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Prequalification Criteria for Pavement Inspectors

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BACKGROUND

OCTA Measure M

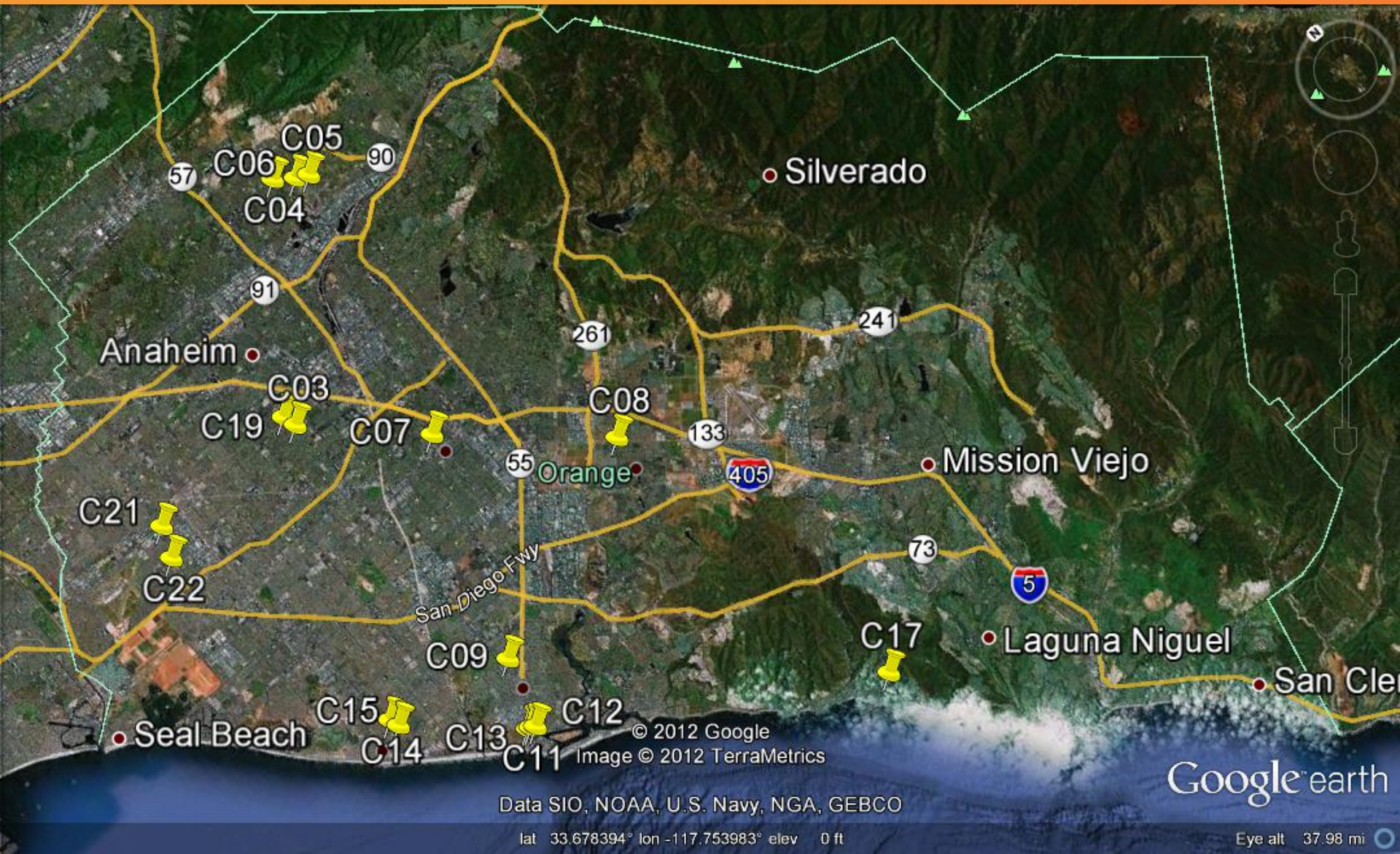
- OCTA = Orange County Transportation Authority
- 34 cities, 3.1 million people, over 6,000 miles of city and county roads
- Eligibility for Measure M funds based on network PCI values
- Scope: Evaluate the ability of inspectors to identify and report distress according to ASTM D6433-11/Paver
- Prequalification studies:2011, 2013, 2014

Prequalification Study Design

- Select minimum 20 control sections
- Survey to establish “baseline” PCI values
- Factorial:
  - Surface: AC, ST, PCC
  - Condition: Poor to Very Good
  - Traffic: Low to High
  - Typical control section:
    - 100’ x 36’ (for manual surveys)
    - 200’ x 12’ (for automated surveys)

PREQUALIFICATION STUDIES AND CRITERIA

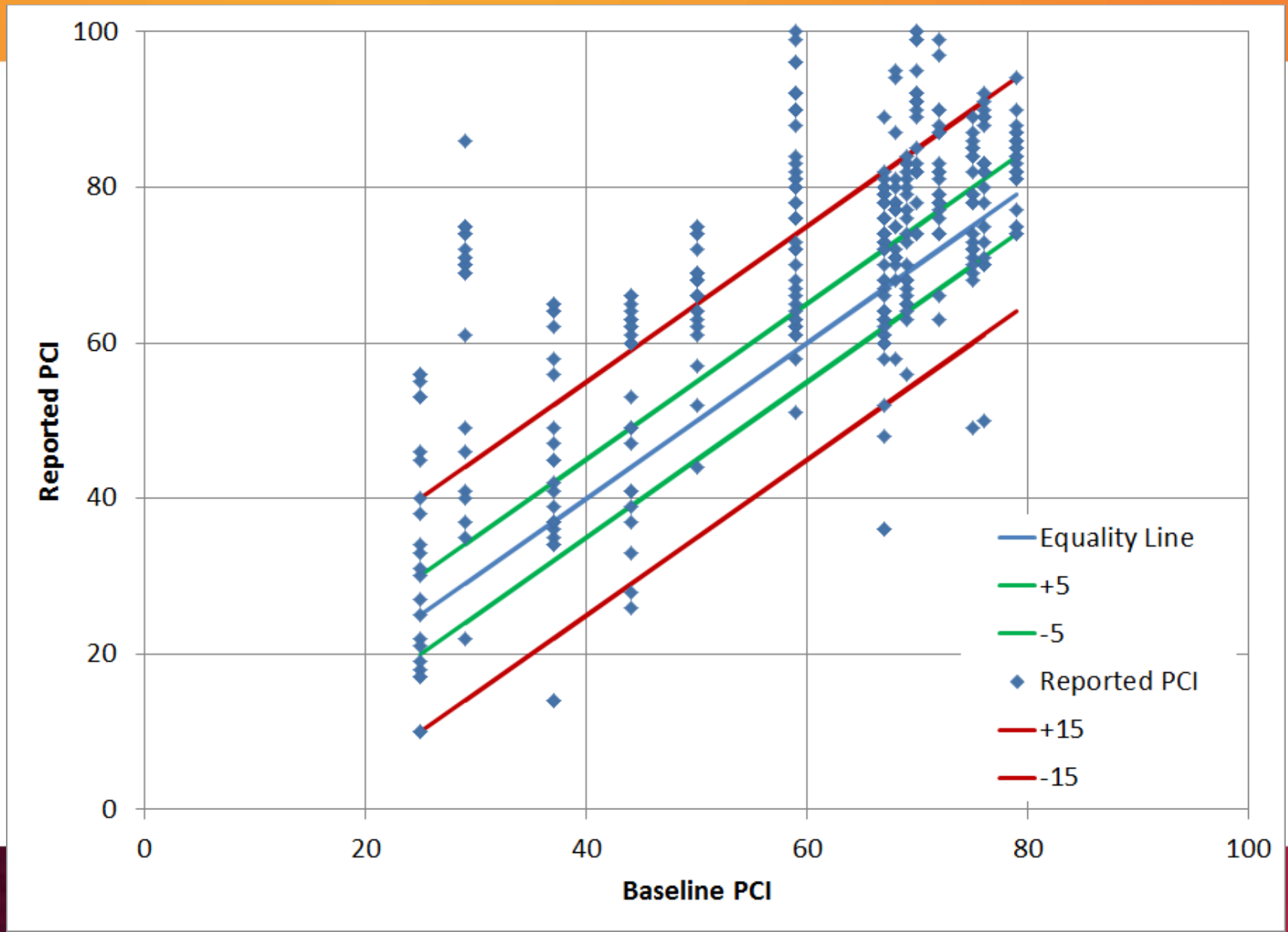
2011 Control Sections



2011 Study Details

- First OCTA prequalification study
- 16 control sections (out of 20 candidate sections)
- 21 inspectors (manual surveys)
- 1 windshield survey
- Criteria:
  - More than 50% within “baseline” PCI +/- 5
  - Less than 10% outside “baseline” PCI +/- 15

2011 Results



2011 Findings

- General trend:
  - Consultants overestimate PCI
  - Agency inspectors underestimate PCI
- Only 1 inspector met the prequalification criteria
- Outcome dependent on the number of sections (e.g. 10% of 16 = 1.6 sections: not practical)

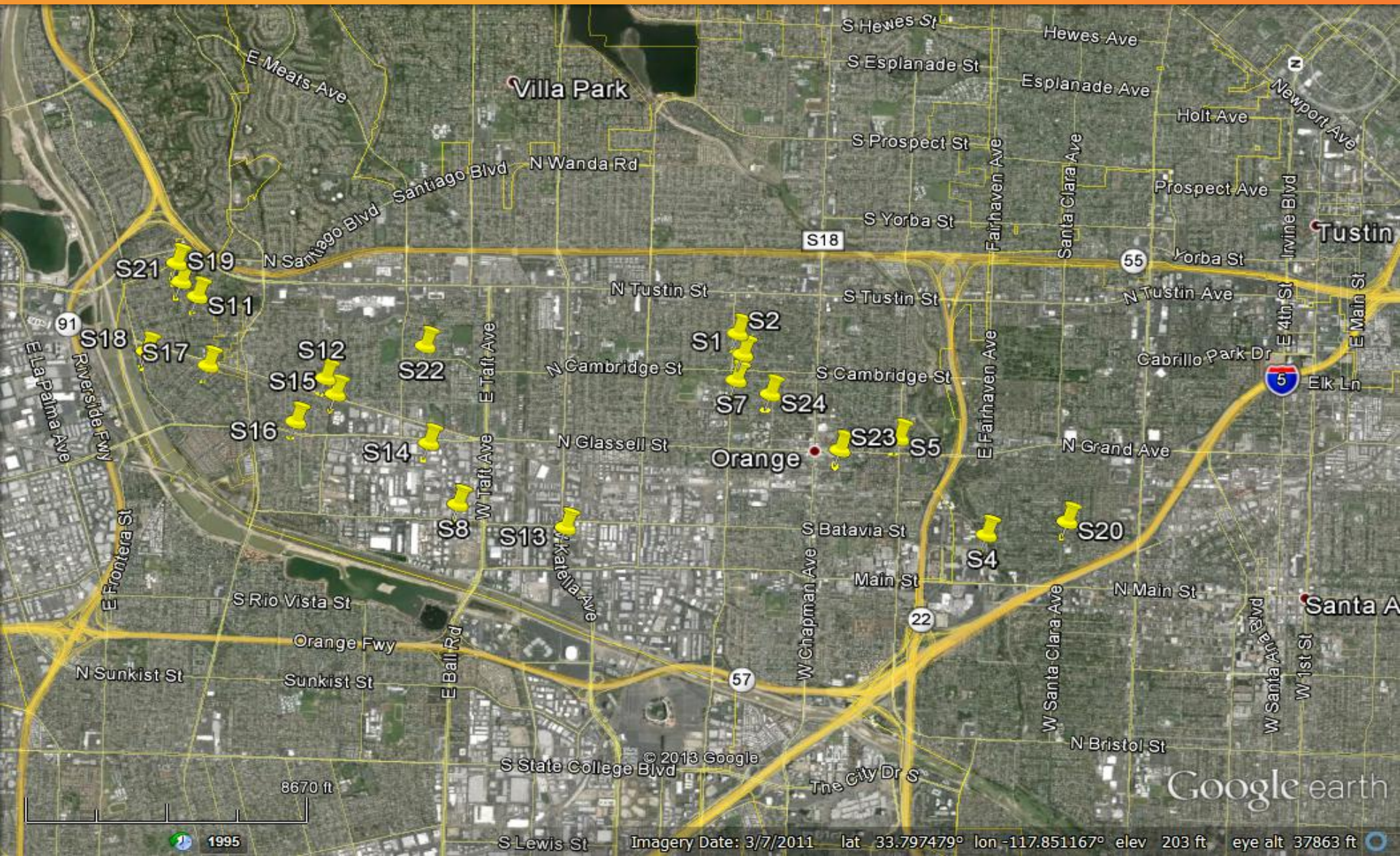
2011 Recommendations

- RMSE proposed as better criterion

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(RPCI_i - BPCI_i)^2}{n}}$$

- RMSE ≤ 12 recommended, would result in 12 inspectors being qualified out of 22
- Inspectors from the same firm/agency did not perform independent surveys
- The prequalification requirement was temporarily waived.

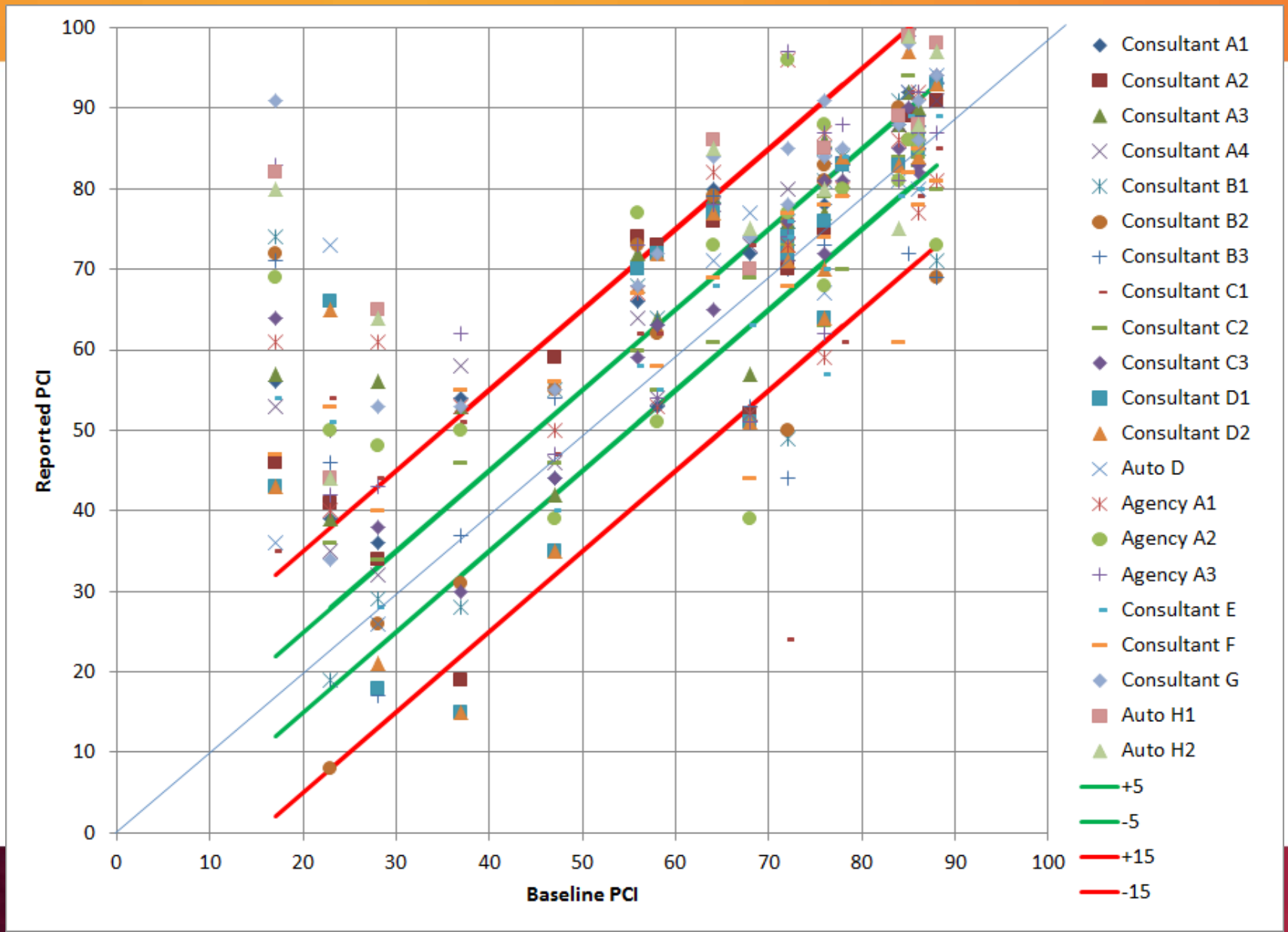
2013 Control Sections



2013 Study Details

- 19 new control sections, (originally 20, one eliminated later in the analysis)
- 18 inspectors (manual surveys, most of them participated in the 2011 study)
- 3 automated surveys
- Windshield surveys not allowed
- Modified Criteria:
  - More than 47% within “baseline” PCI +/- 5
  - Less than 12% outside “baseline” PCI +/- 15

2013 Results



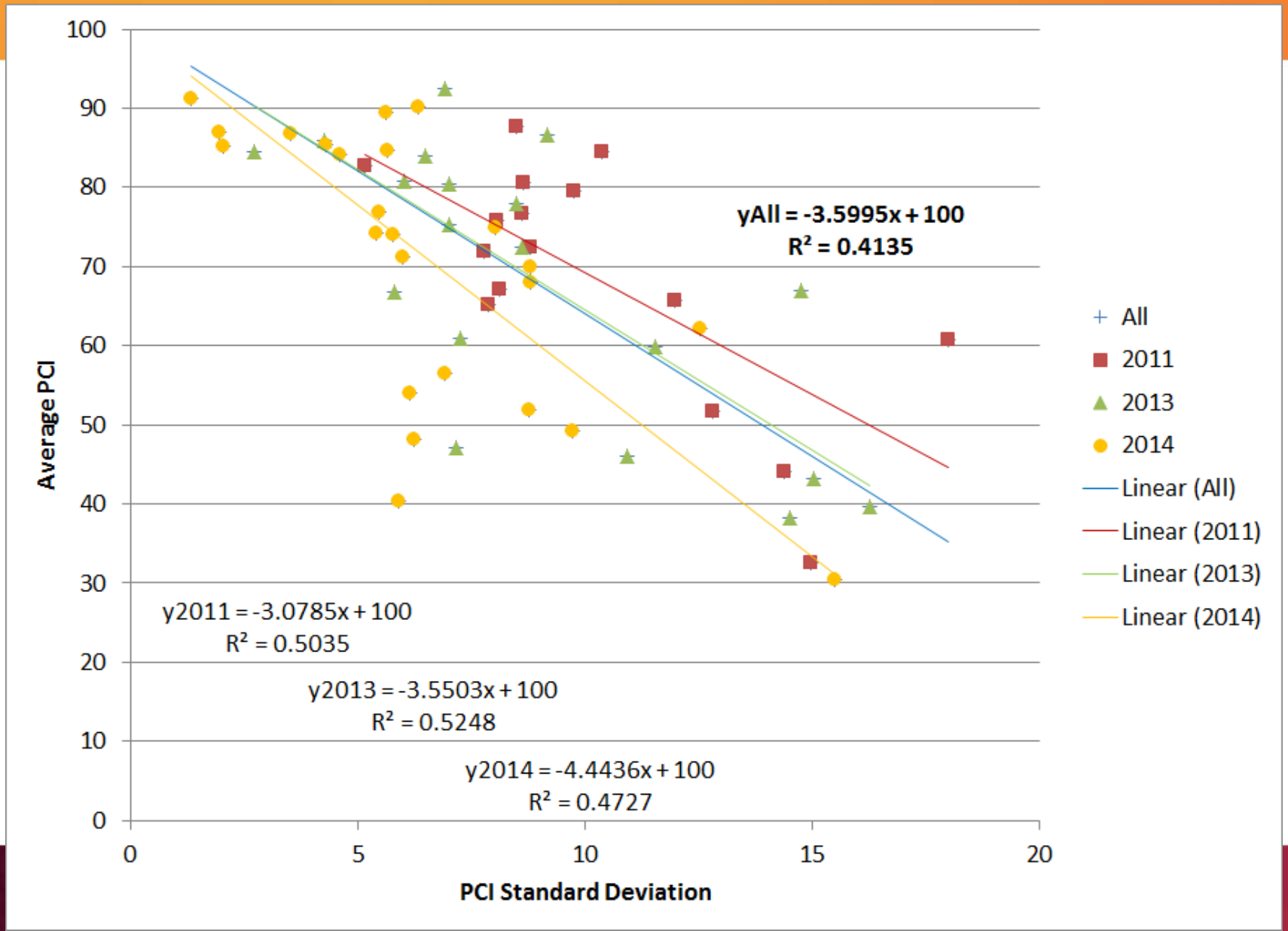
2013 Findings

- Only 3 inspectors met the prequalification criteria
- No difference between agencies and consultants
- Surveys appear to be independent
- RMSE ≤ 14 was used instead and resulted in 13 inspectors being qualified out of the total 18 manual surveys.
- All 3 automated surveys had RMSE ≥ 18

2013 Additional Findings

- PCI variance higher for low PCI sections
- Same trend observed in 2011 study
- Same trend confirmed by 2014 study

Average PCI Vs. PCI Standard Deviation



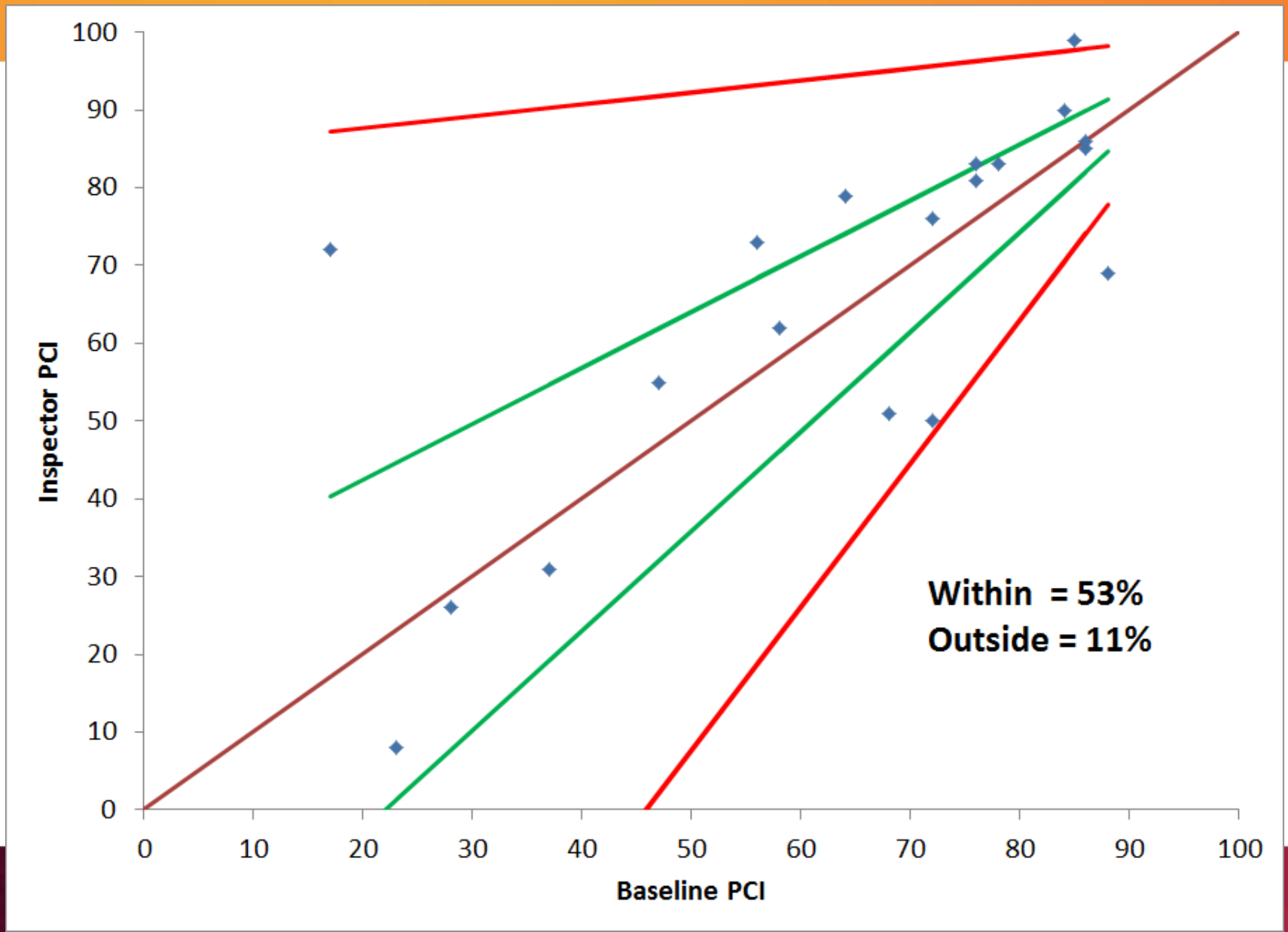
SD_{PCI} Predictive Model

- Estimate PCI standard deviation as a function of the baseline PCI using:

$$SD_{PCI} = \frac{100 - PCI}{3.6}$$

- SD = 2.8 when PCI = 90
- SD = 9.7 when PCI = 65
- SD = 12.5 when PCI = 55
- SD = 18.1 when PCI = 35

Acceptance Criteria Comparison



Proposed Prequalification Criterion

- Normalized RMSE proposed as better criterion:

$$nRMSE = \sqrt{\frac{\sum_{i=1}^{n}\left(\frac{RPCI_i - BPCI_i}{SD_{PCI}}\right)^2}{n}}$$

- Suggested decision matrix:
  - nRMSE ≤ 1.0: Prequalified for 2 years
  - nRMSE ≤ 1.4: Prequalified for 1 year
  - nRMSE ≤ 1.6: Allowed to repeat and resubmit
  - nRMSE > 1.6: Disqualified

2014 Study

- 20 new control sections, 13 Inspectors (most new, many out of state), no automated
- After consultation with OCTA it was decided to use the following simplified approach:
  - nRMSE ≤ 1.4: Prequalified for 2 years
  - nRMSE > 1.4: Allowed to revisit 2 control sections; Disqualified if still > 1.4
- 11 inspectors qualified (2 after reinspection), 2 disqualified

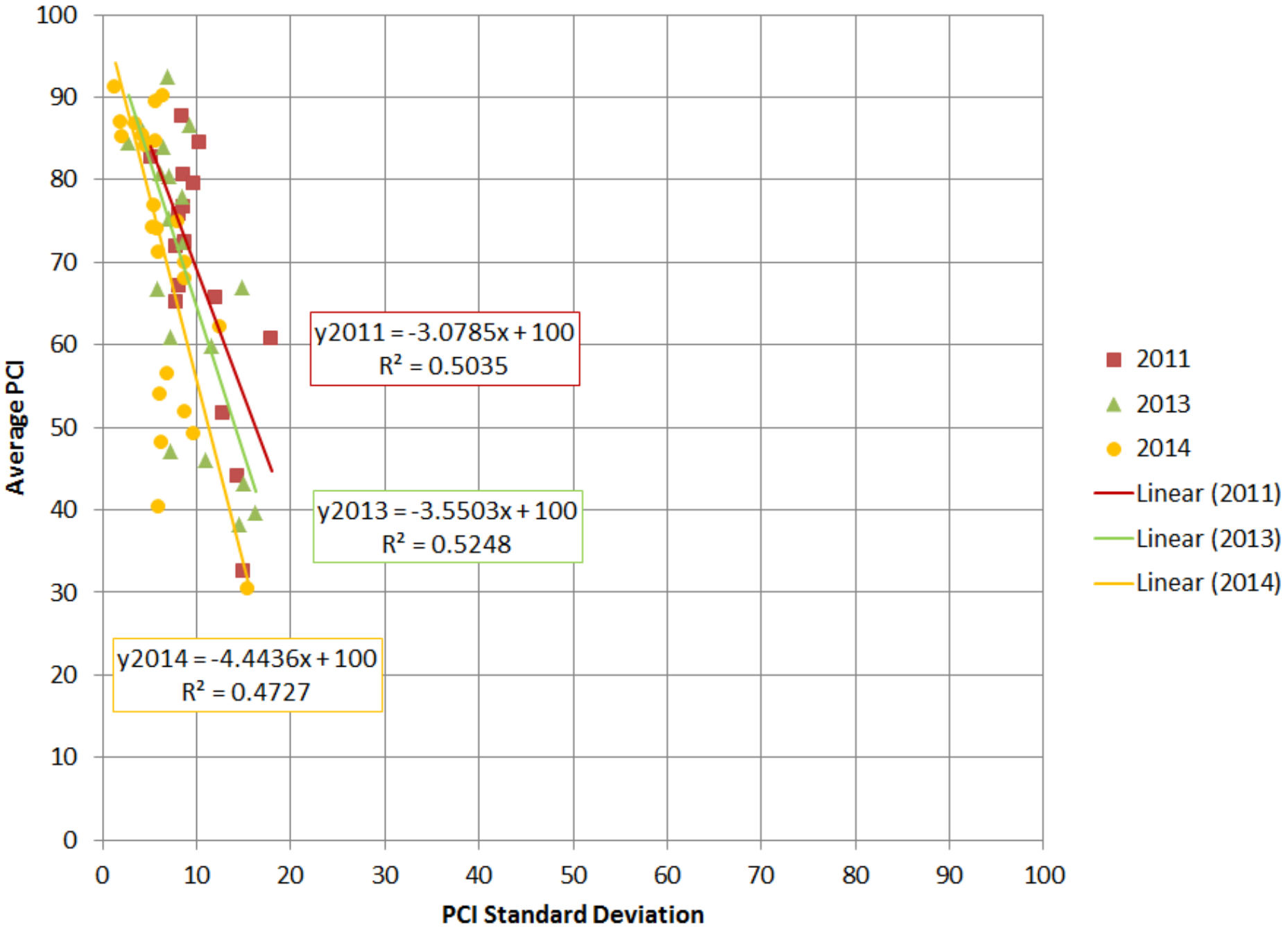
CONCLUSIONS AND RECOMMENDATIONS

PCI Variability

- 3 consecutive prequalification studies confirm that the condition of the pavement correlates with the amount of variability observed in the reported PCI values:
  - Better condition = lower variability
  - Worse condition = higher variability
- Although the correlation is not very strong, it should be accounted for in the evaluation of inspector proficiency.

Evaluation Criteria

- Fixed boundaries such as "*no more than 5% of PCI values outside baseline PCI +/- 15*":
  - are highly dependent on the number of data points (control sections) which is usually less than 20
  - do not account for the expected change in PCI variability as a function of pavement condition.
- Numerical indices, such as RMSE or nRMSE are less dependent on the number of control sections.
- nRMSE takes into account PCI variability and allows for more estimation error on pavements with more distress and lower PCI.


Average PCI
PCI Standard Deviation
0
10
20
30
40
50
60
70
80
90
100
y2011 = -3.0785x + 100
R² = 0.5035
y2013 = -3.5503x + 100
R² = 0.5248
y2014 = -4.4436x + 100
R² = 0.4727
2011
2013
2014
Linear (2011)
Linear (2013)
Linear (2014)

Other Observations

- ASTM D6433-11 does not include distress definitions and deduct curves for surface treatments which are more and more common.
- Inspectors not familiar with “unusual” pavements (e.g. 100 ft long concrete slabs). Local calibration and training are therefore very important.
- Inspections are usually done without traffic control, therefore records of safety training should be required and formal safety programs developed. Training is usually performed by in-house staff, not by safety professionals.

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