Advanced Oxidation Plant at the Tucson International Airport Area Groundwater Remediation Project (TARP)

April 23, 2015

Presentation Outline

- History of TARP & 1,4-dioxane chronology
- Overview of pilot testing and design
- Facility construction
- Dedication Event
- Startup and operational experience

History of TARP & 1,4-dioxane chronology

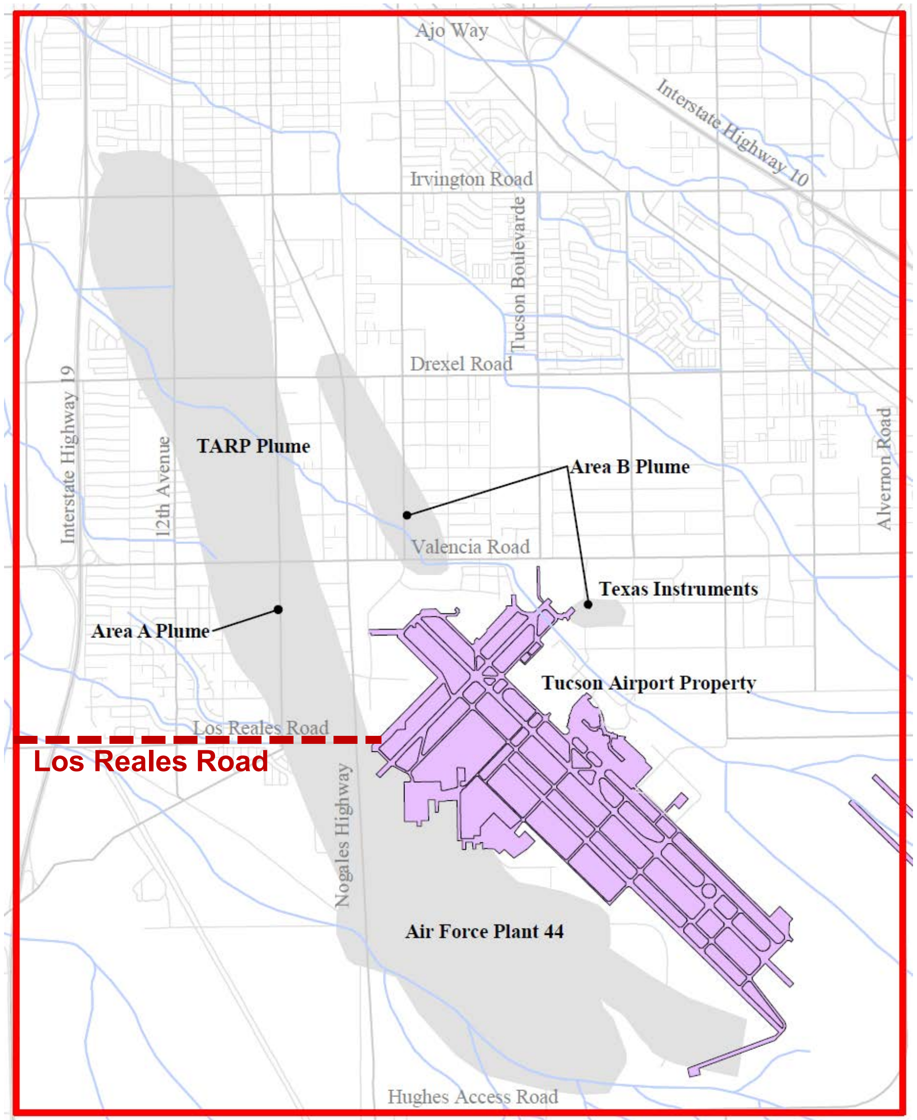
TCE Discovery and Investigation

1981 TCE contamination discovered by EPA and Tucson Water in Tucson Airport area wells.
- 11 City wells and other private wells shut down

1982 EPA adds TAA site to Superfund National Priorities List

1985 CERCLA Remedial Investigation completed.
- Approx. 4-mile by 1-mile plume delineated

1988 CERCLA Feasibilty Study for north area (TARP) completed; EPA issues Record of Decision



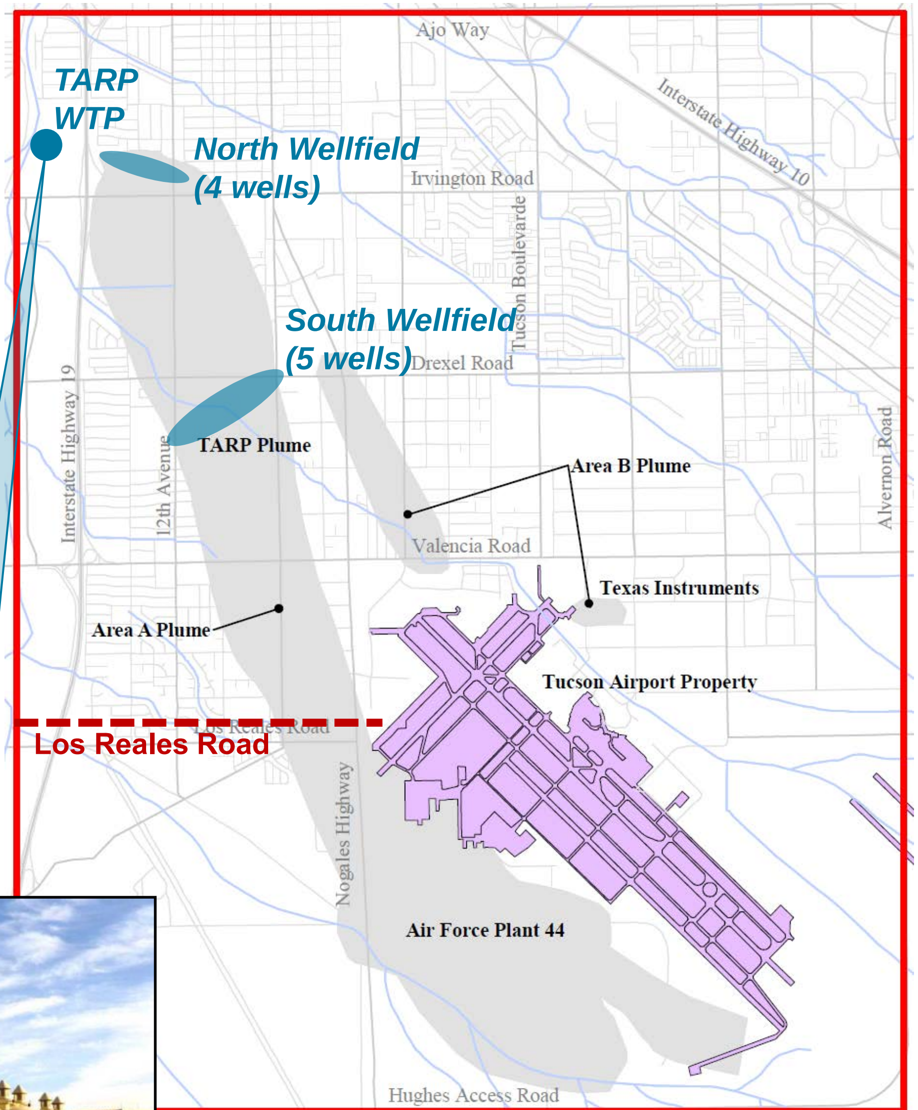
Groundwater Remedy Implemented

1990 Settling Parties enter into Consent Decree with EPA

1991-1994 Design & construction of wellfields, pipelines, and central treatment plant

1994 Nine remediation wells and packed column aeration facility become operational

1995 EPA-sponsored Unified Community Advisory Board (UCAB) formed



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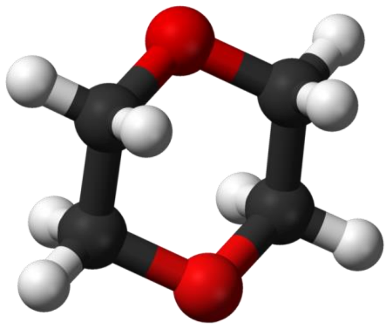
1,4-Dioxane Discovery & Early Efforts

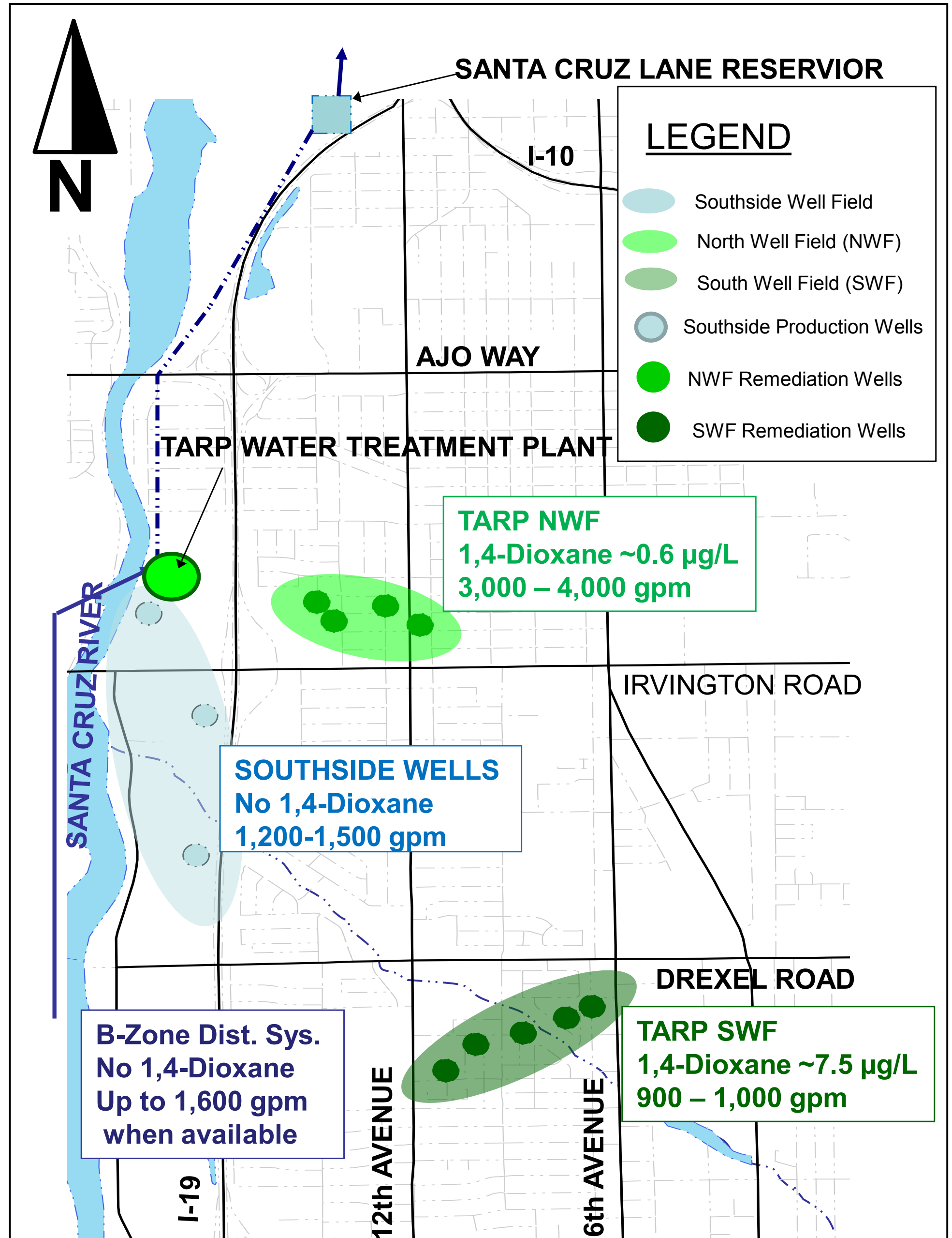
2002 1,4-dioxane initially detected; routine monitoring commenced

2003 Initial conceptual studies for 1,4-dioxane treatment at TARP

2003 Blending efforts initiated by Tucson Water to target ≤ 3 μg/L at the entry point to the distribution system (EPDS)



Blending Approach



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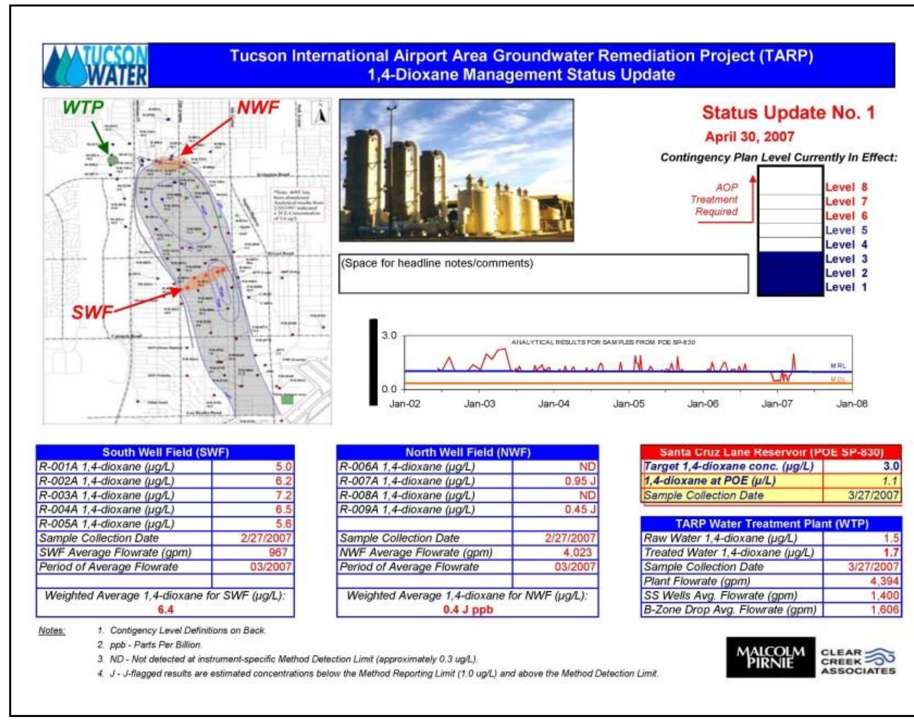
Contingency Preparations

2005 Contingency Plan developed for TARP operations to manage 1,4-dioxane

2009 Advanced Oxidation Process (AOP) Treatment Evaluation conducted

2010

AOP Pilot Treatability Testing conducted



Tucson International Airport Area Groundwater Remediation Project (TARP)
1,4-Dioxane Management Status Update

WTP
NWF
SWF

Status Update No. 1
April 30, 2007
Contingency Plan Level Currently In Effect:
AOP Treatment Required
Level 8
Level 7
Level 6
Level 5
Level 4
Level 3
Level 2
Level 1

(Space for headline notes/comments)

ANALYTICAL RESULTS FOR SAMPLES FROM POE SP-830
3.0
0.0
MRL
MDL
Jan-02 Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08

South Well Field (SWF)	
R-001A 1,4-dioxane (µg/L)	5.0
R-002A 1,4-dioxane (µg/L)	6.2
R-003A 1,4-dioxane (µg/L)	7.2
R-004A 1,4-dioxane (µg/L)	6.5
R-005A 1,4-dioxane (µg/L)	5.6
Sample Collection Date	2/27/2007
SWF Average Flowrate (gpm)	967
Period of Average Flowrate	03/2007
Weighted Average 1,4-dioxane for SWF (µg/L): 6.4	

North Well Field (NWF)	
R-006A 1,4-dioxane (µg/L)	ND
R-007A 1,4-dioxane (µg/L)	0.95 J
R-008A 1,4-dioxane (µg/L)	ND
R-009A 1,4-dioxane (µg/L)	0.45 J
Sample Collection Date	2/27/2007
NWF Average Flowrate (gpm)	4,023
Period of Average Flowrate	03/2007
Weighted Average 1,4-dioxane for NWF (µg/L): 0.4 J ppb	

Santa Cruz Lane Reservoir (POE SP-830)	
Target 1,4-dioxane conc. (µg/L)	3.0
1,4-dioxane at POE (µ/L)	1.1
Sample Collection Date	3/27/2007

TARP Water Treatment Plant (WTP)	
Raw Water 1,4-dioxane (µg/L)	1.5
Treated Water 1,4-dioxane (µg/L)	1.7
Sample Collection Date	3/27/2007
Plant Flowrate (gpm)	4,394
SS Wells Avg. Flowrate (gpm)	1,400
B-Zone Drop Avg. Flowrate (gpm)	1,606

Notes:
1. Contigency Level Definitions on Back.
2. ppb - Parts Per Billion.
3. ND - Not detected at instrument-specific Method Detection Limit (approximately 0.3 ug/L).
4. J - J-flagged results are estimated concentrations below the Method Reporting Limit (1.0 ug/L) and above the Method Detection Limit.

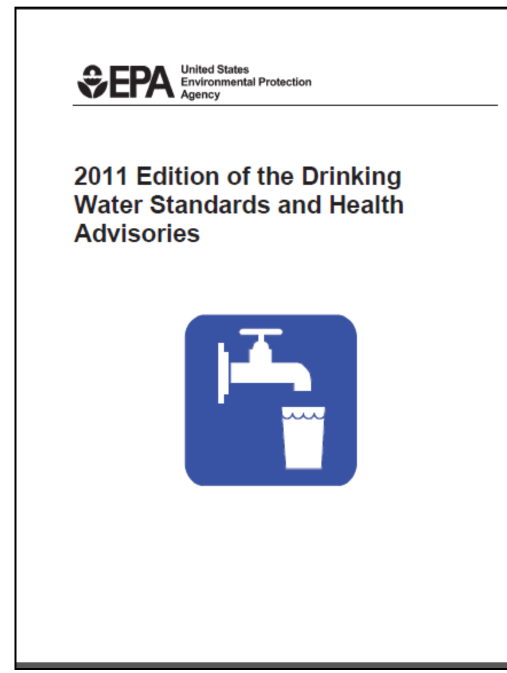
Regulatory Developments & Treatment Implementation

2010 EPA publishes revised Toxicological Evaluation for 1,4-dioxane in August

2011 EPA publishes new Drinking Water Health Advisory for 1,4-dioxane (0.35 μg/L at $1x10^{-6}$ excess lifetime cancer risk level)

2011 AOP preliminary design

2011-2013 AOP design and construction


EPA United States Environmental Protection Agency

2011 Edition of the Drinking Water Standards and Health Advisories

Overview of pilot testing and design

Pilot Testing Objectives

- Ability to remove 1,4-dioxane
- Generate site-specific data
- Evaluate byproduct formation
- Peroxide quenching methods
- Operating experience

Select →

- 1,4-dioxane treatment technology
- Hydrogen peroxide quenching method

Three 1,4-dioxane Treatment Technologies Evaluated

Ozone-Peroxide

Low Pressure High Output (LPHO) UV-Peroxide

Medium Pressure (MP) UV-Peroxide

Two Peroxide Quenching Methods Evaluated

Chemical quenching

- Common treatment chemicals

Catalytic quenching

- Granular activated carbon

LPHO UV-Peroxide Technology Selected for TARP

Exceeded treatment goals for 1,4-dioxane reduction	No formation of bromate or unregulated byproducts
Operational simplicity	Demonstrated full-scale drinking water installations

Peroxide Quenching Using GAC Selected for TARP

Complete quenching at low contact times and high surface loading rates

Potential to decrease byproducts

- Assimilable Organic Carbon (AOC)
- TTHM precursors
- Other unregulated contaminants

Operational and water quality stability advantages over chemical quenching

Objectives for Full-scale Facility

- Provide 1,4-dioxane treatment at the TARP WTP, eliminating need for blending
- Install AOP treatment upstream of existing packed column aeration
- Design for full-flow treatment capacity, with flexibility for partial stream treatment
- Optimize operating variables
  - ✓ Amount of flow directed to AOP
  - ✓ Power and hydrogen peroxide costs

Major Equipment Selection

UV-Peroxide AOP Reactors

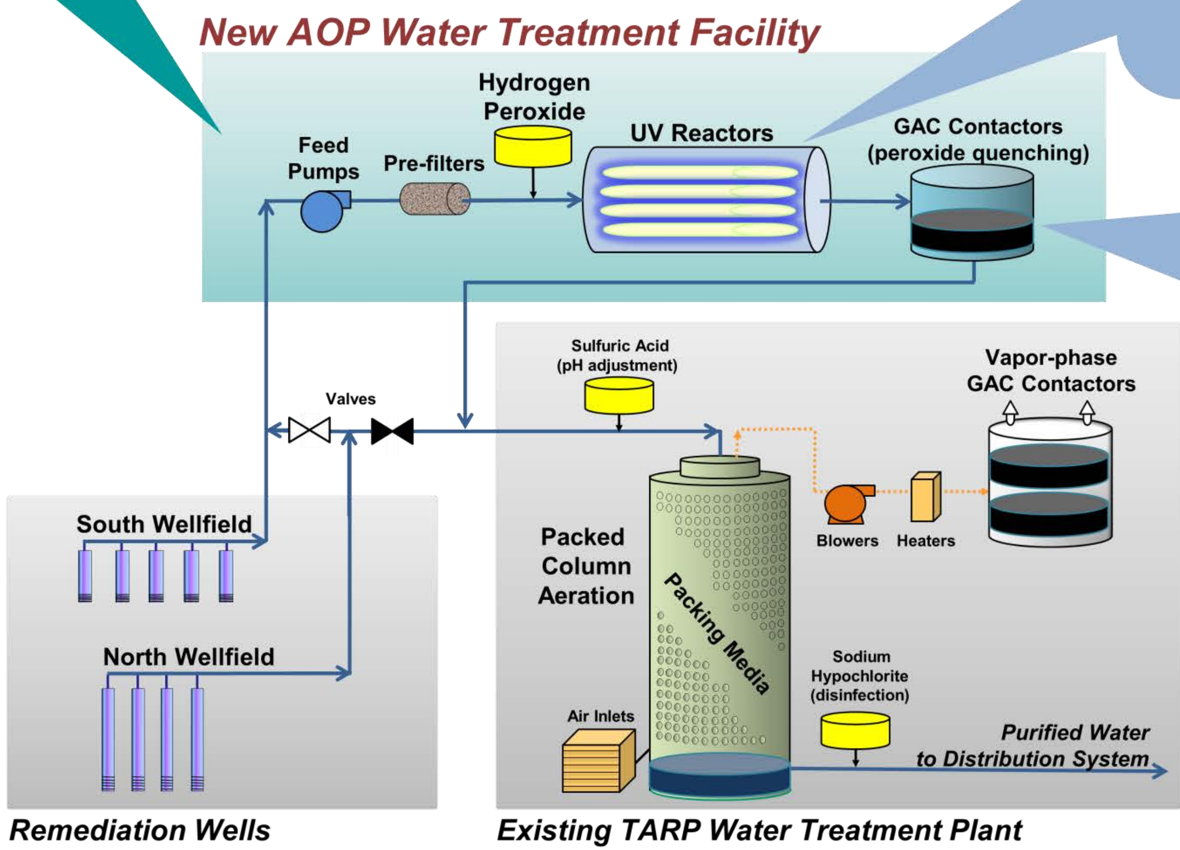
- In-line pressure reactors

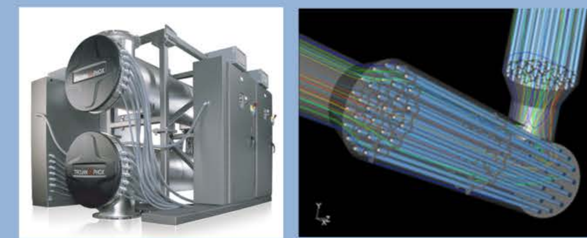
GAC Contactors

- 10-foot diameter pressure vessels
- Catalytic carbon

Schematic

ADVANCED OXIDATION PROCESS (AOP)
A proven technology that combines ultraviolet (UV) light with hydrogen peroxide to create a strong oxidant that removes 1,4-dioxane from water





The UV reactors remove 1,4-dioxane by oxidation

Granular activated carbon (GAC) removes any hydrogen peroxide left in treated water

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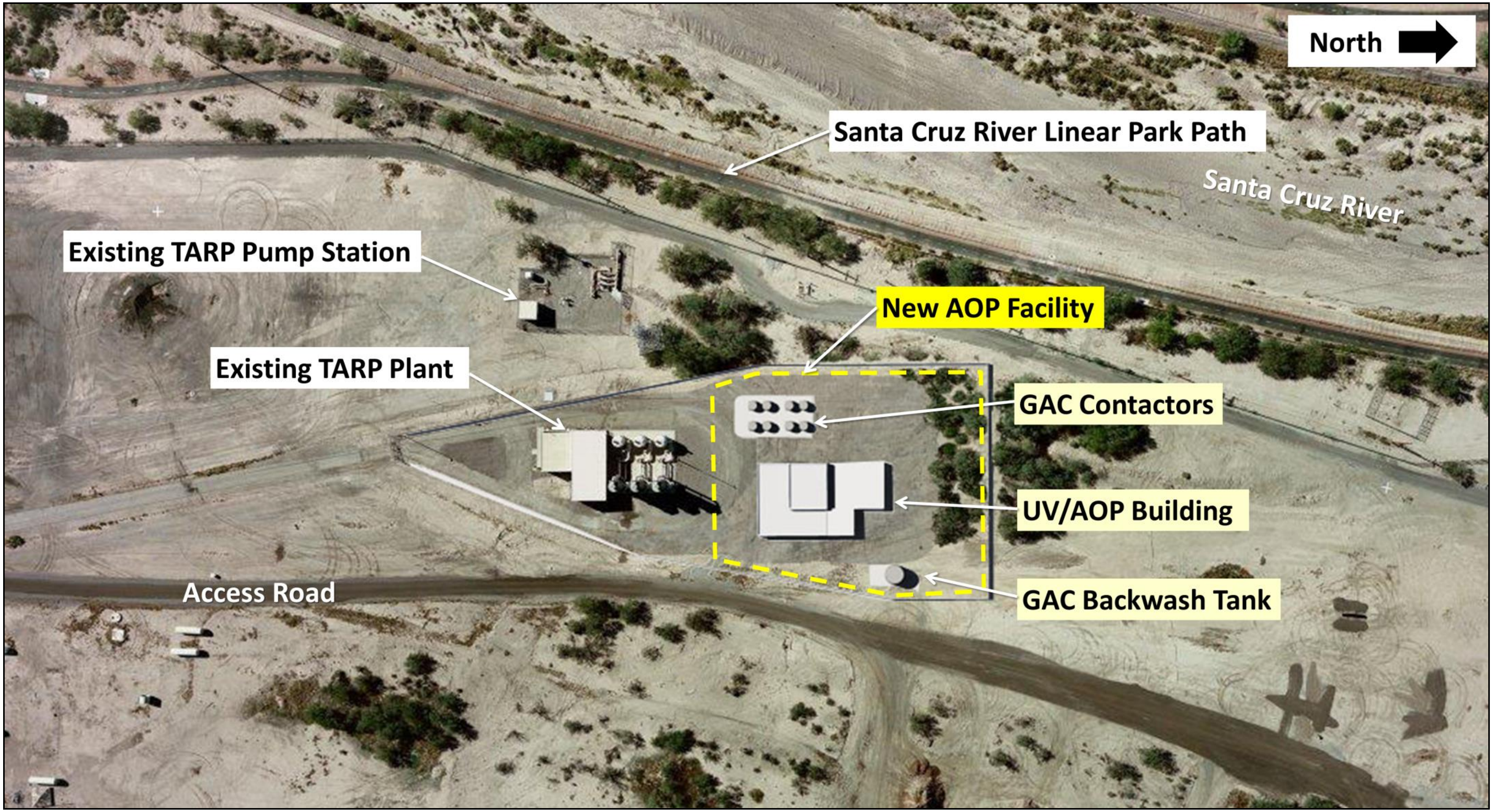
Site Layout


North
Santa Cruz River Linear Park Path
Santa Cruz River
Existing TARP Pump Station
New AOP Facility
Existing TARP Plant
GAC Contactors
UV/AOP Building
Access Road
GAC Backwash Tank

Facility construction

Technical Implementation

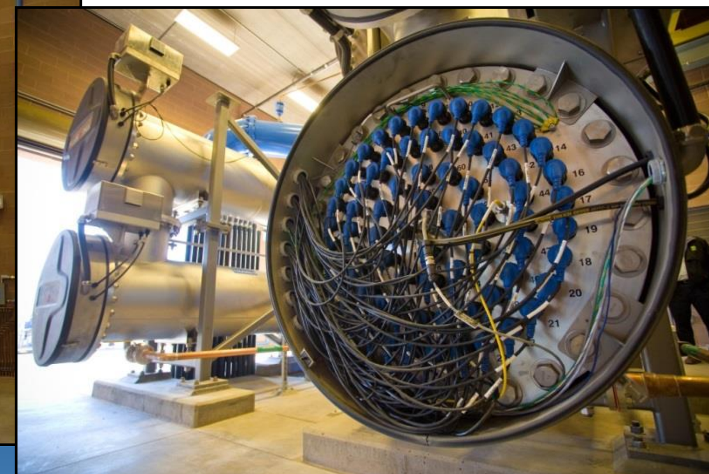
- Contracting approach
  - Construction manager at risk
  - Separate GMPs for long-lead equipment purchase and general construction
- Schedule
  - Major equipment: GMP-1 awarded July 2012
  - Construction: GMP-2 awarded Sept. 2012
  - Substantial completion: November 2013
  - Final completion: February 2014

Construction Site Overview

UV Building/Equipment Construction

Completed Facility

Completed Facility



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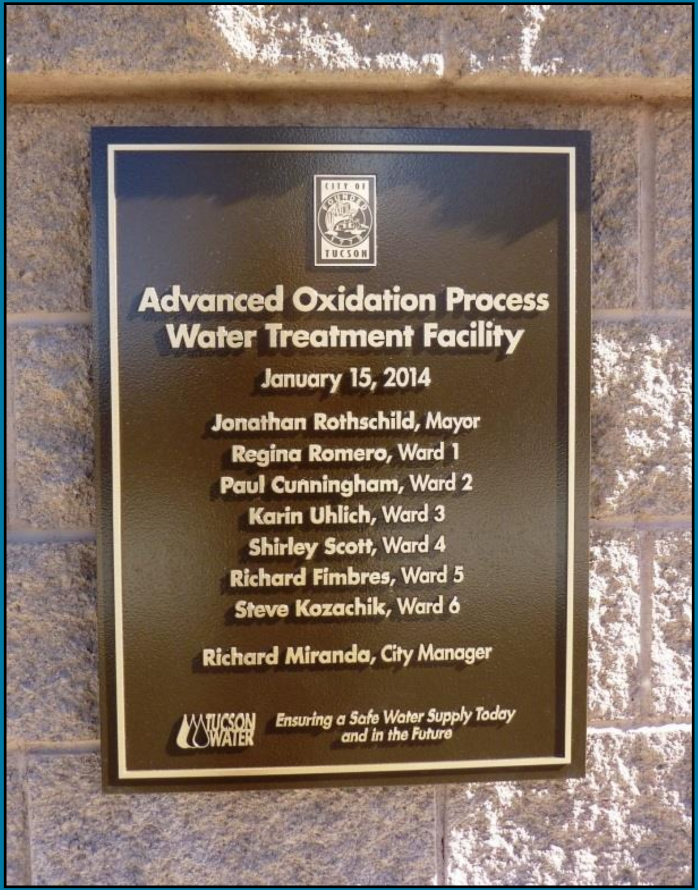
Dedication Event

January 15, 2014



AOP Dedication
January 15, 2014

AOP Dedication

January 15, 2014

Startup and operational experience

Operational Experience During Year 1

- Consistent contaminant destruction:
  - 1,4-dioxane <0.1 µg/L
  - TCE <0.5 µg/L
- Misc. adjustments in AOP control logic and setpoints for operational stability
- Robust peroxide quenching by GAC with little O&M attention needed
- Extremely low backwash frequency required for GAC

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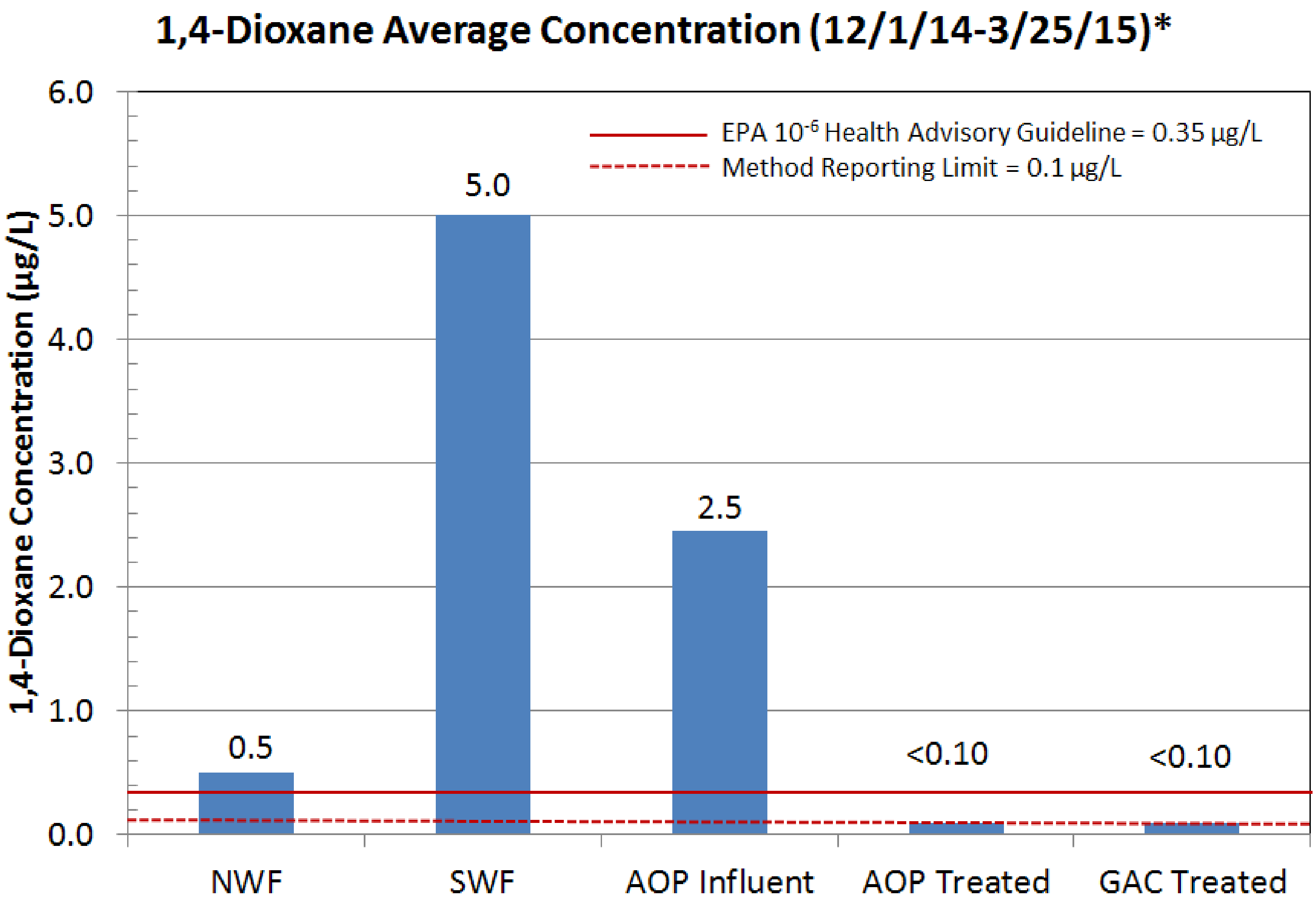
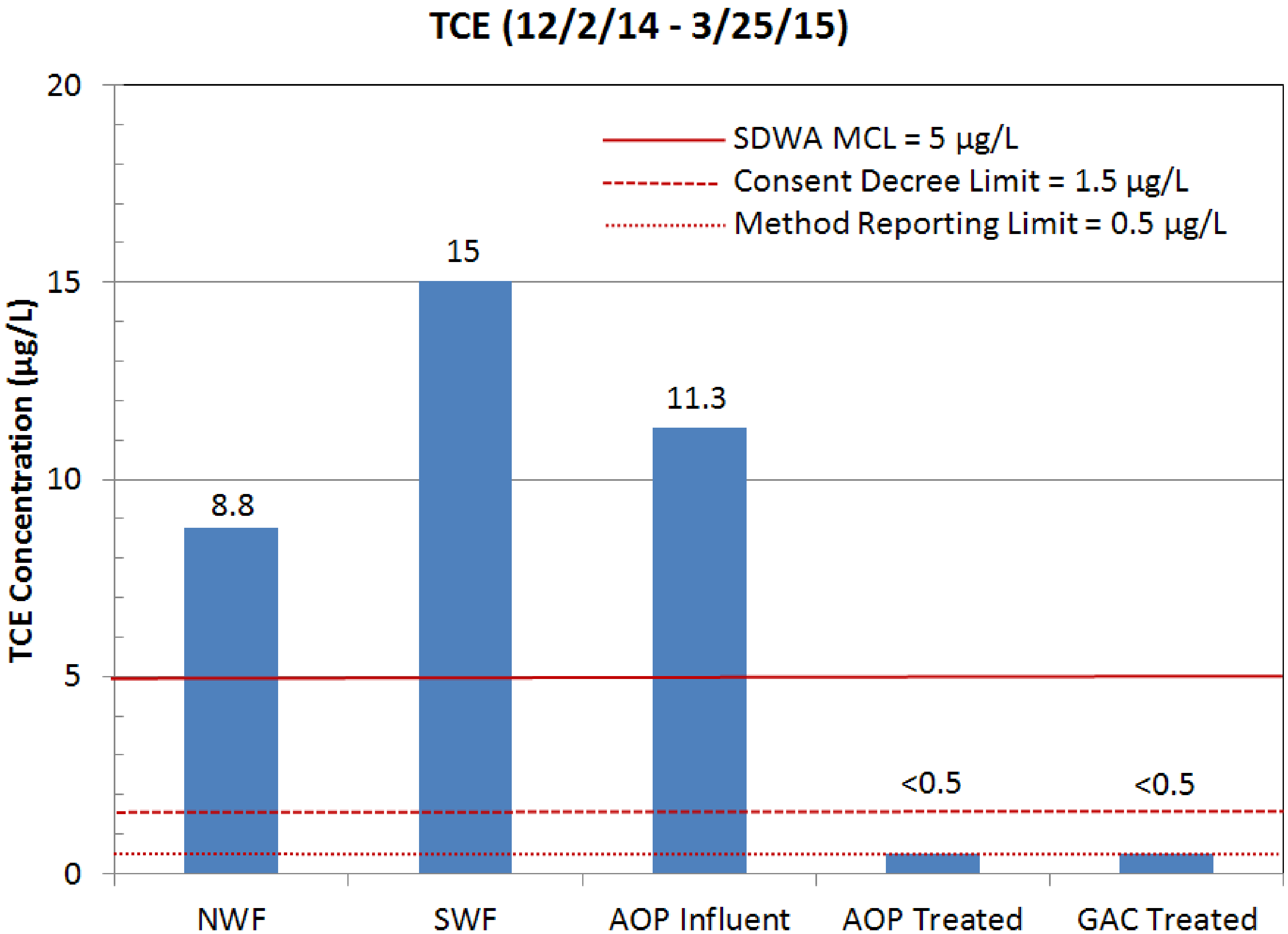
Full-scale Performance: 1,4-dioxane



*Note: only includes data from time periods when AOP Facility was in operation

Full-scale Performance: TCE



Questions

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