Appendix A

Conceptual Site Model (CSM) and Corrective Action Objectives (CAOs)

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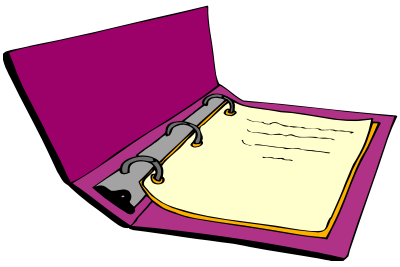
Section 1.0 CAS CSM

Successful implementation of the CAS relies on the development of a complete, yet concise CSM. The CAS places great emphasis on the CSM because it provides the facility and the administrative authority with a broad view of the potential releases to the environment and the proximity of receptors and sensitive environments. The "big picture" approach provides information necessary for:

- performance-based project management
- cost-effective investigations
- risk characterizations and risk management decisions
- development of data quality objectives (DQOs)
- monitored natural attenuation (MNA) determinations, when appropriate
- technical impracticability (TI) waiver determinations, when appropriate
- and sound remedy selection decisions.

Use of the CSM provides a means of documenting and periodically updating all general facility information, *i.e.*, land use changes, new release information, etc. Keeping the CSM updated allows the facility and the administrative authority to use the CSM as the "go to" document for future site inspections, and to document site conditions as risk is reduced through remedy implementation. The CSM is a three-dimensional representation of site conditions that conveys what is known or suspected, at a discrete point in time, about the sources, releases, release mechanisms, contaminant fate and transport, exposure pathways, potential receptors and risks.

The CAS CSM is unique in that it provides a way to organize all components of a CSM into a document that can be used as a "stand alone" deliverable. As site conditions change, it provides the facility manager with a means to keep all pertinent site information in one document.



Facility Profile
Physical Profile
Land Use and Exposure Profile
Release Profile
Ecological Profile
Risk Management Profile

The CAS CSM includes the following profiles; 1) Facility Profile, 2) Physical Profile, 3) Land Use and Exposure Profile, 4) Release Profile, 5) Ecological Profile, and 6) the Risk Management Profile (**Figure A-1**).

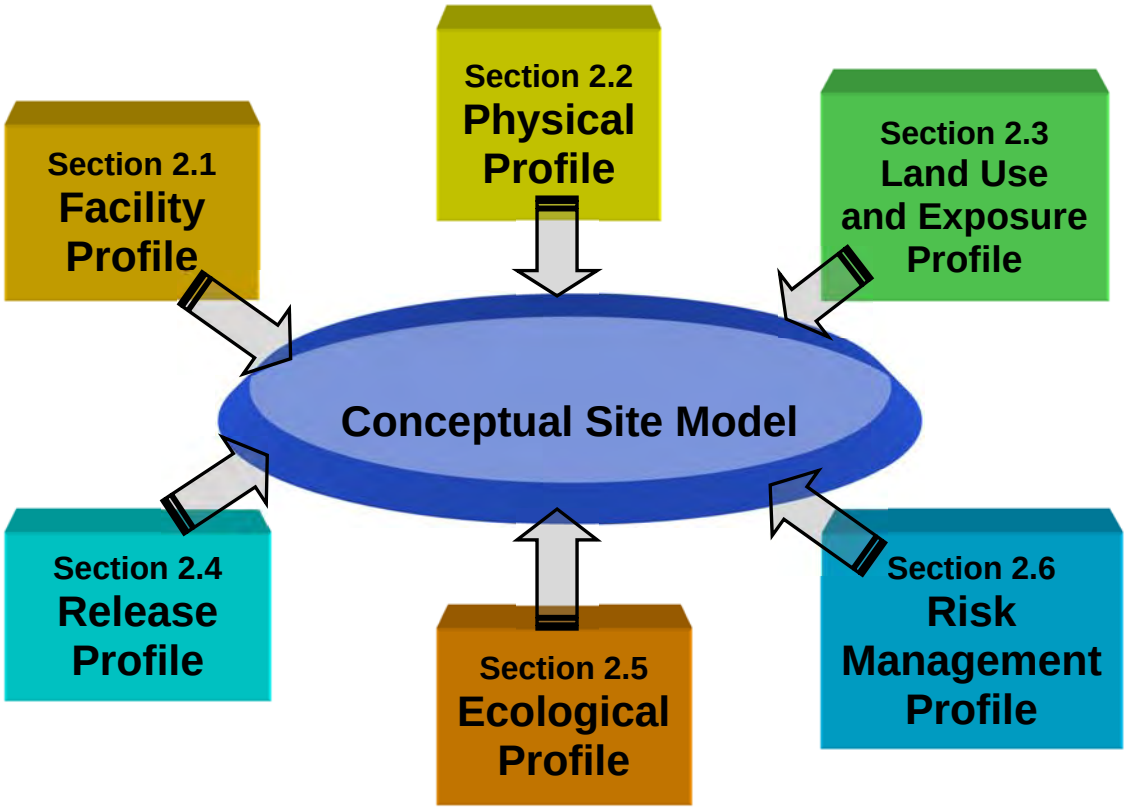


Figure A-1 CAS CSM Profiles

The CAS CSM is focused on putting together the "nuts and bolts" of a comprehensive model that depicts current site conditions. To expand on how the CSM evolves through the life-cycle of site characterization through remediation, please refer to the EPA Best Management Practice (BMP) paper on the "Effective Use of the Project Life Cycle Conceptual Site Model" (EPA 542-F-11-011) July 2011. (http://epa.gov/tio/download/remed/csm-life-cycle-fact-sheet-final.pdf)

All CAS profiles are documented by written descriptions supported by maps, geological cross sections, tables, diagrams and other illustrations to depict site conditions. Before the Scoping Meeting, the facility and the administrative authority will discuss and agree upon the scope, quantity, and relevance of information to be included,

balancing the need to present as complete a picture as possible to document current site conditions and justify risk management decisions, and keep the information focused without becoming extraneous or irrelevant.

The first step for the project manager is to identify known releases, or other potential sources and incorporate all available information into the six profiles. At this point, the risk manager will need to identify all potential receptors, sensitive environments or other special subpopulations. Once this information is compiled, the team has a preliminary CSM that can be presented at the Scoping Meeting.

As the Preliminary CSM is presented at the Scoping Meeting, the administrative authority and facility managers can discuss and agree upon land use, groundwater use and classification.

Section 2.0 CAS CSM Profiles

2.1 The Facility Profile

The facility profile describes the various manmade features present on or near the site, including:

- facility structures, including sewer systems, underground lines, etc.
- process areas, including historical processing sites
- solid waste management units (SWMUs) or other potential source areas identified by a routine and systematic release of hazardous constituents to the environment (i.e. truck or railcar loading/unloading areas)
- historical features that may be potential release areas because of past waste management practices, (*i.e*, old dump sites).

The facility profile may provide information on potential source areas and identify buildings or process structures that may affect site characterization or remedy implementation. The location of facility structures and process areas relative to a release is important in identifying contaminants of potential concern (COPCs) during the screening process (Chapter 4).

2.2 Physical Profile

The physical profile describes the factors that may affect releases, fate and transport, and receptors;

- topographical features, such as hills, gradients, surface vegetation or pavement
- surface water features such as drainage routes, surface water bodies, wetlands, and watershed parameters and characteristics
- surface geology including soil types and parameters, outcrops, and faulting
- subsurface geology including stratigraphy, continuity, and connectivity
- hydrogeologic information identifying the water-bearing zones, hydrologic parameters, and impermeable strata
- soil boring and monitoring well logs and locations

The physical profile should concentrate on site-specific environmental setting information in the absence of a release. The physical profile information will generally be integrated with information from the release profile to describe the behavior of contaminants in the environment. The initial development of the physical profile will begin with some preliminary understanding of the environmental setting. Data gaps can then be identified and used to design future investigations.

2.3 Land Use and Exposure Profile

The land use and exposure profile consists of information used to identify and evaluate the applicable exposure scenarios and receptor locations, including:

- land use on the facility and adjacent properties (including specific land use categories, i.e., single-family homes, recreational, agricultural, or commercial/industrial uses)
- beneficial resource determination (groundwater classification, protected natural resources, wetlands, etc.)
- resource use locations (water supply wells, surface water intakes, etc.)
- subpopulation types and locations (schools, hospitals, day care centers, etc.)
- applicable exposure scenarios
- applicable exposure pathways identifying the specific sources, releases, migration mechanisms, exposure medium, exposure routes and receptors.

To develop the land use and exposure profile, the facility should begin by evaluating the types of land use and determining the beneficial resources on and around the facility. In addition, information on potential receptors (surface water bodies, water wells, and residences) should be incorporated into the CSM for each release. For example, the

identification of surface water bodies at locations in the assessment area indicates the potential for exposure from ingestion of fish and possible drinking water sources. Also, receptor information is vital in demonstrating complete or incomplete exposure pathways during screening (Chapter 4).

2.4 Release Profile

The release profile should describe the nature of contaminants in the environment, including the following:

- identification of source materials (LNAPL or DNAPL)
- identification of contaminants of potential concern (COPC) and contaminants of concern (COC), as appropriate
- potential source locations
- source locations where a release has been confirmed
- delineation of the release area (including soil sampling and monitoring well locations)
- distribution and magnitude of COPC and COC in release areas
- migration routes and mechanisms, and
- fate and transport modeling results, if appropriate.

As with the other profiles, the release profile will be developed over time as information is obtained. At the beginning of the CAS, the release profile may consist of the potential source locations, but at the completion of the CAS, it should contain site-specific information on release characteristics. The contaminant migration and fate and transport aspects of the release profile should be integrated with the geologic and hydrogeologic information developed for the physical profile; this information can also aid in the development of the performance monitoring for risk management activities implemented under the CAS.

2.5 Ecological Profile

The ecological profile consists of information concerning the physical relationship between the developed and undeveloped portions of the site, the use and level of disturbance of the undeveloped property, and the type of ecological receptors present in relation to completed exposure pathways. The following information should be included in the ecological exposure profile (some of this information already may be available from other CSM profiles):

- description of the developed property on the site, including but not limited to, structures, process areas, waste management units, property boundaries, and historical uses (reference to a facility map)

- description of the undeveloped property on the site, including but not limited to, sensitive environmental areas (Federal or state parks or protected areas) habitat type (wetland, grassy area, forested, pond, stream, etc.), primary use, degree and nature of disturbance, ornamental areas, drainage ditches, creeks, and landfill areas (reference to a facility map)

- description of site receptors in relation to habitat type, including but not limited to, endangered or protected species, mammals, birds, fish, etc.

- description of the relationship of releases to potential habitat areas, contaminants of potential concern present or suspected, media contaminated, sampling data summary, potential or likely routes of migration or exposure of potential receptors, etc.

The information captured in the ecological profile will be critical in completing the Ecological Exclusion Criteria Worksheet and Ecological Assessment Checklist (Appendix B). The exclusion worksheet was developed to help facilities and the administrative authority identify incomplete or insignificant exposure pathways that exist at the affected property, thus potentially eliminating the need for a formal Ecological Risk Assessment.

2.6 Risk Management Profile

The risk management profile is used to illustrate the relationship between releases and risks. It illustrates how the release-risk relationship can be altered by implementing risk management activities. The risk management profile can include:

- a summary of risks
- the impact of a risk management activity on release and exposure characteristics
- performance monitoring locations and media, and
- contingency plans in the event performance monitoring criteria is exceeded.

The risk management profile will represent the risk of the selected risk management activity(ies). This profile is the basis for determining appropriate performance monitoring locations and establishing contingency plans to ensure

protectiveness. During the development of the preliminary CSM, the profile may serve as a placeholder. As the facility progresses through the CAS, the information contained in the risk management profile will be augmented and refined and will ultimately demonstrate how facility risk will be managed in the Risk Management Plan (RMP).

Section 3.0 Using the Preliminary CSM to determine Performance Standards

Using the CSM enhances focused data collection, thus saving time and money during field activities. Instead of determining the nature and extent of releases without consideration of the end use of the data, investigations are streamlined with DQOs which clearly define the needed outcome. The performance standards give a broad general direction for cleanup activities. Site and source area characteristics must be evaluated in order to determine if sources can be removed, or if the best option is treatment (in-situ or ex-situ) or containment. **Figure A-2** illustrates the key elements of the CAS used for successful remedy selection.

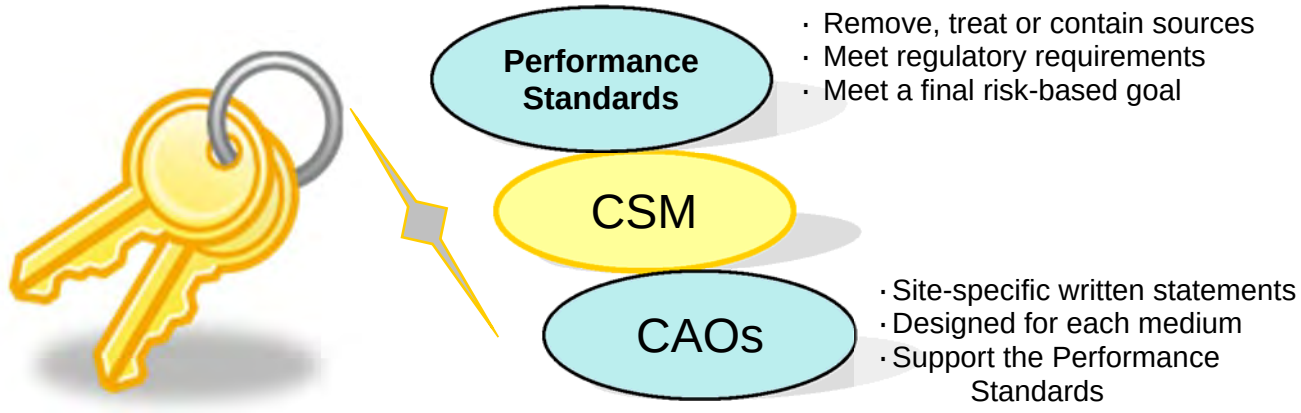


Figure A-2 Keys to Successful Remedy Selection

A preliminary CSM is also used to document the groundwater classification, which can direct the selection of performance standards. For instances where groundwater is not a current or potential future drinking water source, or in instances in which restoration is not practical, the expectation is that human health and the environment must be protected at the point of exposure (POE). If a state does not consider groundwater beneath a facility to be a current or potential future drinking water source, the POE may be placed at the facility boundary. (See **Figures A-3** through **A-5**.) Protection of groundwater and receptors, both ecological and human, would occur at the new POE. In all cases, decisions on attainment of source control through removal, treatment or containment is paramount and will precede the development of final CAOs.

Section 4.0 Using the Systematic Planning Process for Field Investigations – to complete the CSM

Once the project manager selects appropriate performance standards for a facility, they are proposed at the scoping meeting. The project manager will then want to use the systematic planning approach to ensure focused data collection to achieve the objectives of the data end use. Using this approach will enhance the data collection design to develop the SAP/QAPP needed for the CAS workplan.

First Define the End Use of Data Collection

Systematic Planning = Data Quality Objectives (DQOs)

Systematic planning has been described as the thread that connects all performance-based tools, *i.e.*, the CSM, the CAS workplan and CAOs. Additional information on the systematic planning process and use of DQOs can be found at the following EPA web site: http://www.epa.gov/QUALITY/dqos.html. The CAS supports the use of the Triad approach of using the systematic planning process (use of DQOs) and real-time measurement technologies as developed in *dynamic work plans.* The CAS workplan can be written as a dynamic workplan to further streamline data collection. The overall CAS workplan objective is to fill in data gaps identified in the preliminary CSM – with the goal of attaining the most complete CSM for making sound remedy decisions. ITRC developed a guidance document on the use of the Triad approach, "Technical and Regulatory Guidance for the Triad Approach: A New Paradigm for Environmental Project Management". December 2003. This guidance document has also been supplemented with the following ITRC guide: "Triad Implementation Guide". May 2007. http://www.itrcweb.org/Documents/SCM-3.pdf

Section 5.0 CAOs to Support the Performance Standards

Once the CSM is complete (all known data gaps resolved), the project manager is ready to propose site-specific corrective action objectives for the final remedy to attain. ITRC documents such as "Exit Strategy – Seeing the Forest Beyond the Trees" (March 2006) http://www.itrcweb.org/Documents/RPO-3.pdf use the term 'remedial action objectives' (RAOs) in lieu of CAOs. The CAS considers the terms equivalent.

CAOs will be media-specific, and they will define the "endpoints" for corrective action at the site. As stated earlier, the selected performance standards will address source control through removal, treatment or containment (or a combination). For supporting CAOs, it will be necessary to finalize site-specific and appropriate points of exposure

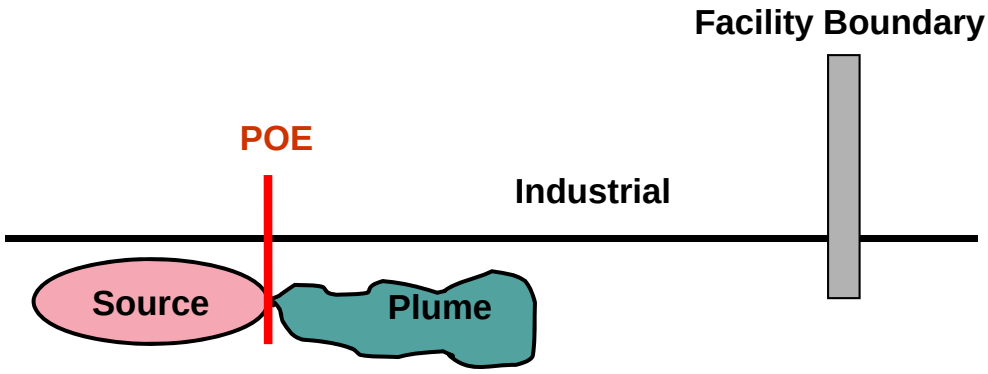
(POE). In the CAS, we consider the POE to be the same as the point of compliance (POE = POC). Performance metrics to measure the success of the selected remedy will be the cleanup values to attain at the POE.

To assist in making determinations for the POE, the CAS has developed four scenarios including land use and groundwater classification. **Figure A-3** illustrates a case where groundwater is currently used for primary drinking water, therefore the POE is at the source boundary. In **Figure A-4** and **Figure A-5** groundwater is a beneficial resource, but not a primary drinking water source. In **Figure A-4** the POE is determined to be at the facility boundary , land use is industrial and offsite land use beyond the facility boundary is residential. **Figure A-5** illustrates a case where a POE is determined to be inside the facility boundary where on-site undeveloped property is classified as residential. The only case where the POC is not the POE is for RCRA regulated units operating under a permitted detection monitoring program or compliance monitoring program. In this case the POC is at the edge of the waste management area.

CAOs must include monitoring of performance metrics (or final cleanup numbers). During Performance Reviews of the final remedy, the facility will report on how well the implemented technology is attaining the performance metrics in the CAOs. With the performance-based approach to remedy implementation, the emphasis is on attaining the CAOs, and monitoring and measuring whether a risk management activity is achieving the goal (see Chapter 6). The administrative authority determines the frequency of the Performance Reviews, depending on the complexity of the groundwater contamination, hydrogeology and proximity to receptors.

Figure A-3

POE at Source Boundary…



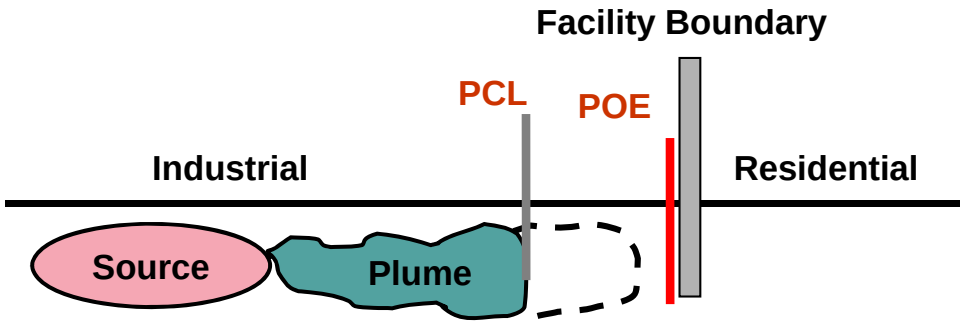
- Groundwater is a primary drinking water source

CAOs:

- Treat/remove sources
- Meet MCLs throughout the plume

Figure A-4

POE at Facility Boundary…



- Groundwater is a beneficial resource, but not a primary drinking water source

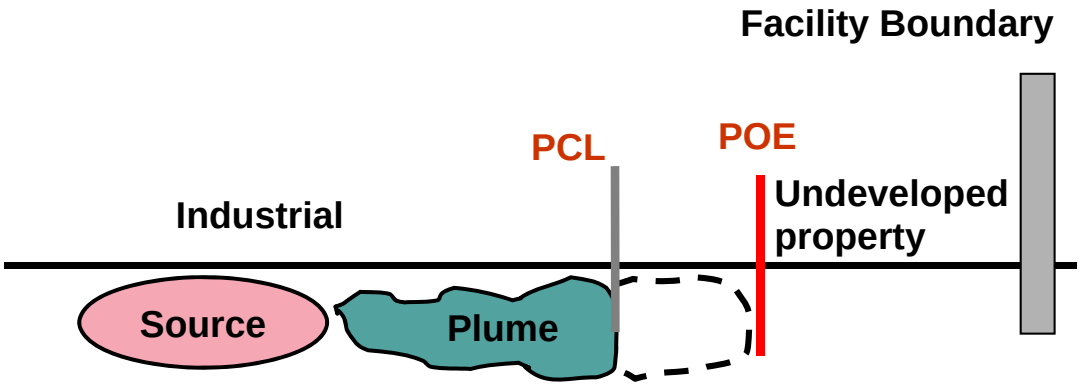
CAOs:

- Treat/remove/contain sources
- Meet MCLs at the facility boundary (POE)
- Meet PCL at edge of plume to show that the plume is stable or shrinking

Where the POE is designated at the facility boundary as in **Figure A-4,** the administrative authority may choose to manage the further migration of the groundwater plume by designating a protective concentration level (PCL) to maintain at the edge of the plume. The new PCL must be derived from calculations that support the attainment of MCLs at the facility boundary.

Figure A-5

POE inside Facility Boundary…



- Groundwater is a beneficial resource, but not a primary drinking water source
- POE can be at the extent of the "industrial use" institutional control (IC)

CAOs:

- Treat/remove/contain sources
- Meet MCLs at the POE
- Meet PCL at edge of plume to show that the plume is stable or shrinking

Some examples of site-specific corrective action objectives and the performance standards they support are provided in the boxes below.

Example 1 scenario: Four defined plumes of DNAPL in groundwater that is not a drinking water source

Performance Standard: Where complete restoration of groundwater is not practical given the nature of contaminants of concern, the value and vulnerability of the groundwater, and the state's determination of the beneficial resource of the aquifer, the performance standard for groundwater at this release site is to conduct source removal to the extent practicable, and contain COCs within a defined groundwater management area or plume management zone.

Corrective Action Objective 1: The facility must remove source material in subsurface soils that could subsequently migrate to groundwater, and attain a subsurface soil cleanup goal protective of groundwater for the COCs.

Corrective Action Objective 2: The facility must contain COCs such that the existing plumes do not increase in size. Groundwater management units (GWMUs) delineated by sentinel monitoring wells will serve as risk-based compliance wells. Statistical analysis of sentinel monitoring well data must demonstrate that each groundwater plume delineated is shrinking or stable.

Corrective Action Objective 3: The POE is the facility boundary, at which COCs must meet MCLs. (Downgradient compliance wells on the facility boundary must show that MCLs are not exceeded.) If the facility is successful in eliminating the human health exposure pathway (including vapor intrusion) for offsite properties through controls on groundwater use, as agreed by property owners and memorialized in the form of Institutional Controls (ICs), the POE can be moved to the boundary of the area under control.

To achieve this performance standard, and meet the clearly defined CAOs, the administrative authority can require the facility to continue interim measure pump and treat technology (with improvements through an optimization program), remove source material within the delineated source zone, or implement a pilot project to test an appropriate insitu treatment technology in a defined source area to decrease COC concentrations. Periodic Performance Reviews will indicate if CAOs are met and maintained.

Example 2 scenario: Extensive DNAPL contamination in drinking water aquifer
Performance Standard: Where groundwater is a drinking water source, the groundwater will be restored to its beneficial resource to drinking water quality standards throughout the plume through continuous source removal and pump and treat technology.

Corrective Action Objective 1: Continuously optimize corrective measure systems to decrease the COC concentrations throughout the plume until drinking water standards (MCLs) are obtained.

Corrective Action Objective 2: Control, to the extent practicable, the migration of COCs from source DNAPL areas to groundwater.

Corrective Action Objective 3: Prevent, to the extent practicable, the lateral migration of COCs in groundwater into the surface water bodies at levels that would cause sediment or surface water to pose an unacceptable risk.

Corrective Action Objective 4: Prevent human exposure to groundwater containing COCs at concentrations that exceed the relevant groundwater standards for both water-bearing zones in the Aquifer system.

Corrective Action Objective 5: Control and monitor on-site worker dermal contact with, or ingestion of, COCs in shallow groundwater in accordance with applicable state/OSHA requirements.

In this example the facility and administrative authority have explicit CAOs to meet while trying to attain the long-term performance standard of cleaning up the aquifer to MCLs throughout the plume. Throughout the cleanup process the CAOs are enforceable conditions of the RCRA permit.