



With the exception of evaporation basins, disposal options could not be fully evaluated through CO-RADS due to the need for site-specific evaluations and permitting issues. Pirnie worked with CDPHE to devise a preferred process for treating the liquid residuals. It was assumed in the CO-RADS reports that liquid residuals would be treated in a concrete-lined evaporation basin constructed on-site (see details in project report). CO-RADS systems should evaluate alternative disposal options as they progress through the design phases of their projects.

Moving Forward

CO-RADS systems will need to work with CDPHE as they move forward to select and implement a compliance alternative. The CO-RADS reports provided to the systems provide a considerable amount of information on the defined compliance alternatives, as well as other potential compliance alternatives the systems may choose to further evaluate. Systems will need assistance selecting a compliance alternative and working towards implementing the alternative.

Building TMF Capacity

Cost of compliance is not the only challenge facing CO-RADS systems. Based on Pirnie's high-level technical, managerial, and financial, (TMF) evaluation conducted as part of CO-RADS, it appears many CO-RADS systems have significant TMF capacity challenges that need to be addressed in order to successfully comply with the Radionuclides Rule. Specifically, a majority of the systems lack the appropriate level of staffing, funding, and businesses processes to operate and manage their water systems.

CO-RADS systems will likely need some assistance building TMF capacity to select and implement a compliance alternative. In addition, demonstration of TMF capacity is required for funding from the State's Drinking Water Revolving Fund (DWRf). Pirnie recommends CO-RADS

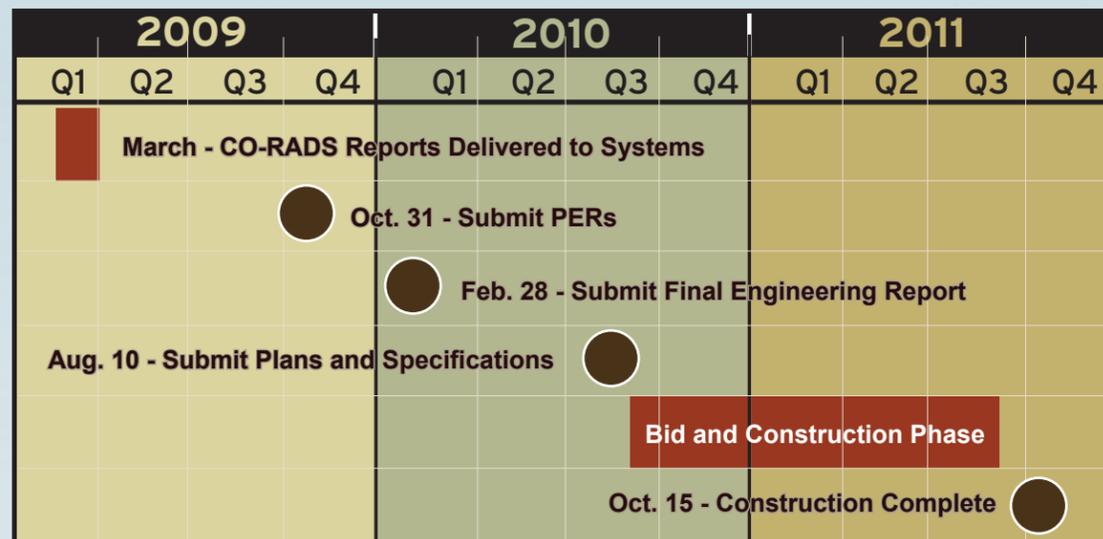


Technical, Managerial and Financial Issues are Interlocked

systems participate in CDPHE's TMF capacity development program to achieve TMF capacity and successfully achieve Radionuclides Rule compliance.

Compliance Schedule

Deadlines for submitting deliverables to CDPHE throughout the CO-RADS process are shown in the schedule below. Systems have approximately six months after they receive their CO-RADS Reports to select a compliance alternative, develop their preliminary engineering report (PER), and submit it to CDPHE. CDPHE's compliance schedule requires systems to achieve Radionuclides Rule compliance by October 2011.



Colorado Radionuclide Abatement and Disposal Strategy (CO-RADS)

Executive Summary: CDPHE helps small water systems achieve Radionuclides Rule compliance

Background

In order to protect public health, the United States Environmental Protection Agency (USEPA) established drinking water standards for several radioactive contaminants as part of the Radionuclides Rule (established in 1976 and revised in 2000). The maximum contaminant levels (MCLs) include:

- Adjusted gross alpha activity (GAA): 15 pCi/L
- Combined radium 226/228: 5 pCi/L
- Uranium: 30 µg/L
- Beta and photon particle activity: 4 mrem/year

The Water Quality Control Division (WQCD) of the Colorado Department of Public Health and Environment (CDPHE) adopted these MCLs as part of the Colorado Primary Drinking Water Regulations (CPDWRs). Over 40 water systems in Colorado are affected by radionuclides and struggle to achieve one or more of those MCLs. Those systems all use groundwater and most of them serve small communities that are primarily located in rural areas of the State. The locations and sizes of the 33 systems participating in CO-RADS are illustrated in Figure 1.

In order to proactively assist those small, struggling communities, WQCD launched the Colorado Radionuclides Abatement and Disposal Strategy (CO-RADS) project to offer compliance and technical assistance at no charge. The ultimate goal of the CO-RADS project is to resolve drinking water radionuclide violations and further protect public health of Colorado residents. There are five phases to CO-RADS:

- **Phase 1** - Review existing data and identify affected systems
- **Phase 2** - Sample affected sources to characterize water quality
- **Phase 3** - Perform engineering analyses and pilot-studies of treatment and disposal options
- **Phase 4** - Build technical, managerial, and financial capacity
- **Phase 5** - Provide assistance to systems during

Population Served:

- < 500
- 501 - 3,300
- > 3,300

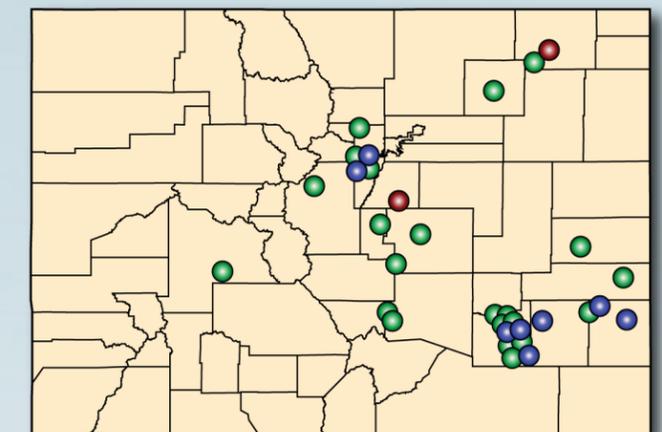


Figure 1: Locations and Sizes of CO-RADS Systems

Over the last two years, CDPHE contracted Malcolm Pirnie, Inc. (Pirnie) to assist with Phases 2 and 3. This Executive Summary presents an overview of the seven tasks performed through Phase 3 of CO-RADS. The progression of tasks is shown in Figure 2.

Figure 2: CO-RADS Tasks Performed by Malcolm Pirnie



Project Overview

Pirnie performed seven tasks as part of CO-RADS Phase 3. The following summarizes the primary activities performed for each task and the major outcomes from each task. Details of this project are included in the CO-RADS Final Project Report (March 2009).

Summary of CO-RADS Phase 3 Results

Task 1: Policy Development	
Description:	Major Outcome:
Pirnie assisted CDPHE with research to support policy related to interim Radionuclides Rule compliance and use of point-of-use/point-of-entry POU/POE (POU/POE) treatment for compliance.	<ul style="list-style-type: none"> Using information provided by Pirnie, CDPHE is in the process of defining policy for POU/POE treatment and bottled water usage for long-term and interim compliance with the Radionuclides Rule.
Task 2: Source Water Sampling	
Description:	Major Outcome:
Pirnie collected and analyzed water quality data for the CO-RADS systems to characterize their source waters to support compliance evaluations and treatment decisions.	<ul style="list-style-type: none"> CO-RADS systems received a full analysis of their source waters, including radionuclides. Many systems had little or no analytical information to support decision making prior to CO-RADS.
Task 3: Treatment Evaluations	
Description:	Major Outcomes:
Pirnie researched and analyzed treatment options for compliance with the Radionuclides Rule	<ul style="list-style-type: none"> Each CO-RADS system received a defined treatment compliance alternative that will confidently provide water in compliance with the Radionuclides Rule. CO-RADS systems also received substantial information on alternative radionuclides treatment options, including treatment efficacy, residuals, and operator certification requirements
Task 4: Worker Safety and Waste Disposal Evaluations	
Description:	Major Outcomes:
Pirnie performed worker safety and disposal evaluations to characterize waste streams and determine the potential exposure of workers to radionuclides by working around radionuclide treatment systems and handling wastes from these systems.	<ul style="list-style-type: none"> Pirnie and CDPHE developed a preferred method of treating liquid residuals. Liquid residuals from radionuclide treatment systems will be treated in a concrete-lined evaporation basin. Pirnie conducted modeling to estimate and mitigate worker exposure around radionuclide treatment technologies. CO-RADS systems received a residuals management plan template that was reviewed by CDPHE.

Task 5: Bench-top and Pilot-scale Studies	
Description:	Major Outcomes:
Pirnie worked with the Colorado School of Mines (CSM) to develop and conduct bench- and pilot-scale studies on treatment technologies for removing radionuclides from drinking water.	<ul style="list-style-type: none"> Pirnie/CSM confirmed the ability of various EPA approved technologies to remove radionuclides from Colorado source waters. Results of Pirnie/CSM bench-and pilot-testing can assist CO-RADS systems evaluate technologies and design treatment systems for compliance with the Radionuclides Rule.
Tasks 6 & 7: CO-RADS Reports and Project Report	
Description:	Major Outcomes:
Pirnie developed 33 system-specific CO-RADS reports - one for each participating system. Each report met the requirements of a Preliminary Engineering Report, as defined by the State Revolving Fund application requirements. Pirnie also developed a final project report.	<ul style="list-style-type: none"> Each CO-RADS system received a CO-RADS Report with cost estimates and a preliminary design of a treatment system, as well as information on other treatment and non-treatment compliance alternatives. This CO-RADS project report summarizes the work conducted through CO-RADS.

CO-RADS Compliance Alternatives

Pirnie defined a treatment compliance alternative for all CO-RADS systems, with the exception of those that already had treatment for radionuclides in place. The compliance alternative specified a treatment alternative that Pirnie and CDPHE are confident can help the water system comply with the Radionuclides Rule. However, due to the nature of the CO-RADS project, Pirnie could not evaluate every compliance option that a community may want to consider. As such, CO-RADS systems may elect to further evaluate compliance options and identify a preferred option. Total opinions of probable cost for the defined alternatives (capital, 20-year O&M, net present value (NPV)) as illustrated in Figure 3.

Pirnie also estimated the specific cost impact, per household, of the defined alternatives on each water system as a percentage of the median household incomes in each CO-RADS county. Results indicated the cost of the CO-RADS defined alternatives represent a cost increase of between 0.4% to 23.3% of median household incomes for each community, with an average of 4.7%.

The following are some items that CO-RADS systems were directed to further evaluate, if appropriate:

- Regionalization compliance options
- POU/POE treatment for very small communities
- Source water blending or development of a new source
- Proprietary solutions

In addition, several decisions made through CO-RADS impacted costs. Systems may find ways to reduce costs through the design phase of the project. Some specific examples include:

- Residuals disposal strategies
- Treatment redundancy
- O&M labor costs

Radionuclide Residuals

The primary challenge with treating waters containing radionuclides is handling and disposal of the solid and liquid residuals produced from the treatment processes. Because these residuals contain high levels of radionuclides, they must be carefully, handled and disposed of to avoid worker exposure and contamination issues. Several disposal options were researched as part of CO-RADS:

- Discharge to groundwater, surface water or sewer
- Evaporation basins or deep well injection
- Brine concentration (zero-liquid discharge (ZLD))
- Spray irrigation

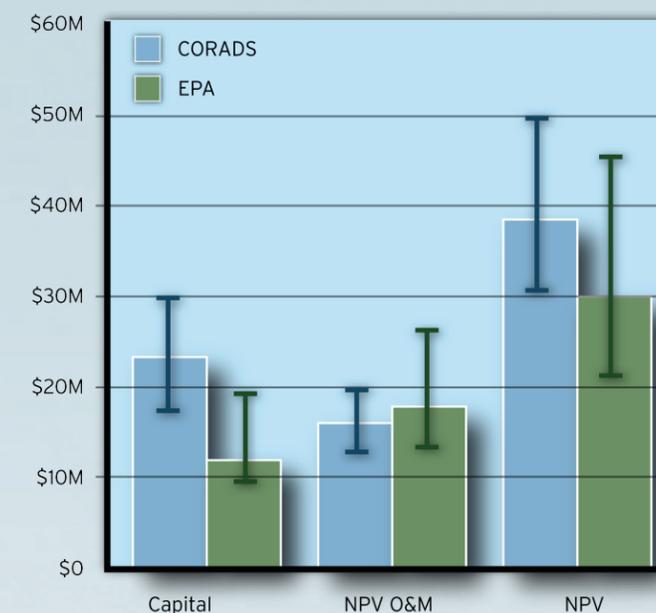


Figure 3: Opinion of Probable Costs for Radionuclide Treatment for 27 Systems