

# Implementation of a Dose-based Compliance System for Waste Control Specialists

Emily Caffrey<sup>1</sup>, Colby Mangini<sup>1</sup>, Art Rood<sup>1</sup>, Helen Grogan<sup>1</sup>, Justin Mohler<sup>1</sup>, Jim Rocco<sup>1</sup>, John Till<sup>1</sup>, Jay Cartwright<sup>2</sup>, Chris Shaw<sup>2</sup>, Travis Matthews<sup>2</sup>

<sup>1</sup>Risk Assessment Corporation

<sup>2</sup>Waste Control Specialists

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# Outline

- **Purpose of the dose compliance methodology (DCM)**
- **Overview of the current system**
- **Dose compliance methodology**
- **Implementation of the DCM in RACER@WCS**
- **Evaluation and Benefits to WCS**

# Purpose of the DCM

- **The current system uses media, location, facility, and radionuclide specific concentration-based investigation and action levels**
- **Now, instead of comparing sample results to thousands of individual concentration limits, we are proposing to relate them to total effective dose**
- **The advantage of total effective dose is that it relates directly to regulatory standards**

# Overview of the current system

- **Concentration-based investigation levels (ILs) and action levels (ALs) with analytical decision levels**
  - ◆ Media specific → air, soil, water
  - ◆ Radionuclide specific → U-238, H-3, etc.
  - ◆ Disposal facility specific → FWF, CWF
  - ◆ Location specific → groundwater, soil

# Current System Continued

- **End result of the current system: thousands of individual IL and AL values that need to be managed and evaluated routinely to demonstrate compliance**
- **Exceedances under the current system trigger comparisons to additional isotopic ILs per sample**
- **Bottom line: current system is cumbersome, costly, and difficult to manage**

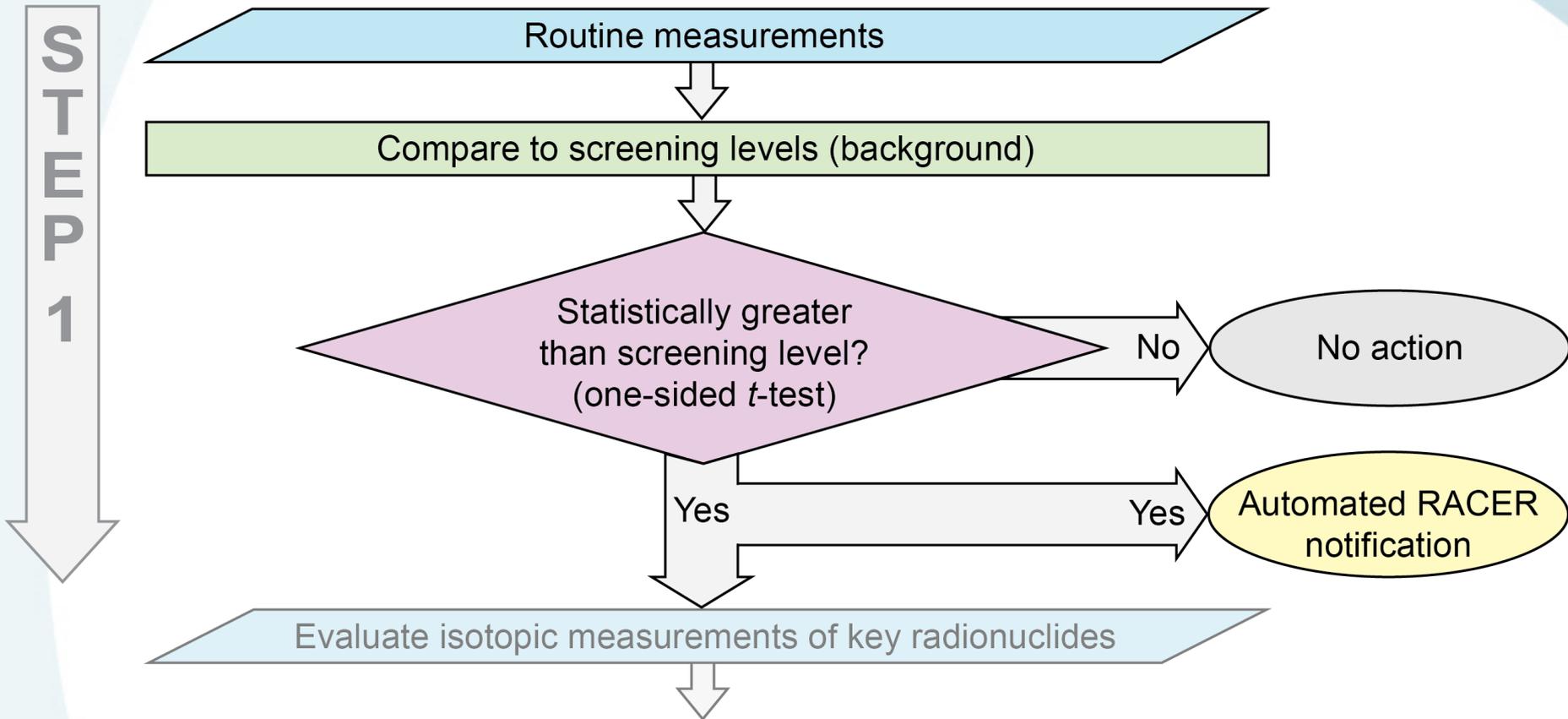
# Dose Compliance Methodology

- **Step 1: Screening and comparison to background**
  - ◆ Gross alpha/beta, detection of specific isotopes, and isotopic ratios
  - ◆ Isotopic analysis only for gross alpha and beta statistically above background
- **Step 2: Compute and compare to background dose**
  - ◆ Test for statistical significance above background dose
- **Step 3: Comparison to dose-based ILs and ALs**
  - ◆ Below? Notify, investigate, document
  - ◆ Above? Take appropriate action

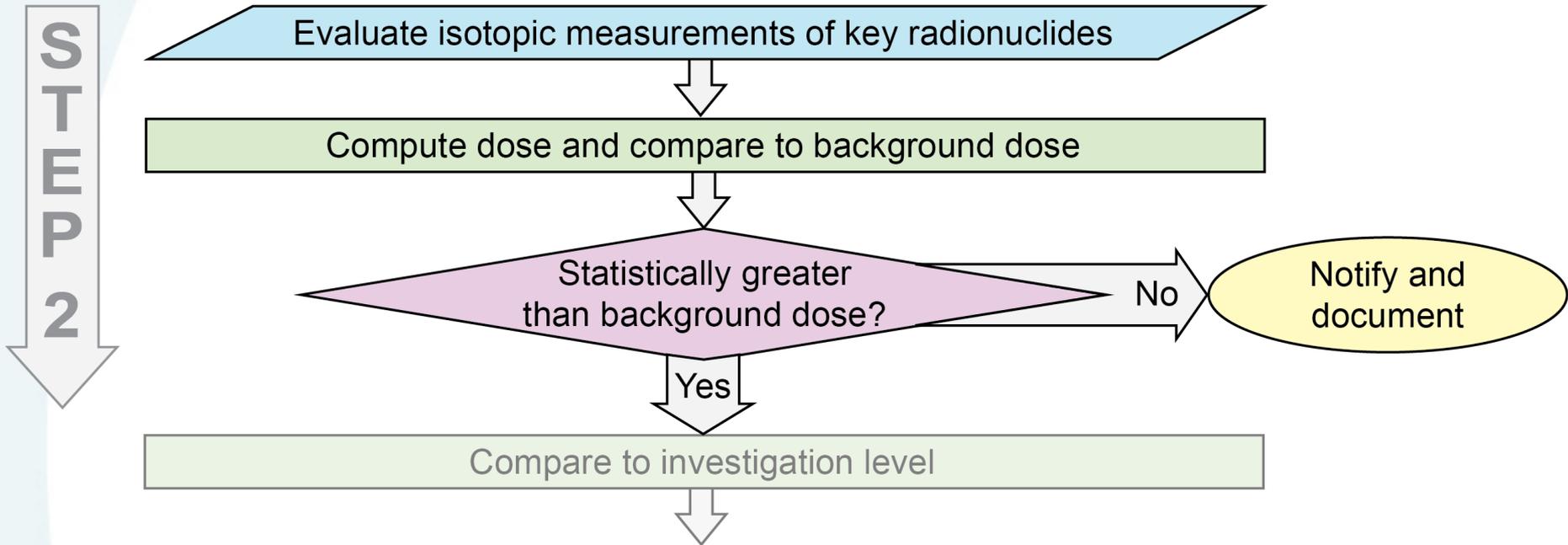
# Proposed Dose-Based ILs and ALs

- **Continuous Routine Monitoring, Air**
  - ◆ IL of 0.025 mSv annual dose
  - ◆ AL of 0.05 mSv annual dose
- **Continuous Routine Monitoring, Soil**
  - ◆ IL of 0.04 mSv annual dose
  - ◆ AL of 0.075 mSv annual dose
- **Annual All-Pathways Dose**
  - ◆ IL of 0.08 mSv
  - ◆ AL of 0.125 mSv
- **All doses calculated with an approved exposure scenario for an individual residing at the monitoring location both onsite and on perimeter**

# Dose Compliance Methodology

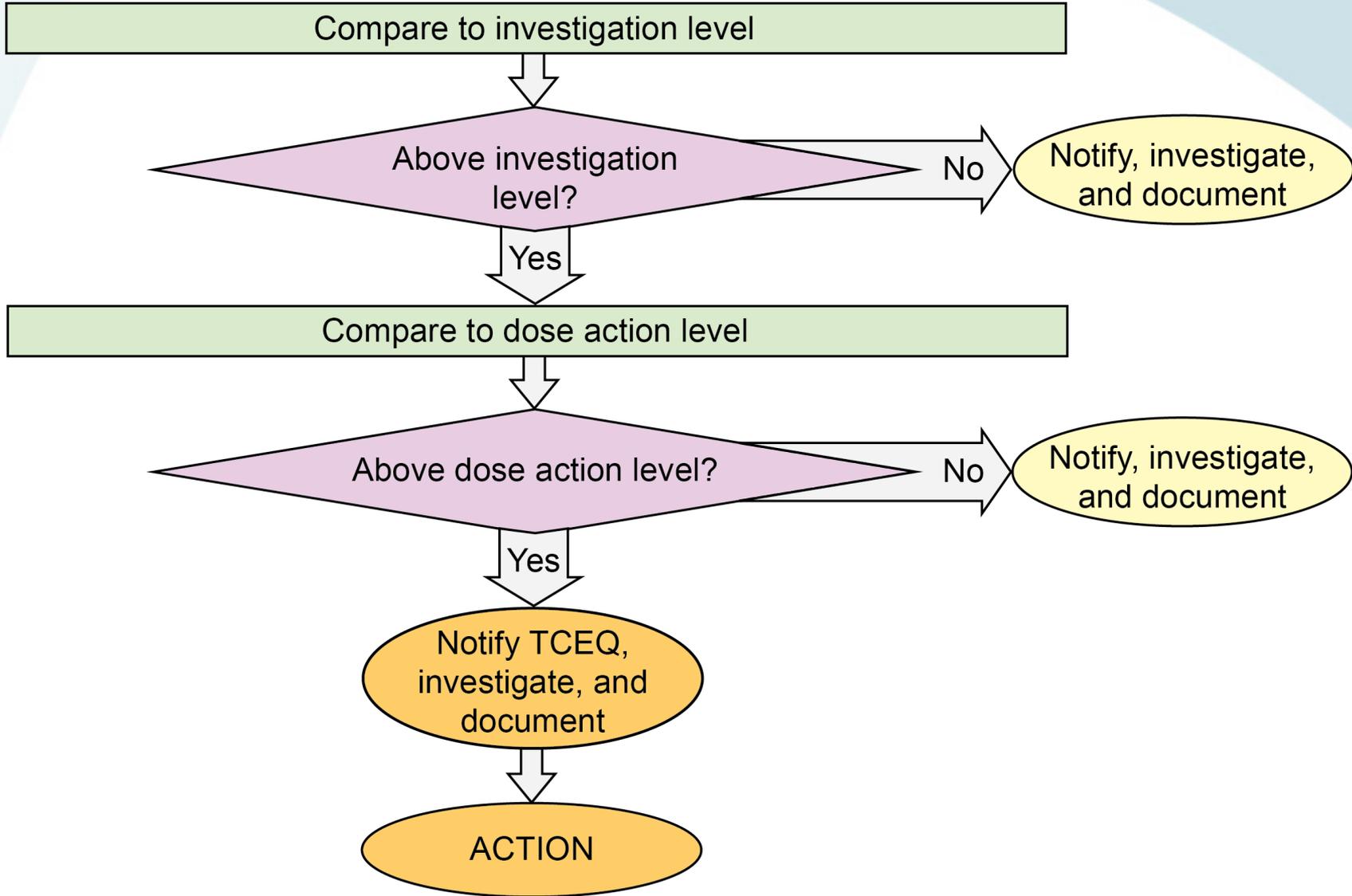


# Dose Compliance Methodology



# Dose Compliance Methodology

STEP 3

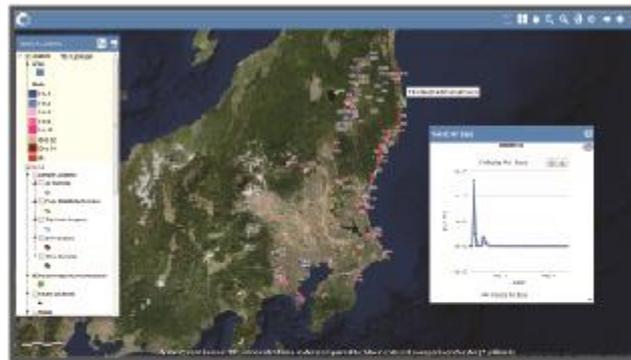


# DCM Implementation in RACER

- RACER: Risk Analysis, Communication, Evaluation, and Reduction
- Developed by RAC to convert environmental data directly to human health risk to facilitate and enhance decision making and communication about risks from chemicals and radionuclides in the environment



ID	Name	...
DCM_001	...	...
DCM_002	...	...
DCM_003	...	...
DCM_004	...	...
DCM_005	...	...
DCM_006	...	...
DCM_007	...	...
DCM_008	...	...
DCM_009	...	...
DCM_010	...	...
DCM_011	...	...
DCM_012	...	...
DCM_013	...	...
DCM_014	...	...
DCM_015	...	...
DCM_016	...	...
DCM_017	...	...
DCM_018	...	...
DCM_019	...	...
DCM_020	...	...



DATA

INFORMATION

KNOWLEDGE

Facility Main

**WCS Facility**  
Andrews, Texas



Database



Analytics



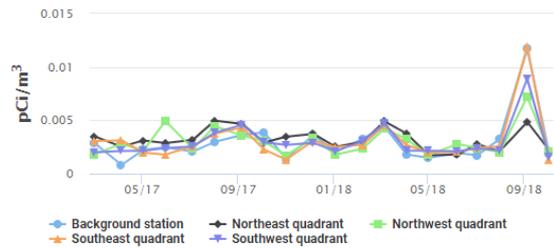
Maps



Documents

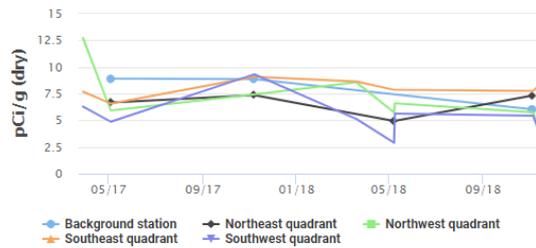
[Edit Dashboard](#)

Average Gross Alpha Concentration in Air



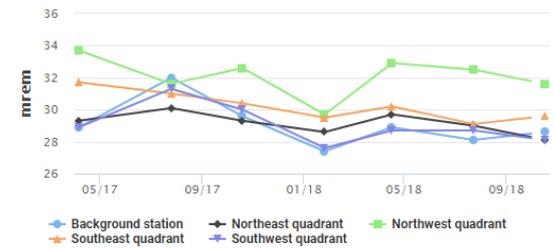
Show Y-axis on Logarithmic scale

Average Gross Alpha Concentration in Soil



Show Y-axis on Logarithmic scale

Average X-9 Dosimeter Reading



Show Y-axis on Logarithmic scale

Analytics

WCS Facility

**Dose Compliance Module**

Sample Summary



Compliance Evaluation

Calculation Options	Analysis Type	Calculate	Data Summary Output	Options	Compliance Results Output	Options
Year: 2018 Start Month: January End Month: December	<b>Continuous Sample-specific</b> <i>Air and soil</i> Gross α/β Isotopes (gases) Dose <i>Groundwater</i> Ratios Isotopes Dose <i>Dosimeters</i> Measurements	▶ ▶ ▶ ▶ ▶ ▶ ▶ ▶ ▶ ▶				
	<b>Annual Compliance</b> Dose	▶				

Activity Parameters

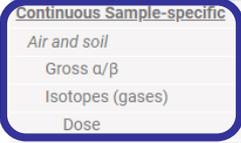
**ACTIVITY PARAMETERS FOR** WCS\_Screening

Exposure Frequency: 350 d/yr - Exposure Duration: 1 yr

Exposure Medium	Exposure Route	Parameter	Value (units)
Indoor air	Immersion	Exposure Time	16.4 (hr/d)
Indoor air	Immersion	Shielding Factor	1 (none)
Outdoor air	Immersion	Exposure Time	7.6 (hr/d)
Outdoor air	Immersion	Shielding Factor	1 (none)
Surface soil	Indoor external radiation	Exposure Time	16.4 (hr/d)
Surface soil	Indoor external radiation	Shielding Factor	0.7 (none)
Surface soil	Indoor external radiation	Soil Depth	90 (cm)
Surface soil	Soil ingestion	Food Consumption Fraction	1 (none)
Surface soil	Soil ingestion	Impact Food Fraction	1 (none)
Surface soil	Soil ingestion	Intake Rate	0.00012 (kg/d)
Surface soil	Soil ingestion	Soil Depth	90 (cm)
Indoor air	Inhalation	Exposure Time	16.4 (hr/d)
Indoor air	Inhalation	Intake Rate	0.625 (m3/hr)
Indoor air	Inhalation	Soil Depth	5 (cm)

▲ Compliance Evaluation

Calculation Options	Analysis Type	Calculate	Data Summary Output	Options	Compliance Results Output	Options
<b>Year</b> 2016 ▼	<b>Continuous Sample-specific</b>					
	Air and soil					
	Gross α/β	▶				
	Isotopes (gases)	▶				
	Dose	▶				
	Groundwater					
	Ratios	▶				
	Isotopes	▶				
	Dose	▶				
	Dosimeters					
	Measurements	▶				
	<b>Annual Compliance</b>					
	Dose	▶				



▲ Compliance Evaluation

Calculation Options

Year

2016 ▼

Start Month

January ▼

End Month

December ▼

Analysis Type	Calculate	Data Summary Output	Options	Compliance Results Output	Options
<b>Continuous Sample-specific</b>					
<i>Air and soil</i>					
Gross α/β	▶			<b>21 records</b>	⬇
Isotopes (gases)	▶				
Dose	▶				
<i>Groundwater</i>					
Ratios	▶				
Isotopes	▶				
Dose	▶				
<i>Dosimeters</i>					
Measurements	▶				
<b>Annual Compliance</b>					
Dose	▶				

Compliance Evaluation

Gross Alpha Beta Screening Statistics for 2016

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Medium	Sample ID	Sample Date	Station Name	Parameter	Units	Result	Uncertainty	Background Re...	Background Re...	Background Un...	T Value	Ratio	Value
Air	16-AP-12-050	11/2/2016 12:00:00 AM	7	Gross beta	pCi/m3	0.0207	0.00095		0.00702	0.000333	13.6	1.29	0.016
Air	16-AP-07-053	6/1/2016 12:00:00 AM	10	Gross beta	pCi/m3	0.0223	0.00076		0.00988	0.00054	13.3	1.39	0.016
Air	17-AP-01-044	12/7/2016 12:00:00 AM	1	Gross beta	pCi/m3	0.0289	0.000775		0.0177	0.000645	11.1	1.81	0.016
Air	16-AP-02-060	1/6/2016 12:00:00 AM	50	Gross beta	pCi/m3	0.0183	0.000805		0.00976	0.00064	8.3	1.14	0.016
Air	16-AP-02-063	1/6/2016 12:00:00 AM	58	Gross beta	pCi/m3	0.0172	0.00076		0.00976	0.00064	7.49	1.07	0.016
Air	16-AP-02-057	1/6/2016 12:00:00 AM	30	Gross beta	pCi/m3	0.0168	0.000845		0.00976	0.00064	6.64	1.05	0.016
Air	16-AP-02-058	1/6/2016 12:00:00 AM	31	Gross beta	pCi/m3	0.0163	0.00076		0.00976	0.00064	6.58	1.02	0.016
Air	17-AP-01-046	12/7/2016 12:00:00 AM	3	Gross beta	pCi/m3	0.0224	0.000735		0.0177	0.000645	4.81	1.4	0.016
Air	17-AP-01-068	12/7/2016 12:00:00 AM	63	Gross beta	pCi/m3	0.0218	0.00071		0.0177	0.000645	4.27	1.36	0.016
Air	17-AP-01-060	12/7/2016 12:00:00 AM	50	Gross alpha	pCi/m3	0.00591	0.00083		0.00168	0.00055	4.25	1.41	0.0042
Air	17-AP-01-069	12/7/2016 12:00:00 AM	66	Gross alpha	pCi/m3	0.00634	0.000955		0.00168	0.00055	4.23	1.51	0.0042
Air	16-AP-02-065	1/6/2016 12:00:00 AM	60	Gross alpha	pCi/m3	0.00457	0.00076	<	0.000856	0.000456	4.19	1.09	0.0042
Air	17-AP-01-068	12/7/2016 12:00:00 AM	63	Gross alpha	pCi/m3	0.00518	0.00076		0.00168	0.00055	3.73	1.23	0.0042
Air	16-AP-12-050	11/2/2016 12:00:00 AM	7	Gross alpha	pCi/m3	0.00702	0.0012		0.0029	0.00049	3.19	1.67	0.0042

All gross alpha/beta results for air and soil samples collecting during the selected year are summarized here.  
Monday, 02/18/2019

▲ Compliance Evaluation

Calculation Options

Year  
2016 ▼

Start Month  
January ▼

End Month  
December ▼

Analysis Type	Calculate	Data Summary Output	Options	Compliance Results Output	Options
<b>Continuous Sample-specific</b>					
<i>Air and soil</i>					
Gross α/β	▶			21 records	⬇
Isotopes (gases)	▶	6 records	⬇	1 records	⬇
Dose	▶				
<i>Groundwater</i>					
Ratios	▶				
Isotopes	▶				
Dose	▶				
<i>Dosimeters</i>					
Measurements	▶				
<b>Annual Compliance</b>					
Dose	▶				

Compliance Evaluation

Specific Isotope Screening for Air for 1/1/2016 through 12/31/2016

Back to Report Options

Year	Medium	SAMPLE ID	Location	Screening Date	Parameter	Symbol	Units	Result	Uncertainty	Detection Limit	Screening Value	Screening Valu...
2016	Air	16-AC-11-033	31	10/5/2016 12:00:00	I-129	=	pCi/m3	0.0066	0.00233	0.00256	0	NA

Only results exceeding the screening value for H-3 or detections for C-14, I-129, and Kr-85 are shown.  
Monday, 02/18/2019

▲ Compliance Evaluation

Calculation Options

Year  
2016 ▼

Start Month  
January ▼

End Month  
December ▼

Analysis Type	Calculate	Data Summary Output	Options	Compliance Results Output	Options
<b>Continuous Sample-specific</b>					
<i>Air and soil</i>					
Gross α/β	▶			21 records	⬇
Isotopes (gases)	▶	6 records	⬇	1 records	⬇
Dose	▶	1037 records	⬇	20 records	🔄 ⬇
<i>Groundwater</i>					
Ratios	▶				
Isotopes	▶				
Dose	▶				
<i>Dosimeters</i>					
Measurements	▶				
<b>Annual Compliance</b>					
Dose	▶				

▲ Compliance Evaluation

Sample-Specific Dose Screening Report for 1/1/2016 through 12/31/2016

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Screening Limit Exc...	Source	Sample Type ▲	Sample Date	Units	Gross dose	Gross dose uncertai...	Background dose	Background dose u...	Compliance dose	Compliance dose un...	T Value
None	58-AIR-@2016-01-06	Air	1/6/2016 12:00:00 AM	mrem	1.58	0.0462	1.26	0.0479	0.323	0.0666	4.85
None	60-AIR-@2016-01-06	Air	1/6/2016 12:00:00 AM	mrem	1.47	0.0479	1.26	0.0479	0.211	0.0677	3.11
None	60-AIR-@2016-01-06	Air	1/6/2016 12:00:00 AM	mrem	1.44	0.044	1.26	0.0479	0.18	0.065	2.77
None	63-AIR-@2016-12-07	Air	12/7/2016 12:00:00 AM	mrem	1.61	0.0491	1.46	0.0454	0.148	0.0669	2.21
None	60-AIR-@2016-01-06	Air	1/6/2016 12:00:00 AM	mrem	1.34	0.0403	1.26	0.0479	0.0792	0.0626	1.26
None	61-AIR-@2016-12-07	Air	12/7/2016 12:00:00 AM	mrem	1.53	0.046	1.46	0.0454	0.0644	0.0647	0.995
None	61-AIR-@2016-10-05	Air	10/5/2016 12:00:00 AM	mrem	1.26	0.0479	1.26	0.0479	0.00601	0.0677	0.0888
None	61-AIR-@2016-01-06	Air	1/6/2016 12:00:00 AM	mrem	1.26	0.0479	1.26	0.0479	0.0002	0.0677	0.00296
None	610-AIR-@2016-06-01	Air	6/1/2016 12:00:00 AM	mrem	1.19	0.0378	1.26	0.0479	-0.0684	0.061	-1.12
None	63-AIR-@2016-11-02	Air	11/2/2016 12:00:00 AM	mrem	1.08	0.0354	1.26	0.0479	-0.178	0.0595	-3
None	650-AIR-@2016-12-07	Air	12/7/2016 12:00:00 AM	mrem	1.26	0.0479	1.46	0.0454	-0.204	0.066	-3.09
None	66-AIR-@2016-12-07	Air	12/7/2016 12:00:00 AM	mrem	1.26	0.0479	1.46	0.0454	-0.204	0.066	-3.09
None	663-AIR-@2016-12-07	Air	12/7/2016 12:00:00 AM	mrem	1.26	0.0479	1.46	0.0454	-0.204	0.066	-3.09
None	67-AIR-@2016-11-02	Air	11/2/2016 12:00:00 AM	mrem	1.05	0.0352	1.26	0.0479	-0.209	0.0594	-3.52

Investigation limit for air = 2.5 mrem and for soil = 4 mrem. Action limit for air = 5 mrem and for soil = 7.5 mrem. Investigation limit for groundwater = 1 mrem  
Monday, 02/18/2019



# Example Summary

- **Jan-Dec 2016 air and soil data examined**
- **Alpha/beta screening identified 21 instances where result was statistically greater than screening level**
  - ◆ 6 soil measurements
  - ◆ 15 air measurements
- **Looking only at air, there were 2 positive detections, one for H-3 and one for I-129**
  - ◆ H-3 detection below screening value
  - ◆ I-129 was positive detection
- **All doses below ILs and ALs**

Compliance Evaluation

Sample-Specific Dose Screening

Screening Limit Exc...	Source	Sa
Investigation	62-AIR-@2018-03-07	Air
Investigation	4-AIR-@2018-02-07	Air
Investigation	1-AIR-@2018-03-07	Air
Investigation	63-AIR-@2018-03-07	Air
None	59-AIR-@2018-03-07	Air

Compliance Evaluation

Sample-Specific Dose Screening Report for 1/1/2018 through 12/31/2018

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Screening Limit Exc...	Source	Sample Type	Sample Date	Units	Gross dose	Gross dose uncertai...	Background dose	Background dose u...	Compliance dose	Compliance dose un...	T Value
Investigation	62-AIR-@2018-03-07	Air	3/7/2018 12:00:00 AM	mrem	5.71	0.514	1.93	0.0536	3.77	0.517	7.3
Investigation	4-AIR-@2018-02-07	Air	2/7/2018 12:00:00 AM	mrem	5.93	0.24	2.51	0.212	3.42	0.32	10.7
Investigation	1-AIR-@2018-03-07	Air	3/7/2018 12:00:00 AM	mrem	4.79	0.389	1.93	0.0536	2.85	0.393	7.26
Investigation	63-AIR-@2018-03-07	Air	3/7/2018 12:00:00 AM	mrem	4.68	0.469	1.93	0.0536	2.75	0.472	5.83
None	59-AIR-@2018-03-07	Air	3/7/2018 12:00:00 AM	mrem	4.01	0.445	1.93	0.0536	2.07	0.449	4.62
None	60-AIR-@2018-03-07	Air	3/7/2018 12:00:00 AM	mrem	3.96	0.391	1.93	0.0536	2.02	0.394	5.13
None	58-AIR-@2018-04-04	Air	4/4/2018 12:00:00 AM	mrem	2.5	0.228	1.42	0.0448	1.09	0.233	4.68
None	62-AIR-@2018-08-01	Air	8/1/2018 12:00:00 AM	mrem	3.1	0.408	2.18	0.169	0.922	0.442	2.09
None	66-AIR-@2018-04-04	Air	4/4/2018 12:00:00 AM	mrem	2.23	0.198	1.42	0.0448	0.814	0.203	4
None	61-AIR-@2018-04-04	Air	4/4/2018 12:00:00 AM	mrem	2.06	0.245	1.42	0.0448	0.645	0.249	2.59
None	61-AIR-@2018-02-07	Air	2/7/2018 12:00:00 AM	mrem	2.66	0.166	2.51	0.212	0.146	0.269	0.542
None	54-AIR-@2018-07-03	Air	7/3/2018 12:00:00 AM	mrem	2.12	0.209	2.02	0.173	0.0999	0.272	0.368
None	63-AIR-@2018-04-04	Air	4/4/2018 12:00:00 AM	mrem	1.33	0.0457	1.42	0.0448	-0.0828	0.064	-1.29
None	63-AIR-@2018-05-02	Air	5/2/2018 12:00:00 AM	mrem	1.26	0.0367	1.35	0.0856	-0.0907	0.0931	-0.974

Investigation limit for air = 2.5 mrem and for soil = 4 mrem. Action limit for air = 5 mrem and for soil = 7.5 mrem. Investigation limit for groundwater = 1 mrem  
 Saturday, 02/23/2019

Compliance Evaluation

Calculation Options

Year  
2018

Start Month  
January

End Month  
December

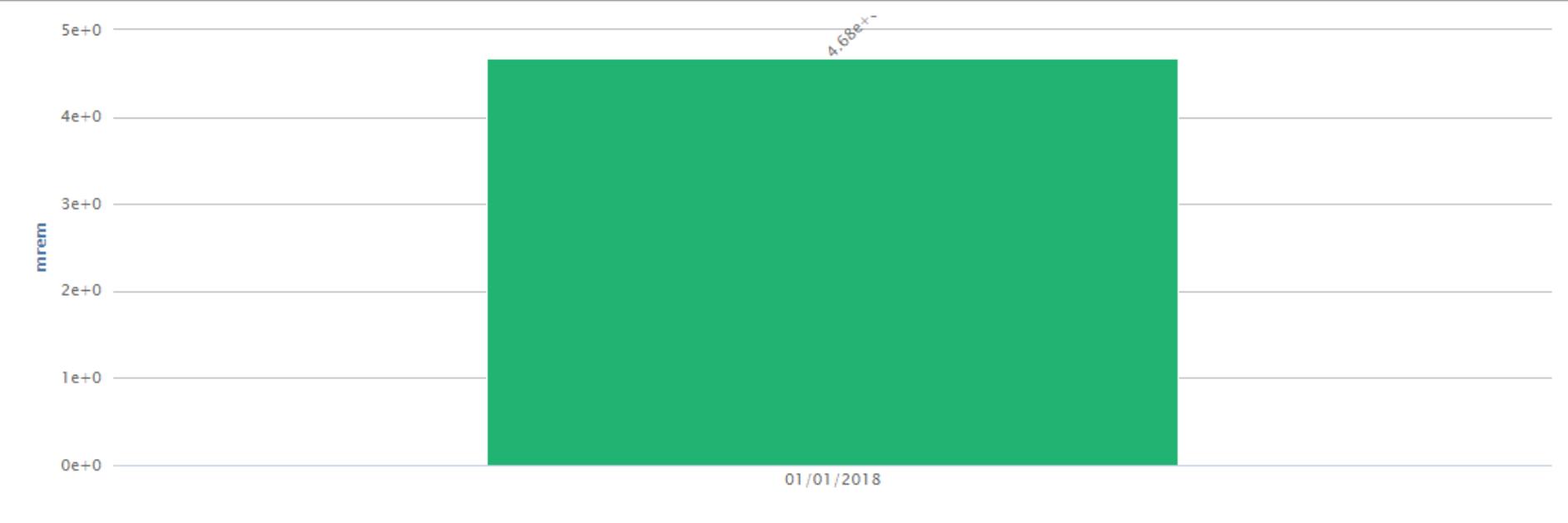
Analysis Type	Calculate	Data Summary Output	Options	Compliance Results Output	Options
<b>Continuous Sample-specific</b>					
<i>Air and soil</i>					
Gross α/β	▶	12 records	⬇	39 records	⬇
Isotopes (gases)	▶	9 records	⬇	15 records	⬇
Dose	▶	2564 records	⬇	49 records	⬇
<i>Groundwater</i>					
Ratios	▶				
Isotopes	▶				
Dose	▶				
<i>Dosimeters</i>					
Measurements	▶				
<b>Annual Compliance</b>					
Dose	▶				

⌚ ⬇

Evaluate Contributors to Gross Dose

Activity Parameters

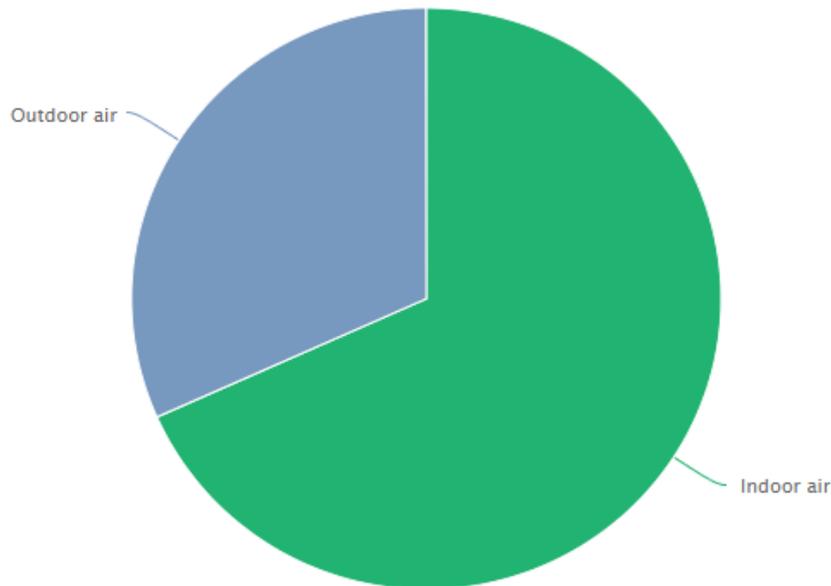
# Health Impact Summary



### Detail Chart



Detail Type Medium



### Analytes



Analyte Key \*

Code	Percent	Description	Analyte Group
Th-232	64.13%	Thorium-232	Radionuclide
Pb-210	15.59%	Lead-210	Radionuclide
Th-228	7.67%	Thorium-228	Radionuclide
U-238	3.50%	Uranium-238	Radionuclide
U-233/234	3.10%	Uranium-233/234	Radionuclide
Th-230	2.50%	Thorium-230	Radionuclide
Am-241	1.94%	Americium-241	Radionuclide
Pu-238	0.62%	Plutonium-238	Radionuclide
Pu-242	0.31%	Plutonium-242	Radionuclide
Ra-226	0.23%	Radium-226	Radionuclide
Pu-239/240	0.18%	Plutonium-239/...	Radionuclide
U-235/236	0.12%	Uranium-235/236	Radionuclide
Ra-228	0.06%	Radium-228	Radionuclide

# Evaluation and Benefits

- **The proposed system identified all potential issues and resulted in significantly fewer false positives than the current system**
- **Proposed system is streamlined, simple, transparent, timely, and cost effective**
  - ◆ Screening eliminates unnecessary isotopic analyses and identifies only exceedances that are statistically above background
  - ◆ Any exceedances in routine sampling results are identified automatically and evaluated on the basis of dose
  - ◆ Groundwater focuses on early detections of mobile radionuclides (e.g. Tc-99, H-3)
  - ◆ Provides doses for annual environmental report

# Evaluation and Benefits Continued

- **Cloud-based system allows WCS to access their data securely from anywhere at any time**
- **Automated email notifications increase transparency and allow review of facility operations on a continuous basis**
- **The regulator (TCEQ) can access the system securely to review reports and data**

# RACER Security

## ○ RAC values data security:

- System security assurance
- Redundancy and backup
- User privilege management
- SSAE-16 Certification
- Secure Socket Layer (SSL)  
128/256-bit encryption



**Questions?**