

Colorado Radionuclide Abatement and Disposal Strategy

Phase 4 Kick-off Meeting

March 2009



Introductions

- WQCD Staff
 - Jon Erickson – CO-RADS Project Manager
 - Ron Falco – Drinking Water Program Manager
 - Paul Kosik – Drinking Water Engineer
 - Dave Knope – District Engineer
 - Jackie Whelan – Compliance Assurance
 - Michael Beck – Financial Solutions Unit
- Office of Planning and Partnerships
 - Melanie Chase – Facilitator

Why are we here today?

- “Well, it all starts when a nucleole comes out of its nest...” *H. Simpson*
- CO-RADS project Update
- CO-RADS Report Development
 - Development processes
 - Key assumptions and findings
- Discuss next steps for CO-RADS

Agenda



- Introductions
- Session 1
 - Presentation: Phase 4 Summary
 - Breakout 1: Work to date
- Session 2
 - Presentations: CO-RADS Report Highlights
 - Breakout 2: Distribute reports
- Session 3
 - Presentations: Options to Consider
 - Breakout 3: Rank top options

Session 1: Phase 4 Summary

- CO-RADS Summary
- Work to Date
- Phase 4 Workplan
- System Expectations

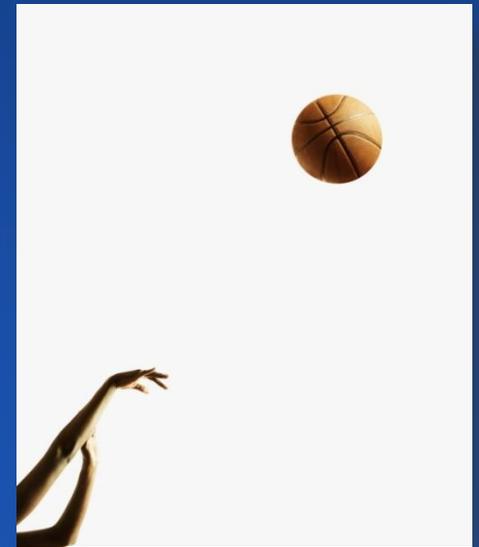
Session 1: Breakout Session

Preview and Considerations

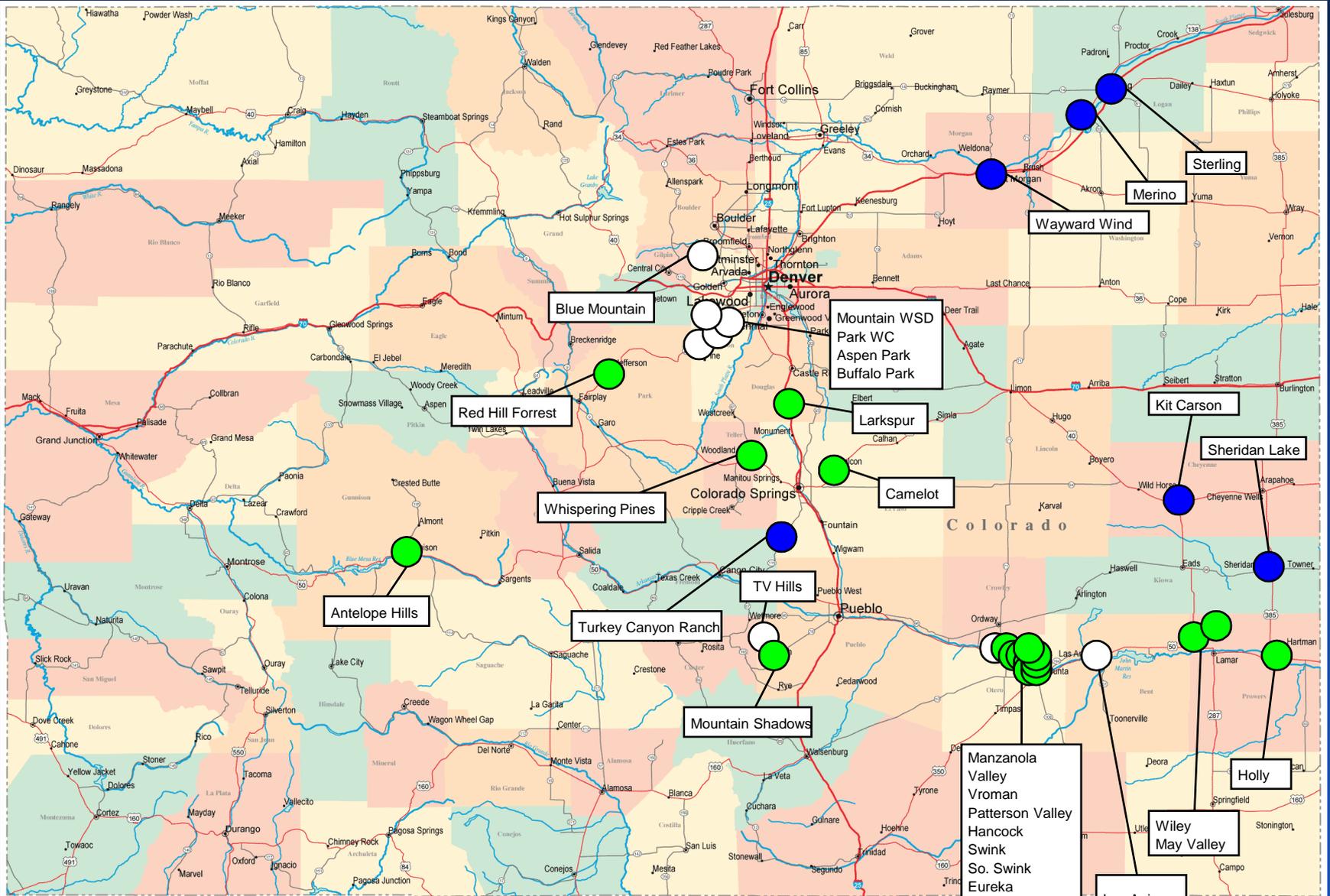
- See Session 1 Feedback worksheet from handouts
 - Q1: What is your opinion on the workplan for Phase 4 of CO-RADS?
 - Q2: What do you think will be the most effective aspect of Phase 4?
 - Q3: Please describe any activities that your system has performed to identify or implement compliance options:

CO-RADS Goals

- Help water systems resolve radionuclides violations
- Facilitate implementation of appropriate waste management strategies



CO-RADS Systems Map



● - Radium
 ● - Uranium
 ○ - Radium and Uranium

Manzanola Valley
 Vroman
 Patterson Valley
 Hancock Swink
 So. Swink
 Eureka
 Hillside MHP
 Fayette
 North Hollbrook

Wiley
 May Valley

Las Animas

Holly

Lamar

Towner

Sheridan Lake

Kit Carson

Mountain WSD
 Park WC
 Aspen Park
 Buffalo Park

Camelot

Larkspur

Whispering Pines

Turkey Canyon Ranch

Mountain Shadows

Antelope Hills

Red Hill Forrest

Blue Mountain

Wayward Wind

Sterling

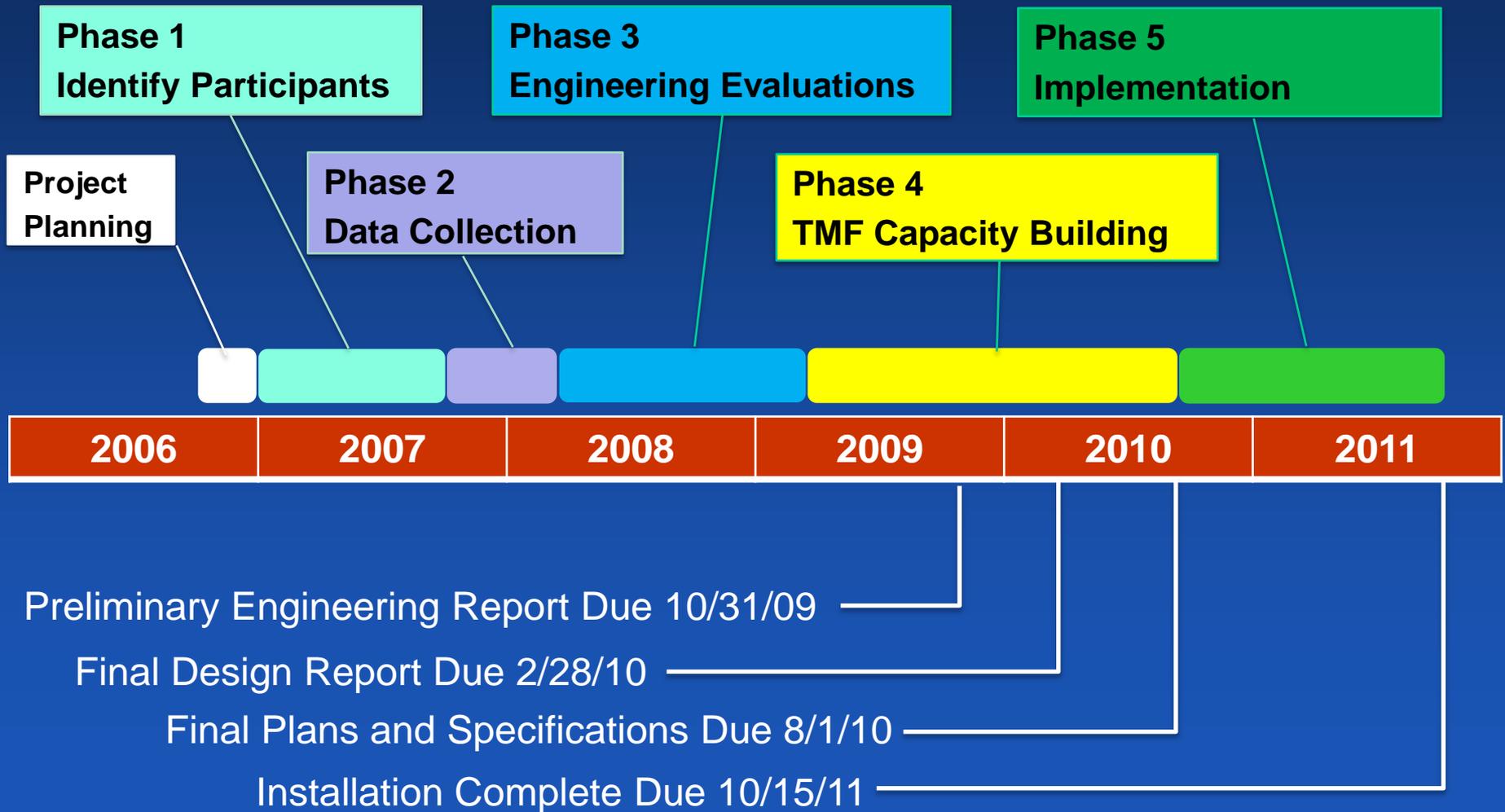
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Welcome to New Participants

- Systems that were not involved can now join in Phase 4 of CO-RADS
- New systems have the same compliance schedule as existing systems
- New systems will have some catch-up work
- CO-RADS Reports can provide insight

CO-RADS Summary

The Long Road



CO-RADS Summary

Work to Date

- Sample Variability Investigation
- Sampling and Onsite Visits for 33 systems
- Treatment Alternatives Analysis
- Waste Disposal Evaluations
- Bench and Pilot Testing
- CO-RADS Report for 33 systems
- Phase 3 Summary Report (pending)

CO-RADS: Phase 4

Work Plan and Schedule

- Phase 4 goal:
 - Build Technical, Managerial, and Financial Capacity
- Overall Strategy
 - Activities coincide with enforcement compliance schedule
 - Assistance will be tailored to help meet schedule milestones
 - General assistance sessions targeting common needs
 - Individual case managers to help guide systems
 - Feedback from systems will be used to focus general assistance
 - Develop partnerships
- Phase 4 is the critical phase of project

CO-RADS: Phase 4

Work Plan and Schedule: Initial Focus

- Phase 4 Initial Focus:
 - Meet 10/31/09 PER Deadline
 - Compliance option selection
 - Preliminary Engineering Report development
- General assistance workshops every 2 months
- Malcolm Pirnie, Inc. will perform onsite TMF assistance training at larger systems (10 systems)
- Small systems will receive separate, tailored assistance
- Public outreach and community involvement

CO-RADS: Phase 4

Work Plan and Schedule

- **General Assistance Meetings**
 - March 2009 – Information Sharing
 - May 2009 – Detailed review of options
 - July 2009 – Tailored assistance
 - September 2009 – Tailored assistance
- **Case Manager Contact**
 - Contact will be on a monthly basis
 - Provide individualized guidance
 - Collect feedback to help craft general assistance meetings

CO-RADS: Phase 4

Work Plan and Schedule

- May 2009 General Assistance Meeting
 - Detailed evaluation of options
 - Malcolm Pirnie, Inc will be assisting
 - Options for Discussion
 - Technical, Managerial, and Financial Capacity Building
 - Proprietary solutions (Basin Water, WRT, etc.)
 - Point-of-use requirements
 - Interim measures options
 - Funding agencies and options
 - Regionalization/consolidation
 - Formation of special districts

CO-RADS: Phase 4

System Expectations

- Participation in CO-RADS is not mandatory
- Accountability for meeting enforcement order requirements
 - Systems must be diligent evaluating options
 - Compliance schedule can be amended, but system must be proactive in requesting amendment and have appropriate justification
 - If a system does not meet enforcement requirements, escalation may occur, potentially including referral for judicial review
- Resolving residuals handling issues
 - Compliance will be enforced by agencies outside of the Drinking Water Program

Breakout Session 1

Instructions

- Existing participants should group together
- New participants should group together
- Roundtable discussion
 - Opinions and feedback on Phase 4
 - Work that your system has done to date
- Each person should complete a feedback sheet

Session 2: CO-RADS Reports

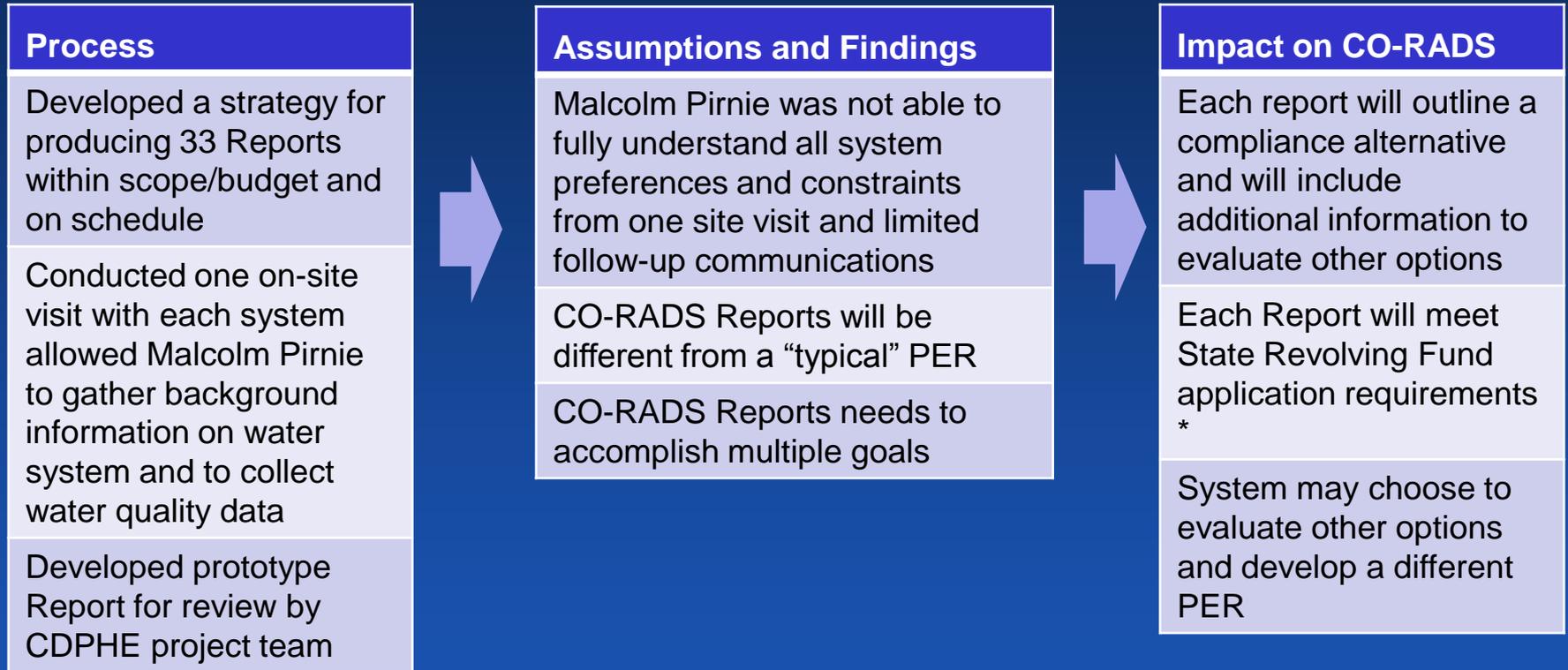
- Difference between CO-RADS Report and typical PER
- CO-RADS Report highlights
- Key decisions behind report development

Session 2: Breakout Session

Preview and Considerations

- See Session 2 Feedback worksheet from handouts
- Reports will be passed out to existing systems
 - Q1: What is your initial overall opinion of the CO-RADS Report that was developed for your system?
 - Q2: What do you think about the technical feasibility of the option outlined in the CO-RADS Report?
 - Q3: What do you think about the costs of the project and whether or not it will be feasible from a cost perspective?
- New participants will discuss catch-up activities

CO-RADS Reports



*Dependent on information provided by systems

Report Comparison

	CO-RADS Report	Typical PER	Comments
Level of water system involvement in process	Low	Medium to High	<ul style="list-style-type: none"> • Identify system preferences and constraints • Interact with Board/Council • Conduct customer working session and/or additional communications
Compliance solution	Recommended alternative, can be modified	Final selected alternative	
Level of design definition	~15%	Variable	
Cost estimates	Class 4 (-20% to +30%)	Variable	

AACE Cost Estimate Classifications

Estimate Class	Level of Project Definition	End Usage	Expected Accuracy Range
Class 5	0% to 2%	Concept Screening	L:-20% to -50% H:+30% to +100%
Class 4	1% to 15%	Study or Feasibility	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget, Authorization, or Control	L: -10% to -20% H: +10% to +30%
Class 2	30% to 70%	Control or Bid/Tender	L: -5% to -15% H: +5% to +20%
Class 1	50% to 100%	Check Estimate or Bid/Tender	L: -3% to -10% H: +3% to +15%
L = Low; H = High			

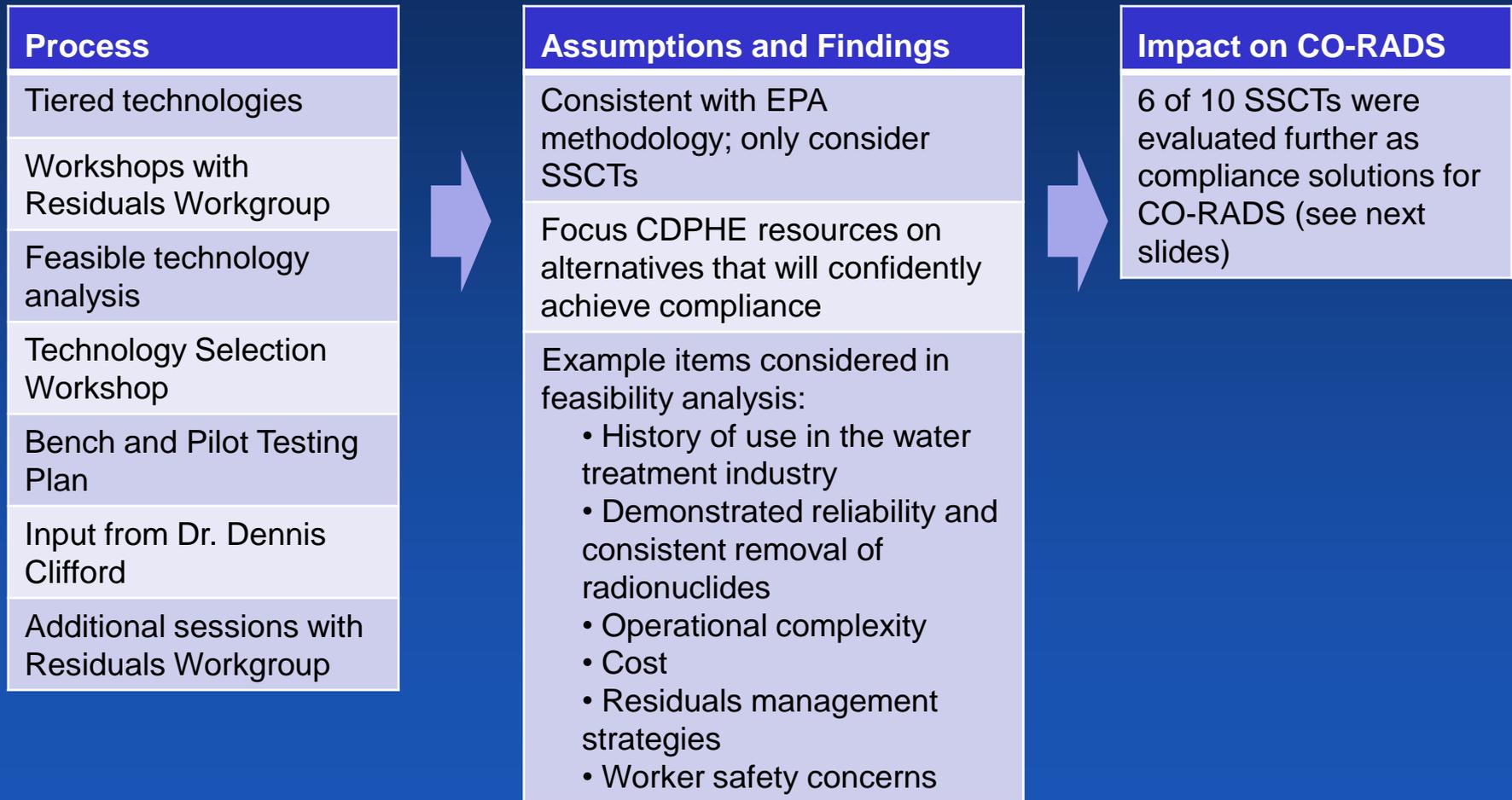
CO-RADS Report Constraints

- Lack of contact with water system board
- Difficulties evaluating non-treatment options
- Decision made to focus on treatment
 - Many systems have already ruled out non-treatment options
 - Important for systems to have a solid treatment option for comparison
 - Risks and unknown/unaccountable costs with non-treatment options
 - Blending, consolidation, regionalization, alternate source, POU
- Could not obtain vendor quotes for 33 systems
 - Basin Water, WRT, FilterTech, Virotek, not evaluated

CO-RADS Report Development

- General Process:
 - 1. Treatment feasibility screening
 - 2. Residuals disposal options review
 - 3. Comparison of feasible treatment and disposal options
 - 4. Preliminary design of most feasible option

Treatment Feasibility Screening



Ion Exchange

 Evaluated further

 Not evaluated further

Treatment Technology	Contaminant Removed	Consistently Achieves ~0.5x MCL	Operational Complexity and Certification	Worker Exposure to Radiation	Industry Experience with Technology	Primary Factor(s) for Elimination
Anion exchange	Uranium	Yes	Intermediate	Low – if proper operational and safety procedures are in place	Widely used	Not eliminated
Cation exchange	Radium	Yes	Intermediate	Low – if proper operational and safety procedures are in place	Widely used	Not eliminated

Adsorption

 Evaluated further

 Not evaluated further

Treatment Technology	Contaminant Removed	Consistently Achieves ~0.5 x MCL	Operational Complexity and Certification	Worker Exposure to Radiation	Industry Experience with Technology	Primary Factor(s) for Elimination
Activated alumina (regenerated)	Uranium	Yes	Advanced – handling of chemicals during regeneration and pH adjustment	Low – if proper operational and safety procedures are in place	Very limited	- Treats 1,000's of bed volumes compared to 10,000-300,000 for anion exchange - System operation advance complexity
Activated alumina (disposable)	Uranium	Yes	Advanced – chemicals handling of chemicals for pH adjustment	Low – if proper operational and safety procedures are in place	Very limited	- Very limited use in industry - Input from Dr. Clifford
Greensand filtration	Radium	No – percentage removal typically ranges 50 to 60%	Basic	Potentially high – radium accumulates on media	Wide	- Not confident it will achieve compliance - Worker exposure considerations and residuals management

Membranes

 Evaluated further

 Not evaluated further

Treatment Technology	Contaminant Removed	Consistently Achieves ~0.5x MCL	Operational Complexity and Certification	Worker Exposure to Radiation	Industry Experience with Technology	Primary Factor(s) for Elimination
High pressure membranes (RO/NF)	Uranium and Radium	Yes	Advanced	Low	Widely used	Not eliminated
Electrodialysis-electrodialysis reversal (ED/EDR)	Uranium and Radium	Yes	Basic to intermediate	Low	Extremely limited use	- Extremely limited use - No identified benefit over RO/NF

Physical/Chemical Removal

 Evaluated further

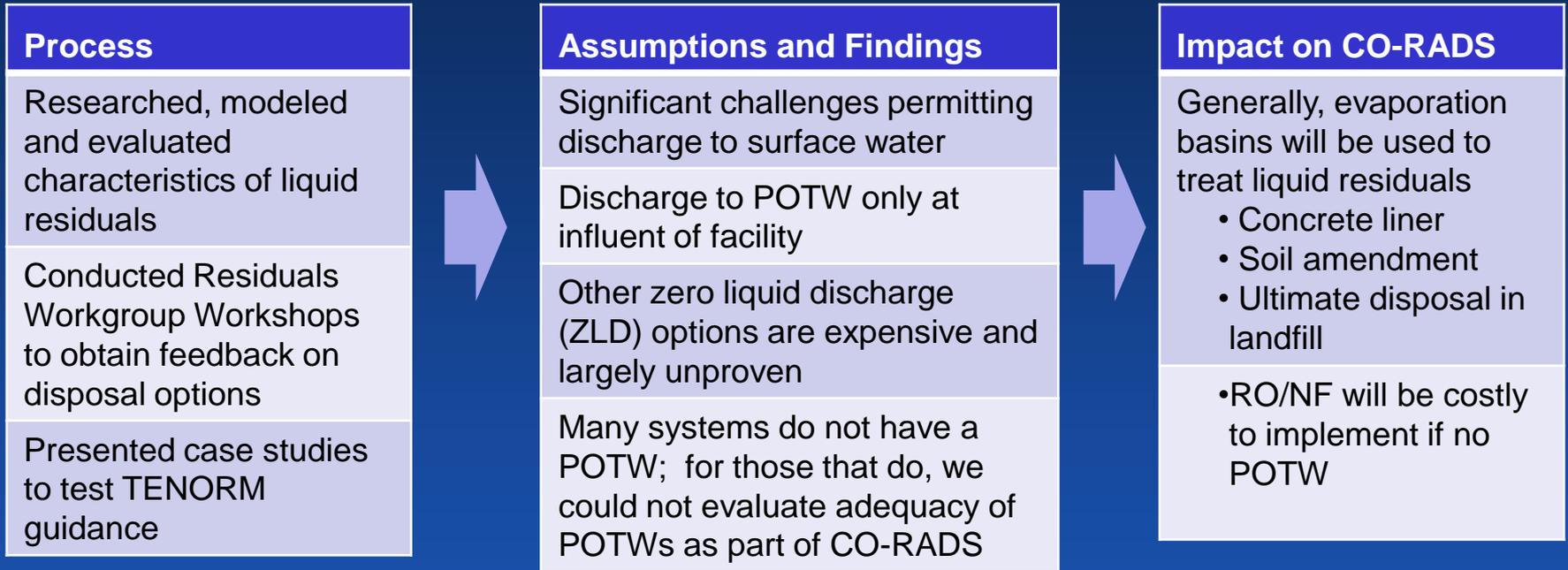
 Not evaluated further

Treatment Technology	Contaminant Removed	Consistently Achieves ~0.5x MCL	Operational Complexity and Certification	Worker Exposure to Radiation	Industry Experience with Technology	Primary Factor(s) for Elimination
Lime softening	Uranium and Radium	Yes	Advanced	Low	Widely used	
Enhanced coagulation	Uranium	Yes	Advanced	Low	Widely used	
Hydrous manganese oxide (HMO)	Radium	Yes	Intermediate	Potentially high – requires thorough filter backwashing process to mitigate	Limited	
Co-precipitation with barium sulfate	Radium	? – requires high sulfate in raw or addition of sulfate	Intermediate to advanced	Low	Very limited	<ul style="list-style-type: none"> - Not confident it will achieve compliance - Requires static mixing, detention basin, and filtration

Treatment Alternatives Summary

Feasible	<ul style="list-style-type: none">• Anion Exchange• Cation Exchange• High Pressure Membranes
Conditionally Feasible	<ul style="list-style-type: none">• Lime Softening – system with more than 10,000 customers• Enhanced Coagulation – systems with more than 10,000 customers• Hydrous Manganese Oxide (HMO) – systems with existing or potential future filtration equipment
Not Further Evaluated	<ul style="list-style-type: none">• Activated Alumina• Greensand Filtration• Electrodialysis / Electrodialysis Reversal• Co-precipitation with Barium Sulfate

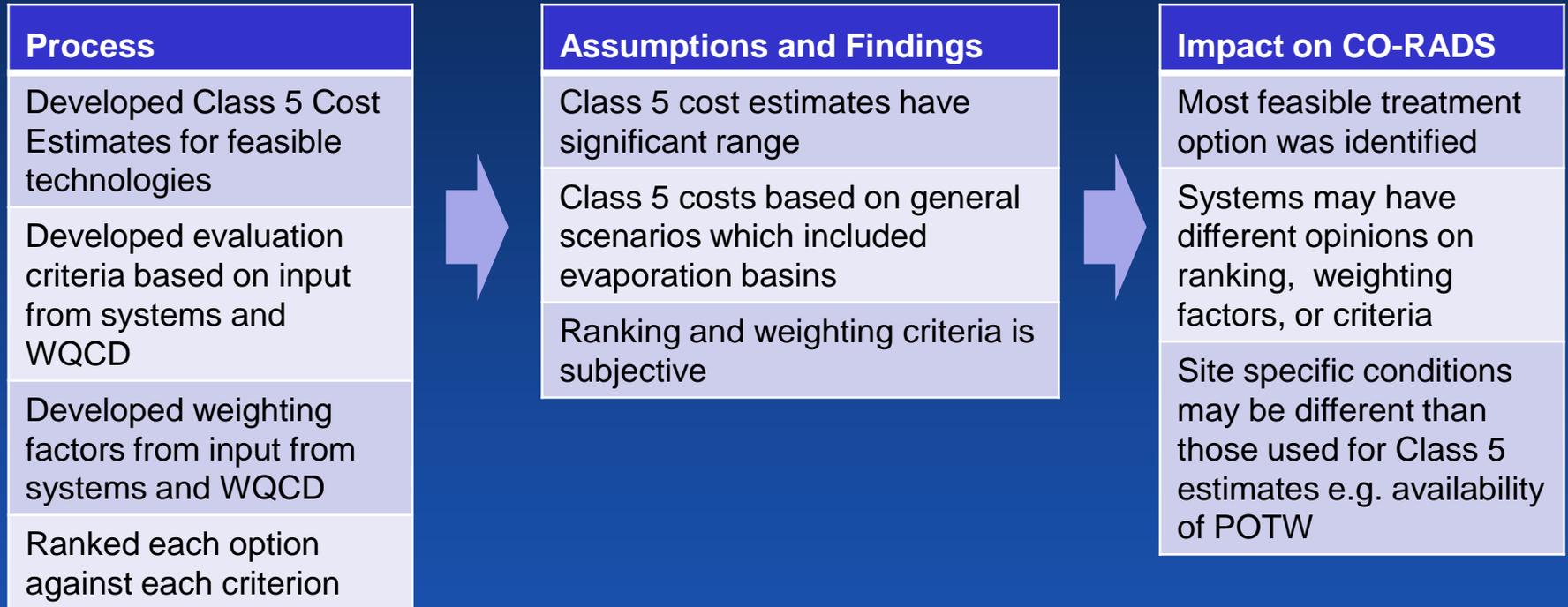
Residuals Disposal Options



Liquid Residuals Disposal Options

Feasibility	Disposal Options	Obstacles for CO-RADS Systems
Feasible	Evaporation pond	- Very large and expensive for RO/NF liquid residuals
Feasible pending system-specific evaluations	Surface water	- Significant permitting challenges - Liquid would likely require treatment prior to discharge
	Sewer/POTW	- Few systems have POTWs - Capacity, treatment technology, and discharge requirements - Potential impact to POTW treatment process
Not feasible for CO-RADS systems	Spray irrigation	- Only if discharge provides a benefit
	Groundwater discharge, infiltration or deep well	- Impractical for various permitting and financial reasons
	Brine concentrator (ZLD)	- Cost prohibitive

Comparison of Options

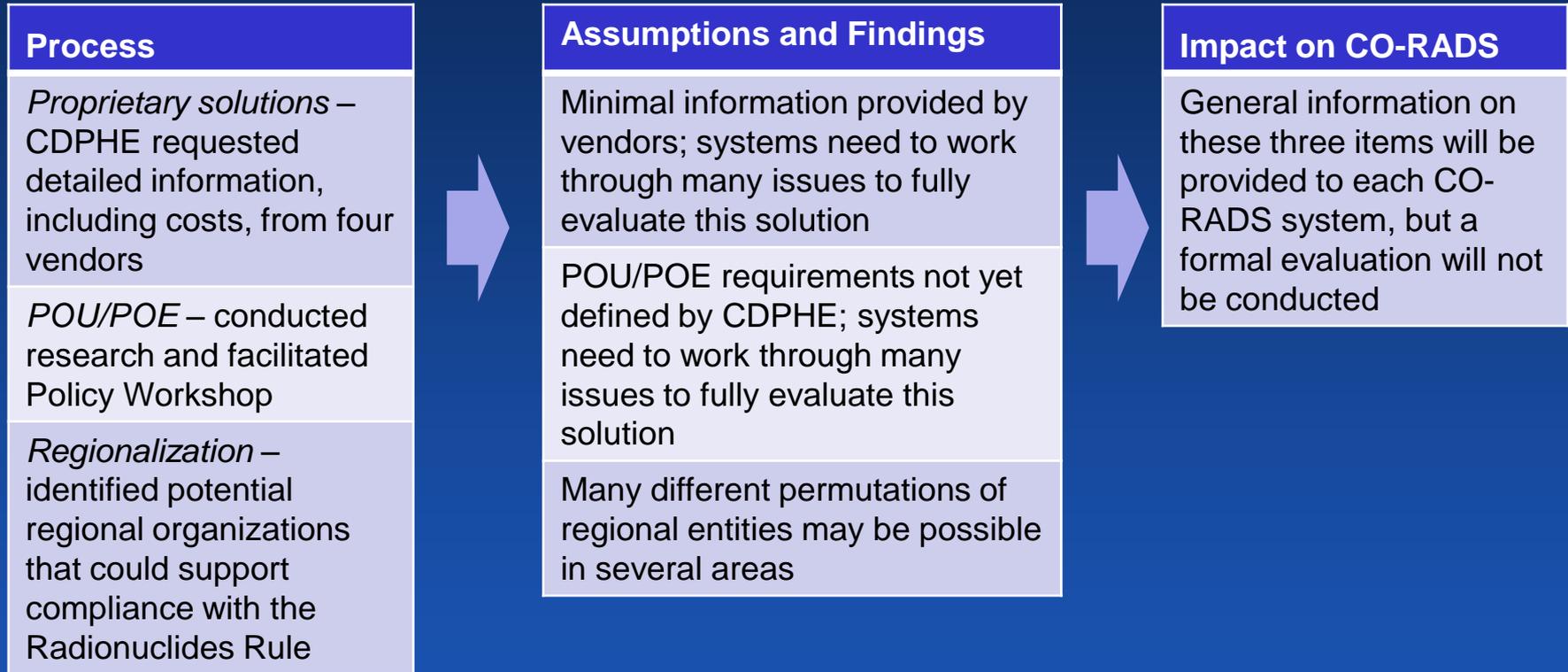


		Cation Exchange			Hydrous Manganese Oxide		
Criterion	Weight	Description	Score	Weighted Score	Description	Score	Weighted Score
NPV Range	45 %	\$1,900,000 to \$4,000,000	3	1.35	\$1,600,000 to \$3,300,000	4	1.8
Reliability to Meet Rad Rule	25 %	Ion exchange systems are not a physical barrier to radionuclides and if they are not regenerated at the right frequency, rads will pass through	3	0.75	Removal may vary depending on water quality. Additional testing and work with CDPHE will be required to demonstrate treatment capabilities.	1	0.25
Use of Existing Infrastructure	15 %	The existing well, filtration system, and chlorine storage and feed system may be re-used	4	0.60	The existing well, filtration system, and chlorine storage and feed system may be re-used	4	0.60
Additional Benefits	5 %	Will remove radium and hardness	3	0.15	Will remove radium only	2	0.10
Operational Complexity	5 %	Requires operator to have a Class C certification. Regular O & M will include backwash and regeneration, both of which can be fully automated.	4	0.20	Requires operator to have a Class B certification. Regular O & M will include backwash and airscour of the filters, monitoring HMO dose, overdosing, will discolor the water	1	0.05
Exposure and Residuals Handling	5 %	Brine will require evaporation and disposal as a solid. Radium may accumulate	3	0.15	Backwash will require evaporation and disposal as a solid. Radium may accumulate	3	0.15
Overall Score				3.2			2.95

Preliminary Design

- After most feasible option was selected, preliminary design was developed
 - Application of site specific factors
 - Use of process models
 - Establish process design criteria
 - Equipment sizing
 - More detailed cost estimate
- Preliminary Design is at approximately 15% definition
 - Class 4 cost estimate accuracy
 - Actual project costs likely to be within 20 to 30 % of estimated costs

Other Compliance Alternatives



Additional Decision Points

- Robust treatment design
 - Malcolm Pirnie followed state Design Criteria for redundancy
 - Generally 100% of flow is treated due
 - Net Present Value used for cost comparison
- Worker safety
 - MicroShield used to evaluate general exposure scenarios
 - Does not appear to be a design limiting factor for a regenerated ion exchange system, will need field verification
- Water quality sampling
 - Representative sources sampled
 - Two sampling events – winter and summer

Bottom Line

- Many strategic decisions were made
- CO-RADS Report Treatment Option
 - Meets MCL and protects public health
 - Lowest cost option
 - Reliable
 - Operator friendly
 - Disposal options are available
 - Confident technology will work
- There is an opportunity for cost reductions

Impacts of High Costs

- WQCD understands the potential burden of the cost of compliance
- WQCD will work with systems to find the most economically feasible path forward
- WQCD will seek support from a variety of places

Value of the CO-RADS Approach

- Concrete answer to the question of what it takes to achieve compliance
 - Drinking water regulations
 - Waste handling requirements
- Documented evidence of the major financial impacts to many systems across Colorado
- Provides a significant mechanism to leverage external support

Session 3 Preview

- After Breakout Session 2, will regroup and discuss options
 - Alternative compliance options
 - Next steps your system should take
 - Resources and information to consider

Breakout Session 2

Instructions

- Existing participants should group together
 - Review Executive Summary of CO-RADS Report
 - Roundtable Discussion
 - Opinions and feedback on CO-RADS Report
- New participants should group together
 - Discussion will focus on catch-up activities
- Each person should complete a feedback sheet

Session 3: Options to Consider

- Options available to reduce costs
- Next steps
- Information to consider

Session 3: Breakout Session

Preview and Considerations

- Breakout Session 3 Format:
 - Participants free to move about and discuss options
 - Participants will rank:
 - Top 3 compliance options
 - Top 3 obstacles to achieving compliance
 - General feedback collected
- WQCD staff available for questions

Options to Reduce Costs

- General categories
 - Refine CO-RADS Report option
 - Value engineering, alternate disposal method
 - Identify alternate treatment approach
 - Proprietary solution, HMO, etc.
 - Non-treatment
 - Blending, well re-hab, consolidation with compliant system
 - Regionalization
 - Regional treatment or waste disposal, collective piloting
 - Point-of-use
 - Interim measures approach
- See CO-RADS Guidance: Potential Options to Consider

Options to Reduce Costs

- General categories
 - Refine CO-RADS Report option
 - Value engineering, alternate disposal method
 - Identify alternate treatment approach
 - Proprietary solution, HMO, etc.
 - Non-treatment
 - Blending, well re-hab, consolidation with compliant system
 - Regionalization
 - Regional treatment or waste disposal, collective piloting
 - Point-of-use
 - Interim measures approach
- See CO-RADS Guidance: Potential Options to Consider

Options to Reduce Costs

- Point-of-use and Interim measures approaches
 - Due to high project costs, WQCD is potentially open to these approaches
 - WQCD has not completely defined its position, complete information should be available in May 2009
 - Preliminary information available for POU

Options to Reduce Costs

- Point-of-use Preliminary Requirements
 - POU units must be owned, controlled and maintained by the public water system.
 - The system must have authority in its service contract, charter, ordinance, etc. to be able to install devices and ability to disconnect/discontinue service to customers who refuse.
 - The system must have participation of 100% of its customers.
 - The system is responsible for all POU devices installed.
 - Existing devices owned by customers cannot be used by the system to meet compliance.
 - A program for long-term operation, maintenance and monitoring must be provided by the water utility to ensure proper performance. (5 CCR 1003-1, §

Options to Reduce Costs

- Point-of-use Items to be Determined
 - Eligibility prerequisites
 - Compliance monitoring requirements
 - Monitoring plan requirements
 - Use of surrogates
 - Engineering requirements for device design including appurtenances
 - Residuals management issues
 - Radiation exposure issues
 - Items needed for plans review and approval

Existing Waste Handling Issues

- Many systems have existing waste handling issues
 - Iron filtration – radium accumulation in filters and backwash
 - Sampling efforts revealed significance of issue
 - Existing ion exchange installations
- Systems will likely have to implement changes to waste handling practices
 - Cost implications
 - Regulatory/permitting challenges
- Beyond Drinking Water Program jurisdiction
 - We will help to facilitate identification and implementation of appropriate measures

Next Steps

1. Hire an engineer
2. Ensure compliance with all other Enforcement Order requirements:
 - Public Notice
 - Quarterly progress reports
 - Interim measures
 - See guidance in meeting handouts
3. Review CO-RADS Report and other options with engineer and water system board
or
New participants perform catch-up activities

Next Steps

4. Identify options of interest and associated questions or concerns
5. Provide feedback to WQCD case managers
6. Attend May 2009 CO-RADS meeting
 - Board member attendance and involvement is critical
 - Detailed review of options
 - Funding opportunities and requirements

Closing Remarks

Ron Falco, P.E.

Drinking Water Program Manager

Water Quality Control Division

Colorado Dept. of Public Health and Environment

Session 3: Breakout Session

Instructions

- Breakout Session 3 Format:
 - Participants free to move about and discuss options
 - Participants will rank:
 - Top 3 compliance options
 - Top 3 obstacles to achieving compliance
 - Workshop and facilitator feedback
- WQCD staff available for questions
 - CO-RADS Reports/Phase 4 Workplan – Jon Erickson
 - Funding – Michael Beck
 - Enforcement – Jackie Whelan
 - Point-of-use – Paul Kosik