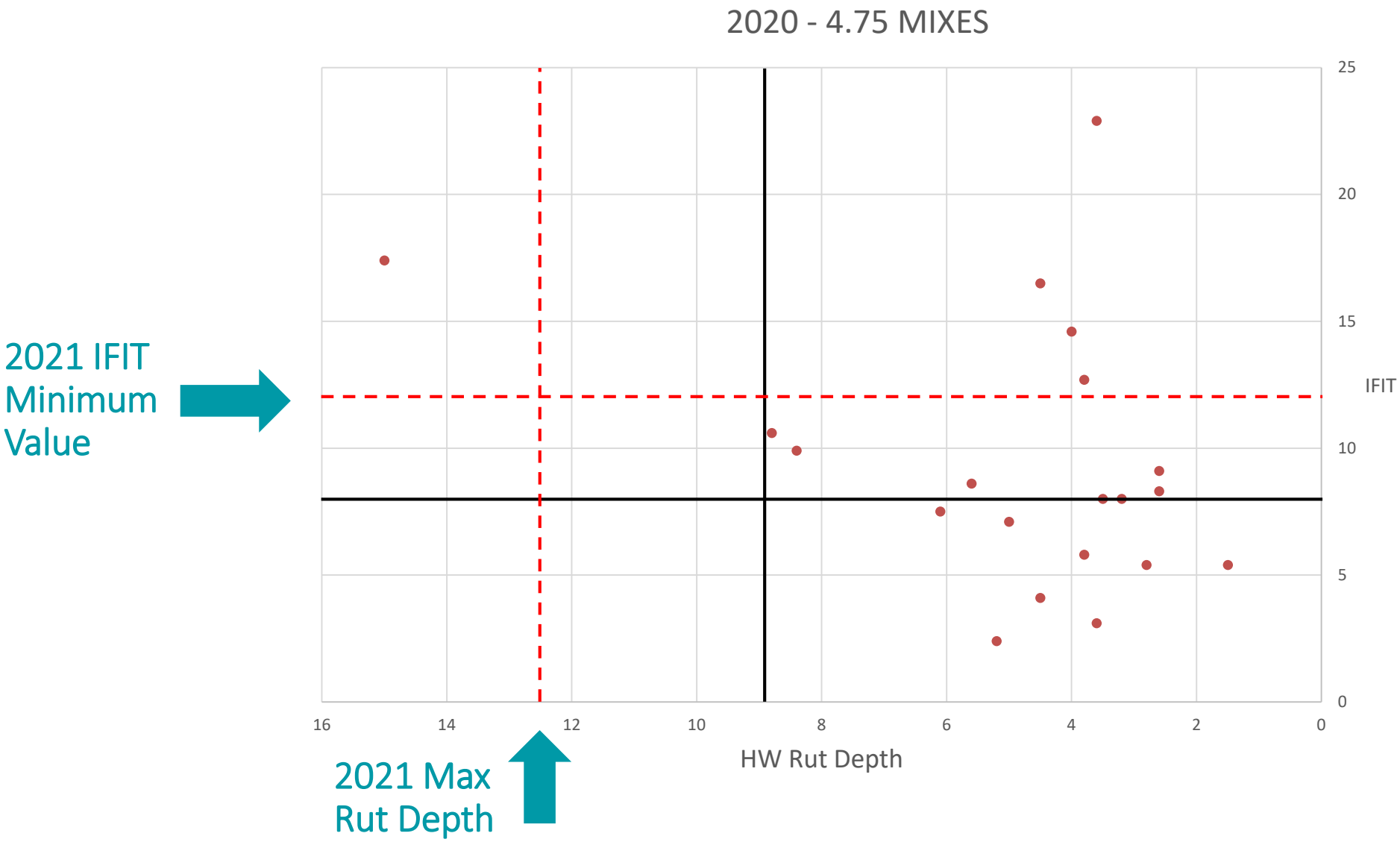


	TOTAL SAMPLES	w/RAS	w/o RAS
	184	82	102
PASSING FI	126	49	77
% PASSING	68.50%	59.80%	75.50%
HW RUT DEPTH NOT PASSING:			
>5.0 mm	7	3	4
>3.5 mm	27	5	21
<3.5 mm	24	25	5

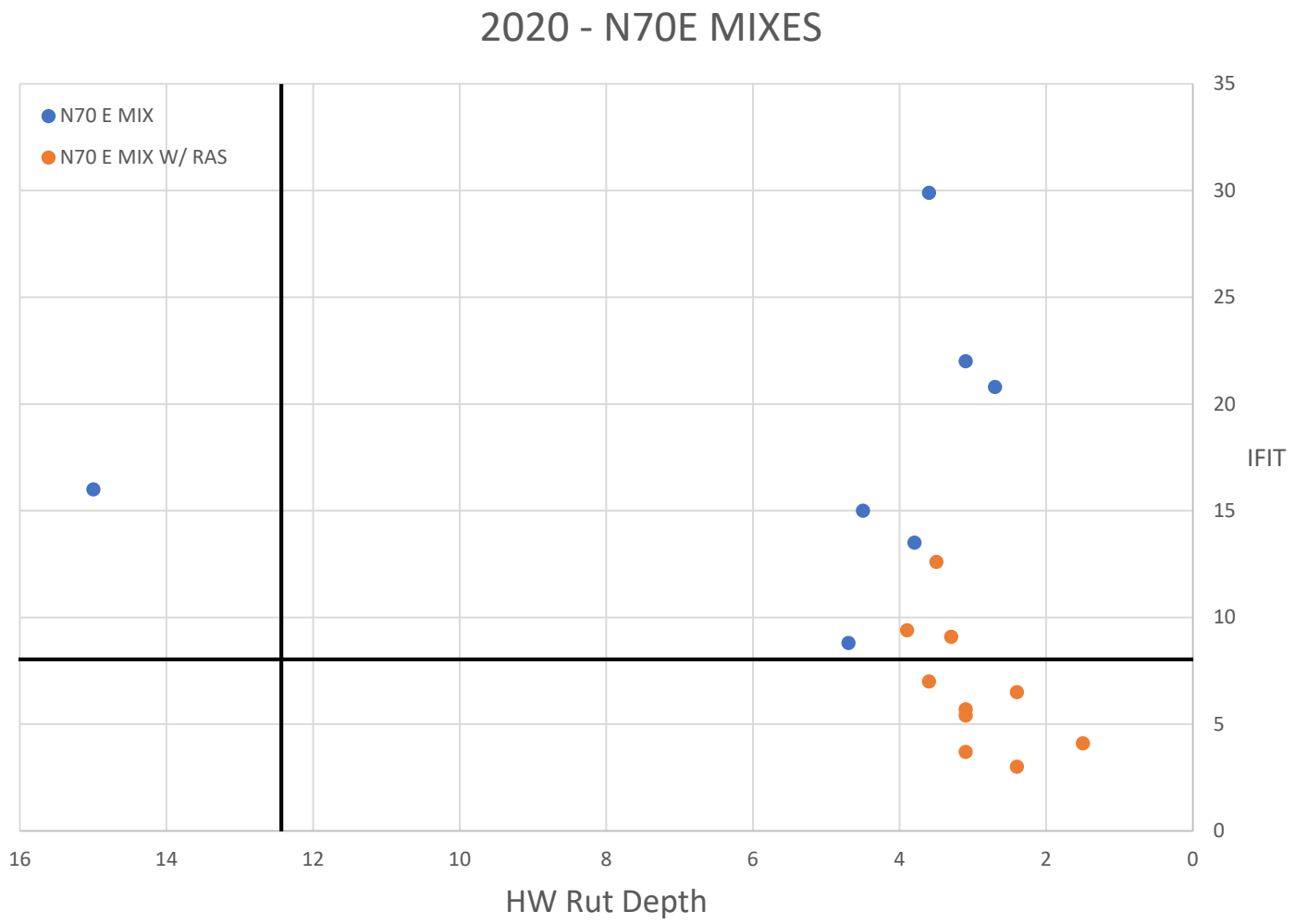
2020 – ALL SMA MIXES



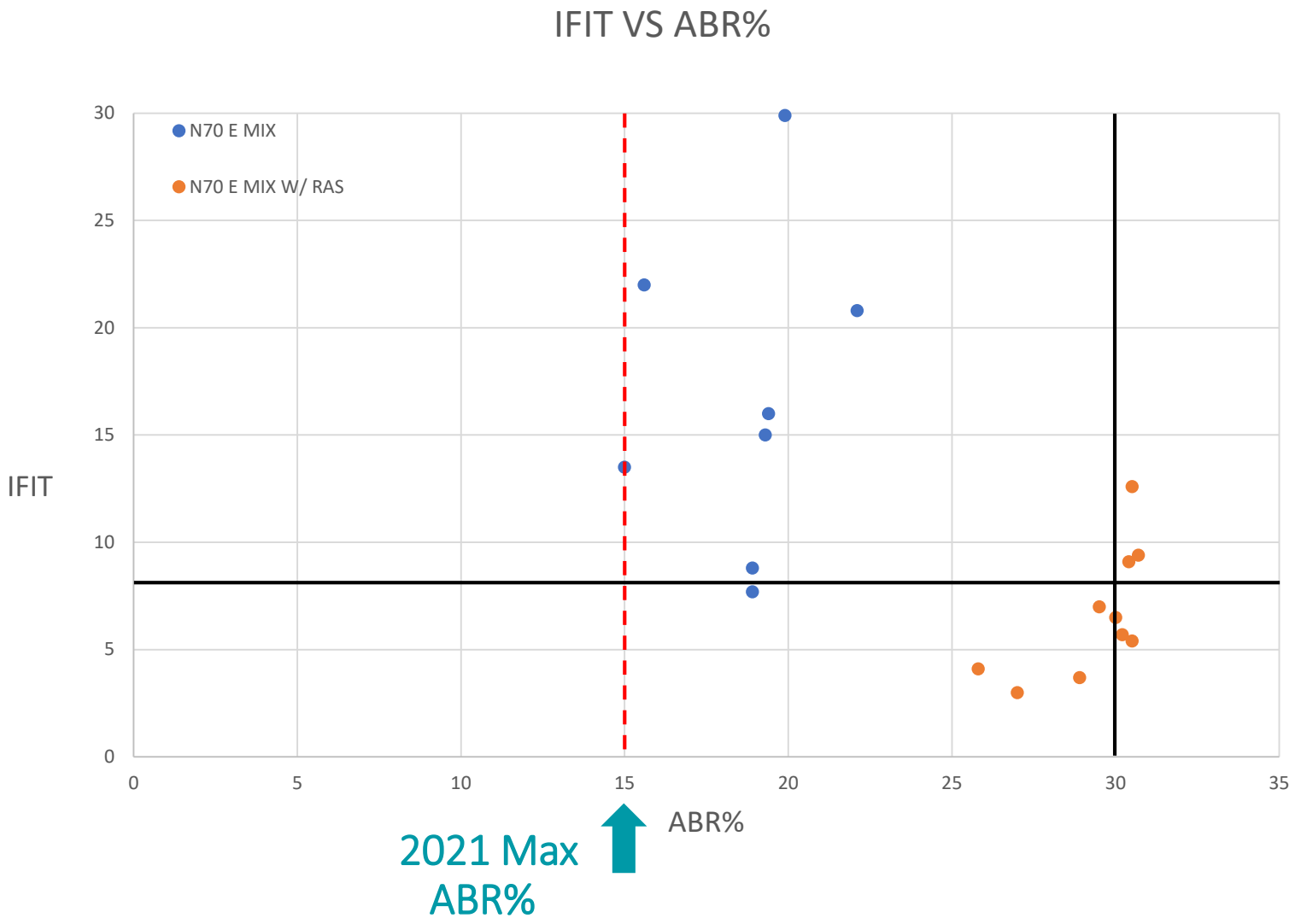
2020 – 4.75 MIXES



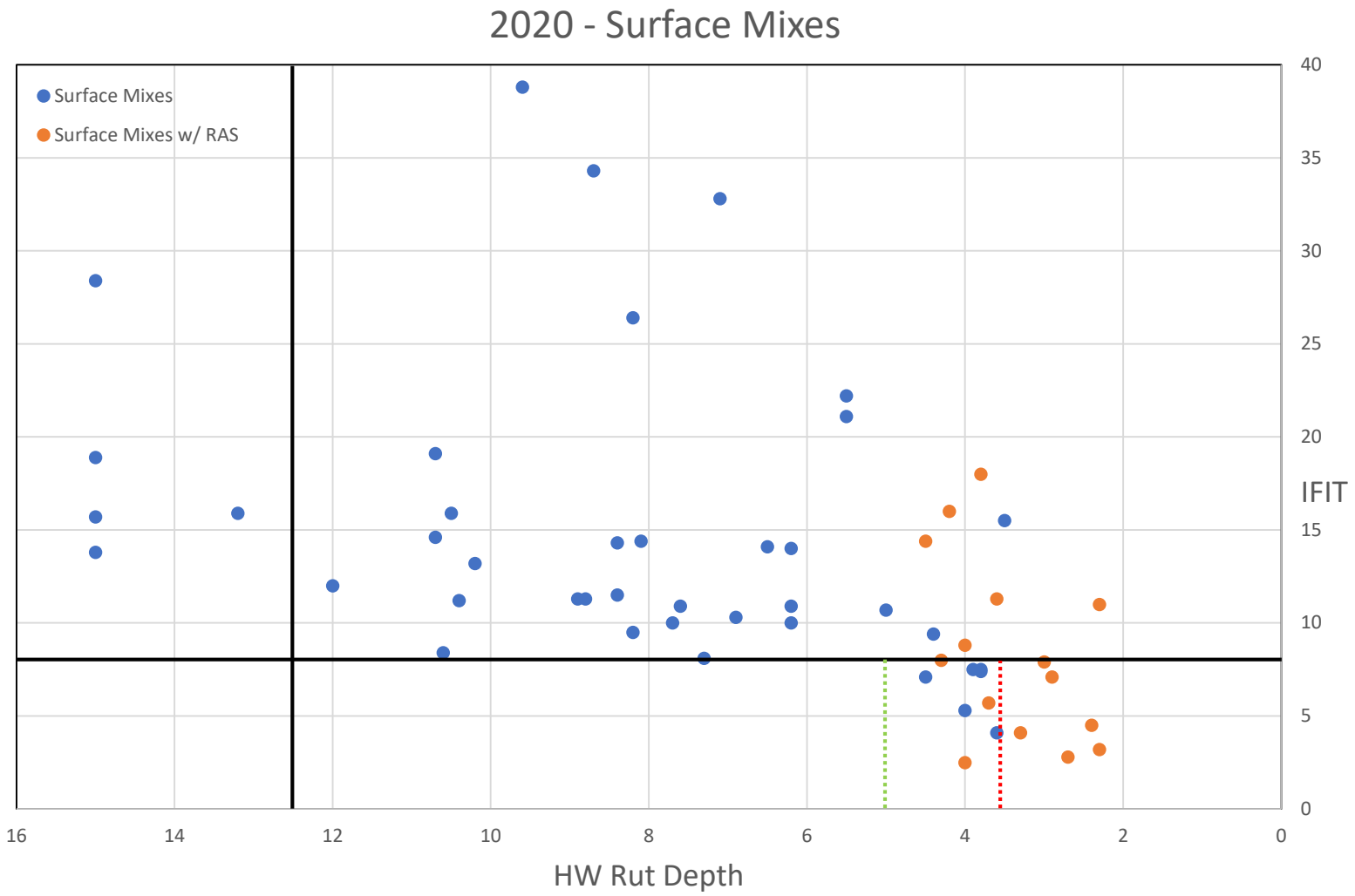
2020 – N70E MIXES



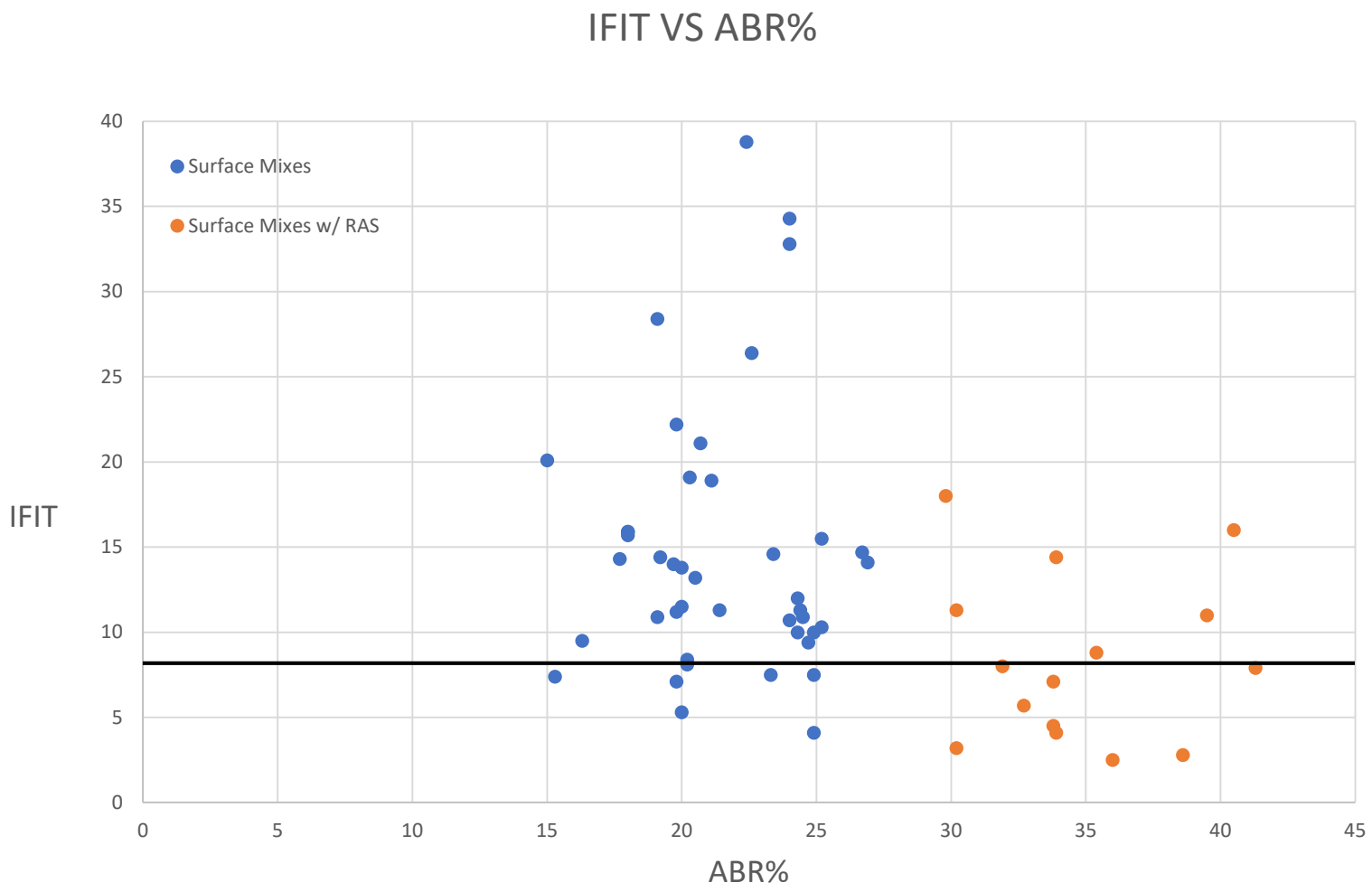
2020 – N70E MIXES



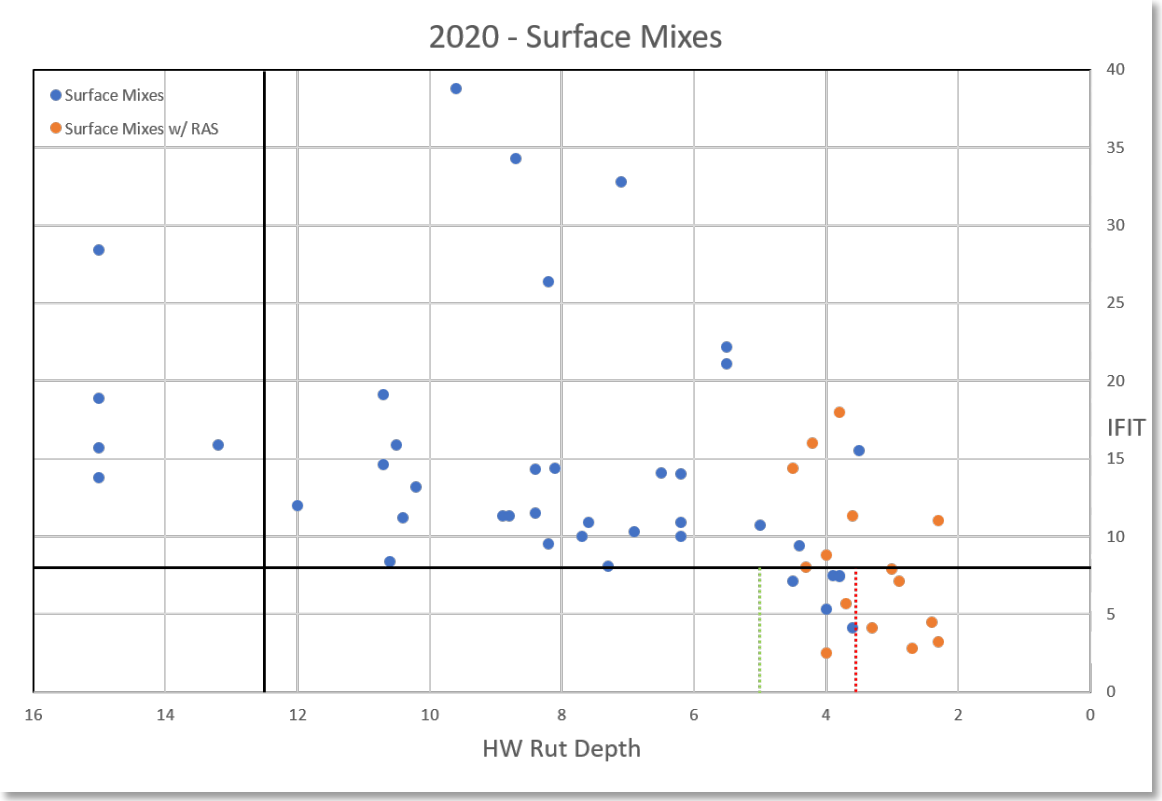
2020 – SURFACE MIXES

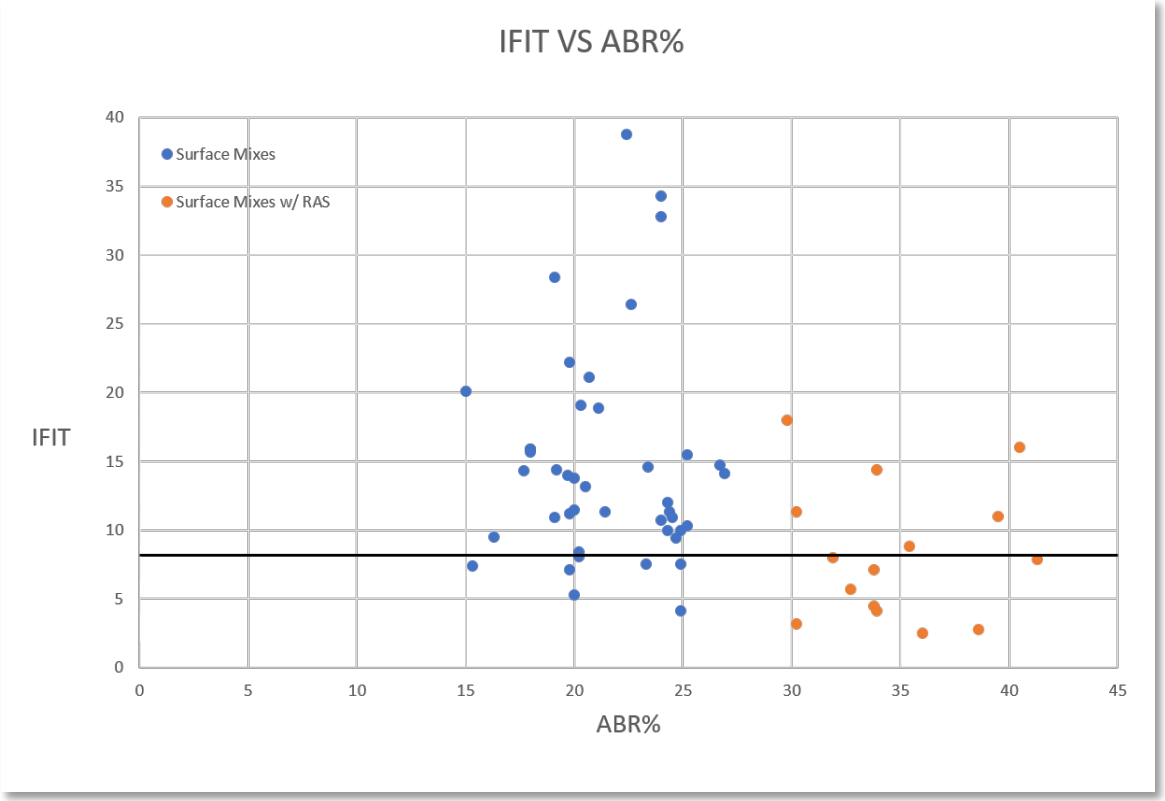


2020 – SURFACE MIXES

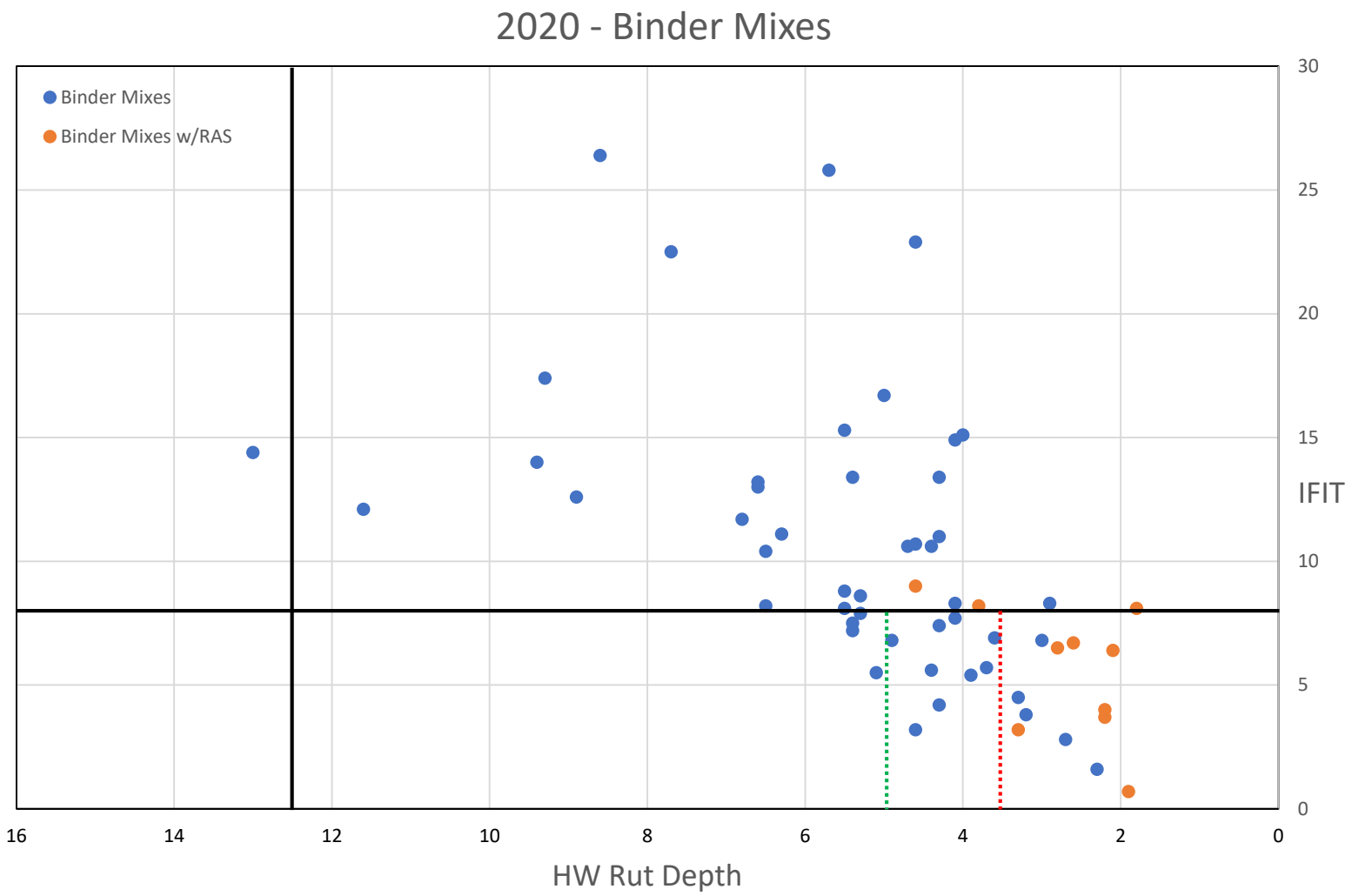


2020 – SURFACE MIXES

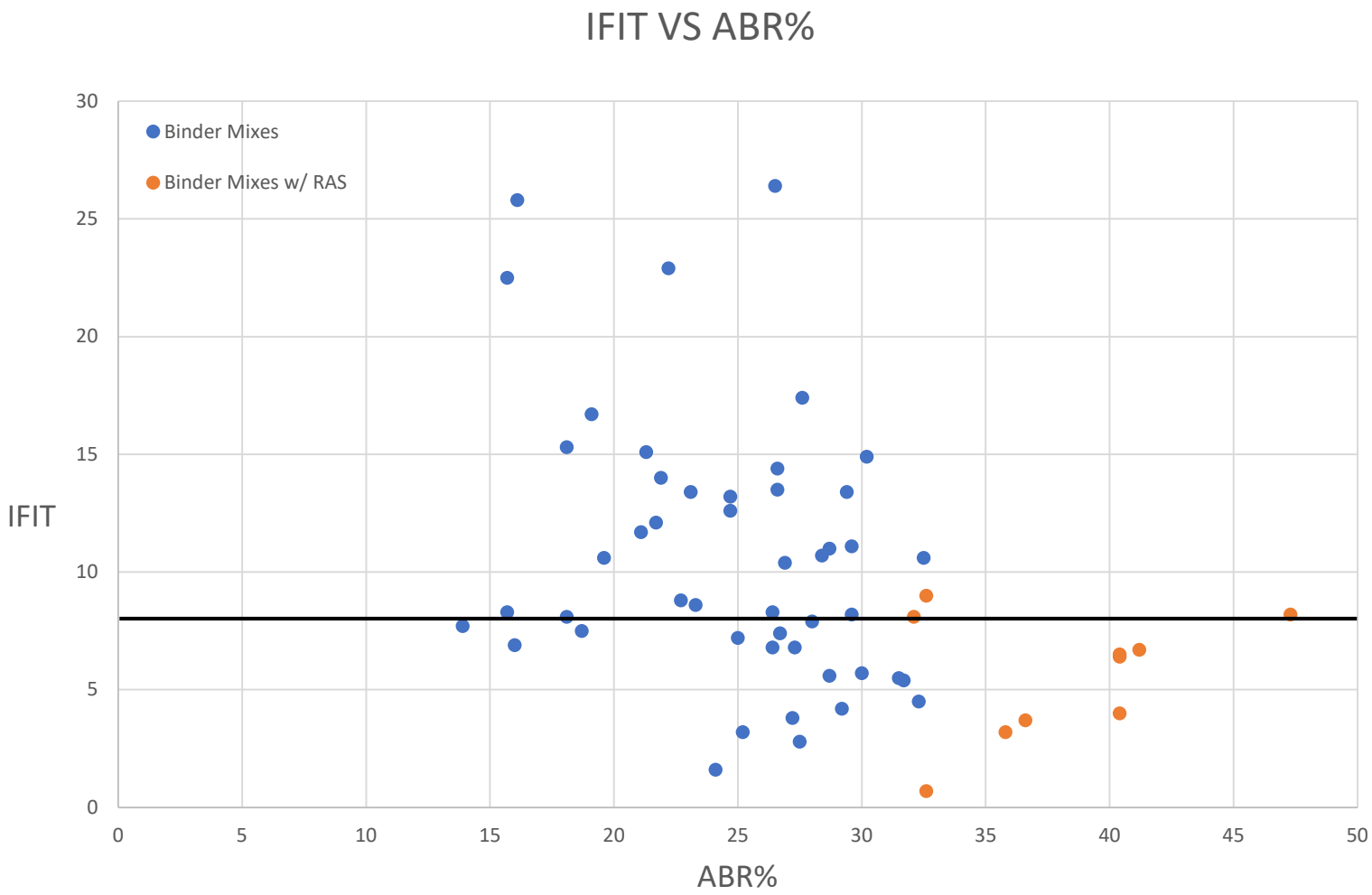




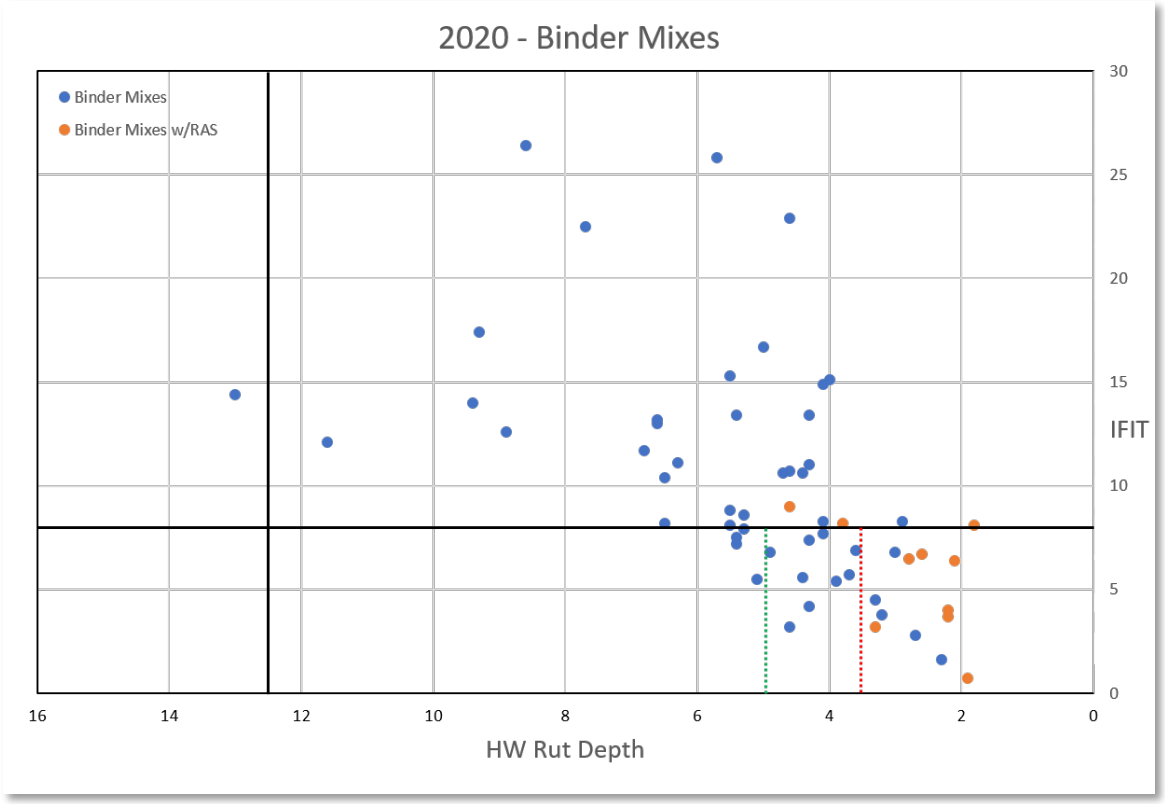
2020 – BINDER MIXES

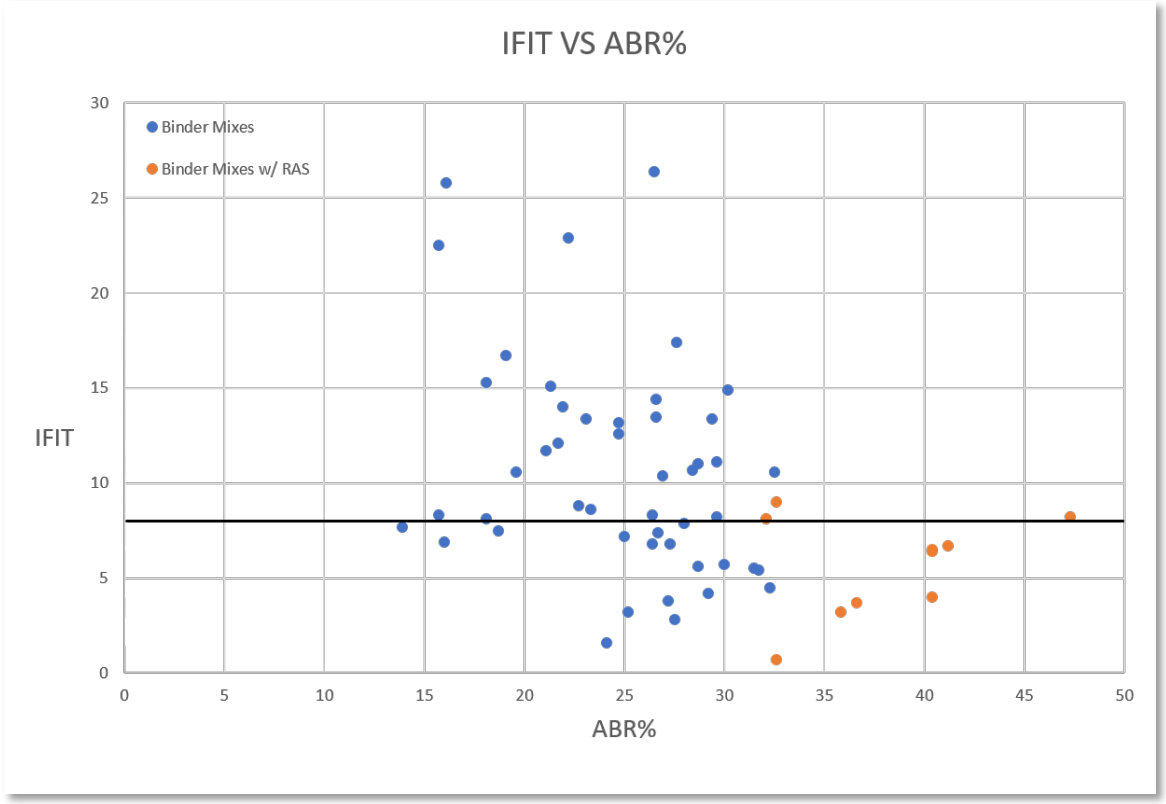


2020 – BINDER MIXES



2020 – BINDER MIXES





FACTORS AFFECTING RESULTS

MIX COMPONENTS INFLUENCING IFIT:

- Asphalt Binder Replacement(ABR)
- Design VMA
- Virgin Aggregates
- Virgin AC Source
- Additives

2019 – SHADOW PROJECT A

District 1 - Project A

Mixture	N70 E IL-9.5
Binder Grade	SBS 70-28
VMA (%)	15.9
ABR(%)	17.7

Day	STA FI Avg.	LTA FI Avg.	Six Month LTA FI Avg.	ΔTc(°C)	%FI Reduction	6 Month %FI Reduction	Rut Depth @ 20,000 Passes
1	13.8	7.9	10.3	-5.5	42.8	25.4	5.7
2	18.1	8.2	12.1	-5.5	54.7	33.1	3.8
3	28.1	12.3	11.6	-4.5	56.2	58.7	3.9
4	26.2	13.5	11.5	-3.6	48.5	56.1	10.7
5	20.1	9.9	5.7		50.7	71.6	10.7
6	19.0	9.7	6.6		48.9	65.3	5.9
7	18.1	12.2	11.9	-2.2	32.6	34.3	16080
AVE	20.5	10.5	10.0	-4.3	47.8	49.2	

2019 – SHADOW PROJECT B

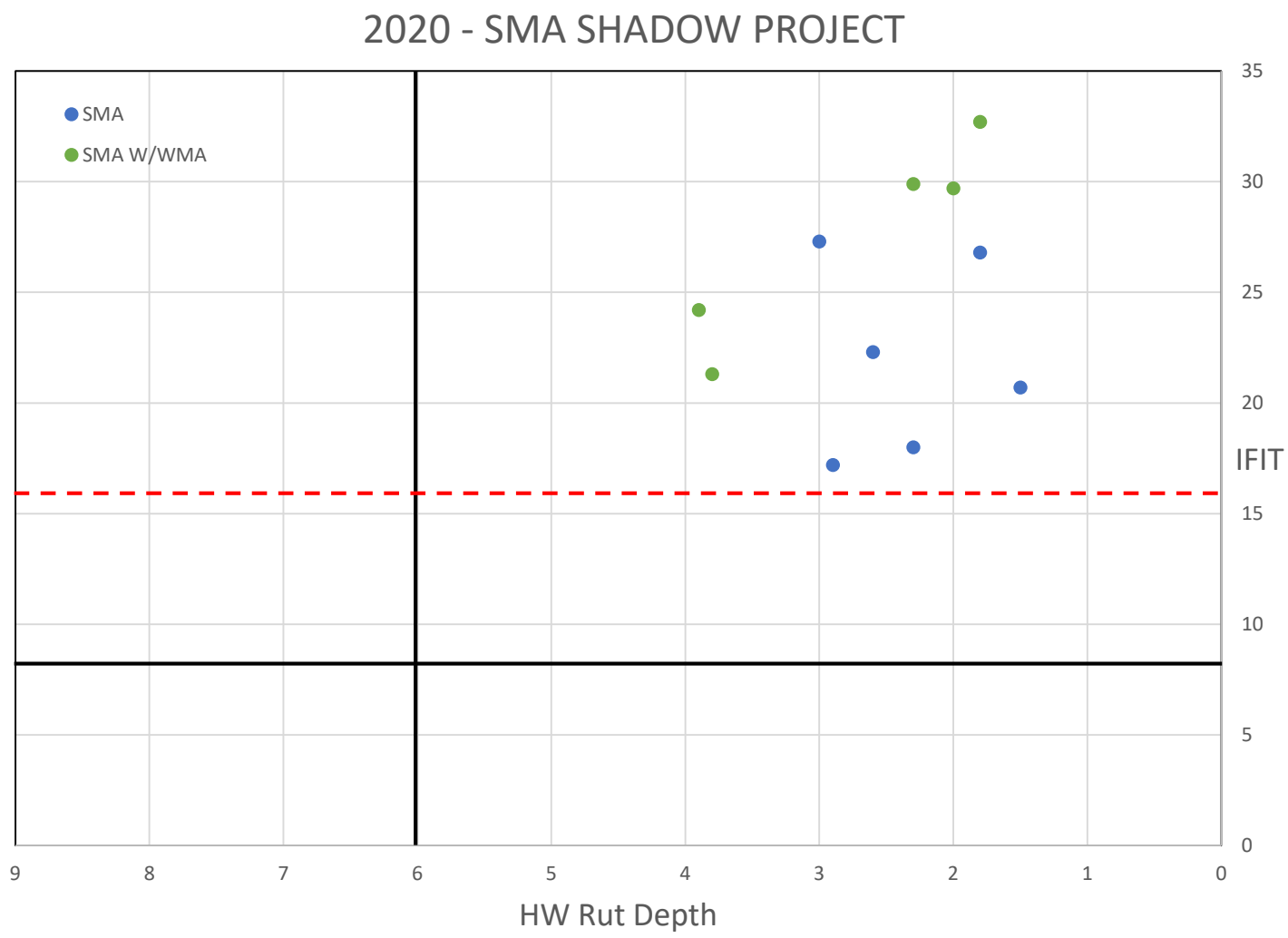
District 1 - Project B

Mixture	N70 E IL-9.5
Binder Grade	SBS 70-28
VMA (%)	15.5
ABR(%)	18.2

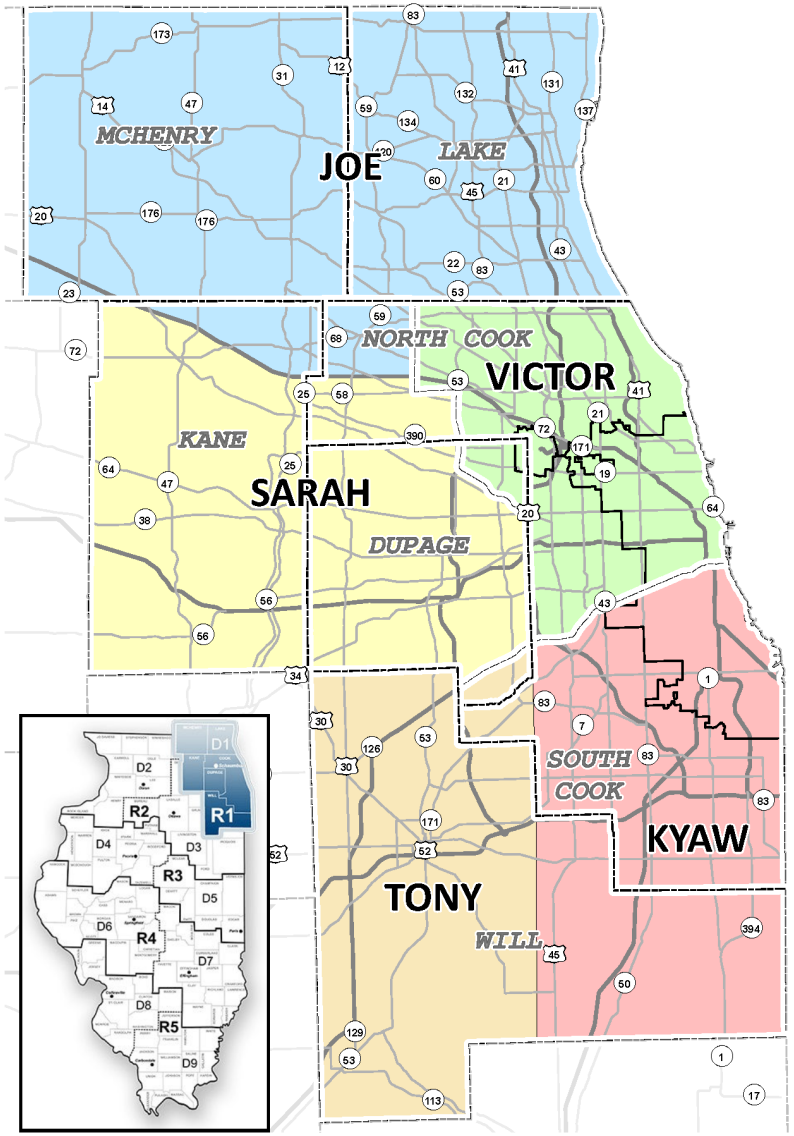
Day	STA FI Avg.	LTA FI Avg.	6 Month LTA FI Avg.	ΔTc(°C)	%FI Reduction	6 Month %FI Reduction	Rut Depth @ 20,000 Passes
1	11.7	6.3	6.9	-8.5	46.2	41.0	9.1
2	6.6	4.3	4.3	-12.8	34.8	34.8	2.5
3	10.0	7.0	6.4	-14.4	30.0	36.0	3.5
4	9.4	8.4	5.4	-15.8	10.6	42.6	7.3
5	10.1	5.5	3.6	-12.9	45.5	64.4	4.6
6	12.2	5.5	5.3	-17.3	54.9	56.6	2.7
7	9.0	4.1	4.8		54.4	46.7	3.9
8	17.8	5.7	5.0	-11.4	68.0	71.9	4.4
AVE	10.9	5.9	5.2	-13.3	43.1	49.3	

2020 – SMA SHADOW PROJECT

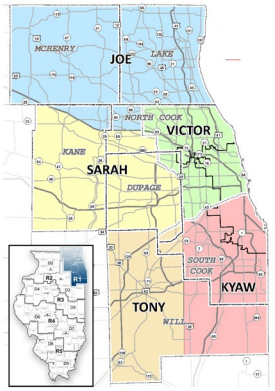
2021 IFIT Minimum Value

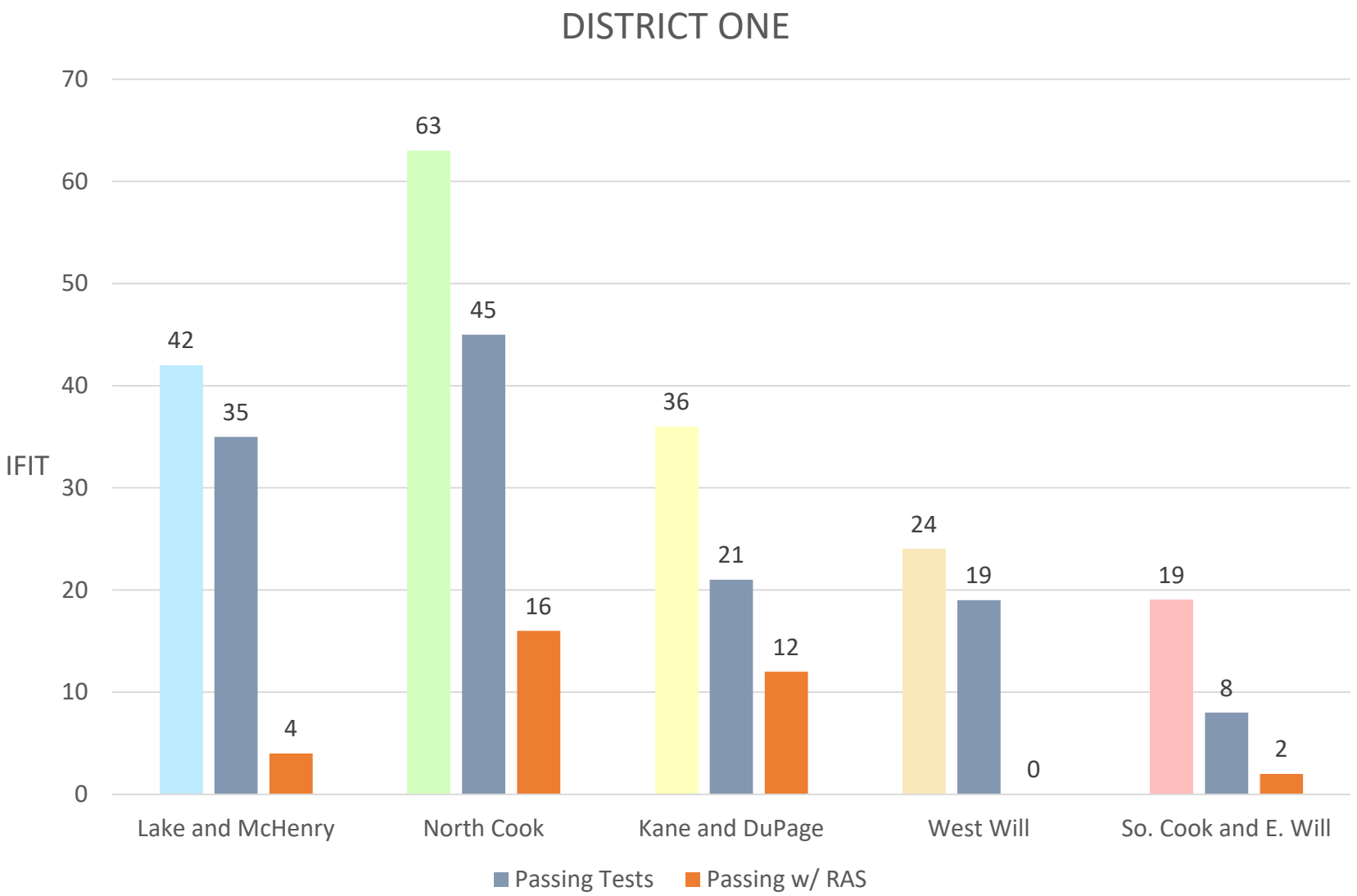


DISTRICT ONE REGIONS



2020 – IFIT BY REGION





“GOLDILOCKS” CONCLUSIONS

HELPFUL TOOLS:

- Watch HW Rut Depth
- Multiple ABR Designs
- Increase Design VMA
- Different Virgin Aggregates
- Consistent Virgin AC Source
- Additives

QUESTIONS?

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