Is bigger still better?

Considerations in increasing size of haulage equipment

Magreth Dotto, Tim Joseph, Mark Curley

AEGIS, University of Alberta, Canada.

What happens when you increase size?

Roads need to be wider ~ 3.5 x truck width

Operating space needs to be larger = f (turning radius), equipment interactions

Pits need to be larger – larger stripping ratios?

Higher competency in road construction materials

More good quality road construction materials

Higher fuel requirements for same tier engine

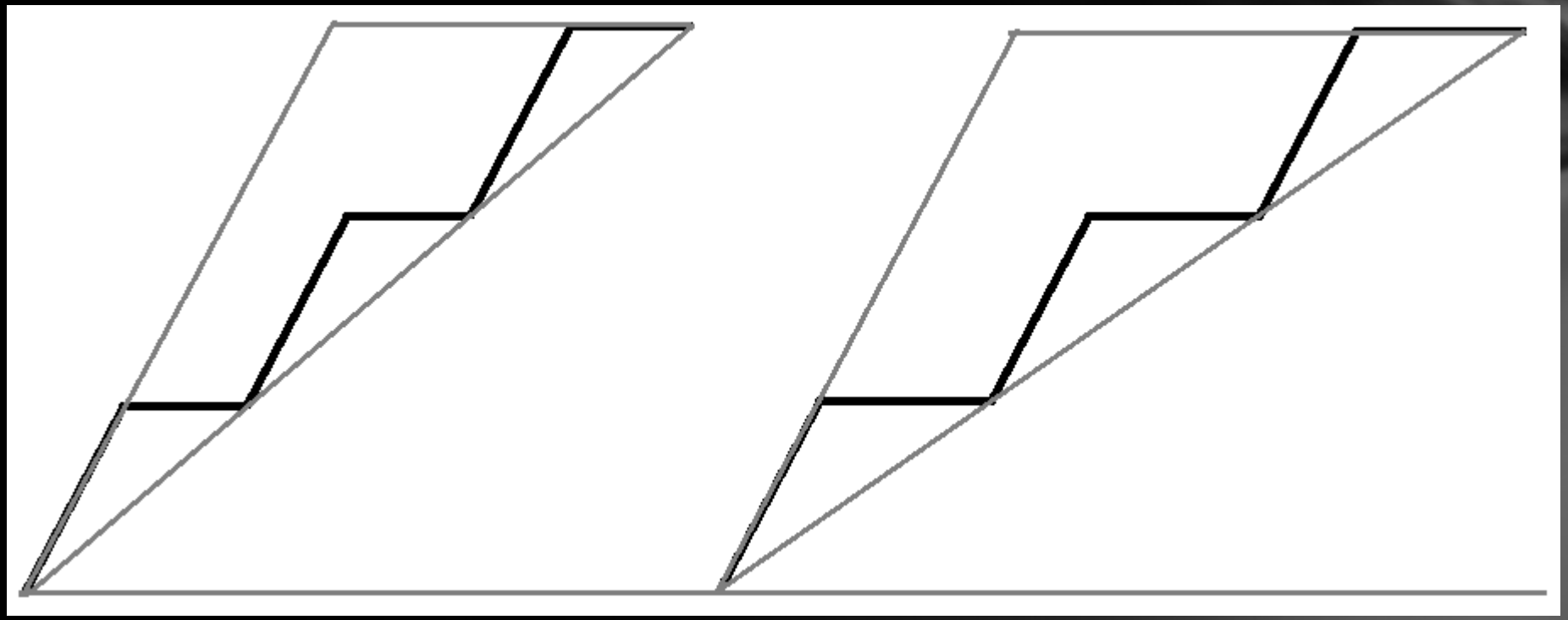
Higher emissions

What about rolling resistance? And cycle times?

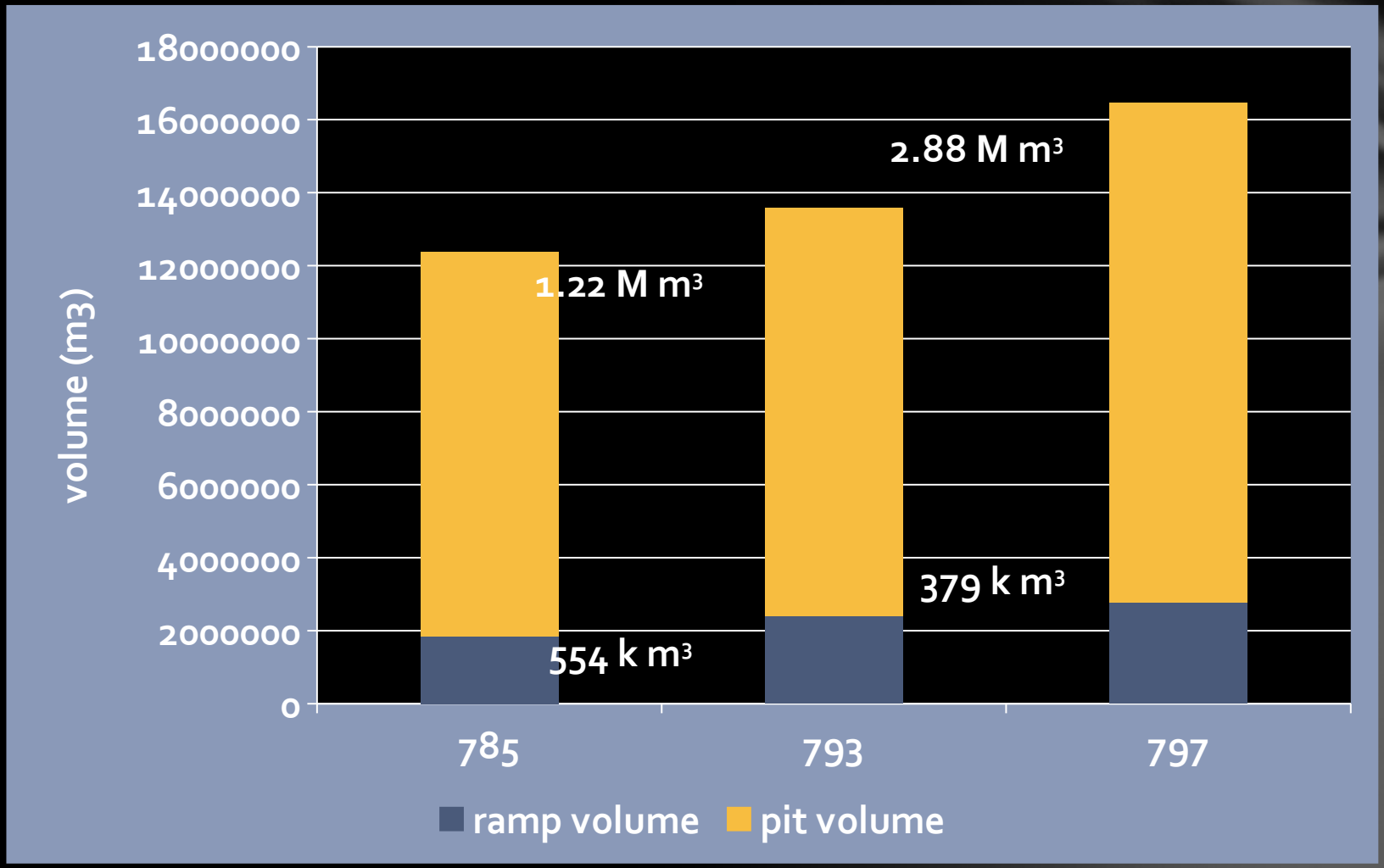
Hauler size increases considered

Truck type	Width (m)	Length (m)	Empty weight (t)	Payload (t)	GVW (t)	Payload/ GWV ratio	Net Power (hp)	Tire Size	Surface Ground Stress* (kPa)
CAT 785C	6.3	11.0	102	136	249.4	0.57	1,348	33.00-R51	523
CAT 793F	8.3	13.7	163	227	390.0	0.58	2,478	40.00R57	625
CAT 797F	9.5	14.8	260	363	623.6	0.58	3,793	59/80R63	754

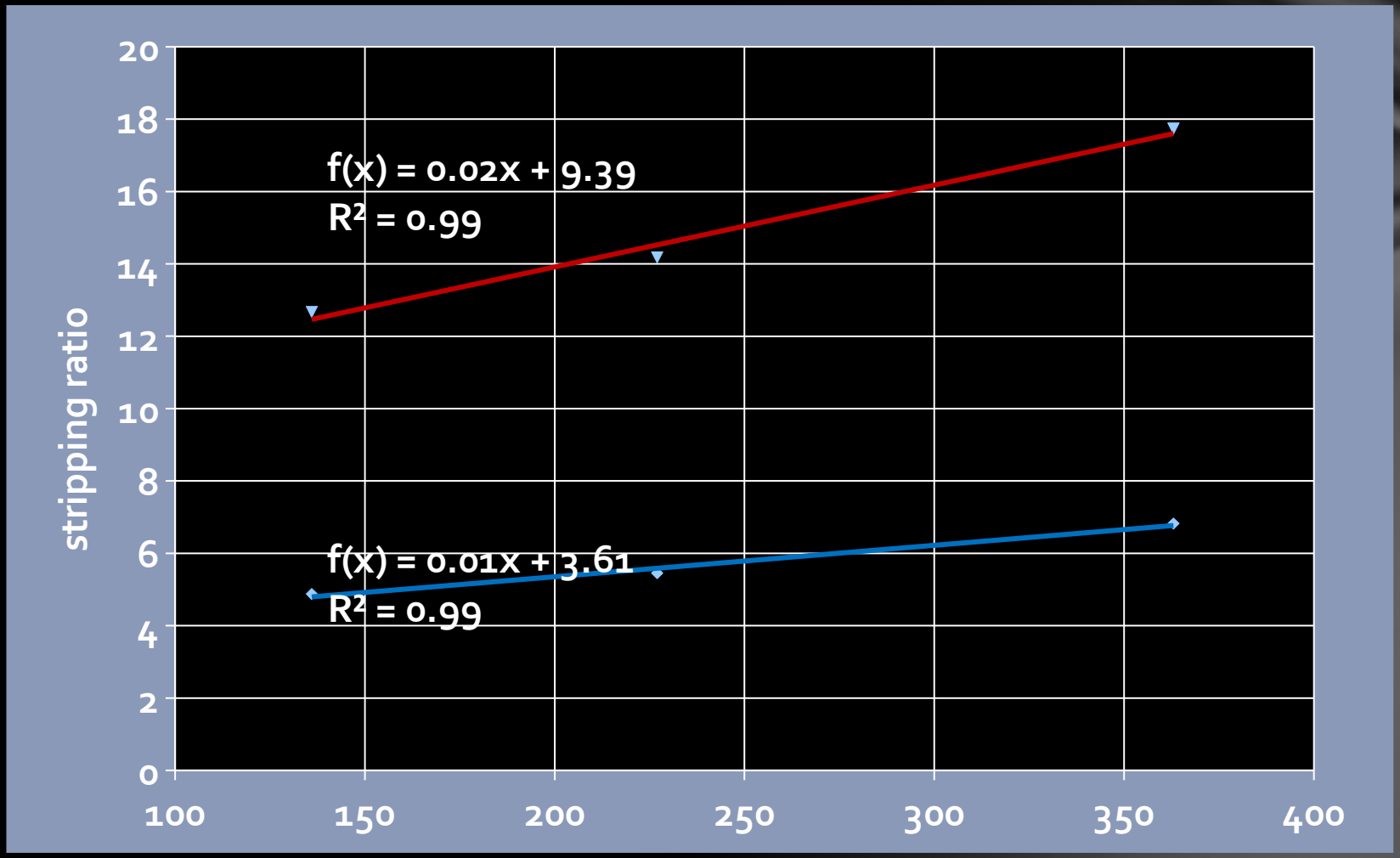
Impact of increased ramp width



Increased ramp and pit volume



Increased stripping ratio



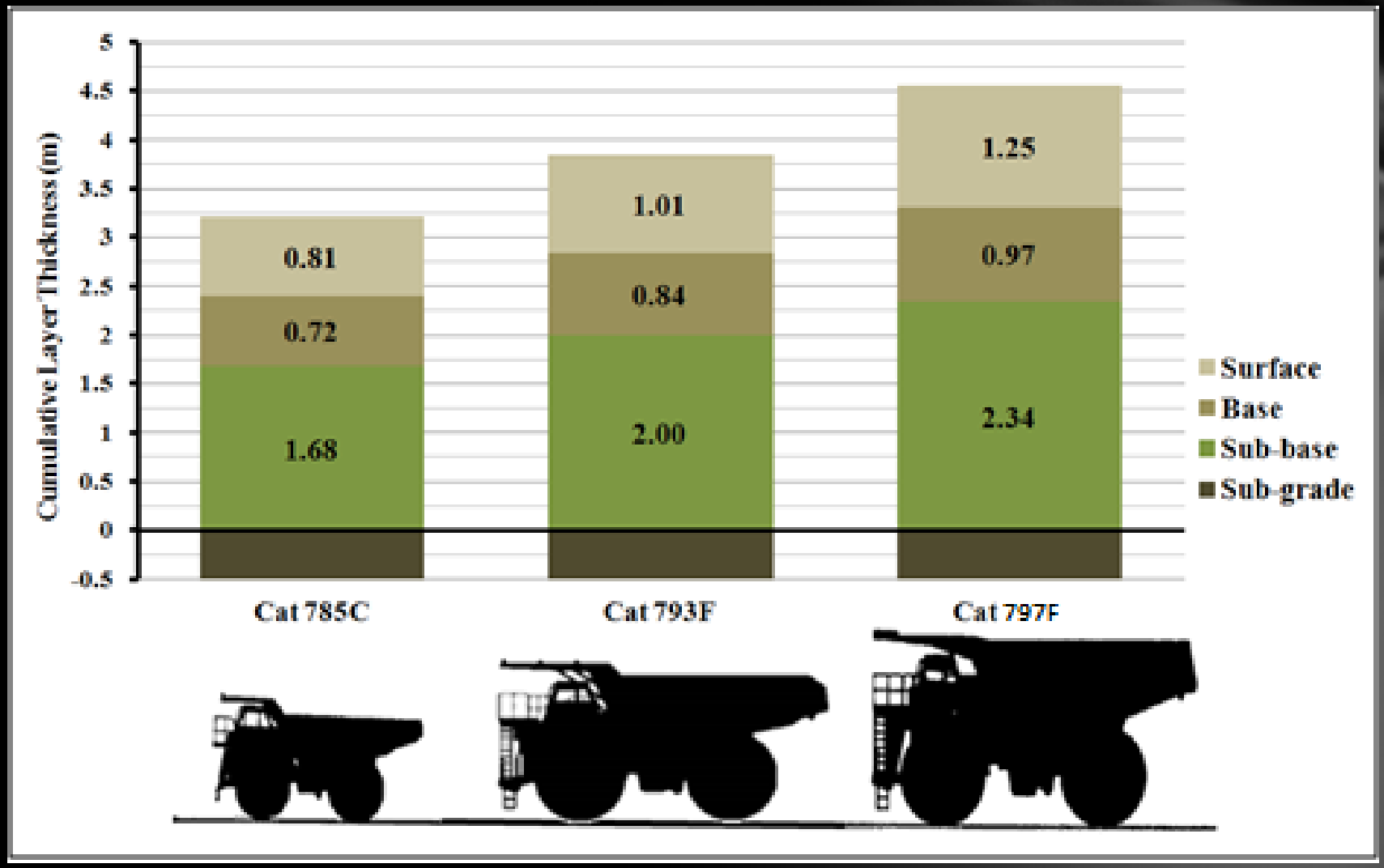
Road construction materials

Layer	Typical material	CBR (%)	Resilient modulus, MPa
Surface	Crushed rock	95	330
Base	Pit-run	60	245
Sub-base	Till, mine spoil	25	130
Sub-grade	Firm clay	4	40

Thompson's critical strain estimate

Truck type	Max 20% overload	GVW (overload)	# of units	Cycles per day	Load or Production kt/day (fixed)	Critical strain
CAT 785C	163.2	265.35	17	672	175	1506
CAT 793F	272.16	435.45	10	403	175	1730
CAT 797F	435.6	696.29	6	252	175	1964

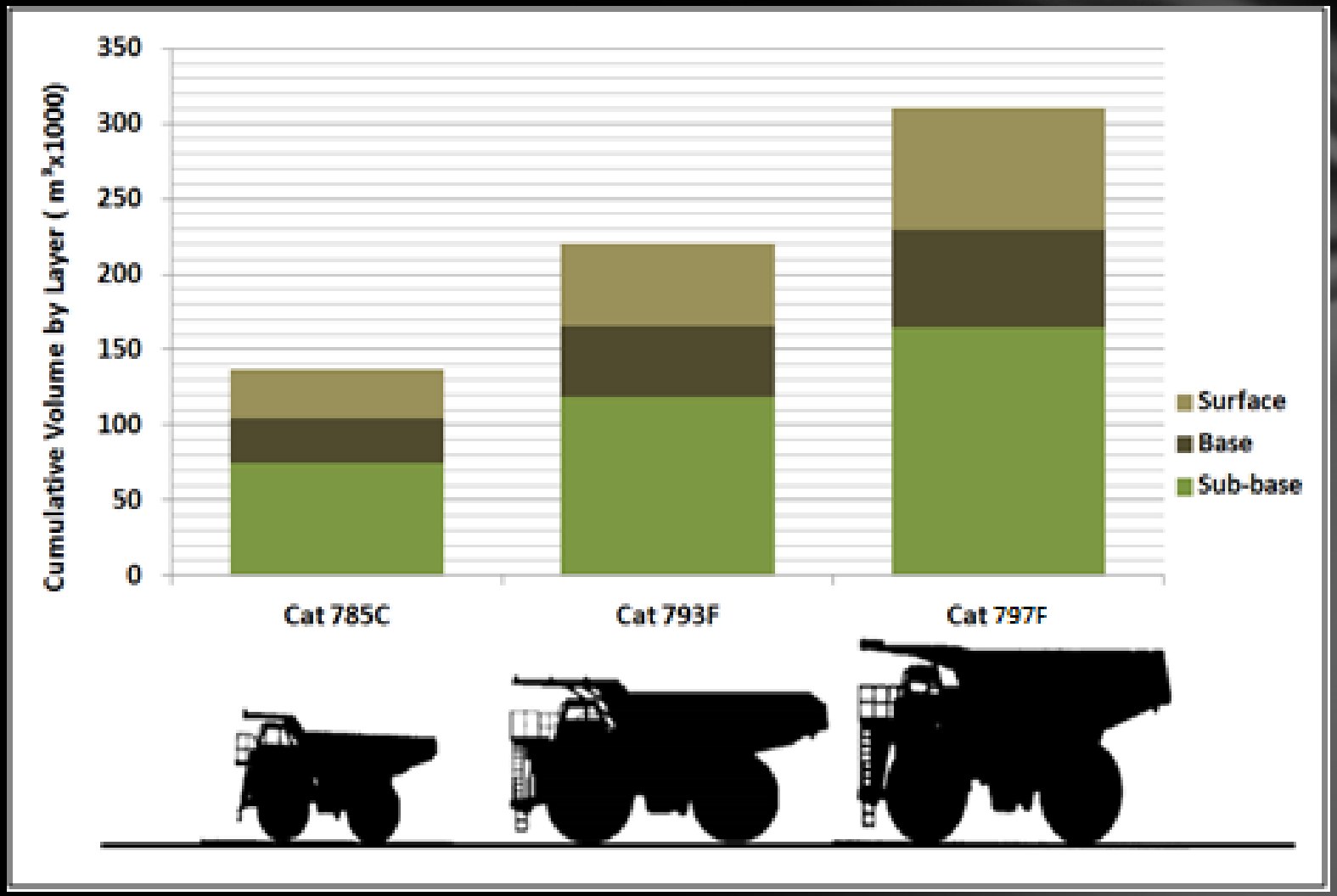
Road thickness requirements



Ramp design for 100 m pit depth

Truck type	Design width (m)	Turning radius (m)	Switchback length (m)	Pit slope angle (°)
CAT 785C	26	150	471	70
CAT 793	34	159	500	61.5
CAT 797F	40	166	521	55.5

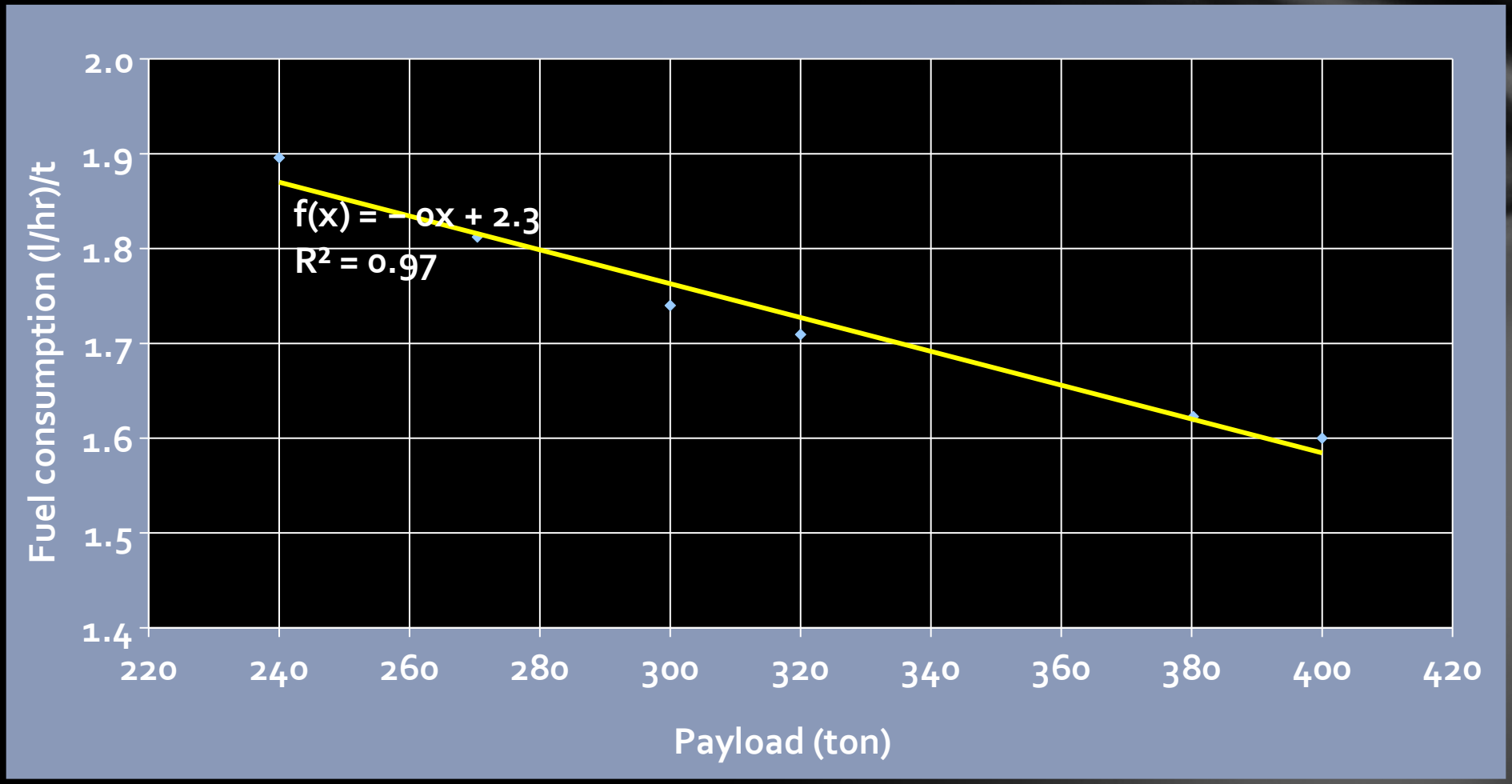
Ramp road construction material



Construction volume comparison

Layer	CAT 793F/785C	CAT 797F/793F	CAT 797F/785C
Surface	67%	48%	146%
Base	58%	37%	117%
Sub-base	58%	39%	121%

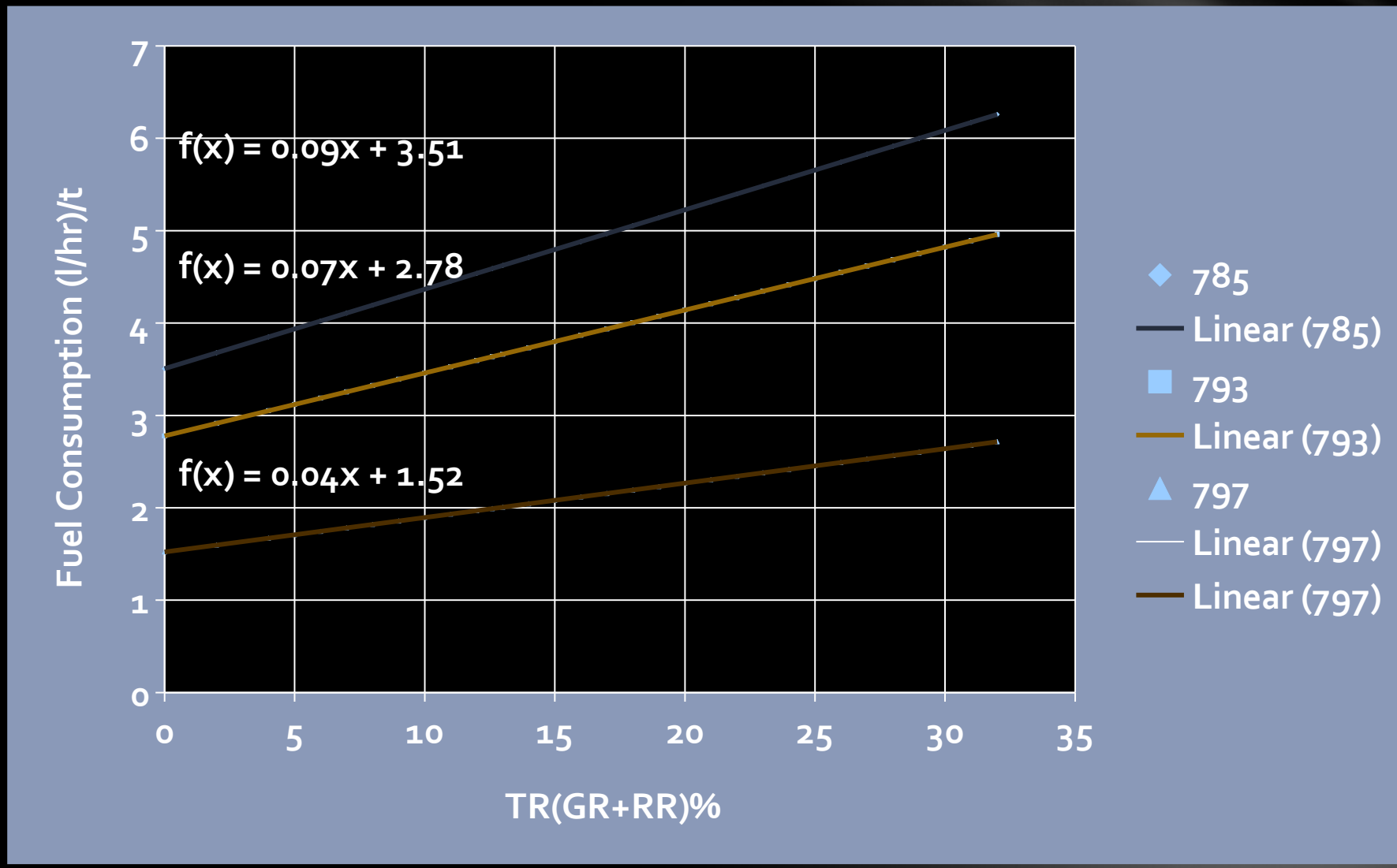
Fuel consumption (tier 2/3)



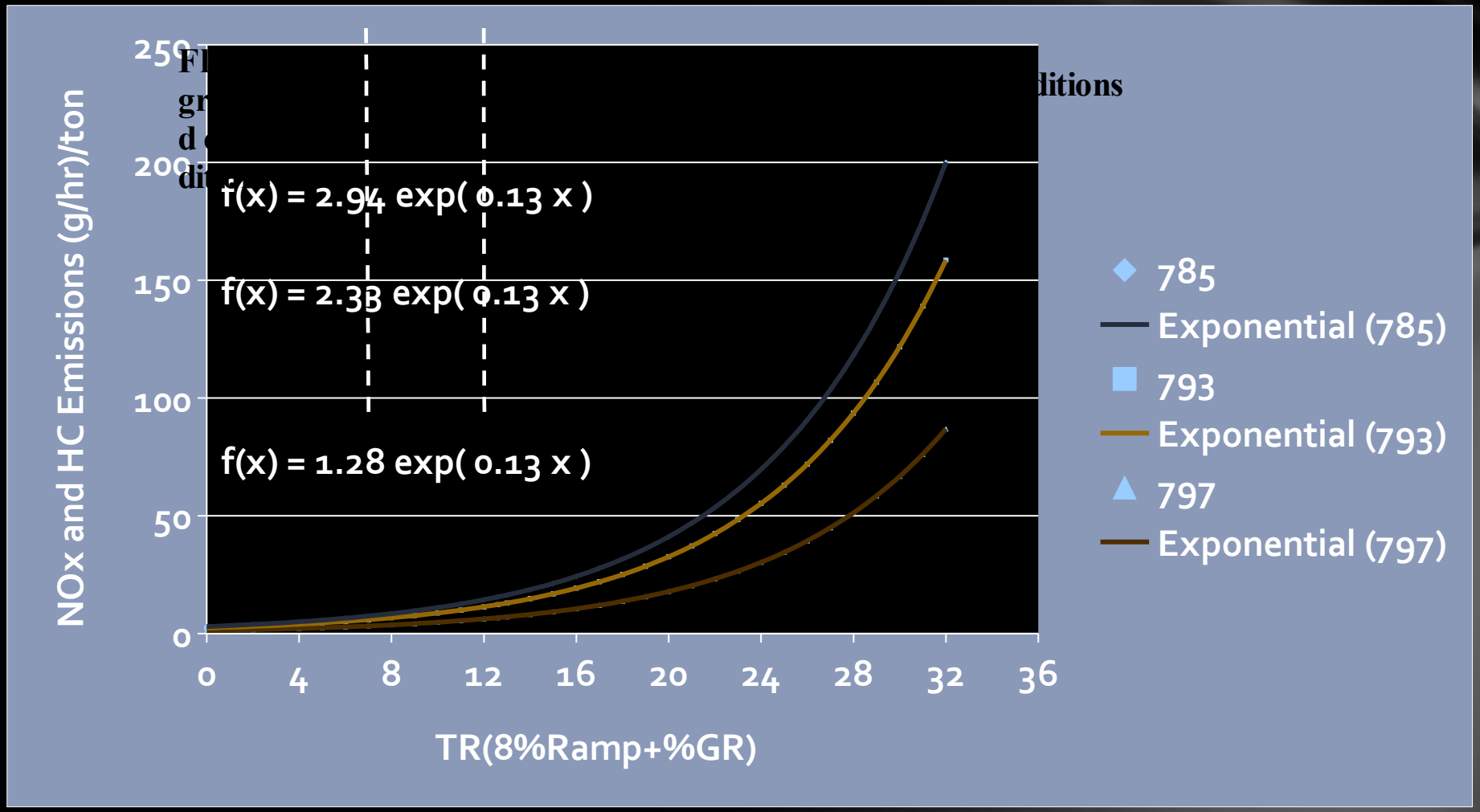
Fuel consumption & emissions

Hauler (ton)	Fuel (lb/hr) /t	Fuel (lb/hr)	hp	NOx (g/hp-hr)	CO (g/hp-hr)	HC (g/hp-hr)	PM (g/hp-hr)
240	3.6	850	2337	4.8	2.6	4.8	0.15
320	3.0	945	2700	2.3	0.697	2	0.1
345	2.6	900	3188	1	0.7	0.5	0.075
400	2.0	800	3793	0.5	0.5	0.5	0.025

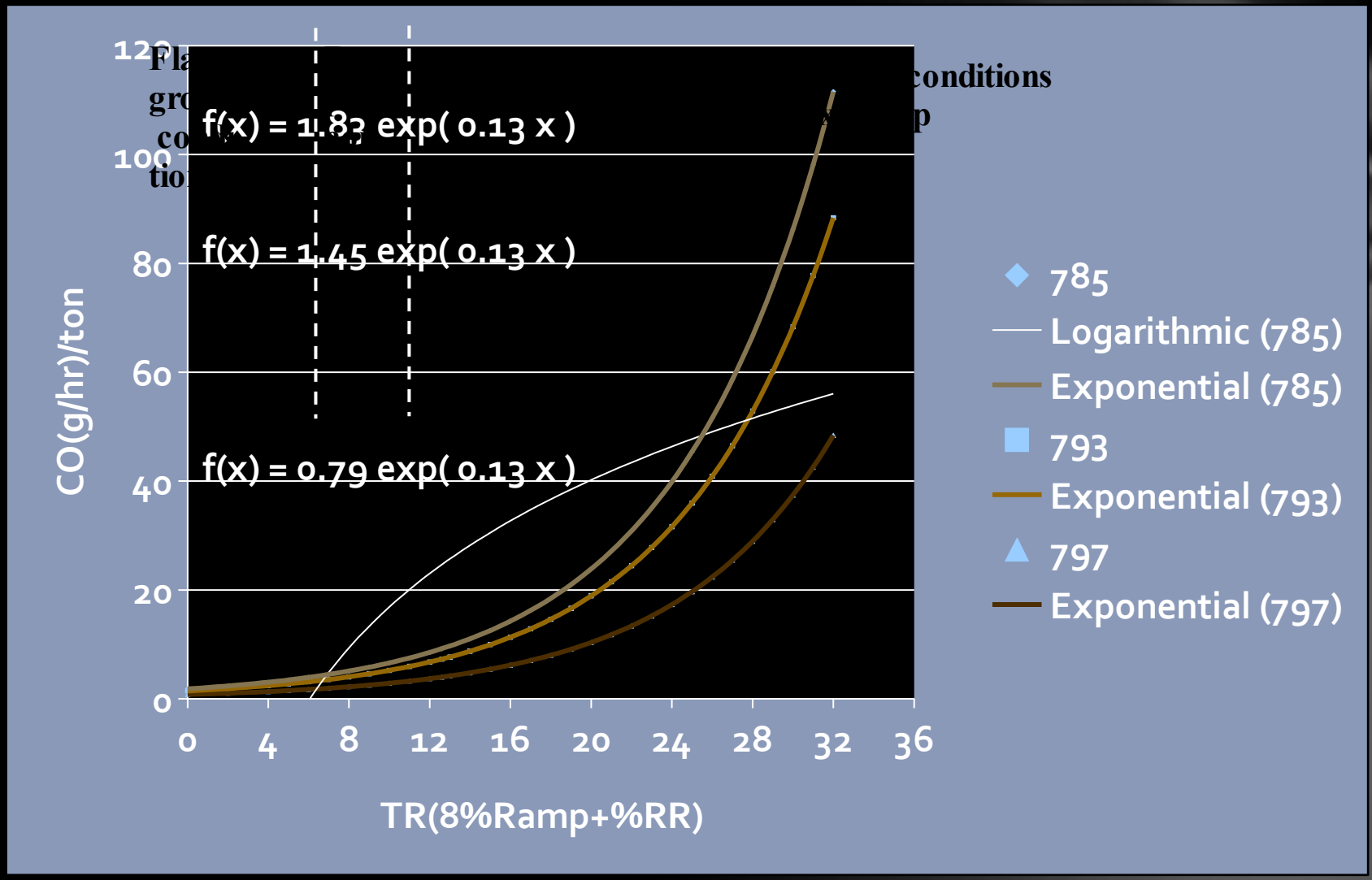
Fuel per ton moved = f (RR + GR)



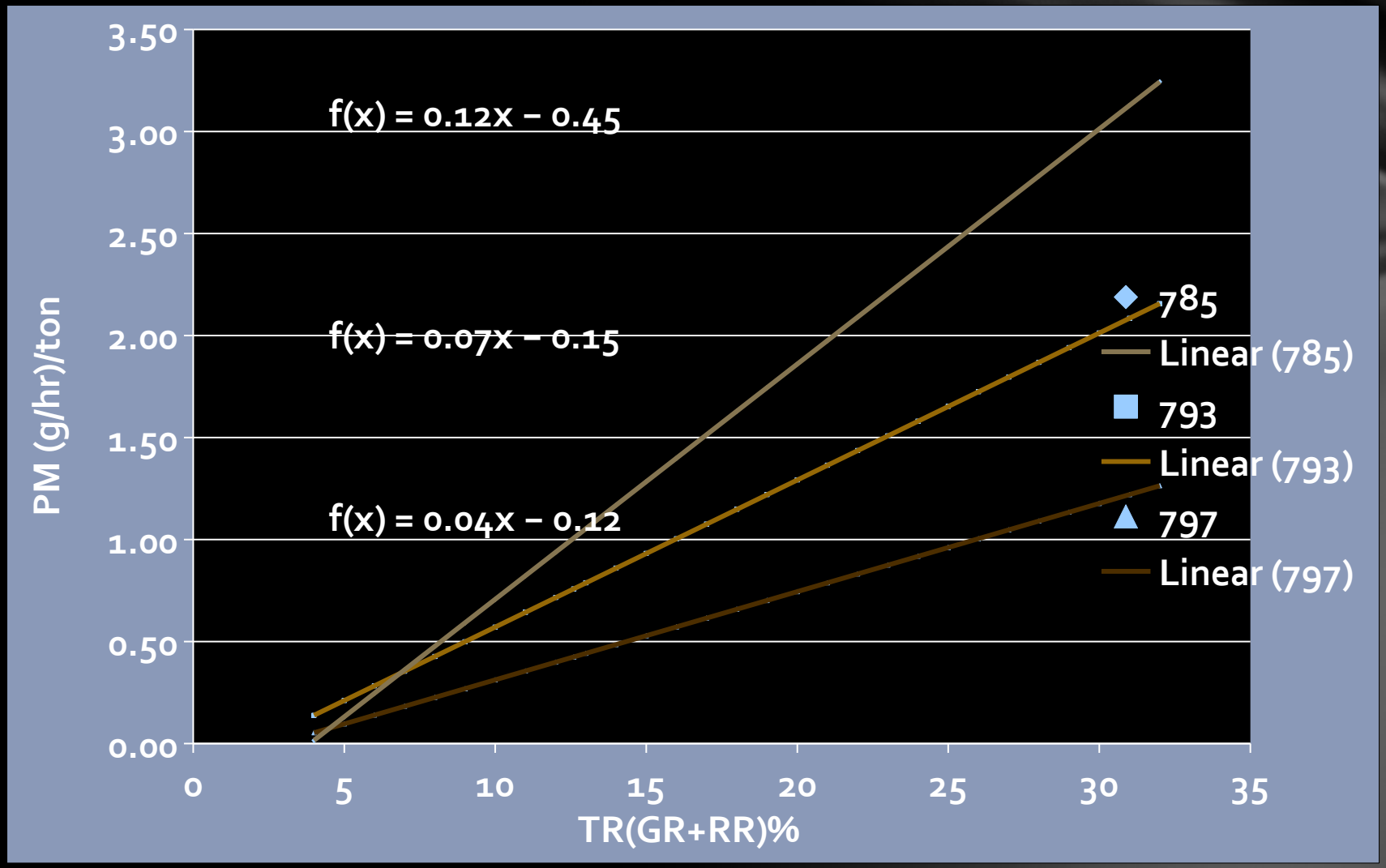
NOx and HC emissions = f (RR + GR)



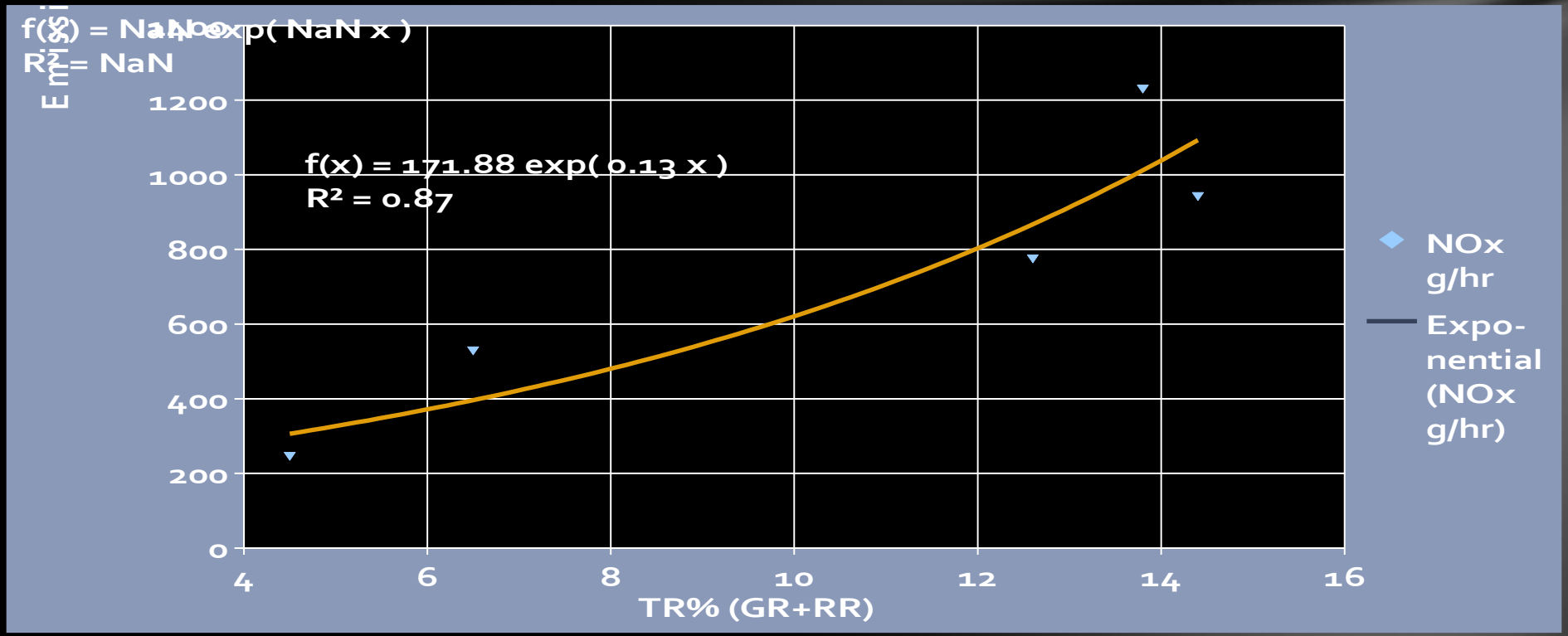
CO = f (RR + GR)


f(x) = 1.83 exp(0.13 x)
f(x) = 1.45 exp(0.13 x)
f(x) = 0.79 exp(0.13 x)
CO(g/hr)/ton
TR(8%Ramp+%RR)
0
20
40
60
80
100
120
0
4
8
12
16
20
24
28
32
36
785
Logarithmic (785)
Exponential (785)
793
Exponential (793)
797
Exponential (797)

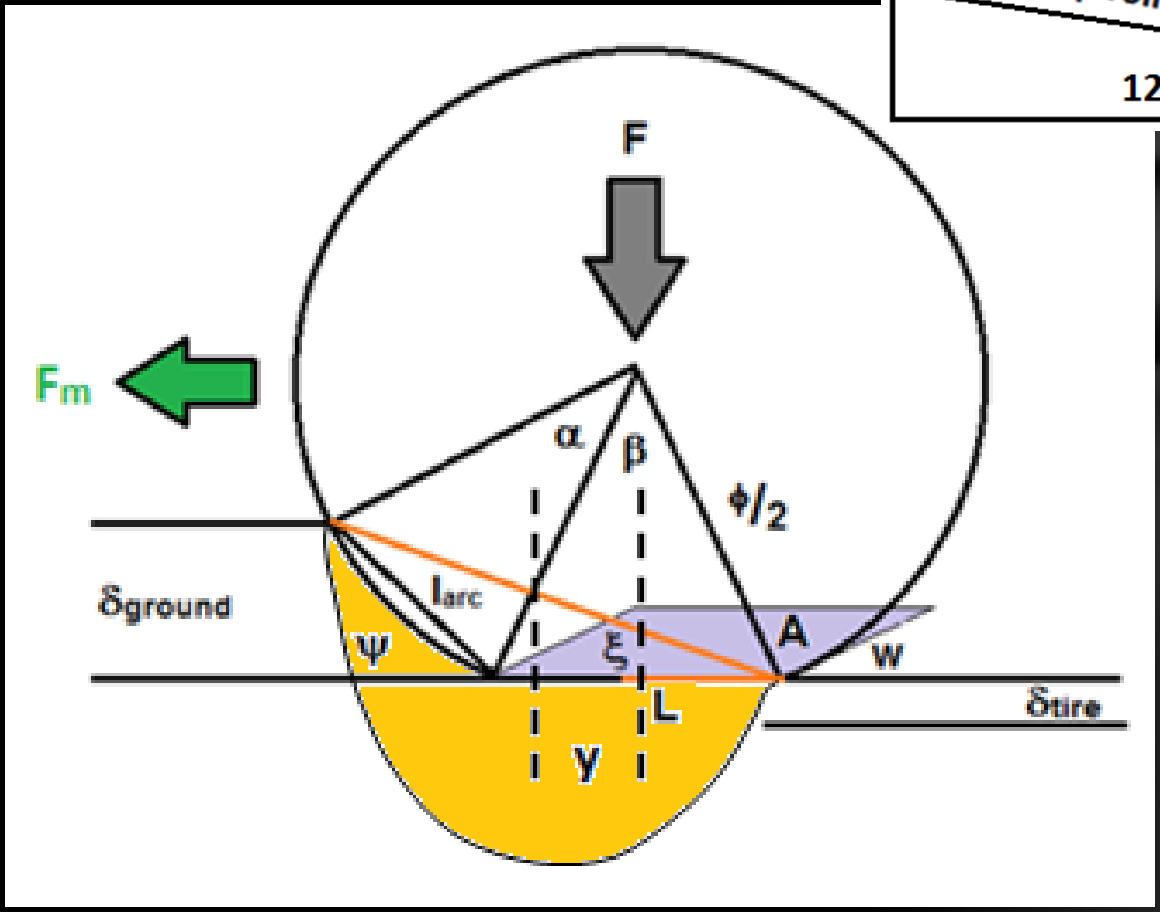
Particulate emissions = f (RR + GR)



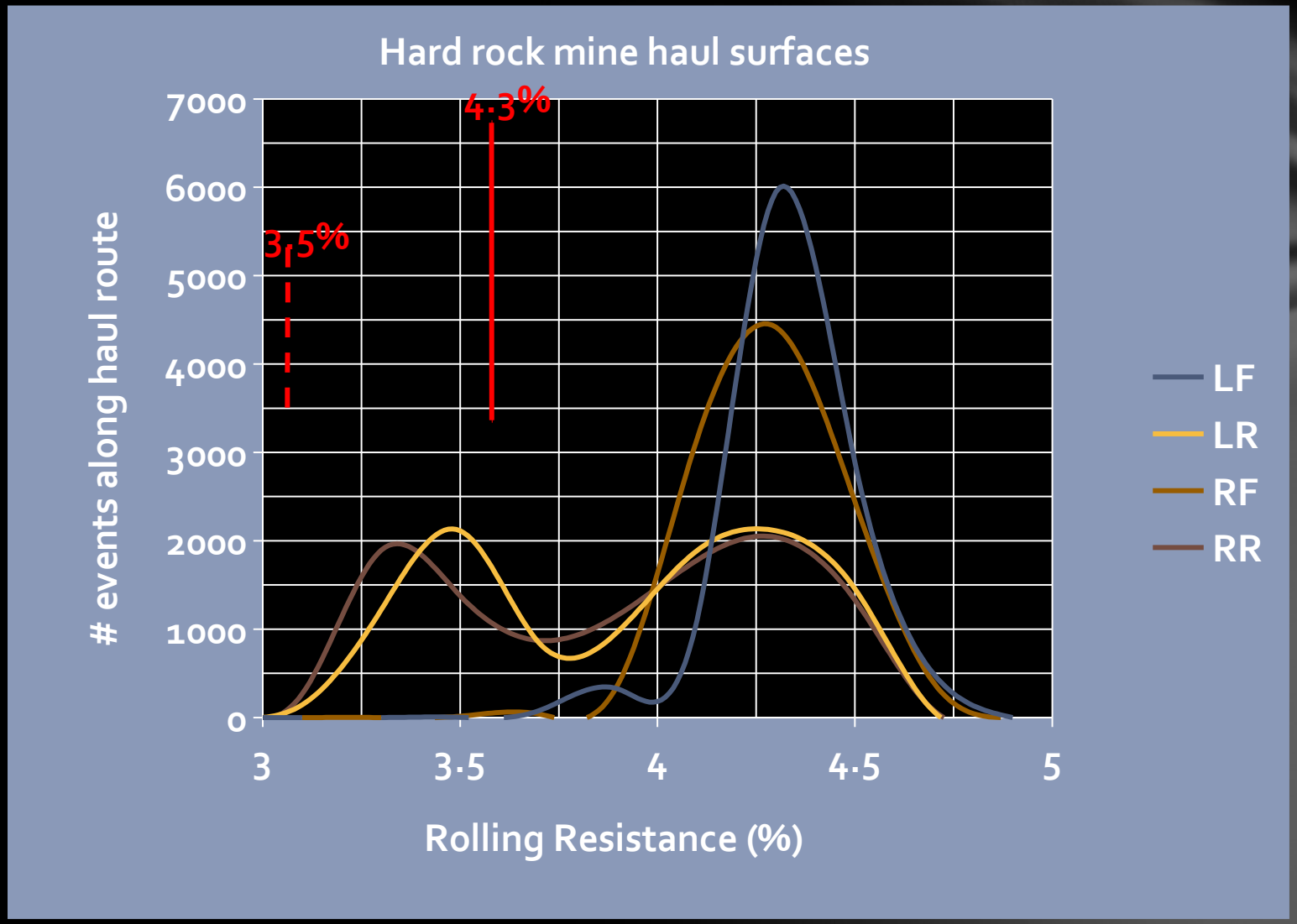
Emissions = f (total resistance)



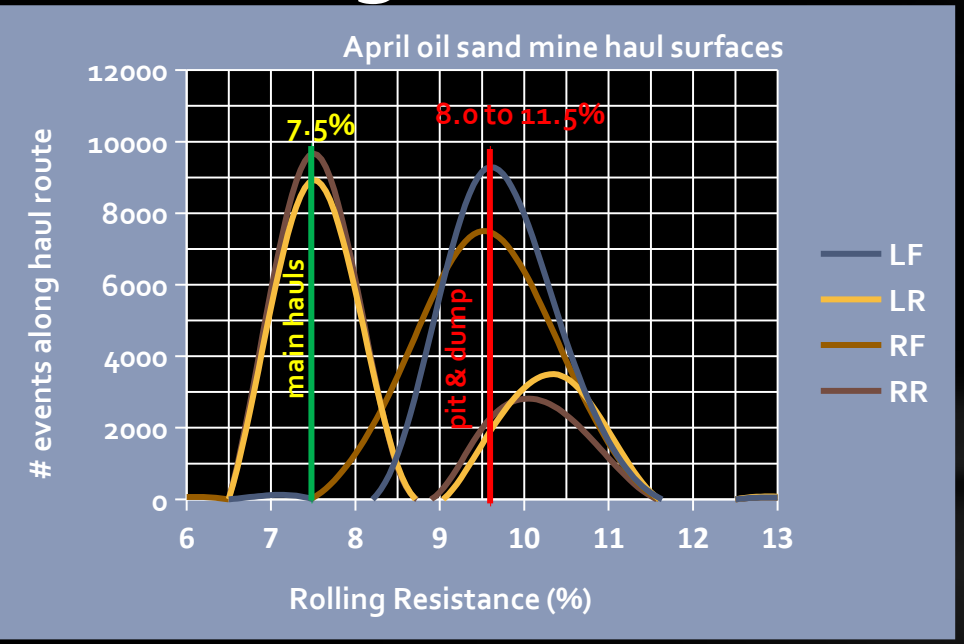
A new rolling resistance determination

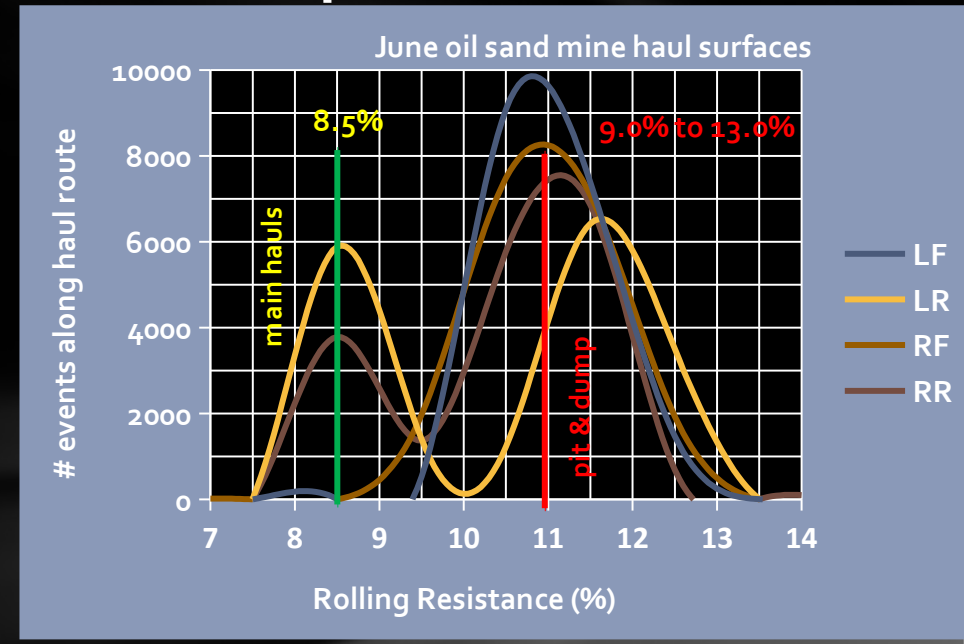


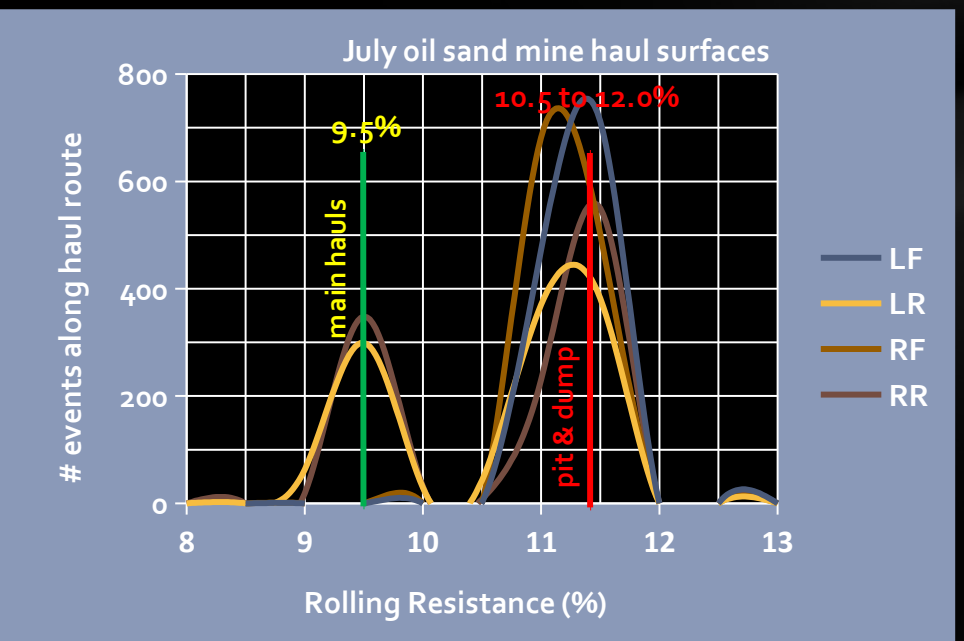
Rolling resistance from suspension

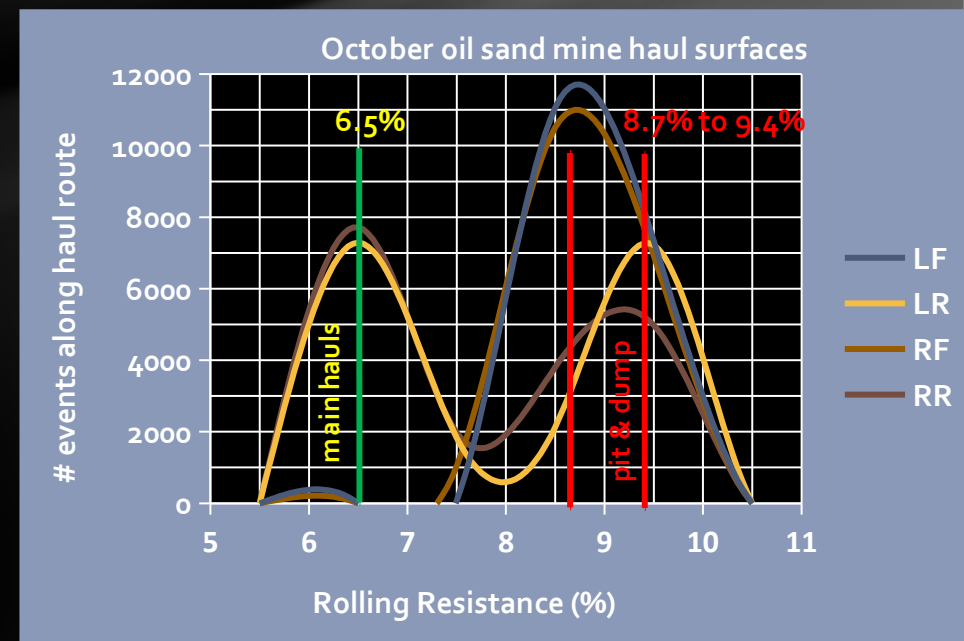


Rolling resistance from suspension

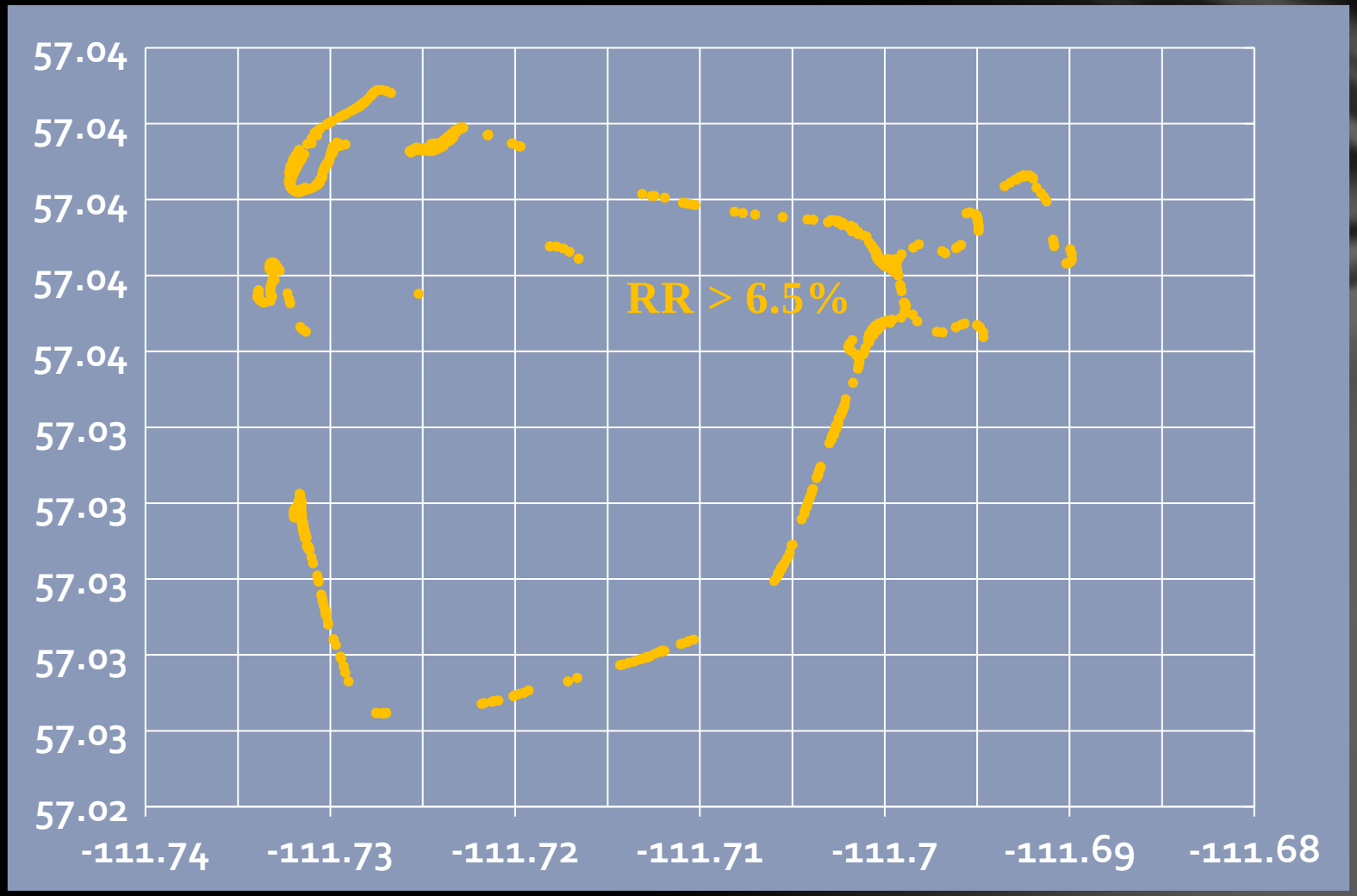








Map RR for maintenance target areas



Conclusions

- **Bigger means**
  - **wider roads and ramps**
  - **higher stripping ratio**
  - **higher volume of road construction materials**
  - **running surface critical strain limit coverged sooner**
  - **lower road life**
  - **higher fuel usage and emissions**
- **Smaller means**
  - **counter to all above**
  - **greater redundancy**