

Section 4

Detailed Analysis of Alternatives

A detailed evaluation of the alternatives provides the relevant information necessary for decision makers to select an appropriate site remedy. In this section, each of the alternatives developed in [Section 3](#) are assessed under the specified evaluation criteria, and analyzed in terms of how well each one meets those criteria.

The detailed analysis of alternatives consists of the following components:

- A detailed evaluation of each alternative under the first seven of the nine evaluation criteria listed in the NCP. The two modifying criteria, state and community acceptance, are evaluated after the FS undergoes public comment and are not included in the FS.
- A comparative evaluation of the alternatives.

EPA developed this standardized approach to provide decision makers with sufficient information to analyze alternatives and select an appropriate remedy for the site pursuant to CERCLA remedy selection requirements.

4.1 Evaluation Criteria

Provisions of the NCP require that each alternative be evaluated under nine criteria listed in 40 CFR 300.430(e)(9). These criteria were published in the March 8, 1990, Federal Register (55 FR 8666) to provide grounds for comparison of the relative performance of the alternatives and to identify their advantages and disadvantages. This approach is intended to provide sufficient information to adequately analyze the alternatives and to select the most appropriate alternative for implementation as a remedial action at the site. The nine evaluation criteria are:

1. Overall protection of human health and the environment
2. Compliance with ARARs
3. Long-term effectiveness and permanence
4. Reduction of toxicity, mobility, and volume (TMV) through treatment
5. Short-term effectiveness

6. Implementability
7. Cost
8. State acceptance
9. Community acceptance

The criteria are categorized into three groups: threshold criteria, balancing criteria, and modifying criteria. Threshold criteria must be met by a particular alternative for it to be eligible for selection as a remedial action. There is little flexibility in meeting the threshold criteria; a particular alternative either meets the threshold criteria, or that alternative is not considered acceptable. The two threshold criteria are overall protection of human health and the environment, and compliance with ARARs. If ARARs cannot be met, a waiver may be obtained when one of the six exceptions listed in the NCP occur (see 40 CFR 300.430 (f)(1)(ii)(C)(1 to 6)).

Unlike the threshold criteria, the five balancing criteria assess the advantages and disadvantages among alternatives. A low rating on one balancing criterion can be compensated by a high rating on another. The five balancing criteria are: long-term effectiveness and permanence; reduction of TMV through treatment; short-term effectiveness; implementability; and cost.

The two modifying criteria are community and state acceptance. These criteria are evaluated after the FS undergoes public comment and are used to modify the recommended alternative, as appropriate. Modifying criteria are not included in the comparative analysis of alternatives in the FS. The seven evaluation criteria used in the FS are described in further detail below.

4.1.1 Threshold Criteria

To be eligible for selection, an alternative must meet the two threshold criteria described below, or in the case of ARARs, must justify why a waiver is appropriate.

Overall protection of human health and the environment. Under this criterion, alternatives are assessed to determine whether they can adequately protect human health and the environment, in both the short- and long-term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site by eliminating, reducing, or controlling exposures to levels established during development of remediation goals consistent with 40 CFR 300.430(e)(2)(i).

Overall protection of human health and the environment draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

Compliance with ARARs. The alternatives are assessed to determine whether they attain ARARs under federal environmental laws and state environmental or facility siting laws, or provide grounds for invoking one of the waivers under paragraph (f)(1)(ii)(C) of 40 CFR 300.430.

4.1.2 Balancing Criteria

The five criteria listed below represent the criteria upon which the detailed evaluation and comparative analysis of alternatives is based. The level of detail required to analyze each alternative under these NCP evaluation criteria depends on the nature and complexity of the site, the types of technologies and alternatives being considered, and other project-specific considerations. The analysis is performed in sufficient detail to understand the significant aspects of each alternative and to identify the uncertainties associated with the evaluation.

Long-term effectiveness and permanence. Alternatives are assessed for the long-term effectiveness and permanence they afford, along with the degree of certainty that the alternative will prove successful. Factors considered as appropriate include the following:

- (a) The magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities. The characteristics of the residuals were considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, and propensity to bioaccumulate.
- (b) The adequacy and reliability of controls such as containment systems and institutional controls necessary to manage treatment residuals and untreated waste. This factor addresses in particular the uncertainties associated with land disposal for providing long-term protection from residuals; the assessment of the potential need to replace technical components of the alternative such as a cap, a slurry wall, or a treatment system; and the potential exposure pathways and risks posed should the remedial action need replacement.

Reduction of TMV through Treatment. The alternatives are assessed to determine the degree to which they employ recycling or treatment that reduces TMV. In addition, the alternatives are assessed to determine how treatment is used to address the principal threats posed by the site. Factors that are considered as appropriate include the following:

- (a) The treatment or recycling processes the alternatives employ and the materials they will treat.
- (b) The amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated, or recycled.

- (c) The degree of expected reduction in TMV of the waste due to treatment or recycling and the specification to which reduction(s) is occurring.
- (d) The degree to which the treatment is irreversible.
- (e) The type and quality of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate hazardous substances and their constituents.
- (f) The degree to which treatment reduces the inherent hazards posed by principal threats at the site.

Short-term effectiveness. The short-term impacts of alternatives are assessed considering the following:

- (a) Short-term risks that might be posed to the community during implementation of an alternative.
- (b) Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures.
- (c) Potential environmental effects of the remedial action and the effectiveness and reliability of mitigative measures during implementation.
- (d) Time until protection is achieved.

Implementability. The ease or difficulty of implementing the alternatives is assessed by considering the following types of factors, as appropriate:

- (a) Technical feasibility, including the technical difficulties and the unknowns associated with the construction and operation of a technology, the reliability of the technology, the ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.
- (b) Administrative feasibility, including the activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (for offsite actions).
- (c) Availability of services and materials, including the availability of adequate offsite treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to ensure any necessary additional

resources; the availability of services and materials; and the availability of prospective technologies.

Cost. The types of costs that are assessed include the following:

- (a) Capital costs, including both direct and indirect costs.
- (b) Annual operations and maintenance (O&M) costs.
- (c) Net present value of capital and O&M costs.

4.1.3 Modifying Criteria

The two modifying criteria are state and community acceptance. As previously discussed, evaluations of the alternatives under the modifying criteria are not used in the comparative analysis of alternatives described in this FS; evaluation of these criteria is performed after the FS is completed.

State acceptance. The state concerns that are assessed include the following:

- (a) The state's position and key concerns related to the preferred alternative and other alternatives.
- (b) The state's comments on ARARs or the proposed use of waivers.

State acceptance of any of the alternatives will be evaluated as part of the remedy selection process.

Community acceptance. This assessment includes determining which components of the alternatives that interested persons in the community support, have reservations about, or oppose. Community acceptance of any of the alternatives will be evaluated as part of the public comment period during the remedy selection process.

4.2 Individual Analysis of Alternatives

The individual analysis of alternatives consists of evaluating each of the five remedial alternatives developed for the GWP under the seven NCP evaluation criteria described above. For each alternative and treatment/discharge option, the procedures described by the EPA FS costing guidance, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study (EPA, 2000a)*, were used to develop Class 4 cost estimates, as defined by the American Association of Cost Estimators Guidelines. Support for these cost estimates is provided in [Appendix B](#). These cost estimates are considered accurate to +50/-30 percent for the quantities and methods assumed, and were prepared to provide guidance in project evaluation and implementation from information available at the time of

the estimate. The actual cost of the selected alternative will depend on the actual labor and material costs, the actual site and weather conditions during the activities, the final project schedule, the final engineering design, and other variable factors. The following paragraphs describe each alternative under the seven NCP criteria.

4.2.1 Alternative 1: No Action

The No Action alternative constitutes the absence of any remedial actions. Under this alternative, the existing water supply system would function without blending or further modifications. Although natural attenuation would occur primarily through dispersion and diffusion, the ground water data indicate biodegradation is not a significant factor. The No Action alternative would not include monitoring of natural attenuation to determine if cleanup is occurring at a reasonable rate. The following paragraphs analyze this alternative under the seven NCP criteria.

4.2.1.1 Overall Protection of Human Health and the Environment

Under the No Action alternative, PCE in the ground water would exceed the MCL such that the RAOs would not be met. PCE would continue to be present in the ground water at concentrations exceeding the MCL for greater than 30 years and as such will continue to pose a potential human health risk to residents who obtain their potable water from this municipal supply (this alternative assumes that the blending program would not be in place) or who complete a private well within the plume. In addition, expansion of the plume is not controlled. The JSP ground water model predicts that over time, existing monitor well GWMW11 and existing municipal supply well CLC No. 26 will become impacted with PCE.

4.2.1.2 Compliance with ARARs

The chemical-specific ARARs include the Federal SDWA MCLs, MCLGs, and Action Levels (40 CFR Part 141), which specify primary drinking water standards for public water supply systems and New Mexico Regulations for Public Drinking Water Systems (20.7 NMAC) which set drinking water standards for public water supply systems in the state. These requirements are applicable to water supplied by the impacted water supply system. These chemical-specific ARARs for PCE will be exceeded in an untreated drinking water supply and are predicted by the JSP ground water model to be exceeded for greater than 30 years.

4.2.1.3 Long-Term Effectiveness and Permanence

Under the No Action alternative, the ground water contaminant plume would remain for an indefinite length of time posing an unacceptable risk of exposure and because of plume migration; PCE could impact other municipal supply wells. The JSP model predicts future plume expansion with impact to

CLC Well No. 26, and it also predicts PCE concentrations remaining above the MCL in the ground water for longer than 30 years.

4.2.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Under the No Action alternative, no overall reduction in TMV through treatment would occur. Transport processes such as dilution and dispersion could reduce PCE concentrations in the ground water over time thereby reducing toxicity. Migration of PCE in ground water could increase the volume of affected ground water. Expansion of the plume could result in additional detections in wells outside the current plume boundary.

4.2.1.5 Short-Term Effectiveness

Because no action would be implemented under this alternative, there are no additional risks to workers associated with implementation of this remedy. The existence of PCE at levels above the MCL and the potential for PCE to migrate to other municipal supply wells poses an unacceptable health risk to residents relying upon the municipal water supply.

4.2.1.6 Implementability

The No Action Alternative does not require any additional administrative coordination, labor, equipment, or materials.

4.2.1.7 Cost

There are no costs associated with the No Action Alternative.

Alternative 1 Total Present Worth Estimated Cost: \$0

4.2.2 Alternative 2: Ground Water Extraction with Blending

Under Alternative 2, ground water would be extracted from municipal supply wells CLC Well Nos. 18 and 27 at flow rates of 380 and 520 gpm, respectively. Modeling results indicate that plume containment is achieved at these flow rates. Neighboring CLC Well Nos. 20, 24, and 26 remain pumping, and CLC Well Nos. 19, 21, and 38 are turned off. The extracted contaminated ground water from CLC Well Nos. 18 and 27 would be combined with ground water from municipal supply wells containing little or no PCE and blended such that the resulting concentration is below the MCL. The blended water would then be discharged to the public water supply system. The blending process can only be successful if a sufficient quantity of clean water is available to dilute PCE concentrations in the extracted ground water to below the MCL. If an adequate quantity of clean water for blending is not available, an alternative treatment process would be necessary to remove PCE from the extracted ground water.

PCE in ground water is expected to decline over time; however, it is not possible to determine a rate of decline based on the available data. This would require data to determine the PCE flux (rate of PCE mass transfer) from soil vapor to ground water in the source areas of the ground water plume by measuring temporal concentrations (trends over time) in soil vapor and shallow ground water.

In addition, although current data suggests that there is no continuing source of contamination into the ground water, soil contamination can be very difficult to find. Ground water concentration data from existing water table monitor wells indicate a decreasing trend, further indicating that a continuing source of PCE contamination is not present. Currently, insufficient data exist to determine if this decrease is statistically significant. These uncertainties will be managed with an annual review of the remedy as discussed in [Section 3.2.4](#).

The following paragraphs analyze this alternative using the seven criteria.

4.2.2.1 Overall Protection of Human Health and the Environment

Under Alternative 2, hydraulic containment is expected to prevent the expansion of the plume and eventually lower PCE concentrations in ground water to below the MCL. The time frame to achieve the MCL in ground water is predicted to be approximately 23 years based on JSP model simulations. LTM of ground water would detect changes in the size of the plume and concentrations in the plume. Monitoring over time also would provide data to evaluate the success of plume containment.

This alternative also provides blending of the extracted ground water to meet the MCL before being introduced to the public water supply system. Blending the extracted ground water would reduce the human health risk to residents who obtain their potable water from this municipal supply as long as the blending process is maintained and actively monitored to ensure compliance before discharge to the water supply system. Maintaining a proper blending program is less reliable than treatment alternatives due to the potential fluctuation in concentrations. More frequent monitoring may be required than for other alternatives to ensure the blending ratio is appropriate and concentrations are consistently maintained below the MCL standard prior to distribution into the municipal water supply.

This alternative involves low risk to workers from affected ground water or the blending process during active remedial action and O&M.

4.2.2.2 Compliance with ARARs

The blending program would provide water that meets the MCL for PCE as long as the blended water is actively monitored prior to discharge to the water supply system. PCE concentrations in ground

water are predicted based on the JSP model to persist above the MCL for approximately 23 years. May require more frequent monitoring than other alternatives to ensure MCLs are met prior to distribution to the drinking water supply. LTM of ground water could detect changes in the size of the plume and concentrations in the plume. Monitoring over time also would provide data to observe the success of plume containment.

4.2.2.3 Long-Term Effectiveness and Permanence

Under Alternative 2, extracting contaminated ground water from the aquifer should reduce the size of the plume over time by removing PCE mass. LTM of ground water would detect changes in concentrations of contaminants and the size of the plume. The potential for plume expansion is thus minimized with the use of hydraulic containment.

The plume would be hydraulically contained using CLC Wells No. 18 and 27. The JSP model estimates the aquifer would be restored to its beneficial use as a municipal water supply within about 23 years.

4.2.2.4 Reduction of Toxicity, Mobility or Volume through Treatment

Under Alternative 2, no overall reduction in TMV through treatment would occur (blending does not constitute treatment). Plume containment using CLC Well Nos. 18 and 27 will minimize expansion of the PCE plume and remove contaminant mass from the aquifer over the long term. However, PCE concentrations in the ground water are predicted based on the JSP model to persist above the MCL for approximately 23 years.

4.2.2.5 Short-Term Effectiveness

Under Alternative 2, the immediate risk to human health receptors who obtain their potable water from municipal supply wells within and in the vicinity of the plume would be reduced with blending. This alternative would provide the City with potable water. However, there is the potential for failures in the blending process, including but not limited to, equipment mechanical failure and control logic failures which could result in an increased risk of exceeding the MCL.

Based on the JSP modeling results, it will take approximately 23 years to achieve the MCL for PCE in the ground water. CLC Well Nos. 18 and 27 are predicted to provide plume containment, reducing the potential requirement for new wells. If determined to be required, the installation of new extraction wells would pose a risk to drillers that may come into contact with contaminated ground water during installation. This risk, however, is expected to be low with the use of OSHA-trained workers and if protective equipment is maintained.

4.2.2.6 Implementability

The infrastructure to achieve plume containment is in place in the form of existing supply wells CLC Well Nos. 18 and 27. Based on the JSP model, it is estimated that pumping 380 and 520 gpm, respectively, from each of these wells should achieve plume containment.

The infrastructure for blending affected ground water is also in place and is currently managed by the CLC. Therefore, no additional treatment, or disposal of contaminated water is identified for this alternative. O&M for the blending infrastructure is estimated to be necessary for a period of approximately 23 years.

LTM is necessary to determine the effectiveness of this remedy. This includes the ground water sampling and performance monitoring discussed in [Section 3.2.2](#). Performance monitoring would be essential to this alternative to verify the zone of influence of the treatment system and to verify hydraulic plume containment. If downgradient monitor wells detect PCE migration toward municipal supply wells or indication of plume expansion, then either ground water pumping rates would need to be increased and/or additional extraction wells installed to maintain plume containment. Frequent monitoring of PCE in the blended water is necessary to ensure that the municipal supply is maintained below MCL.

The blending process can only be successful if a sufficient quantity of clean water is available to dilute PCE concentrations in the extracted ground water to below the MCL.

4.2.2.7 Cost

The cost estimates for this option include the annual O&M costs for operation of the blending infrastructure for a period of 23 years. Costs for this alternative do not include the City's existing blending process equipment and O&M for that process.

Alternative 2 Total Present Worth Estimated Costs:

Capital Cost:	\$ 1.1 MM
Annual O&M Cost (Year 1):	\$ 0.6 MM
Annual O&M Cost (Years 2-5):	\$ 0.5 MM
Annual O&M Cost (Year 6-23):	\$ 0.3 MM
Total Present Worth Cost:	\$10.2 MM

4.2.3 Alternative 3: Ground Water Extraction with Treatment

Under Alternative 3, ground water would be extracted at higher rates than in Alternative 2 and neighboring CLC Well Nos. 19, 20, 21, 24, 26, and 38 are turned off. In addition, the extracted ground water would be treated to below the MCL via one of three technologies (air stripping, GAC, or chemical/UV oxidation) as discussed in [Section 3](#). The treated water will then be available for use by the municipal supply system. The JSP modeling results show that existing CLC Well Nos. 18 and 27 can be used to contain the entire plume. If these wells are pumped at a rate of 460 and 620 gpm, respectively, the cleanup time is reduced to 21 years. The estimated costs for this alternative consider the use of these two wells for plume containment and rely on the predicted model estimate of 21 years of operation to meet the MCL throughout the plume. LTM would be used to monitor changes in the plume boundaries and to monitor the effectiveness of hydraulic containment and the remedial system. The following paragraphs analyze this alternative under the seven criteria.

4.2.3.1 Overall Protection of Human Health and the Environment

Alternative 3 focuses on the area of the plume that is above the MCL with the objective of reducing PCE concentrations to levels below the MCL and restoring the aquifer to its beneficial use as a drinking water supply. Ground water would be extracted using CLC Well Nos. 18 and 27 and treated to reduce the PCE to below the MCL before distribution to the municipal water supply system. Therefore, MCLs are maintained and remain protective of residents who obtain their potable water from municipal supply. The JSP model results predict pumping these two wells would prevent further expansion of the PCE plume. LTM would be used to monitor changes in the plume boundaries and to monitor the effectiveness of the hydraulic containment. The model predicts that the MCL will be achieved throughout the plume in approximately 21 years. The treatment option for extracted ground water would be to destroy or transfer PCE to another medium. The transfer of contaminants to another medium (such as air) can introduce a separate risk to human health and the environment if it is not properly handled and/or disposed.

This alternative involves low risk to workers from affected ground water or the treatment process during active remedial action and O&M.

4.2.3.2 Compliance with ARARs

The extracted and treated ground water would provide water that meets the MCL; monitoring would be required to ensure MCLs are met prior to distribution to the drinking water supply. Under this alternative, the network of extraction wells would provide hydraulic containment of the entire plume. Operation of the extraction well network would adequately contain the PCE plume and treatment of

the contaminated ground water to below the MCL would ensure compliance and eventual restoration of the aquifer.

Also, if the air stripping option is selected under this alternative, controls to remove contaminants from the vapor phase may be also be required, depending on the concentration of contaminants in the emissions and local requirements. Las Cruces is an attainment area under the CAA. In accordance with the OSWER Directive 9355.0-28 "Control of Air Emissions from Superfund Air Strippers at Superfund Groundwater Sites" (EPA, 1989), preliminary calculations of air emission rates associated with air stripping of PCE were prepared. Air emission estimates are provided in the calculations in [Appendix B](#), and are estimated to be well below National Institute for Occupational Safety and Health (NIOSH) exposure limits as well as permitting thresholds. The air stripping option under this alternative includes air monitoring to confirm emissions are in compliance.

4.2.3.3 Long-Term Effectiveness and Permanence

Under Alternative 3, ground water extraction of the entire plume and treatment is predicted to be effective in remediating the aquifer and preventing further lateral or vertical expansion of the contaminant plume. Treatment of the entire plume provides the likelihood that the RAOs will be permanently met and that the remedy will have long-term success. The JSP model estimates the aquifer would be restored to its beneficial use as a municipal water supply within about 21 years.

4.2.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The extraction and treatment of ground water under this alternative would provide overall reduction in TMV of the contaminated ground water through treatment. The entire plume would be both hydraulically contained and treated under this alternative. The removal of mass would reduce the toxicity and volume with the aquifer, and plume containment would reduce the contaminant mobility.

If the air stripping option is selected, air emissions will be produced. Air emission estimates are provided in the calculations in [Appendix B](#), and are estimated to be well below National Institute for Occupational Safety and Health (NIOSH) exposure limits as well as permitting thresholds. The air stripping option includes air monitoring to confirm emissions are in compliance.

4.2.3.5 Short-Term Effectiveness

Under Alternative 3, the risk to human health of those who obtain their potable water from municipal supply wells within and in the vicinity of the plume would be reduced by treating the extracted water to below the MCL. This alternative would provide the City with potable water and would contain the

plume. The JSP ground water model predicts that under this alternative RAOs will be reached in approximately 21 years.

This alternative would generally provide minimal risks to workers, the community, and the environment. There would be minimal risk to the community associated with the consumption of treated ground water as long as adequate controls are in place to warn of system failure. There is minimal potential for failure in the treatment process, including but not limited to, mechanical failure of equipment or control logic failures. Potential risk levels apply during the construction and maintenance of the ex-situ treatment unit. This risk is expected to be low with the use of OSHA-trained workers and if protective equipment is maintained.

The use of a non-destructive treatment technology (i.e., air stripping or GAC) transfers the contaminants to another medium and poses a potential risk to human health and the environment by the production of air emissions or a waste that requires proper disposal. The chemicals used for the ex-situ treatment units (i.e., air stripper and chemical/UV oxidation) will pose a risk to the workers.

4.2.3.6 Implementability

The ground water extraction technologies are commonly accepted and applied at remedial sites and are generally easy to maintain. Although all treatment technologies require management, GAC is the easiest treatment technology to implement and maintain, followed by air stripping and chemical/UV oxidation, respectively.

Scaling within wells and conveyance piping can potentially occur at most sites over time but can be determined and mitigated using bench or pilot tests. Scaling within an air stripper system has a higher potential than within the wells and conveyance piping due to the removal of CO₂ during the process and subsequent change in pH. RSI calculations show the potential for scaling within the air stripper is borderline. Scaling can be managed through use of an acid pretreatment system. Chemical/UV oxidation would require a continuous supply of treatment chemicals and ozone production. Once the ground water is treated, it will be available for immediate distribution. Construction of a conveyance system to the central treatment unit, and the siting of the treatment unit itself, could present logistical issues in the populated areas and temporary conditions during construction. LTM is necessary to determine the effectiveness of this remedy. This includes the ground water sampling and performance monitoring discussed in [Section 3.2.2](#).

If downgradient monitor wells detect PCE increases in ground water or indicate plume expansion ground water pumping rates would need to be increased or additional extraction wells installed to

maintain hydraulic containment of the plume. The duration of O&M for the treatment infrastructure is expected to be 18 years.

4.2.3.7 Cost

The cost estimate for ground water extraction and ex-situ treatment includes the design and installation of the extraction well network, the design and installation of conveyance piping, a treatment plant, treatment equipment, design and installation of a supervisory control and data acquisition (SCADA) system, and annual O&M costs for operation of the treatment infrastructure for a period of 21 years. Costs presented below assume ex-situ treatment using air stripping without acid pretreatment. Costs for the other technologies, including air stripping with acid pretreatment, are presented in [Table 4-2](#).

Alternative 3 Total Present Worth Estimated Costs:

Capital Cost:	\$ 3.9 MM
Annual O&M Cost (Year 1):	\$ 0.8 MM
Annual O&M Cost (Years 2-5):	\$ 0.6 MM
Annual O&M Cost (Year 6-21):	\$ 0.5 MM
Total Present Worth Cost:	\$ 16.6 MM

A preliminary evaluation indicates the potential for scaling (and, therefore, the need for pretreatment) is borderline under the ex-situ air stripping treatment option. The RSI calculated for CaCO₃ scaling potential at GWP is 6.1; RSI less than 6 indicates higher potential for scaling. The Langlier Index (LI) calculated for CaCO₃ scaling potential at GWP is 0.9; LI greater than 1 indicates higher potential for scaling. Because the assumptions used in making these calculations can greatly affect the result, a more detailed evaluation of the scaling potential and associated need for pretreatment is recommended during the RD.

4.2.4 Alternative 4: Enhanced Ground Water Extraction with Treatment

This alternative is similar to Alternative 3, but includes pumping modifications to existing CLC supply wells and the addition of one new extraction well. CLC Wells Nos. 18 and 27 will be redesigned to extract water from targeted ground water intervals that contain higher PCE concentrations. One new extraction well will be installed along the axis of the PCE plume northeast of CLC Well No. 27. The new extraction well will be used to replace CLC Well No. 18 after the first five years of operation because the JSP model predicts that CLC Well No. 18 will start to draw more

clean water over time and will, therefore, become less efficient in extracting contaminated ground water. The objective of this alternative is to restore the aquifer in a shorter time frame than Alternative 3. The JSP modeling results were used to support development of this alternative. As with Alternative 3, the modeling scenario assumed that CLC Wells 19, 20, 21, 24, 26, and 38 are turned off.

4.2.4.1 Overall Protection of Human Health and the Environment

Under Alternative 4, water will be pumped from municipal supply wells CLC Well Nos. 18 and 27 and one new extraction well (operated as described in [Section 3.6](#)) and treated to reduce the PCE to below the MCL before distribution to the public water supply system. This would reduce the human health risk to residents who obtain their potable water from this municipal supply. The JSP model predicts that operation of these extraction wells would provide hydraulic containment of the PCE plume. The RAOs are expected to be reached in approximately 14 years. LTM would provide data trends on PCE concentrations and confirm hydraulic containment of the plume. Treatment of the entire plume permanently reduces TMV within the aquifer providing protection of human health and the environment. Depending on which treatment technology is selected, the contaminants would be either destroyed or transferred to another medium. The transfer of contaminants to another medium can introduce a separate risk to human health and the environment if they are not properly handled and/or disposed.

This alternative involves low risk to workers from affected ground water or the treatment process during active remedial action and O&M.

4.2.4.2 Compliance with ARARs

Under this alternative, the extracted and treated ground water would meet the MCLs. Monitoring would be required to ensure MCLs are met prior to distribution to the drinking water supply. Existing supply wells CLC Well Nos. 18 and 27 would be modified and a new extraction well installed to maximize hydraulic containment of ground water containing PCE concentrations above the MCL. Operation of the extraction well network would adequately contain and treat the PCE plume to meet the ARARs. The removal of PCE mass from the aquifer by pumping also would restore ground water to its beneficial use of providing municipal water supply that meets water quality standards.

Also, if the air stripping option is selected under this alternative, controls to remove contaminants from the vapor phase may be also be required, depending on the concentration of contaminants in the emissions and local requirements. Las Cruces is an attainment area under the CAA. In accordance with the OSWER Directive 9355.0-28 "Control of Air Emissions from Superfund Air Strippers at

Superfund Groundwater Sites” (EPA, 1989), preliminary calculations of air emission rates associated with air stripping of PCE were prepared. Air emission estimates are provided in the calculations in [Appendix B](#), and are estimated to be well below National Institute for Occupational Safety and Health (NIOSH) exposure limits as well as permitting thresholds. The air stripping option under this alternative includes air monitoring to confirm emissions are in compliance.

4.2.4.3 Long-Term Effectiveness and Permanence

Under Alternative 4, ground water extraction and treatment are predicted to be effective in remediating the aquifer and preventing further lateral or vertical expansion of the contaminant plume. Treatment of the entire plume provides the likelihood that the RAOs will be permanently met and that the remedy will have long-term success. The JSP model estimates the aquifer would be restored to its beneficial use as a municipal water supply within about 14 years.

4.2.4.4 Reduction of Toxicity, Mobility, and Volume through Treatment

The extraction and treatment of ground water under this alternative would provide reduction in TMV in the contaminated ground water through treatment. The entire plume would be both hydraulically contained and treated under this alternative. The removal of mass would reduce the toxicity and volume of PCE within the aquifer, and plume containment would reduce the contaminant mobility.

If the air stripping option is selected, air emissions will be produced. Air emission estimates are provided in the calculations in [Appendix B](#), and are estimated to be well below NIOSH exposure limits as well as permitting thresholds. The air stripping option includes air monitoring to confirm emissions are in compliance.

4.2.4.5 Short-Term Effectiveness

Under Alternative 4, the immediate risk to human health receptors who obtain their potable water from this source would be reduced by treating the extracted water to below the MCL. This alternative would provide safe, potable water, while removing PCE mass from the aquifer. The MCL is expected to be achieved throughout the plume in approximately 14 years.

Minimal risks to workers, the community, or the environment are expected to occur with this alternative. There would be minimal risk to the community associated with the consumption of treated ground water as long as adequate controls are in place to warn of system failure. There is minimal potential for failure in the treatment process, including but not limited to, mechanical failure of equipment or control logic failures.

Potential risk could occur during the construction and maintenance of the treatment system. The use of a non-destructive treatment technology (i.e., air stripping or GAC) transfers the contaminants to another medium and could pose a risk to human health and the environment through the production of air emissions or waste and requires proper disposal. The chemicals used for the ex-situ treatment units (i.e., air stripper and chemical/UV oxidation) will pose a risk to the workers.

Construction activities associated with the installation and modification of pumping wells could pose a risk to workers if they are exposed to untreated ground water. This risk is expected to be low with the use of OSHA-trained workers and if protective equipment is maintained.

4.2.4.6 Implementability

Ground water extraction technologies are commonly used, and generally easy to maintain. All treatment technologies require operation and maintenance. GAC is the easiest treatment technology to implement and maintain, followed by air stripping and chemical/UV oxidation. Scaling within wells and conveyance piping can potentially occur at most sites over time but can be determined and mitigated using bench or pilot tests. Scaling within an air stripper system has a higher potential than within the wells and conveyance piping due to the removal of CO₂ during the process and subsequent change in pH. RSI calculations show the potential for scaling within the air stripper is borderline. Scaling can be managed through use of an acid pretreatment system. Chemical/UV oxidation would require a continuous supply of treatment chemicals and ozone production. Once the ground water is treated, it will be available for immediate distribution. Construction of a conveyance system to the central treatment unit, and the siting of the treatment unit itself, could present logistical concerns in the populated areas and temporary conditions during construction. LTM is necessary to determine the effectiveness of this remedy. This includes the ground water sampling and performance monitoring discussed in [Section 3.2.2](#).

The extraction rates of CLC Well Nos. 18 and 27 are close to their maximum capacities and it is estimated that the wells will operate 95-percent of the time at their design capacity. This increases the risk of mechanical failure from stress to the equipment. Failure of these wells could result in a temporary loss of plume containment while repairs are being made.

If downgradient monitor wells detect PCE increases in ground water or indicate plume expansion, ground water pumping rates would need to be increased or additional extraction wells installed to maintain hydraulic containment of the plume. The duration of O&M for the treatment infrastructure is expected to be 14 years.

4.2.4.7 Cost

Under Alternative 4, the O&M costs are the same as Alternative 3 since the treatment flow rates are the same. Capital costs for this alternative are slightly higher due to pumping well modifications and the installation of one new extraction well. However, O&M costs would occur over a shorter period of time (approximately 14 years) and would reduce the net present worth. Costs presented below are based on use of air stripping as the treatment technology without acid pretreatment. Costs for the other technologies, including air stripping with acid pretreatment, are presented in [Table 4-2](#).

Alternative 4 Total Present Worth Estimated Costs:

Capital Cost:	\$ 5.2 MM
Annual O&M Cost (Year 1):	\$ 0.8 MM
Annual O&M Cost (Years 2-5):	\$ 0.6 MM
Annual O&M Cost (Year 6-14):	\$ 0.5 MM
Total Present Worth Cost:	\$ 13.8 MM

A preliminary evaluation indicates the potential for scaling (and, therefore, the need for pretreatment) is borderline under the ex-situ air stripping treatment option. The RSI calculated for CaCO₃ scaling potential at GWP is 6.1; RSI less than 6 indicates higher potential for scaling. The LI calculated for CaCO₃ scaling potential at GWP is 0.9; LI greater than 1 indicates higher potential for scaling. Because the assumptions used in making these calculations can greatly affect the result, a more detailed evaluation of the scaling potential and associated need for pretreatment is recommended during the RD.

4.2.5 Alternative 5: In-Well Air Stripping in Higher Concentration Areas of the Ground Water Plume

Under Alternative 5, in-well air stripping is used to treat the source areas in the aquifer with the highest PCE concentrations. In-well air stripping is described in [Section 3](#) and is different from the air stripping treatment proposed for Alternative 3 and 4. In-well air stripping removes PCE from the ground water in the aquifer as it is collected and circulated within the well. The air stripping treatment in Alternatives 3 and 4 removes PCE at an above ground treatment location after the ground water has been extracted. Based on modeling results and the expected rapid reduction of contaminant concentrations, hydraulic plume containment of the portion of the plume not treated using in-well stripping is expected to be obtained by one new extraction well operated at 300 gpm. The extracted ground water from this well would be treated to meet the MCL using one of the technologies

described in [Section 3](#). The treated water would be available for distribution to the municipal supply system.

4.2.5.1 Overall Protection of Human Health and the Environment

Under Alternative 5, wells with two ground water intake zones will be installed in the highest concentration areas (i.e., the area above 20 µg/L) at a spacing of approximately 300 feet. In the long-term, the entire plume is expected to be reduced over time with the removal of contaminant mass. However, in the short-term, PCE would continue to be present in the ground water at concentrations exceeding the MCL, posing a human health risk if the *CLC* extracts water for municipal use or if private wells are installed in the area of the plume. Ground water removed from the aquifer to maintain hydraulic containment would be treated at the surface prior to distribution into the municipal supply. LTM would detect PCE in the ground water and monitor the effectiveness of plume containment.

This alternative involves low risk to workers from affected ground water or the treatment process during active remedial action and O&M.

4.2.5.2 Compliance with ARARs

Under this alternative, operation of the in-well air stripping network would remove PCE from ground water in the source areas as the plume is hydraulically contained. Operation of one new extraction well is expected to adequately contain the PCE plume. Low levels of PCE would persist in the ground water. LTM would detect expansion of the plume and monitor the effectiveness of the system. Ground water extracted for plume containment would be treated to below the MCL before distribution to the municipal water supply. Monitoring would be required to ensure MCLs are met prior to distribution to the drinking water supply.

Controls to remove contaminants from the vapor phase may be also be required, depending on the concentration of contaminants in the emissions and local requirements. Las Cruces is an attainment area under the CAA. In accordance with the OSWER Directive 9355.0-28 “Control of Air Emissions from Superfund Air Strippers at Superfund Groundwater Sites” (EPA, 1989), preliminary calculations of air emission rates associated with air stripping of PCE were prepared. Air emission estimates are provided in the calculations in [Appendix B](#), and are estimated to be well below National Institute for Occupational Safety and Health (NIOSH) exposure limits as well as permitting thresholds. This alternative includes air monitoring to confirm emissions are in compliance.

4.2.5.3 Long-Term Effectiveness and Permanence

Under Alternative 5, in-well air stripping would be effective by actively remediating the most contaminated portions of the aquifer. Air stripping of PCE from the ground water would permanently remove the contaminant from the aquifer and the plume would be hydraulically contained by the pumping of one new extraction well. The JSP model estimates the aquifer would be restored to its beneficial use as a municipal water supply within about 20 years.

4.2.5.4 Reduction of Toxicity, Mobility, and Volume through Treatment

In-well air stripping would provide overall reduction in TMV in the contaminated ground water through treatment. This alternative would remove PCE from the ground water in the highest concentration area (i.e., the area above 20 µg/L) of the plume resulting in the reduction in contaminant mobility, volume, and toxicity in the aquifer. The highest concentration area, where the majority of the contaminant volume exists, would be reduced as the plume is hydraulically contained. Contaminant removal would occur vertically within the aquifer by using a network of in-well air stripping wells at the zones of highest contamination.

Note that air emissions may be produced from the treatment wells. Air emission estimates are provided in the calculations in [Appendix B](#), and are estimated to be well below NIOSH exposure limits as well as permitting thresholds. This alternative includes air monitoring during startup to confirm emissions are in compliance.

4.2.5.5 Short-Term Effectiveness

Under this alternative, there would be minimal risk to the community associated with the consumption of treated ground water as long as adequate controls are in place to warn of system failure. There is minimal potential for failure in the treatment process, including but not limited to, mechanical failure of equipment or control logic failures. Potential risk levels apply during construction and the maintenance of the treatment systems. Construction activities associated with the installation of new wells could pose a risk to workers if they are exposed to untreated ground water. This risk is expected to be low with the use of OSHA-trained workers and if protective equipment is maintained.

The use of a non-destructive treatment technology (i.e., air stripping or GAC) for the extracted ground water transfers the contaminants to another medium which poses a risk to human health and the environment by the production of air emissions or a waste that needs proper disposal. In addition, the chemicals used for the ex-situ treatment units (i.e., the air stripper) will provide a risk to the workers.

4.2.5.6 Implementability

The treatment technology of in-well air stripping is well understood and generally easy to maintain. Ground water from the single extraction well installed for plume containment will be treated and distributed to the City municipal supply. O&M of the treatment system is estimated to be 20 years. The addition of new deep treatment wells is required for this alternative, increasing the difficulty of implementation of this alternative. Multiple blowers would be required, increasing the labor involved with O&M and the potential for mechanical breakdowns. It is anticipated that multiple air stripping wells can be operated with a single blower. This requires connective piping to be run between treatment wells, which could be difficult in populated areas. If connective piping is not possible, additional blowers would be required.

The treatment technologies for the ground water extracted to provide plume containment are well understood and generally easy to maintain. However, the addition of another treatment system (i.e., the in-well stripping system) increases the amount of mechanical equipment, and thus the labor involved with O&M of the system and the potential for mechanical failure. Scaling within wells and conveyance piping can potentially occur at most sites over time but can be determined and mitigated using bench or pilot tests. The RSI calculations show the potential for scaling within both the in-well stripping wells and an ex-situ air stripper is borderline. Scaling can be managed through use of an acid pretreatment system.

LTM is necessary to determine the effectiveness of this remedy. This includes the ground water sampling and performance monitoring discussed in [Section 3.2.2](#).

4.2.5.7 Cost

The cost estimate for this alternative includes the design and installation of an in-well stripping network, the design and installation of conveyance piping, treatment blowers, and annual O&M costs for operation of the treatment system for a period of 20 years. As previously indicated, if connective piping is not possible, a blower would be required for each treatment well, increasing the cost of this alternative. Costs are based on ex-situ treatment using GAC since this technology was the least expensive option in both Alternatives 3 and 4.

Alternative 5 Total Present Worth Estimated Costs:

Capital Cost:	\$ 18.4 MM
Annual O&M Cost (Year 1):	\$ 1.1 MM
Annual O&M Cost (Years 2-5):	\$ 0.7 MM

Annual O&M Cost (Year 6-20):	\$ 0.6 MM
Total Present Worth Cost:	\$ 31.9 MM

4.3 Comparative Analysis

The purpose of the comparative analysis of alternatives is to evaluate the relative performance of each alternative under each of the seven evaluation criteria. This comparison is presented below.

Table 4-1 presents the comparative analysis of alternatives under each of the seven criteria. **Table 4-2** presents a summary of the costs associated with each alternative.

4.3.1 Threshold Criteria

To be eligible for selection, an alternative must meet the two threshold criteria described below, or in the case of ARARs, must justify why a waiver is appropriate.

4.3.1.1 Overall Protection of Human Health and the Environment

Alternative 1 (No Action) is not protective of human health and the environment because elevated levels of contaminants exist above the MCLs and will continue to be a threat through plume expansion predicted by the JSP model. Therefore this alternative will not be discussed further in this comparative analysis.

Of the remaining four alternatives, all provide some measure of protection of human health and the environment. All of these four alternatives provide hydraulic containment to prevent plume expansion, and all four alternatives provide removal of contaminants to eventually restore the aquifer to beneficial use (ranging in remediation time frames from 14 years [Alternative 2] to 23 years [Alternative 4])

Alternative 2 (Ground Water Extraction with Blending), however, relies on blending, which does not constitute treatment. The contaminant remains in the water and is simply diluted. Maintaining a proper blending program is less reliable than the treatment alternatives due to potential fluctuation in concentrations. More frequent monitoring would be required than for other alternatives to ensure the blending ratio is appropriate and concentrations are consistently maintained below the MCL prior to distribution into the municipal drinking water supply.

The remaining three alternatives use treatment to reduce PCE in the extracted water to levels below the MCL prior to distribution to the municipal drinking water supply system. Although monitoring is

still required to confirm the MCL is met, the performance of these alternatives is more predictable than blending.

Alternatives 2 (Ground Water Extraction with Blending), 3 (Ground Water Extraction with Treatment), and 4 (Enhanced Ground Water Extraction with Treatment) are progressively more aggressive in remediation strategy and the expected time to meet the MCL for PCE in ground water subsequently decreases (23 to 14 years, respectively). Alternative 5 (In-Well Stripping in Higher Concentration Areas of the Ground Water Plume) utilizes an aggressive in-situ treatment strategy, but does not significantly reduce the remediation time frame (the expected time to achieve the MCL for PCE in ground water is still 20 years).

Alternatives 3 and 4 include three options for treatment (air stripping, GAC, or chemical/UV oxidation). Alternative 5 uses in-situ air stripping in the treatment wells, but includes three options for treatment of water extracted for hydraulic containment. Air stripping and GAC transfer contaminants to another medium, posing a risk from residual contamination (i.e., either from air emissions or from the disposal of hazardous waste). Since chemical/UV oxidation is a destructive technology, there is no risk associated with residual contamination.

The selection of the ex-situ treatment technology also involves varying risks to workers from the use of chemicals. GAC uses no additional chemicals; therefore the risk to the workers from the implementation of this technology is minimal. Air stripping may require the use of scaling pretreatment chemicals and chemical/UV oxidation uses strong oxidants to destroy contaminants. The risk to the workers from these two technologies is therefore somewhat higher than if GAC is used.

4.3.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

Alternatives 2, 3, 4, and 5 (all of the non-No Action alternatives) are capable of meeting ARARs. All four of these alternatives remove PCE from the ground water and are expected to restore the aquifer to its beneficial use as a source of municipal water supply. Alternative 2 uses blending of the extracted ground water to meet the MCL before delivery to the municipal water supply. However, Alternative 2 might not comply with ARARs through the blending process if the PCE concentrations in extracted ground water exceed the dilution capacity of the blending system. Alternatives 3, 4, and 5 use treatment to reduce PCE in extracted ground water to levels below the MCL. All four alternatives require monitoring to ensure MCLs are met prior to distribution; Alternative 2 blending may require more frequent monitoring than the other alternatives.

Also, for options under Alternatives 3, 4, and 5 that include air stripping, controls to remove contaminants from the vapor phase may be required, depending on the concentration of contaminants

in the emissions and local requirements. Las Cruces is an attainment area under the CAA. In accordance with the OSWER Directive 9355.0-28 “Control of Air Emissions from Superfund Air Strippers at Superfund Groundwater Sites” (EPA, 1989), preliminary calculations of air emission rates associated with air stripping of PCE were prepared. Air emission estimates are provided in the calculations in [Appendix B](#), and are estimated to be well below National Institute for Occupational Safety and Health (NIOSH) exposure limits as well as permitting thresholds. The air stripping alternatives include air monitoring to confirm emissions are in compliance.

4.3.2 Balancing Criteria

The five criteria discussed below represent the criteria upon which the detailed evaluation and comparative analysis of alternatives is based.

4.3.2.1 Long-Term Effectiveness and Permanence

Alternatives 2 through 5 are all expected to reduce the levels of PCE in the aquifer to meet the MCL, and restore the aquifer to its beneficial use within varying time frames (14 years [Alternative 4] to 23 years [Alternative 2]). For all four non-No Action alternatives, the potential for plume expansion is minimized through the use of hydraulic containment. The higher pumping rates under Alternatives 3 and 4 provide higher likelihood of success in maintaining hydraulic containment and restoring the aquifer faster, and the targeted pumping under Alternative 4 decreases the time period for remediation.

4.3.2.2 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 2 (Ground Water Extraction with Blending) provides no reduction of TMV through treatment, as blending does not constitute treatment.

Alternatives 3 (Ground Water Extraction with Treatment), 4 (Enhanced Ground Water Extraction with Treatment), and 5 (In-Well Stripping in Higher Concentration Areas of the Ground Water Plume) provide overall reduction in TMV within contaminated ground water through treatment. Alternative 4 provides the most aggressive reduction of TMV in the contaminated ground water through the use of targeted pumping (estimated to be about 14 years to achieve the MCL for PCE in ground water). Alternative 5 is also aggressive, but the in-situ treatment is less controlled than extraction and ex-situ treatment, and is anticipated to take longer (estimated to be about 20 years to achieve the MCL for PCE in ground water) than the targeted pumping and ex-situ treatment of Alternative 4.

4.3.2.3 Short-Term Effectiveness

Alternative 2 (Ground Water Extraction with Blending) adds no infrastructure, therefore there are no risks to the community, workers, or the environment during the implementation of this alternative. The immediate risk to human health receptors would be reduced by blending the water supply to meet MCLs. Alternatives 3 (Ground Water Extraction with Treatment) and 4 (Enhanced Ground Water Extraction with Treatment), and 5 (In-Well Stripping in Higher Concentration Areas of the Ground Water Plume) involve the addition of treatment systems, increasing slightly the risk to workers, the community, and the environment, but the additional risks are expected to be low. OSHA training for workers minimizes risks.

The use of a non-destructive treatment technology (i.e., air stripping or GAC) for Alternatives 3, 4, and the hydraulic containment portion of Alternative 5 would transfer the contaminants to another medium, potentially posing a risk to human health and the environment from air emissions or a hazardous waste, requiring proper disposal. The use of chemicals associated with the air stripping and chemical/UV oxidation ex-situ treatment technology options for Alternatives 3, 4, and 5 potentially poses a risk to workers.

The installation of a new extraction well in Alternative 4 and new treatment wells in Alternative 5 poses a risk to workers from the exposure to uncontaminated ground water, but the risks are expected to be low since OSHA-trained workers are required.

The JSP model predicts that Alternative 2 will take approximately 23 years to meet RAOs. Alternative 3 is predicted to take 21 years. Alternative 4 is predicted to reach RAOs faster (14 years) than Alternative 3 by pumping the layers with the highest contamination. This results in faster mass removal and a faster time of remediation. Alternative 5 is estimated to reach RAOs in 20 years, based on site conditions and experience at similar sites.

4.3.2.4 Implementability

Alternative 2 (Ground Water Extraction with Blending) relies on existing infrastructure and therefore is the easiest to implement. This alternative includes hydraulic containment, requiring LTM to ensure that the plume is adequately contained. The potential for mechanical failure as well as control failure increases the difficulty of this alternative to implement.

Alternatives 3 (Ground Water Extraction with Treatment) and 4 (Enhanced Ground Water Extraction with Treatment) propose a central treatment unit and a conveyance system. Construction of a conveyance system to the central treatment unit, and the siting of the treatment unit, could impact

populated areas. Alternative 5 (In-Well Stripping in Higher Concentration Areas of the Ground Water Plume) includes wellhead treatment; construction of this unit could also impact populated areas.

The technologies for the removal of PCE from the extracted ground water are commonly used and each requires O&M. GAC is the easiest to implement and maintain, followed by air stripping and chemical/UV oxidation. Scaling within wells and conveyance piping can potentially occur at most sites over time but can be determined and mitigated using bench or pilot tests. Scaling within an air stripper system has a higher potential than within the wells and conveyance piping due to the removal of CO₂ during the process and subsequent change in pH. RSI calculations show the potential for scaling within the air stripper is borderline. Chemical/UV oxidation would require a continuous supply of treatment chemicals and ozone production. The LTM programs for these two alternatives are not expected to be significantly different.

Alternative 4 (Enhanced Ground Water Extraction with Treatment) involves the installation of one new extraction well, and modification to existing wells, making this alternative somewhat harder to implement than Alternative 3 (Ground Water Extraction with Treatment).

Alternative 5 (In-Well Air Stripping in Higher Concentration Areas of the Ground Water Plume) is expected to be the most technically challenging to implement. The addition of deep treatment wells and a new extraction well is required for this alternative increasing the difficulty of implementation. This alternative also involves the installation of many new mechanical components, increasing the O&M requirements and the potential for failure. It is anticipated that multiple air stripping wells can be operated with a single blower provided piping connects the treatment wells. This system could be cumbersome to install in populated areas. The treatment of the extracted ground water will be the similar to Alternatives 3 and 4. The RSI calculations show the potential for scaling within both the in-well stripping wells and an ex-situ air stripper is borderline. This can be managed with an acid pretreatment system

4.3.2.5 Cost

All costs are summarized on [Table 4-2](#). Aside from Alternative 1 (No Action), the lowest costs are associated with Alternative 2 because the existing infrastructure can be used. The cost estimate for Alternative 2 does not consider well failure or the infrastructure costs for conveying clean water from remote areas for blending.

Initially, annual operating costs for Alternatives 3 and 4 are the same due to the same pumping rate. After year five, however, Alternative 4 includes replacement of CLC Well No.18 with a new extraction well at a lower pumping rate, reducing the annual costs.

Alternative 3 net present worth costs are somewhat higher than Alternative 4 due to the slightly higher O&M costs after year 5 and the longer remediation time, which offsets the higher capital costs in Alternative 4. The highest costs are associated with Alternative 5 due to the large capital costs associated with the installation of the treatment infrastructure. The annual operating costs are also much higher in Alternative 5.

The need for an acid pretreatment system for options that include air stripping significantly affects the overall costs. An acid pretreatment system adds substantial capital and annual operating costs. For both Alternatives 3 and 4, treatment using GAC is the least costly option if it is determined that a pretreatment system would be required for an air stripper. If no pretreatment system is needed, air stripping and GAC costs are very similar. In addition, the destructive chemical/UV oxidation technology is lower in cost than air stripping if pretreatment is needed. For costing purposes, chemical oxidation was assumed rather than UV oxidation. Capital costs for UV oxidation are anticipated to be lower than for chemical oxidation, but annual O&M costs would be higher.

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Table 4-1
 Comparative Analysis of Remedial Alternatives
 Griggs and Walnut Ground Water Plume
 Las Cruces, New Mexico

Remedial Alternative	Alternative 1 - No Action	Alternative 2 - Ground Water Extraction with Blending	Alternative 3 - Ground Water Extraction with Treatment	Alternative 4 - Enhanced Ground Water Extraction with Treatment	Alternative 5 - In-Well Stripping in Higher Concentration Areas of the Ground Water Plume
THRESHOLD CRITERIA¹					
Overall protection of human health and the environment¹	<p>NO – No action would be performed and RAOs would not be met.</p> <p>Elevated levels of contaminants exist above the MCLs and will continue to threaten human health and the environment through migration and possible increases in contaminant detections in municipal supply wells.</p>	<p>YES – Hydraulic containment and reduction in contaminant detections in the aquifer by pumping and blending ground water will meet RAOs, thereby reducing risk to human health and the environment.</p>	<p>YES – Hydraulic containment and reduction in contaminant detections in the aquifer by pumping and active treatment will meet RAOs, thereby reducing risk to human health and the environment.</p>	<p>YES – Hydraulic containment and reduction in contaminant detections in the aquifer by pumping higher-concentration zones and active treatment will meet RAOs, thereby reducing risk to human health and the environment.</p>	<p>YES – Hydraulic containment and reduction in contaminant detections in the aquifer by active treatment will meet RAOs, thereby reducing risk to human health and the environment.</p>
		<p>Removal of contaminants from the ground water restores the aquifer to its beneficial use. The JSP ground water fate and transport model predicts elevated levels of PCE will persist for about 23 years.</p>	<p>Removal of contaminants from the ground water restores the aquifer to its beneficial use. The JSP ground water fate and transport model predicts elevated levels of PCE will persist for about 21 years.</p>	<p>Removal of contaminants from the ground water restores the aquifer to its beneficial use. The JSP ground water fate and transport model predicts elevated levels of PCE will persist for about 14 years.</p>	<p>Removal of contaminants from the ground water restores the aquifer to its beneficial use. Based on JSP ground water fate and transport modeling of other alternatives, it is anticipated with this alternative that elevated levels of PCE will persist for about 20 years.</p>
		<p>Provides protection of human health through blending of contaminated ground water to below MCLs with clean water prior to distribution into the public drinking water supply. Note: blending can be effective, but does not constitute “treatment”.</p>	<p>Provides protection of human health through treatment of contaminated ground water to below MCLs prior to distribution into the public drinking water supply.</p>	<p>Provides protection of human health through treatment of contaminated ground water to below MCLs prior to distribution into the public drinking water supply.</p>	<p>Provides protection of human health through treatment of contaminated ground water to below MCLs prior to distribution into the public drinking water supply.</p>

Table 4-1
Comparative Analysis of Remedial Alternatives
Griggs and Walnut Ground Water Plume
Las Cruces, New Mexico

Remedial Alternative	Alternative 1 - No Action	Alternative 2 - Ground Water Extraction with Blending	Alternative 3 - Ground Water Extraction with Treatment	Alternative 4 - Enhanced Ground Water Extraction with Treatment	Alternative 5 - In-Well Stripping in Higher Concentration Areas of the Ground Water Plume
Overall protection of human health and the environment, continued¹		<p>This alternative relies on above-ground (ex-situ) blending which does not constitute treatment. The contaminant remains in the water and is simply diluted.</p>	<p>This alternative relies on above-ground (ex-situ) treatment, which will, depending on the technology chosen, either transfer the contaminants from ground water to another medium (e.g. air) or destroy the contaminants (e.g. chemical/UV oxidation).</p>	<p>This alternative relies on above-ground (ex-situ) treatment, which will, depending on the technology chosen, either transfer the contaminants from ground water to another medium (e.g. air) or destroy the contaminants (e.g. chemical/UV oxidation).</p>	<p>This alternative relies on a combination of in-well treatment using air stripping and above-ground (ex-situ) treatment using Granular Activated Carbon (GAC), both of which transfer the contaminants from ground water to another medium (e.g. air).</p>
		<p>Active long-term monitoring in the aquifer and the blending effluent is required to confirm hydraulic containment and compliance with ARARs (e.g. MCLs). Maintaining a proper blending program is less reliable than treatment alternatives due to the potential fluctuation in concentrations. More frequent monitoring may be required than for other alternatives to ensure blending ratio is appropriate and concentrations are consistently maintained below the MCL prior to distribution into the public drinking water supply.</p>	<p>Active long-term monitoring in the aquifer and in the treatment effluent is required to confirm hydraulic containment and compliance with ARARs (e.g. MCLs).</p>	<p>Active long-term monitoring in the aquifer and the treatment effluent is required to confirm hydraulic containment and compliance with ARARs (e.g. MCLs).</p>	<p>Active long-term monitoring in the aquifer and the treatment effluent is required to confirm hydraulic containment and compliance with ARARs (e.g. MCLs).</p>
		<p>This alternative involves low risk to workers from affected ground water or the</p>	<p>This alternative involves low risk to workers from affected ground water or the</p>	<p>This alternative involves low risk to workers from affected ground water or the</p>	<p>This alternative involves low risk to workers from affected ground water or the</p>

Table 4-1
 Comparative Analysis of Remedial Alternatives
 Griggs and Walnut Ground Water Plume
 Las Cruces, New Mexico

Remedial Alternative	Alternative 1 - No Action	Alternative 2 - Ground Water Extraction with Blending	Alternative 3 - Ground Water Extraction with Treatment	Alternative 4 - Enhanced Ground Water Extraction with Treatment	Alternative 5 - In-Well Stripping in Higher Concentration Areas of the Ground Water Plume
		blending process during active remedial action and O&M.	treatment process during active remedial action and O&M.	treatment process during active remedial action and O&M.	treatment process during active remedial action and O&M.
Compliance with ARARs¹	NO - Not compliant. No action would be performed, and drinking water would not meet MCLs.	YES – Provides drinking water that meets MCLs. Also, provides restoration of the aquifer to its beneficial use as a drinking water supply (within about 23 years as predicted by the JSP model). May require more frequent monitoring than other alternatives to ensure MCLs are met prior to distribution to the drinking water supply.	YES – Provides drinking water that meets MCLs. Also, provides restoration of the aquifer to its beneficial use as a drinking water supply (within about 21 years as predicted by the JSP model). Requires monitoring to ensure MCLs are met prior to distribution to the drinking water supply.	YES – Provides drinking water that meets MCLs. Also, provides restoration of the aquifer to its beneficial use as a drinking water supply (within about 21 years as predicted by the JSP model). Requires monitoring to ensure MCLs are met prior to distribution to the drinking water supply.	YES – Provides drinking water that meets MCLs. Also, provides restoration of the aquifer to its beneficial use as a drinking water supply (within about 20 years as estimated based on the JSP modeling of other alternatives). Requires monitoring to ensure MCLs are met prior to distribution to the drinking water supply.
BALANCING CRITERIA					
Long-term effectiveness and permanence	No action would be performed. Contaminants would remain in the aquifer above MCLs for an indefinite period (predicted by the JSP model to be longer than 30 years).	Removal of contaminants from the ground water will meet RAOs and restore the aquifer to its beneficial use (within the JSP model-predicted time frame of about 23 years).	Removal of contaminants from the ground water will meet RAOs and restore the aquifer to its beneficial use (within the JSP model-predicted time frame of about 21 years).	Removal of contaminants from the ground water will meet RAOs and restore the aquifer to its beneficial use (within the JSP model-predicted time frame of about 14 years).	Removal of contaminants from the ground water will meet RAOs and restore the aquifer to its beneficial use (within about 20 years, as estimated based on the JSP modeling for other alternatives).
	The JSP ground water fate and transport model predicts future plume expansion, with impacts to well GWMW11 and CLC Well No. 26.	The potential for plume expansion is minimized through the use of hydraulic containment.	The potential for plume expansion is minimized through the use of hydraulic containment.	The potential for plume expansion is minimized through the use of hydraulic containment.	The potential for plume expansion is minimized through the use of hydraulic containment.

Table 4-1
 Comparative Analysis of Remedial Alternatives
 Griggs and Walnut Ground Water Plume
 Las Cruces, New Mexico

Remedial Alternative	Alternative 1 - No Action	Alternative 2 - Ground Water Extraction with Blending	Alternative 3 - Ground Water Extraction with Treatment	Alternative 4 - Enhanced Ground Water Extraction with Treatment	Alternative 5 - In-Well Stripping in Higher Concentration Areas of the Ground Water Plume
Long-term effectiveness and permanence, continued		Pumping rates set at the minimum long-term average pumping rate needed to maintain hydraulic containment.	Higher pumping rates than used in Alternative 2 provide higher likelihood of success in achieving and maintaining hydraulic containment and restoring the aquifer.	Targeted pumping provides higher likelihood of success in restoring the aquifer in a shorter period compared to Alternatives 2 and 3.	Targeted in-situ treatment provides higher likelihood of success in restoring the aquifer compared to Alternatives 2 and 3.
Reduction of toxicity, mobility, or volume (TMV) through treatment	No action would be performed and no overall reduction of TMV through treatment would occur.	No overall reduction of TMV in the contaminated ground water through treatment would occur (blending does not constitute treatment).	Provides overall reduction of TMV in the contaminated ground water through treatment.	Provides overall reduction of TMV in the contaminated ground water through treatment.	Provides overall reduction of TMV in the contaminated ground water through treatment.
Short-term effectiveness	No action would be performed, and drinking water would not meet MCLs.	<p>Low risks to workers, the community, and the environment in the short-term are expected.</p> <p>Low risk to the community associated with the use of the blended ground water for drinking water as long as pumping rates to control blending to below the MCL are maintained and adequate controls are in place to warn of system failure. There is the potential for failures in the blending process, including but not limited to, mechanical failure of equipment, control logic failures, or incorrect blending ratio.</p>	<p>Minimal to low risks to workers, the community, and the environment in the short-term are expected.</p> <p>Minimal risk to the community associated with the use of treated ground water for drinking as long as adequate controls are in place to warn of system failure. There is minimal potential for failure in the treatment process, including but not limited to, mechanical failure of equipment or control logic failures.</p>	<p>Minimal to low risks to workers, the community, and the environment in the short-term are expected.</p> <p>Minimal risk to the community associated with the use of treated ground water for drinking as long as adequate controls are in place to warn of system failure. There is minimal potential for failure in the treatment process, including but not limited to, mechanical failure of equipment or control logic failures.</p>	<p>Minimal to low risks to workers, the community, and the environment in the short-term are expected.</p> <p>Minimal risk to the community associated with the use of treated ground water for drinking as long as adequate controls are in place to warn of system failure. There is minimal potential for failure in the treatment process, including but not limited to, mechanical failure of equipment or control logic failures.</p>

Table 4-1
 Comparative Analysis of Remedial Alternatives
 Griggs and Walnut Ground Water Plume
 Las Cruces, New Mexico

Remedial Alternative	Alternative 1 - No Action	Alternative 2 - Ground Water Extraction with Blending	Alternative 3 - Ground Water Extraction with Treatment	Alternative 4 - Enhanced Ground Water Extraction with Treatment	Alternative 5 - In-Well Stripping in Higher Concentration Areas of the Ground Water Plume
Short-term effectiveness, continued		<p>Low risk to workers and to the environment from affected ground water are anticipated during production and O&M.</p>	<p>Low risk to workers during construction and maintenance of the ex-situ treatment unit. The use of a non-destructive treatment technology (i.e., air stripping or GAC) transfers the contaminants to another medium, posing a short-term risk to human health and the environment by the production of air emissions or a waste that requires proper handling and disposal. The chemicals used for certain treatment units (i.e., air stripper with pretreatment and chemical/UV oxidation) provide a risk to workers if not properly handled and disposed. Meeting ARARs for emissions and waste handling and OSHA-training for workers minimizes short-term risks to workers.</p>	<p>Low risk to workers during construction and maintenance of the ex-situ treatment unit. The use of a non-destructive treatment technology (i.e., air stripping or GAC) transfers the contaminants to another medium, posing a short-term risk to human health and the environment by the production of air emissions or a waste that requires proper handling and disposal. The chemicals used for certain treatment units (i.e., air stripper with pretreatment and chemical/UV oxidation) provide a risk to workers if not properly handled and disposed. Meeting ARARs for emissions and waste handling and OSHA-training for workers minimizes short-term risks to workers.</p>	<p>Low risk to workers during construction and maintenance of the in-well and ex-situ treatment units. The use of a non-destructive treatment technology (i.e., air stripping or GAC) transfers the contaminants to another medium, posing a short-term risk to human health and the environment by the production of air emissions or a waste that requires proper handling and disposal. The chemicals used for certain treatment units (i.e. air stripper with pretreatment) provide a risk to workers if not properly handled and disposed. Meeting ARARs for emissions and waste handling and OSHA-training for workers minimizes short-term risks to workers.</p>
		<p>This alternative requires installation of additional wells (for ground water monitoring) that could pose a low risk to workers during installation. OSHA-training for workers minimizes short-term risks to workers.</p>	<p>This alternative requires installation of additional wells (for ground water monitoring) that could pose a low risk to workers during installation. OSHA-training for workers minimizes short-term risks to workers.</p>	<p>This alternative requires installation of additional wells (for ground water extraction and monitoring) that could pose a low risk to workers during installation. OSHA-training for workers minimizes short-term risks to workers</p>	<p>This alternative requires installation of additional wells (for ground water treatment, extraction, and monitoring) that could pose a low risk to workers during installation. OSHA-training for workers minimizes short-term risks to workers.</p>

Table 4-1
Comparative Analysis of Remedial Alternatives
Griggs and Walnut Ground Water Plume
Las Cruces, New Mexico

Remedial Alternative	Alternative 1 - No Action	Alternative 2 - Ground Water Extraction with Blending	Alternative 3 - Ground Water Extraction with Treatment	Alternative 4 - Enhanced Ground Water Extraction with Treatment	Alternative 5 - In-Well Stripping in Higher Concentration Areas of the Ground Water Plume
Implementability	No action to implement.	Easy to implement because the majority of the initial infrastructure is already in place.	The ground water extraction technologies considered under this alternative are commonly used, and are generally easy to install and maintain.	The ground water extraction technologies considered under this alternative are commonly used, and are generally easy to install and maintain.	The ground water extraction technologies considered under this alternative for hydraulic containment are commonly used and are generally easy to install and maintain.
		If the availability of sufficient clean water for blending decreases with increasing concentrations in the extracted water, significant changes to infrastructure or the addition of another treatment technology could become necessary over time. May require more frequent monitoring than other alternatives to ensure MCLs are met prior to distribution to the drinking water supply.	Of the three treatment options considered under this alternative: (1) the air stripper may require pretreatment for scaling (preliminary evaluations indicate the potential for scaling is borderline); (2) GAC treatment requires periodic carbon replacement and disposal; and (3) chemical/UV oxidation requires a continuous source of chemicals.	Of the three treatment options considered under this alternative: (1) the air stripper may require pretreatment for scaling (preliminary evaluations indicate the potential for scaling is borderline); (2) GAC treatment requires periodic carbon replacement and disposal; and (3) chemical/UV oxidation requires a continuous source of chemicals.	The in-well air stripping might result in scaling in wells, and some chemical addition may be required. Additional mechanical equipment and infrastructure associated with this alternative increases O&M costs over the other alternatives.
		Pretreatment not required.	The potential need for pretreatment to address scaling under air stripping option should be considered in more detail during the RD.	The potential need for pretreatment to address scaling under air stripping option should be considered in more detail during the RD.	The need for pretreatment to address scaling associated with in-well air stripping should be considered in more detail during the RD.
		No modifications to existing wells required, other than the addition of piping between CLC Well Nos. 18 and 27, and O&M.	No modifications to existing wells required, other than the addition of piping between CLC Well Nos. 18 and 27, and O&M.	Modifications to the pumping wells and the addition of new extraction wells somewhat increases the difficulty of this alternative.	Installation of in-situ treatment wells and the addition of an extraction well for containment somewhat increases the difficulty of this alternative.

Table 4-1
 Comparative Analysis of Remedial Alternatives
 Griggs and Walnut Ground Water Plume
 Las Cruces, New Mexico

Remedial Alternative	Alternative 1 - No Action	Alternative 2 - Ground Water Extraction with Blending	Alternative 3 - Ground Water Extraction with Treatment	Alternative 4 - Enhanced Ground Water Extraction with Treatment	Alternative 5 - In-Well Stripping in Higher Concentration Areas of the Ground Water Plume
Costs (Present worth)	None – requires no additional expenditure.	\$10.2 MM	\$15.6 – \$18.4 MM Air stripping without pretreatment: \$16.6 MM ² GAC: \$15.6 MM Chemical/UV oxidation: \$18.4 MM	\$13.3 - \$15.4 MM Air stripping without pretreatment: \$13.8 MM ² GAC: \$13.3 MM Chemical/UV oxidation: \$15.4 MM	In-well air stripping and GAC for ground water extracted to maintain hydraulic containment: \$31.9 MM^{3,4}
-30% to +50% range:	None – requires no additional expenditure.	\$7.1 to 15.2 MM	\$10.9 to \$27.6 MM² Air stripping without pretreatment: \$11.6-\$24.9 MM ² GAC: \$10.9-23.5 MM Chemical/UV oxidation: \$12.9-27.6 MM	\$9.3 to \$23.1 MM² Air stripping without pretreatment: \$9.6-\$20.6 MM ² GAC: \$9.3-20.0 MM Chemical/UV oxidation: \$10.8-23.1 MM	\$22.3 to 47.8 MM^{3,4}

Notes:

- To be eligible for selection, an alternative must meet the two threshold criteria, or in the case of ARARs, must justify why a waiver is appropriate. For this reason, each alternative either meets the criterion (i.e., Yes) or does not meet the criterion (i.e., No).
- A preliminary evaluation indicates the potential for scaling is borderline under the ex-situ air stripping treatment option. The Ryznar Stability Index (RSI) calculated for CaCO₃ scaling potential at GWP is 6.1; RSI less than 6 indicates higher potential for scaling. The Langlier Index (LI) calculated for CaCO₃ scaling potential at GWP is 0.9; LI greater than 1 indicates higher potential for scaling. Because the assumptions used in making these calculations can greatly affect the result, a more detailed evaluation of scaling potential must be performed during the RD.
 Pretreatment for scaling under the ex-situ air stripping treatment option would increase the costs of Alternatives 3 and 4 by a net present worth value cost of about \$5 to \$6 MM for the entire period of operation. The cost estimate with acid pretreatment for Alternatives 3 and 4 is as follows:
 Alternative 3: Air stripping with acid pretreatment: \$22.9 MM; +50/-30% range: \$16.0-34.3 MM
 Alternative 4: Air stripping with acid pretreatment: \$18.4 MM; +50/-30% range: \$12.9-27.6 MM
- Costs for Alternative 5 are based on ex-situ treatment using GAC as a representative option for treatment of ground water extracted to maintain hydraulic containment. Other ex-situ treatment technologies such as air stripping or chemical/UV oxidation could also be used.
- Pretreatment for scaling may also be required for the in-well air stripping described under Alternative 5; vendor-supplied system costs include costs for pretreatment for the in-well air stripping. If the ex-situ treatment option is changed from GAC to air stripping, a more detailed evaluation of the potential for scaling and the need for pretreatment should be performed during the RD (see also Note 2).

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Table 4-2

Alternative Cost Summary

Griggs and Walnut Ground Water Plume

Las Cruces, New Mexico

	Alt 1: No Action	Alt. 2: Ground Water Extraction with Blending ¹	Alt. 3: Ground Water Extraction with Treatment ³			Alt. 4: Enhanced Ground Water Extraction With Treatment ³			Alt 5: In-Well Stripping in Higher Concentration Areas of the Ground Water Plume
			Air Stripper	GAC	Chemical/ UV Oxidation	Air Stripper	GAC	Chemical/ UV Oxidation	
Capital Cost	\$ -	\$ 1,122,723	\$ 3,946,036	\$ 4,504,573	\$ 5,211,897	\$ 5,151,978	\$ 5,710,514	\$ 6,340,304	\$ 18,403,797
Total Year 1 Operations and Maintenance	\$ -	\$ 552,472	\$ 821,029	\$ 764,672	\$ 986,991	\$ 821,029	\$ 764,672	\$ 986,991	\$ 1,051,260
Total Year 2-5 Operations and Maintenance	\$ -	\$ 464,797	\$ 638,635	\$ 571,708	\$ 649,457	\$ 638,635	\$ 571,708	\$ 649,457	\$ 679,255
Total Year 6-30² Operations and Maintenance	\$ -	\$ 260,906	\$ 536,818	\$ 460,019	\$ 547,640	\$ 510,090	\$ 433,291	\$ 520,912	\$ 577,438
Five Year Reviews		\$ 3,023	\$ 40,804	\$ 40,804	\$ 40,804	\$ 40,804	\$ 40,804	\$ 40,804	\$ 40,804
Total Post Closure Cost	\$ -	\$ 52,977	\$ 553,867	\$ 553,867	\$ 685,776	\$ 580,249	\$ 580,249	\$ 712,158	\$ 1,028,741
TOTAL PRESENT WORTH	\$ -	\$ 10,152,542	\$ 16,627,776	\$ 15,633,464	\$ 18,407,955	\$ 13,780,213	\$ 13,323,493	\$ 15,407,101	\$ 31,882,979
High Range (+50%)	\$ -	\$ 15,228,813	\$ 24,941,665	\$ 23,450,197	\$ 27,611,932	\$ 20,670,320	\$ 19,985,239	\$ 23,110,651	\$ 47,824,468
Low Range (-30%)	\$ -	\$ 7,106,779	\$ 11,639,443	\$ 10,943,425	\$ 12,885,568	\$ 9,646,149	\$ 9,326,445	\$ 10,784,970	\$ 22,318,085
Treatment Cost per Pound PCE	\$ -	\$ 30,765.28	\$ 50,387.20	\$ 47,374.13	\$ 55,781.68	\$ 41,758.22	\$ 40,374.22	\$ 46,688.18	\$ 96,615.09

Remediation Time Frame (years)	unknown PRG not met in 30 years	23	21	21	21	14	14	14	20
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Notes:

1. It is assumed that existing equipment can be used to perform blending and no additional capital costs are included. Only O&M costs included are for routine operation and sampling to document effectiveness of blending system.

2. Costs are through year 30, or through the predicted remediation timeframe if less than 30 years. See bottom of table for predicted remediation timeframe.

3. The costs EXCLUDE provision of a pretreatment system for control of scaling in the air stripping and other process equipment. The costs of pretreatment would be significant and could greatly affect the overall net present worth for those

A preliminary evaluation indicates the potential for scaling is borderline under the ex-situ air stripping treatment option. The Ryznar Stability Index (RSI) calculated for CaCO₃ scaling potential at GWP is 6.1; RSI less than 6 indicates higher potential for scaling. The Langlier Index (LI) calculated for CaCO₃ scaling potential at GWP is 0.9; LI greater than 1 indicates higher potential for scaling. Because the assumptions used in making these calculations can greatly affect the result, a more detailed evaluation of scaling potential must be performed during the RD.

Pretreatment for scaling under the ex-situ air stripping treatment option would increase the costs of Alternatives 3 and 4 by a net present worth value cost of about \$5 to \$6 MM for the entire period of operation. The cost estimate with acid pretreatment for Alternatives 3 and 4 is as follows:

	Without Acid Pretreatment	With Acid Pretreatment
Alternative 3-Air stripping	\$ 16,627,776	\$ 22,879,028
Alternative 4-Air stripping	\$ 13,780,213	\$ 18,421,834