



Hot-In-Place-Recycling

A Valuable Tool For Denver Pavement Preservation

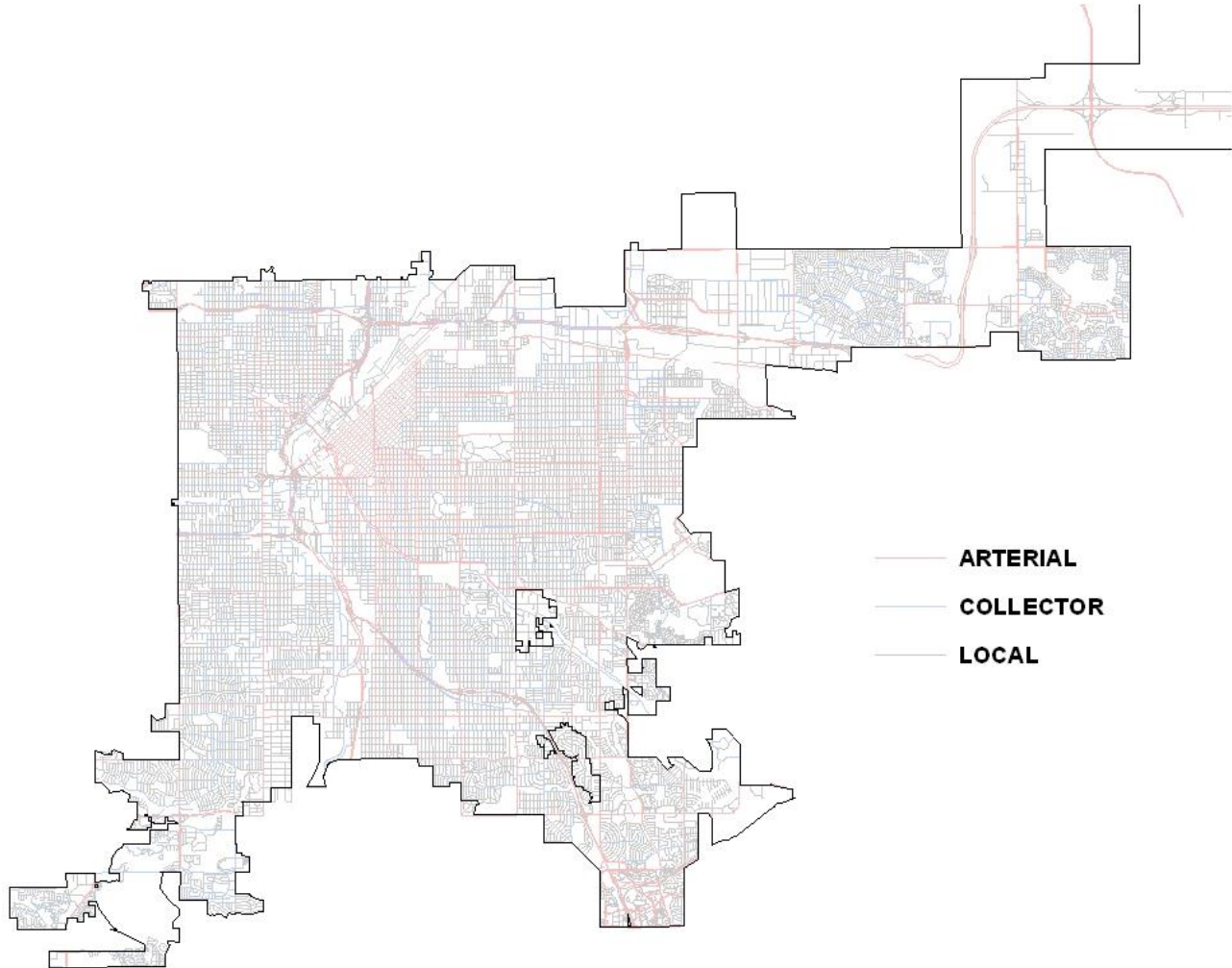
Pat Kennedy, PE
Denver Street Maintenance

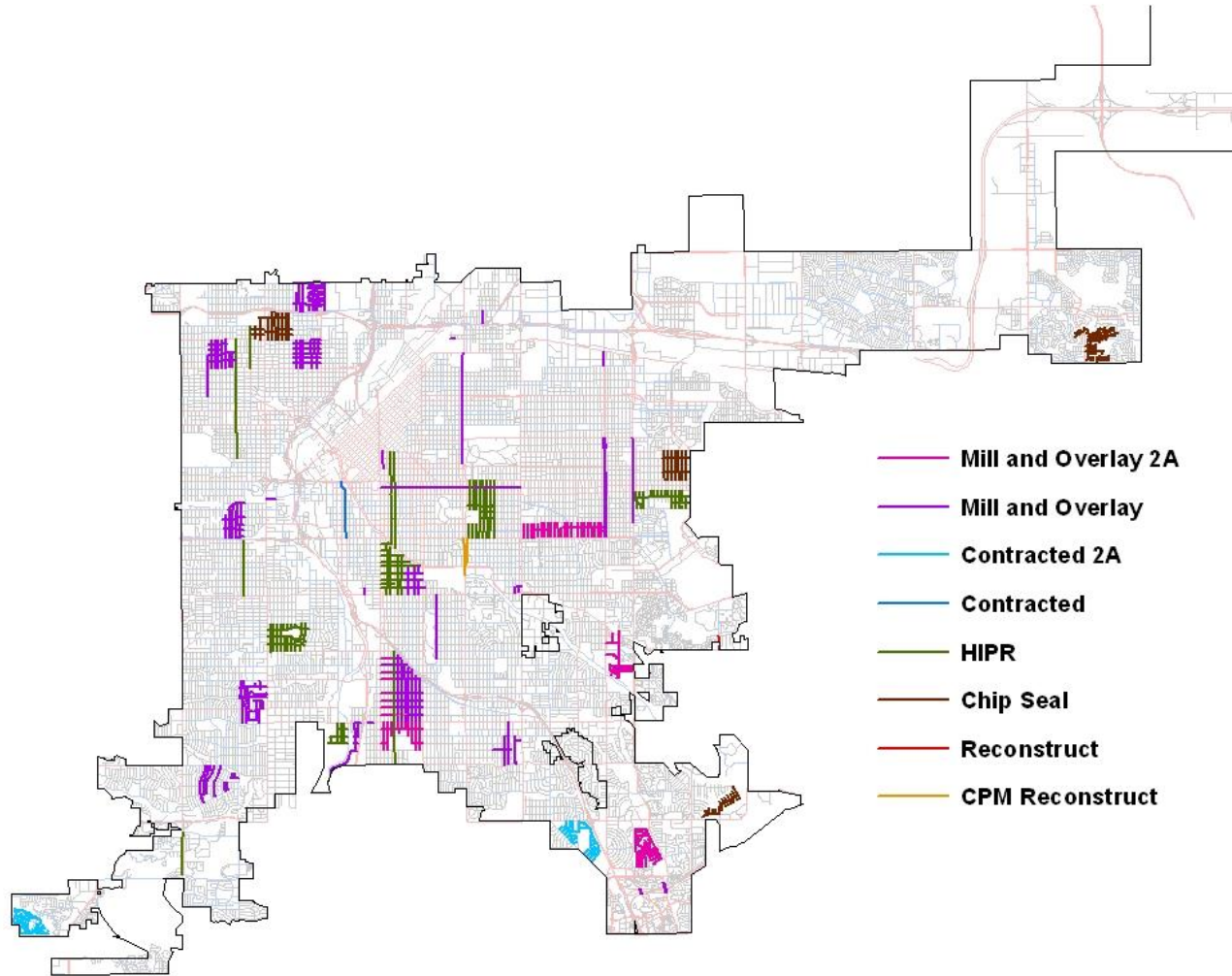
2014 International & Western States
In-Place-Recycling Conference

Denver, CO.



- **Population 634,000 – Metro area 2.5M**
- **Street network 6,100 lane miles**
- **Capital Maintenance Budget \$23M annually**
- **2014 paving program;**
 - **Self performed Mill and Overlay; 210 In-mi 53%**
 - **Contracted Mill and Overlay; 28 In-mi 7%**
 - **Hot-In-Place-Recycle; 109 In-mi 27%**
 - **Chip Seal; 50 In-mi 13%**





Agenda

- **Pavement Management in 30 seconds**
- **Hot-In-Place-Recycling Process**
- **Unique Considerations**
- **Life Cycle**
- **Sustainability**
- **Economics**

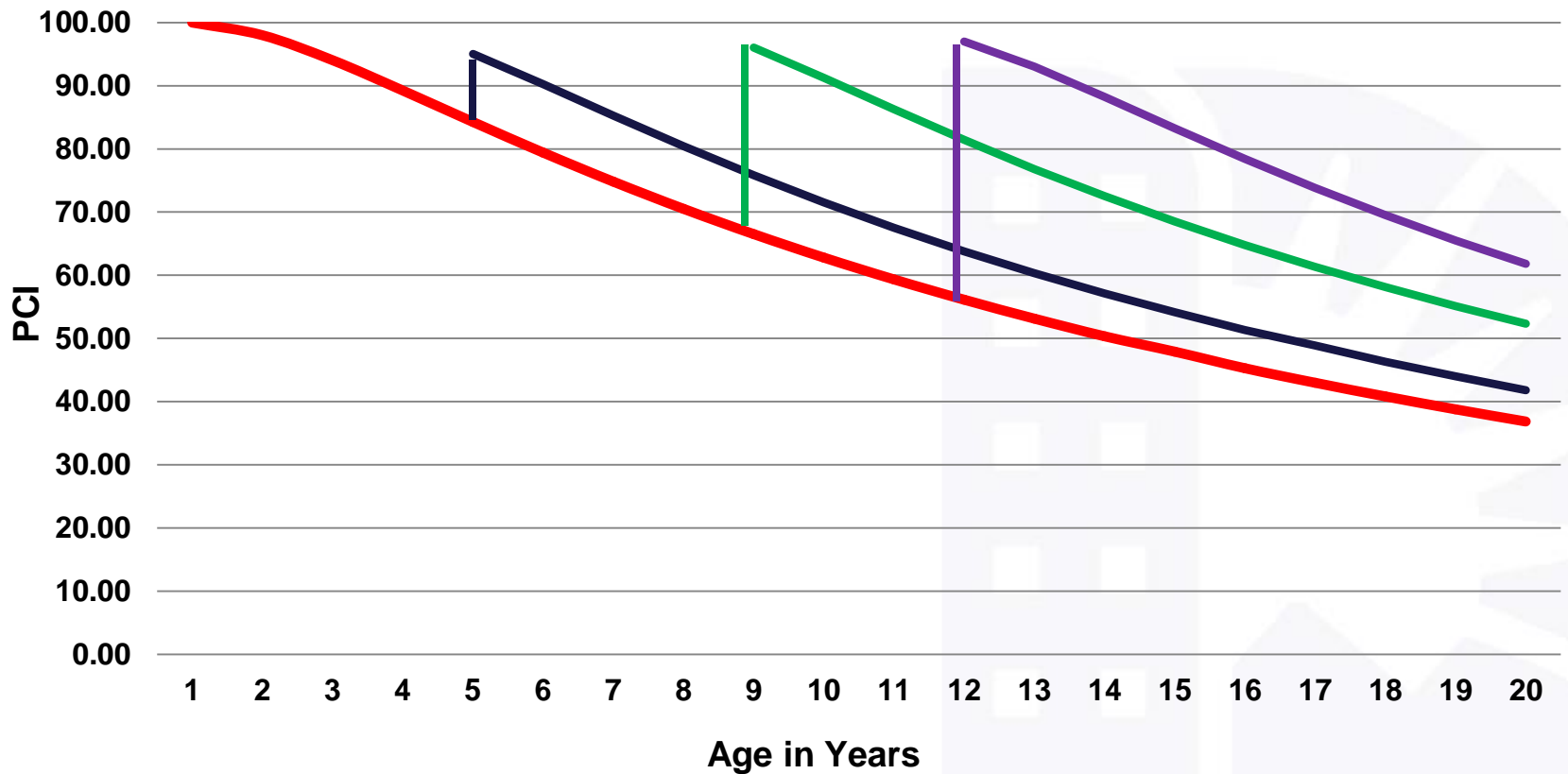
Mid-Range Treatment





Urban Pavement Management

Deterioration Curve



Trigger Point

HIPR

- Fair to slightly Poor
- Few structural defects
- PCI 60 to 70

M&O

- Poor to Very Poor
- Structural defects
- PCI > 65

Milling/Prep

HIPR

- Edge mill only
- Minor patching

M&O

- Full width milling
- Possible extensive patch



Paving Train

HIPR

- Pre heater
- Recycler/Laydown
- Three rollers
 - Breakdown
 - Rubber Tire
 - Finish

M&O

- Tack
- Laydown
- Three rollers
 - Breakdown
 - Rubber Tire
 - Finish

HIPR Preheater



HIPR Paver



HIPR Paving Train

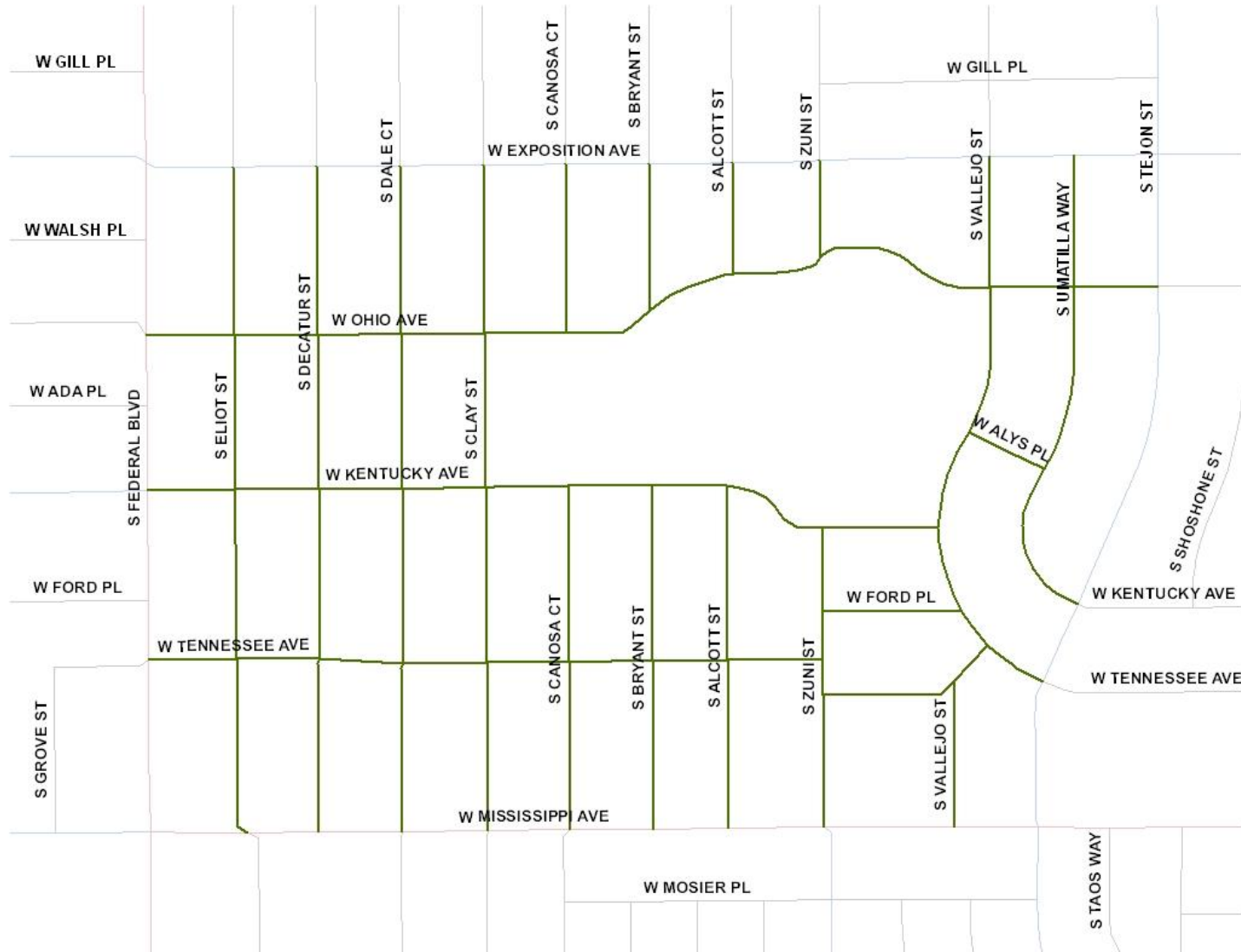


Unique Considerations

- **Traffic Control- No special needs**
- **Street selection- No cul-de-sacs or tight curves, uniform width, x-slope**



Typical Neighborhood



Unique Considerations

- **Traffic Control- No special needs**
- **Street selection- No cul-de-sacs or tight curves, uniform width, x-slope**
- **Vegetation- Minor protection of street side plants**

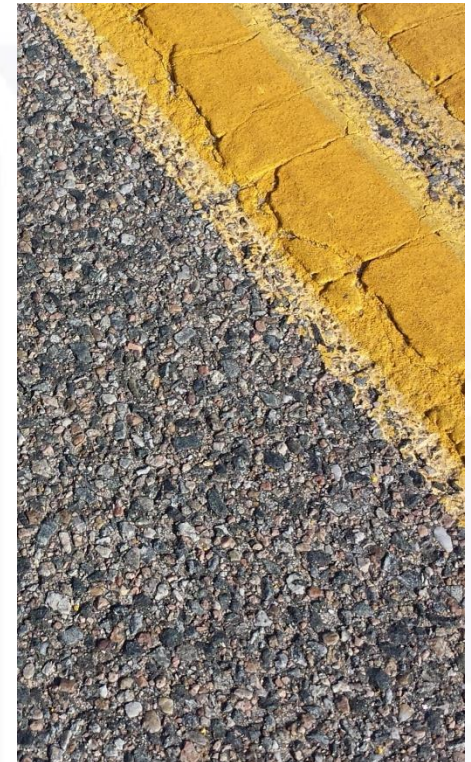


Unique Considerations

- **Traffic Control- No special needs**
- **Street selection- No cul-de-sacs or tight curves, uniform width, x-slope**
- **Vegetation- Minor protection of street side plants**
- **Specialized mixes**
 - SMA
 - AR
 - RAS

Specialized Mixes

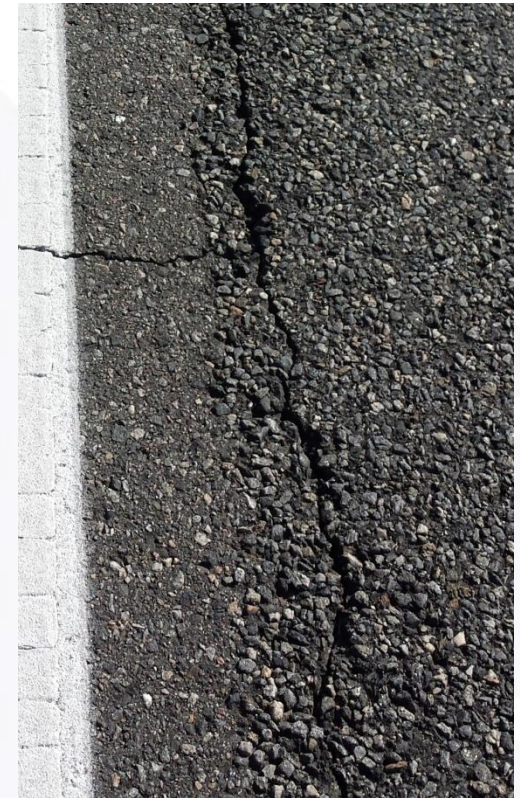
2006 SMA- Major Arterial- 20,000+ AADT each direction



Current PCI ~75

Specialized Mixes

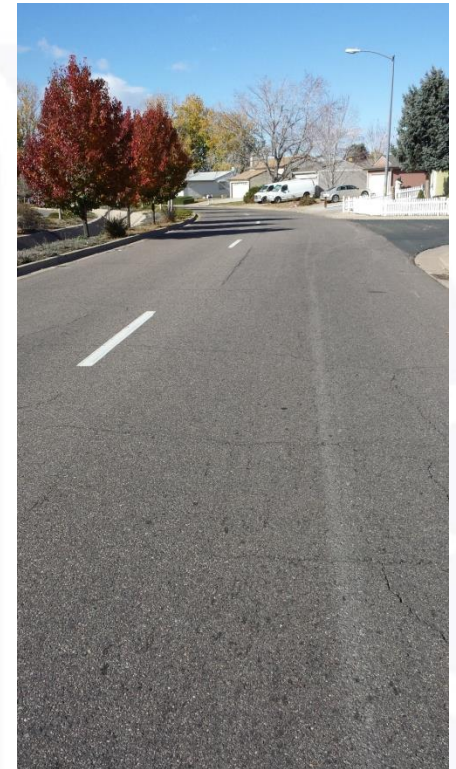
2007 AR- Major Arterial- 10,000 AADT each direction



Current PCI ~70

Specialized Mixes

2010 RAS- Minor Arterial- 5,000 AADT one way



Current PCI ~85

Denver Asphalt Plant

- **City owned Astec asphalt plant**
- **Standard HMA and specialty mixes**
- **Less expensive**
 - **Production costs**
 - **Wait times**
 - **Hauling costs**



Arterials- Track record of 10 years on



2005
Process
10,000 AADT
PCI ~75



2003
Process
10,000 AADT
PCI ~70



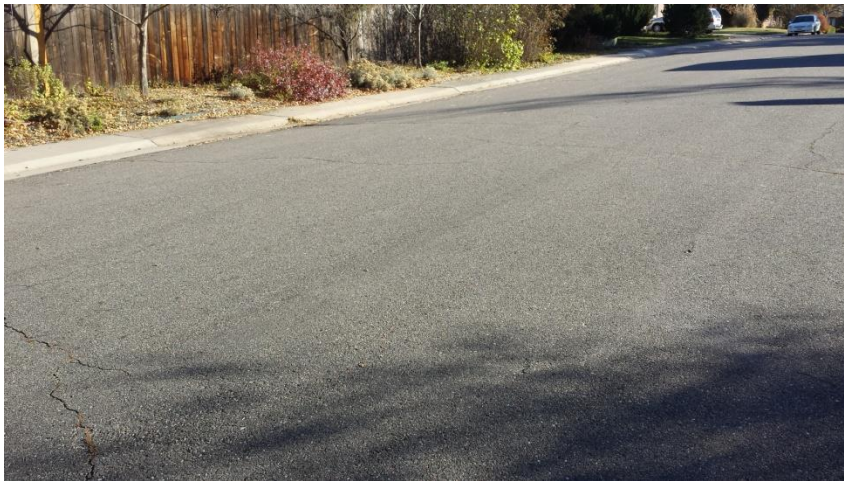
Collectors- Track record of 10 years on collectors



2003
Process
3,000 AADT
PCI ~70

Life Cycle

Locals- ??? Haven't seen full life, some sites covered with chip seal at 7 years



Local streets, 2003 HIPR, average PCI 75

Sustainability

- **Less disruption**
- **Smooth surface**
 - 40% IRI improvement, 265 in/mi to 165 in/mi
- **Less use of raw materials**
 - One half existing pavement reuse
 - One half added pavement at 25% RAP

**Final product 60%+
recycled material**

- **Reduced Mill/Prep**
- **Reduced raw materials**
- **Reduced hauling**
- **Unit cost \$1 to \$2 per sy less than m&o**

**Life cycle cost savings of
6%-10%**

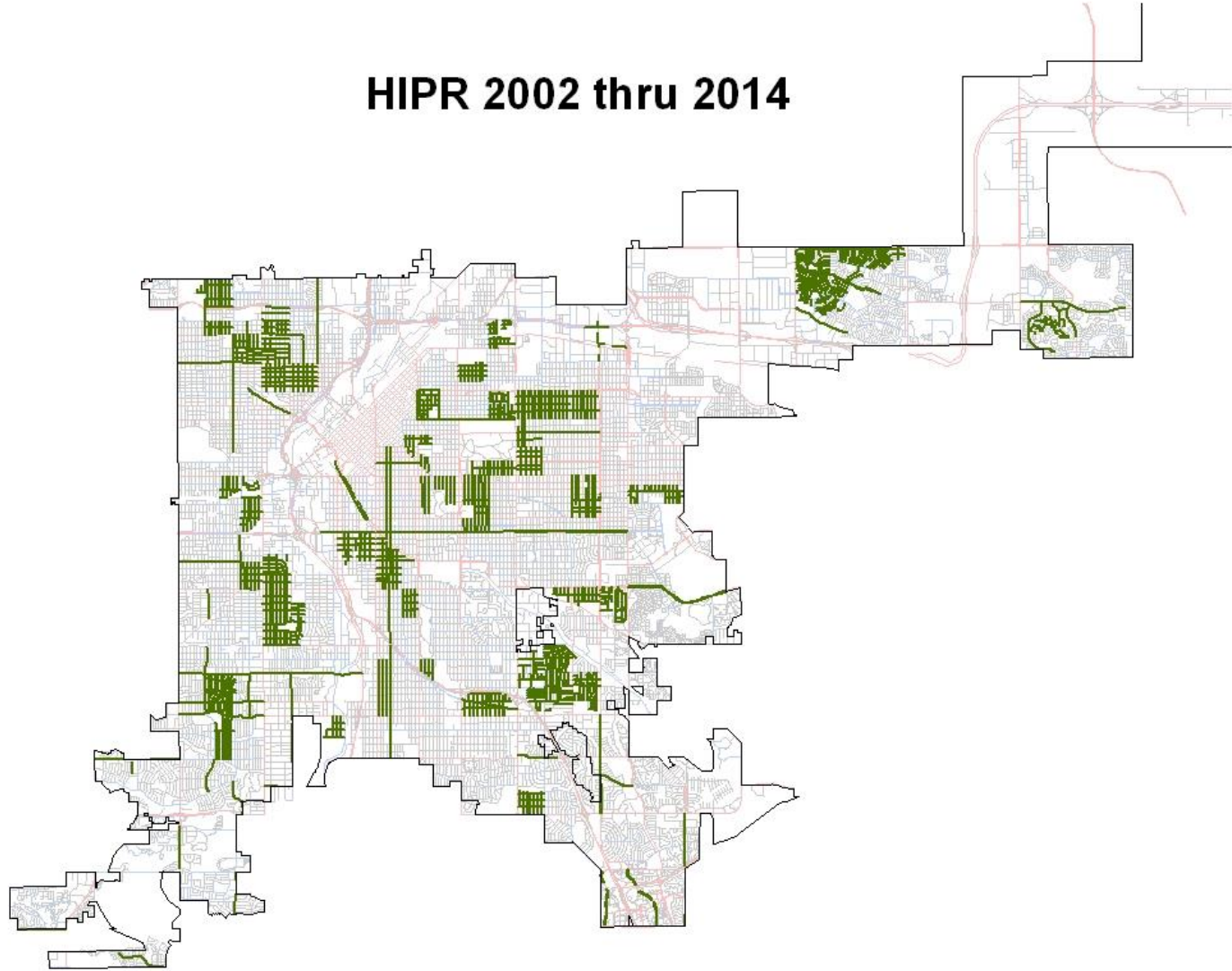
Compared to mill and overlay

Economics

Year	Ln-Mi	Cost/sy	15yr cost	M&O	17yr cost	Savings	
2004	51.85	\$ 4.19	\$ 0.28				
2005	63.53	\$ 5.09	\$ 0.34				
2006	57.94	\$ 6.22	\$ 0.41				
2007	53.53	\$ 7.68	\$ 0.51				
2008	113.17	\$ 7.87	\$ 0.52				
2009	54.83	\$ 8.55	\$ 0.57				
2010	81.94	\$ 7.71	\$ 0.51	\$ 9.43	\$ 0.55	\$ 0.04	7.4%
2011	83.65	\$ 7.73	\$ 0.52	\$ 9.79	\$ 0.58	\$ 0.06	10.5%
2012	62.45	\$ 7.98	\$ 0.53	\$ 9.80	\$ 0.58	\$ 0.04	7.7%
2013	62.02	\$ 8.26	\$ 0.55	\$ 10.25	\$ 0.60	\$ 0.05	8.7%
2014	108.51	\$ 8.97	\$ 0.60	\$ 10.90	\$ 0.64	\$ 0.04	6.7%

HIPR History

HIPR 2002 thru 2014



Questions?

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Denver Street Maintenance

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