Pipeline Design, Construction & Operations Technical Committee

Damage Prevention

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Southern California Gas Company

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PRCI
Technology for Energy Pipelines

DC&O Mission Statement

Develop safe, environmentally responsible, cost-effective and reliable solutions for the design, construction, and operation of energy pipelines

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Key Emphasis Areas

- Offshore
- Onshore & Arctic
- Damage Prevention & Detection
- Reliability-Based Design & Assessment
- Integrity Practice Standardization

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Technical Programs (2001 – 2004)

1.	Prevention of Third Party Damage	$1,305k
2.	Implementing Integrity Standards	$3,060k
3.	Reliability-Based Design Alternatives	$918k
4.	Determination of Max. Safe Surface Loads	$994k
5.	Leak Detection and Notification	$350k
6.	Prevention of Critical Pipeline Strains	$1,363k
7.	Solutions for Adverse Crossings	$245k
		$8,235k

Damage Prevention

- **Addressed by all seven technical programs**
- **Categorized into four areas:**
  - Integrity Assessment for Operating and External Loads
  - Mechanical Damage
  - Industry Standards Development
  - Human Factors (new)

Integrity Assessment for Operating Loads

- **Current Projects**

  Surface Loading

  – effects of non-typical loading conditions on buried pipelines
  – centrifuge modeling of pipe stress from extreme loads
  – effects of static and cyclic surface loadings on the performance of welds in pre-1970 pipelines

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Integrity Assessment for Operating Loads

- **What's Needed**

  Surface Loading

  - Calibrate improved FEM techniques to full-scale test data
  - Expand database for varied load conditions, pipe parameters, soil types and cover depths using FEM
  - Develop tools to assess extreme surface loads on pipelines at various cover depths

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Integrity Assessment for Operating Loads

- **Current Projects**

  Structural Integrity

  – local buckling and collapse of corroded pipelines

  – wrinkle bend integrity study

  – decompression response of high-pressure natural gas pipelines under rupture/blowdown conditions

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Integrity Assessment for Operating Loads

➢ Past and Current Projects

Environmental Forces

- integrity assessment of exposed and unburied pipelines in river channels
- pipeline on-bottom stability
- seismic design and assessment guidelines
- satellite-based ground movement monitoring

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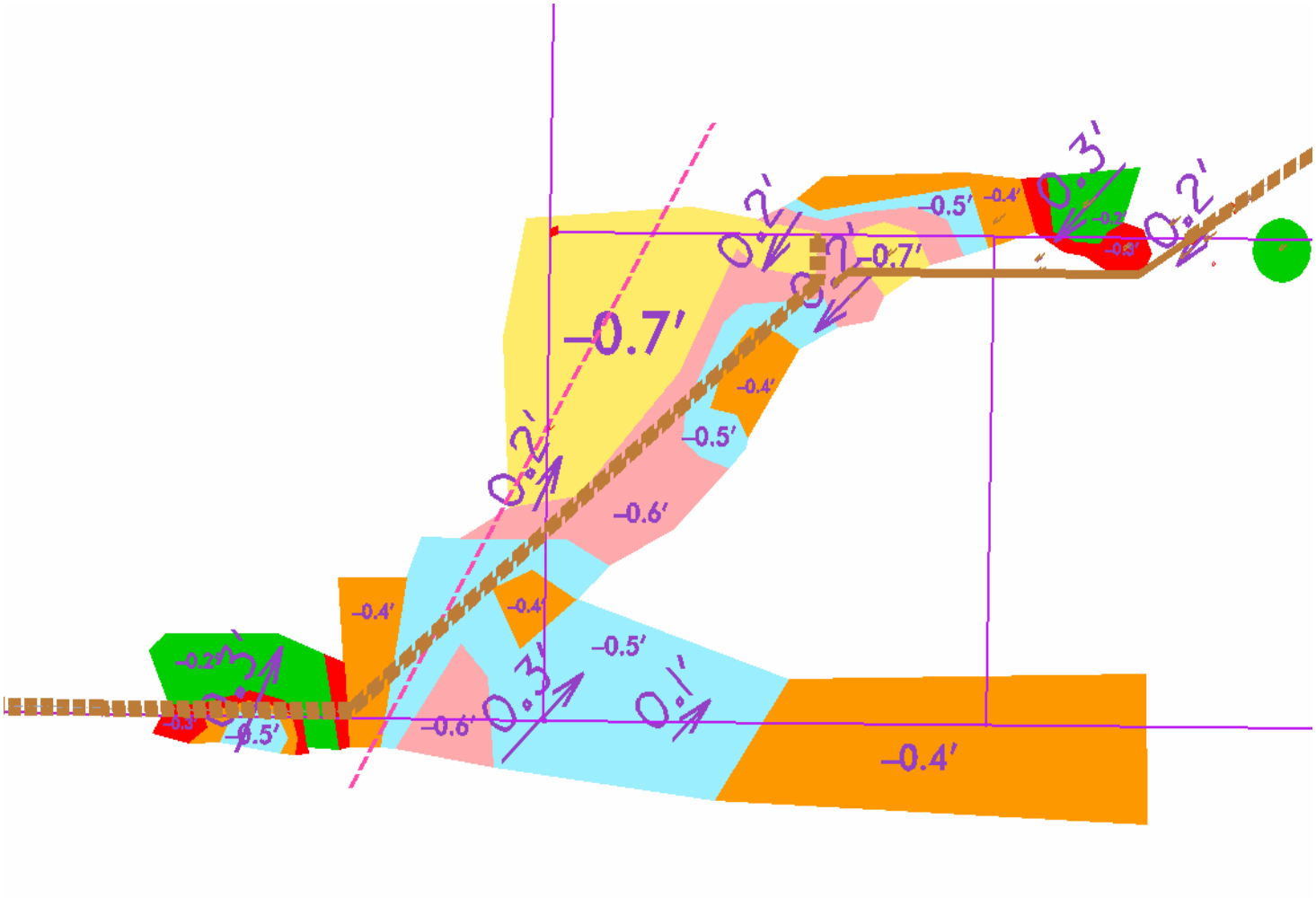

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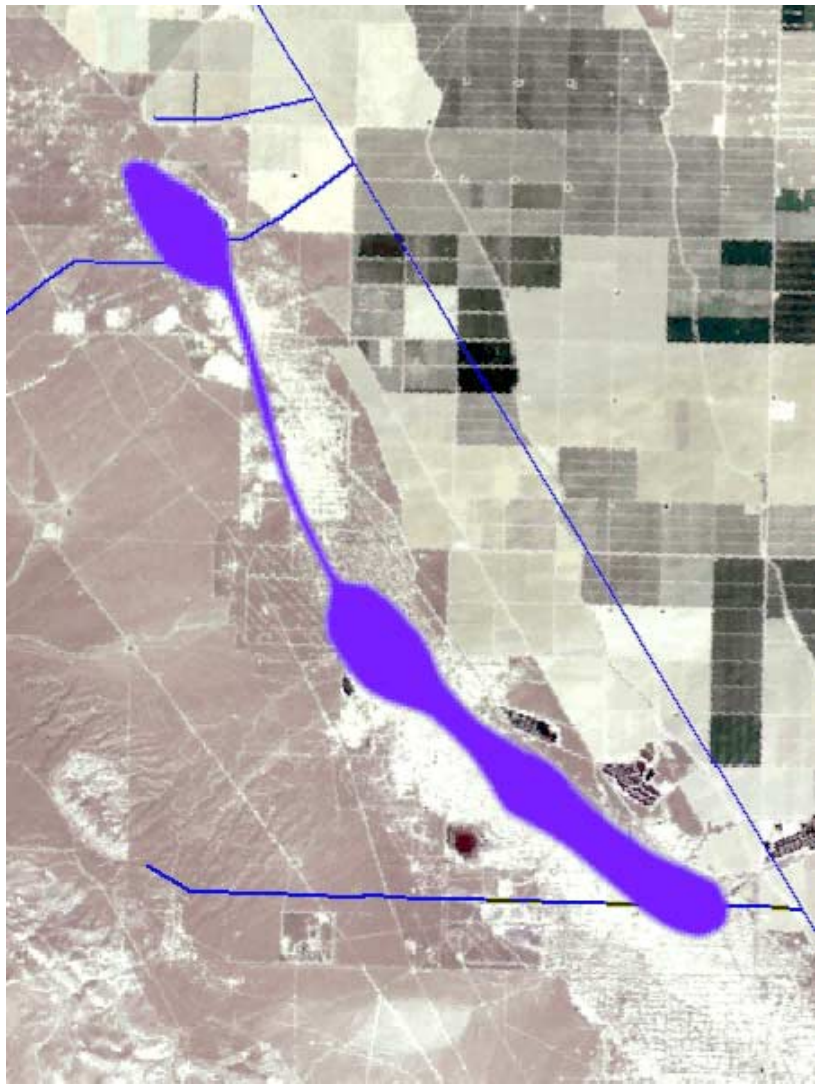

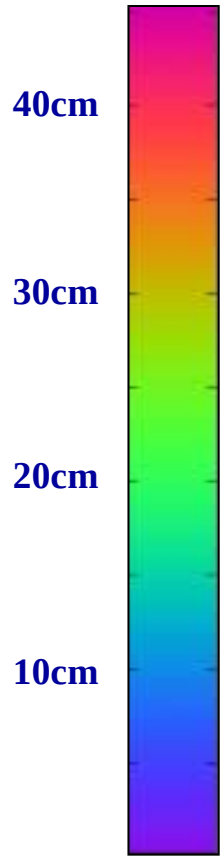

Ground Subsidence Along SoCalGas ROW due to Belridge Oil Production

February 24 to September 29, 2001.

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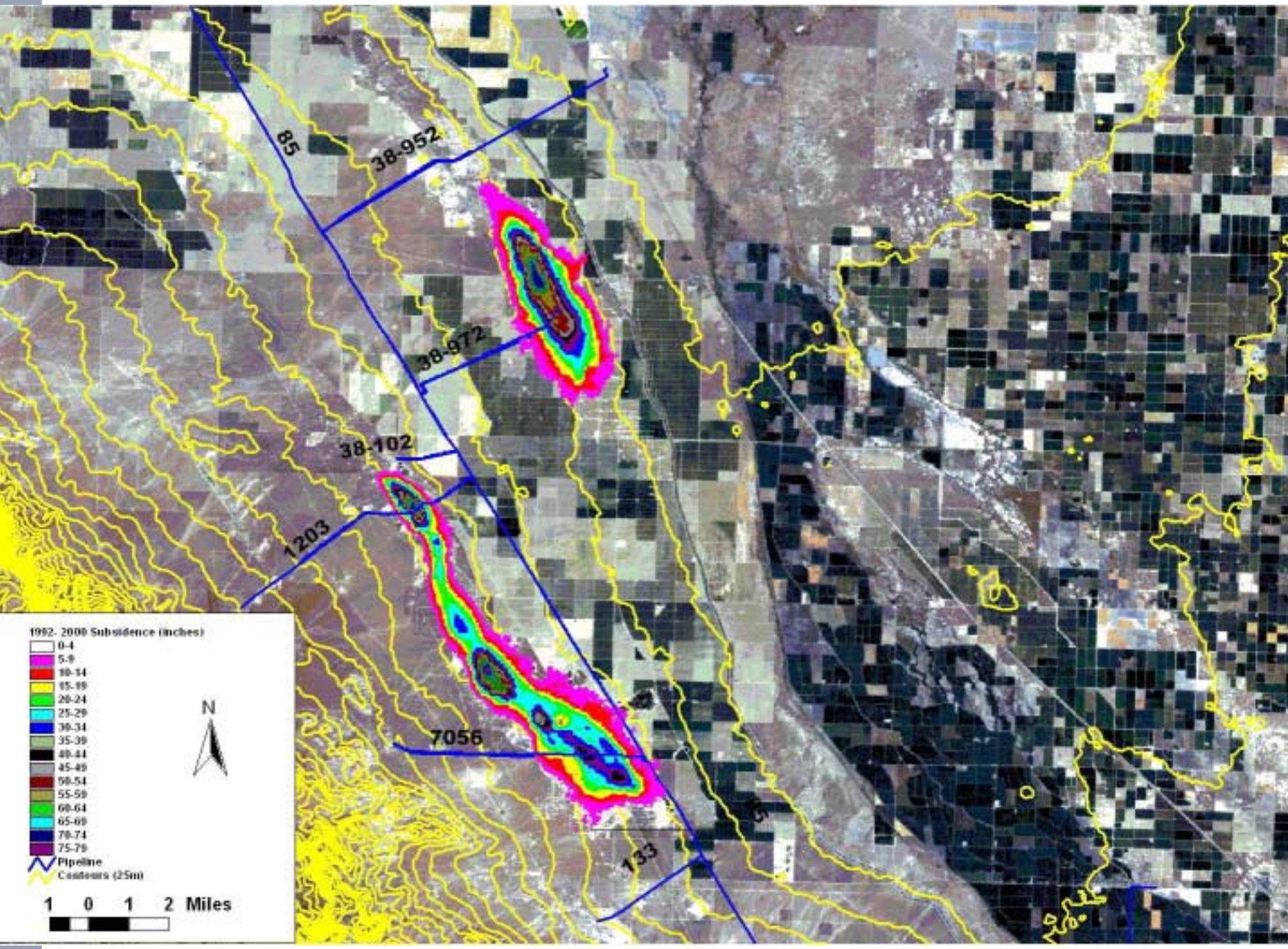
85
38-952
38-972
38-102
1203
7056
133
1992- 2000 Subsidence (inches)
0-4
5-9
10-14
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70-74
75-79
Pipeline
Contours (25m)
N
1 0 1 2 Miles

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Integrity Assessment for Operating Loads

➢ Satellite-Based Ground Movement Monitoring

- Mature service with several providers
- Reliable measurements
- Applicable to most right-of-ways (arid to semi-arid regions ideal)
- Radar reflectors required in regions with moderate to dense vegetation
- Successful pilots conducted
- Large data archive covering most regions back to 1992
- Cost effective when multiple rights-of-way are covered in a single satellite image
- Very cost effective in remote regions
- New satellites are bringing costs down (~30% less than 2002)

Integrity Assessment for Operating Loads

- **What's Needed**
  - more satellites: closer intervals, more images, reduced cost
  - enhanced radar imagery resolution
  - enhanced imagery processing for larger areas
  - enhanced software for automatic detection and notification
  - company-specific pilots to demonstrate benefits
  - tests to determine if reflectors are required

Mechanical Damage

- **Past and Current Projects**
  - pipeline design for mechanical damage
  - reliability-based pipeline design for mechanical damage
  - reliability-based prevention of mechanical damage to pipelines
  - reliability-based planning of inspection and maintenance
  - effectiveness of new prevention technologies for mechanical damage
  - real-time acoustic monitoring
  - detection of third-party encroachment using satellite-based remote sensing technologies
  - automated detection of encroachment events using satellites

Mechanical Damage

- **Satellite-Based Third Party Encroachment Monitoring**
  - Capabilities and performance continue to improve
  - Automated detection rates approaching human performance
  - New satellites bring new levels of performance
  - Optical satellites close to ‘people’ detection
  - Radar satellites similar to optical resolution to be launched in 2005
  - Radar satellites essential for operations in cloud areas
  - High imagery cost - vendors must become part of overall service provision to make service viable in the long term

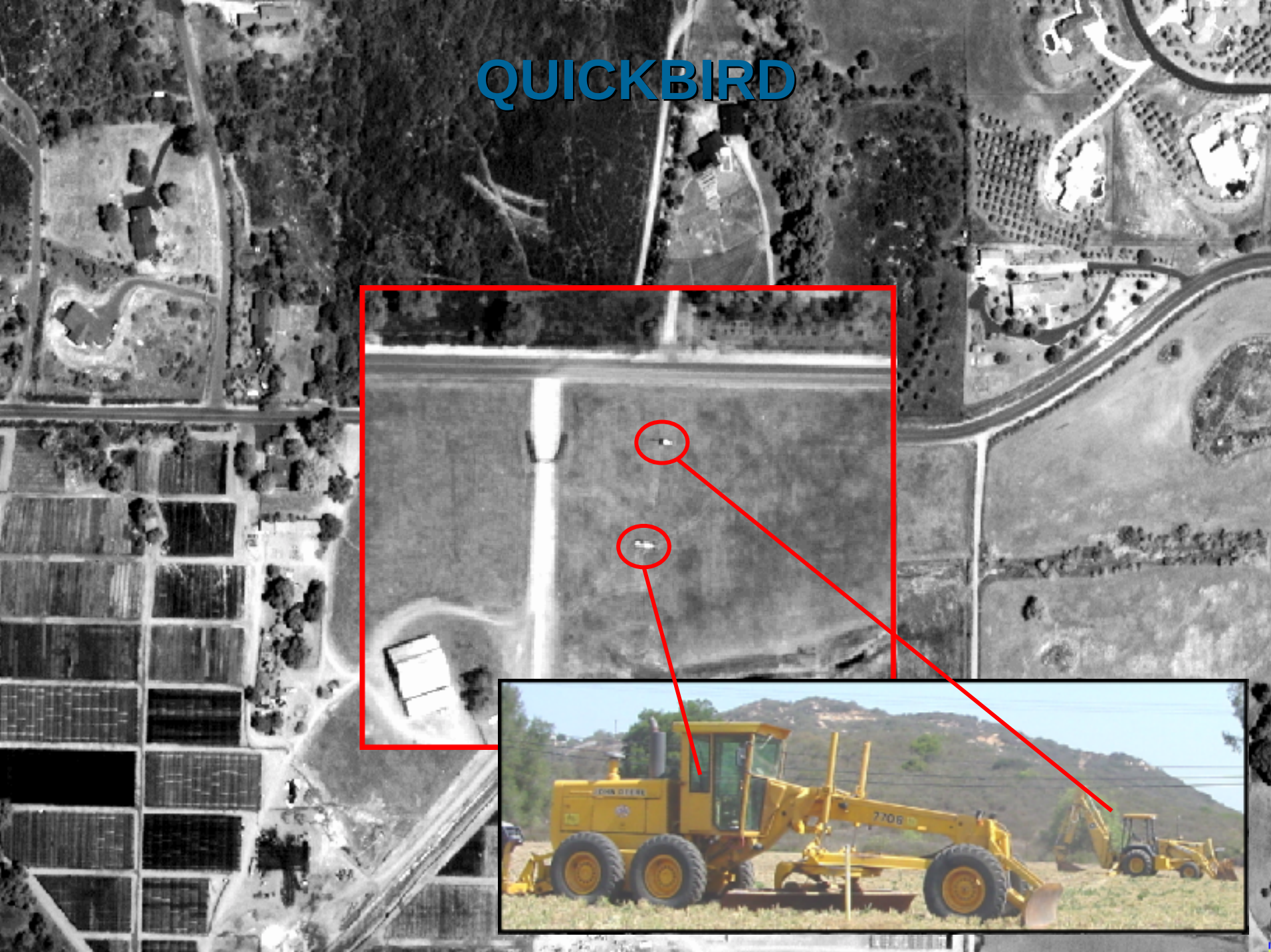
Mechanical Damage

- **What's Needed**
  - More satellites / lower imagery cost
  - Enhanced imagery resolution & processing
  - Higher accuracy rate (less false calls)
  - Alternatives to satellite monitoring (new platforms)
  - High speed processing chain required for full operation
  - Framework for integration with one-call and 1st/2nd party coordination
  - Pilot Projects:

    Short duration (1 month) pilots have been successful

    Long duration (6 month) pilots required to demonstrate full benefits

QUICKBIRD



RADARSAT-1

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Mechanical Damage

- **What's Needed**
  - Best practices compendium with current and emerging technologies to prevent mechanical damage
  - Effective methods for monitoring offshore pipelines

Industry Standards

- **Implementing Integrity Standards**
  - Provide draft language for the periodic integrity assessment and management of threats to pipelines
  - Develop supporting standards for the Integrity Management Program
  - Provide foundation technical reports to ASME, ASNT, NACE, and other Standards Development Organizations (SDOs)

Industry Standards

- **Projects**

  Complete

  - ASME B31.8S – Managing System Integrity of Gas Pipelines
  - API 1162 – Communications for Integrity Management Program
  - Acceptance criteria for mild ripples in pipeline field bends

  In ballot

  - API RP1163 – ILI Qualification Standard

Industry Standards

Projects

Continuing

- ILI Personnel Qualifications Standard - framework for qualification of data interpreters – ASNT ILI-2003
- Conducting analysis of industry incidents
- Conducting analysis of one-call performance
- Developing industry-performance metrics

Initiated

- ASME B31.8Q Operator Qualification Standard
- Study on fatigue as a root cause for pipeline failure

Industry Standards

- **What's Needed**
  - Standards organizations to adopt and incorporate acceptance criteria for mild ripples in pipeline field bends into existing codes and standards
  - Develop standards for RBDA for gas, liquid, Arctic pipelines

Human Factors

- **Human Factors Analysis of Pipeline Control Room Operations and Procedures**
  - Identify recurring human factors that have the potential to compromise the ability of controllers to effectively recognize and respond to leaks
  - Identify strategies that would cost-effectively reduce the likelihood of leaks, accidents, shut-downs or other incidents associated with the identified human factors

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