



Memorandum

To: Laura Malone, ADEQ

From: Tom McKeon & Julie Carver, Matrix-CALIBRE

Date: July 28, 2015

Subject: Evaluation of Feasibility Studies Regarding Technical Completeness,
West Van Buren Water Quality Assurance Revolving Fund (WQARF) Site

The Matrix-CALIBRE Team is under contract with the Arizona Department of Environmental Quality (ADEQ) to complete a Task Order (TO) for the West Van Buren (WVB) Water Quality Assurance Revolving Fund (WQARF) Site located in Phoenix, Arizona (hereafter referred to as the Site). An objective of the TO was to evaluate two Feasibility Studies that were prepared for the Site and submitted to ADEQ by external parties under Arizona Administrative Code (A.A.C.) R18-16-413 and A.A.C. R18-16-407. One element of the Feasibility Study evaluation was to conduct a review of the Feasibility Study technical completeness pursuant to the requirements set forth in the Arizona Revised Statutes (A.R.S.) § 49-282.06 and the A.A.C. R18-16-407. This Technical Memorandum summarizes the technical completeness review of the two Feasibility Studies.

Background

Two separate Feasibility Studies for the Site were submitted to ADEQ in 2014; one prepared by Synergy Environmental, LLC and Montgomery and Associates on behalf of the Roosevelt Irrigation District (RID) and the other prepared by Haley and Aldrich, Inc. on behalf the West Van Buren Working Group (WVBWG).

Feasibility Study Evaluation

The two Feasibility Studies were evaluated and the results are summarized in the attached tables. Table 1 presents a very brief summary of the remedial alternatives considered in the two Feasibility Studies. The Table 1 summary is intentionally brief, for further details consult the original Feasibility Studies. The technical completeness evaluation of the two Feasibility Studies is summarized in Tables 2 and 3 for the selected remedies from each Feasibility Study. The technical completeness evaluation summarizes the relevant requirements from A.R.S. § 49-282.06 and A.A.C. R18-16-407 and describes how each of the recommended remedies considers and addresses those requirements.

Based on the technical completeness evaluation, the two Feasibility Studies were deemed by the Matrix-CALIBRE Team as technically complete. The resumes of the Matrix-CALIBRE Team staff that completed the technical evaluation are attached.

Table 1 WVB Site Feasibility Studies; Summary Table

	RID Reference Remedy	RID Less Aggressive	RID More Aggressive	RID Most Aggressive	WVBWG Reference Remedy	WVBWG Less Aggressive	WVBWG More Aggressive
Remedial Strategy	PR & PC	PR & PC	PR & PC	PR & PC	CM	CM	CM & PC
Approach	P&T 9 current supply wells	P&T 6 current supply wells	P&T 6 current supply wells	P&T 13 current supply wells	RID operates + P&T 1 new well	RID operates	RID operates + P&T 2 new wells
Measures/ Elements to meet goals	RID Extraction & Treatment	RID Extraction & Treatment	RID Extraction & Treatment	RID Extraction & Treatment	RID Extraction, MNA, minor treatment & contingencies	RID Extraction, MNA & contingencies	RID Extraction, MNA, limited treatment & contingencies
Source Control	by ADEQ	by ADEQ	by ADEQ	by ADEQ	by ADEQ	by ADEQ	by ADEQ
Actions to meet potable use	Treatment at selected wells (9) & blending (6 more)	Treatment at selected wells (6) & blending (9 more)	Treatment at selected wells (6) & blending (9 more)	Treatment at all wells (13)	Blending & 1 well replacement; Replace any domestic use well	Blending & 1 well replacement; Replace any domestic use well	Blending & 1 well replacement; Replace any domestic use well
Well replacement/ improvement	Replace 2: RID-92 & RID-106; improve RID-84, RID-114	Replace 1: RID-106; improve RID-84, RID-114	Replace 1: RID-106; improve RID-84, RID-114	Replace 2: RID-92 & RID-106; improve RID-84, RID-114	If converted to potable use: move & replace RID-114	If converted to potable use: move & replace RID-114	If converted to potable use: move & replace RID-114
Other	various **	various **	various ** + Recharge of WWTP effluent**	various **	Contingencies for COT, SRP, and COP supply wells	Contingencies for COT, SRP, and COP supply wells	Contingencies for COT, SRP, and COP supply wells
Groundwater Monitoring	yes	yes	yes	yes	Yes + contingency expansion of MWs	Yes +contingency expansion of MWs	Yes + contingency expansion of MWs
Cost over 30 years as sum of \$s spent (not net present value)	\$104M	\$71M	\$80.6M	\$145M	\$88.6M (w' sum of all contingencies)	\$24.2M (w' sum of all contingencies)	\$102.5M (w' sum of all contingencies)

Bold – Proposed Remedy based on FS Evaluation

** Various system improvements; Enclose lateral from RID-92 to Main canal, Salt canal improvements, seal all manholes

** WWTP effluent recharge via RID-84, RID-85, RID-90, RID-91, and RID-93

CM – Controlled migration; PC – Plume containment; PR – Plume remediation; P&T – Groundwater extraction and treatment

ADEQ – Arizona Department of Environmental Quality

COP – City of Phoenix

COT – City of Tolleson

GAC – granular activated carbon

MNA – monitored natural attenuation

RID – Roosevelt Irrigation District

SRP – Salt River Project

WVBWG – West Van Buren Working Group

WWTP – Waste Water Treatment Plant

**Table 2 Technical Evaluation: Roosevelt Irrigation District
Proposed Remedy – “Less Aggressive”**

FEASIBILITY STUDY STATUTE & RULE APPLICABILITY		TECHNICAL ANALYSIS (see footnotes regarding administrative status for non technical requirements)
R18-16-407(A)	The feasibility study (FS) is a process to identify a reference remedy and alternative remedies that appear to be capable of achieving remedial objectives (ROs) and to evaluate them based on the comparison criteria to select a remedy that complies with A.R.S. § 49-282.06.	Administratively complete (1).
A.R.S. § 49-282.06(A)(1-3)	Remedial actions shall :	
	1. Assure the protection of public health and welfare and the environment.	Current risks are within acceptable thresholds for present use, remedial actions taken would not lower current risks by an appreciable amount. Remedial actions taken would lower future risks when resource is used for potable supply.
	2. To the extent practicable, provide for the control, management or cleanup of the hazardous substances to allow the maximum beneficial use of the waters of the state.	Pump and treat will contain the plume and have mass removal but may not achieve aquifer restoration in a timely manner. Acknowledges that source control by ADEQ is necessary.
	3. Be reasonable,	Remedial actions are not required for current use therefore they are not reasonable at this time; however they are reasonable for future potable use of the resource.
	necessary,	Not necessary until such time as future use of the resource is for potable supply; includes elements targeted more for water supply development rather than remediation. Examples include converting the lateral canal to piping at RID-92 and sealing all manholes/vaults.
cost-effective, and	At the time when potable use of the water is needed, this would be cost effective.	
technically feasible.	Feasible (liquid phase carbon treatment is a reliable treatment technology).	

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FEASIBILITY STUDY STATUTE & RULE APPLICABILITY		TECHNICAL ANALYSIS (see footnotes regarding administrative status for non technical requirements)
A.R.S. § 49-282.06(B)(4)(b)	<p>[...]. Rules adopted pursuant to this subsection shall include rules for: [...]</p> <p>4. The selection of remedial actions including the establishment of the level and extent of cleanup at a site or a portion of a site. The rules shall provide for the selection of a remedial action by comparison of alternative remedial actions, which may include: no action, monitoring, source control, controlled migration, physical containment, plume remediation, and the consideration of the criteria in subsection (C) of this section. The rules also shall provide that the selected remedial action meet the requirements of subsection A of this section and the following:</p> <p style="margin-left: 20px;">a. [...soil only...]</p> <p style="margin-left: 20px;">b. For remediation of waters of the state, the selected remedial action shall address, at a minimum, any well that at the time of selection of the remedial action either supplies water for municipal, domestic, industrial, irrigation or agricultural uses or is part of a public water system if the well would now or in the reasonably foreseeable future produce water that would not be fit for its current or reasonably foreseeable end uses without treatment due to the release of hazardous substances. The specific measures to address any such well shall not reduce the supply of water available to the owner of the well.</p> <p>5. Incentives for initiating early remedial actions and implementing innovative remedial technologies</p>	<p>The basic remedial strategies are discussed in the FS. Acknowledges that source control by ADEQ is necessary.</p> <p>Not Applicable.</p> <p>Current irrigation use is not impaired; foreseeable future includes potable use. Relies on a combination using treatment of selected wells with blending to meet potable use criteria in the Salt canal.</p> <p>An administrative action (2).</p>
A.R.S. § 49-282.06(C)(1-3)	<p>In adopting the rules required by this section and in selecting remedial actions, the director shall consider the following factors:</p> <p>1. Population, environmental and welfare concerns at risk.</p> <p>2. Routes of exposure.</p> <p>3. Amount, concentration, hazardous properties, environmental fate, such as the ability to bioaccumulate, persistence and probability of reaching the waters of the state, and the form of the substance present.</p>	<p>Presently, levels are not above risk thresholds (ADHS, 2015); if and when changes in groundwater use occur corresponding risks are addressed.</p> <p>Presently, levels are not above risk thresholds (ADHS, 2015); if and when changes in groundwater use occur corresponding risks are addressed.</p> <p>Most of the plume is at concentrations near the Aquifer Water Quality Standards (AWQSs) for PCE and TCE (range: 5-15 micrograms per liter). Limited areas have higher concentrations (more than 4 times the AWQSs). Plume is already in ‘waters of the state’.</p>
28	<p>4. Physical factors affecting human and environmental exposure such as hydrogeology, climate and the extent of previous and expected migration.</p>	<p>Presently, levels are not above risk thresholds (ADHS, 2015); if and when changes in groundwater use occur corresponding risks are addressed.</p>

**Table 2 Technical Evaluation: Roosevelt Irrigation District
Proposed Remedy – “Less Aggressive”**

FEASIBILITY STUDY STATUTE & RULE APPLICABILITY		TECHNICAL ANALYSIS (see footnotes regarding administrative status for non technical requirements)
	<p>5. The extent to which the amount of water available for beneficial use will be preserved by a particular type of remedial action.</p> <p>6. The technical practicality and cost-effectiveness of alternative remedial actions applicable to a site.</p> <p>7. The availability of other appropriate federal or state remedial action and enforcement mechanisms, including, to the extent consistent with this article, funding sources established under CERCLA, to respond to the release.</p>	<p>Future water rights are to be determined (outside of ADEQ). The remedial action removes the groundwater resource from the current water basin.</p> <p>It is feasible/practicable when potable supply is needed; the proposed remedy (less aggressive) is more cost-effective as compared to the reference remedy.</p> <p>Not directly applicable (2).</p>
A.R.S. § 49-282.06(D)	Notwithstanding this article, the director may approve a remedial action that may result in water quality exceeding water quality standards after the completion of the remedy if the director finds that the remedial action meets the requirements of this section.	An administrative action, to be completed as necessary (3).
R18-16-407(B) & (B)(3)	<p>[...] The FS process shall include community involvement procedures in compliance with R18-16-404. [...]</p> <p>[...]Notification to interested persons of the availability of FS workplan in accordance with R18-16-404[(C)(1)(d)].[...]</p>	<p>Completed in conjunction with ADEQ.</p> <p>Completed in conjunction with ADEQ.</p>
R18-16-407(C) & (D)	Not Applicable.	Not Applicable.

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Proposed Remedy – “Less Aggressive”**

FEASIBILITY STUDY STATUTE & RULE APPLICABILITY		TECHNICAL ANALYSIS (see footnotes regarding administrative status for non technical requirements)
R18-16-407(E)(1-2)	[...], the FS shall provide for the development of a reference remedy and at least 2 alternative remedies as follows:	Reference remedy and 3 alternates (less aggressive, more aggressive, most aggressive) are presented in the FS.
	<ol style="list-style-type: none"> 1. The reference remedy and alternative remedies shall be capable of achieving all of the ROs. The reference remedy and each alternative remedy shall consist of a remedial strategy under subsection (F) and all remedial measures to be employed. The combination of the remedial strategy and the remedial measures for each alternative remedy shall achieve the ROs. [...] The reference remedy and other alternative remedies shall be developed and described in the FS report in sufficient detail to allow evaluation using the comparison criteria, [...]. 2. The reference remedy shall be developed based upon best engineering, geological, or hydrogeological standards of practice, considering the following: <ol style="list-style-type: none"> a. The information in the remedial investigation; b. The best available scientific information concerning available remedial technologies, and c. Preliminary analysis of the comparison criteria and the ability of the reference remedy to comply with A.R.S. § 49-282.06. [...] 	<p>The FS describes how the ROs are met, the 4 remedies considered are summarized and evaluated in comparison to the applicable criteria [A.R.S. § 49-282.06, and A.A.C. R18-16-407(H)].</p> <p>The remedies presented are developed based on the RI data and the best professional judgments of the authors (licensed engineers and/or geologists).</p>
R18-16-407(E)(3)	3. At a minimum, at least 2 alternative remedies shall be developed for comparison with the reference remedy. At least one of the alternative remedies must employ a remedial strategy or combination of strategies that is more aggressive than the reference remedy, and at least one of the alternative strategies that is less aggressive than the reference remedy	The remedies presented include a reference remedy and three alternates; two more aggressive, one less aggressive (in comparison to the reference remedy).
R18-16-407(F)(1-6)	<p>The remedial strategies to be developed under subsection (E) are listed below. Source control shall be considered as an element of the reference remedy and all alternative remedies, if applicable, except for the monitoring and no action alternatives. [...] The remedial strategies are:</p> <ol style="list-style-type: none"> 1. Plume remediation [...] achieve water quality standards for COCs in waters of the state throughout the site. 2. Physical containment [...] contain contaminants within definite boundaries. 3. Controlled migration [...] control the direction or rate of migration but not 	The basic remedial strategies are discussed in the FS. Acknowledges that source control by ADEQ is necessary. Physical containment through extraction by RID and monitoring is the current condition; increased plume remediation via preferential pumping of higher concentration wells is added.

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FEASIBILITY STUDY STATUTE & RULE APPLICABILITY		TECHNICAL ANALYSIS (see footnotes regarding administrative status for non technical requirements)
	<p>necessarily to contain migration of contaminants.</p> <ol style="list-style-type: none"> 4. Source control [...] eliminate or mitigate a continuing source of contamination. 5. Monitoring [...] observe and evaluate the contamination at the site through the collection of data. 6. No action [...] consists of no action at a site. 	
R18-16-407(G)	<p>Remedial measures necessary for each alternative remedy developed under subsection (E) to achieve ROs or to satisfy the requirements of A.R.S. § 49-282.06(B)(4)(b) shall be identified in consultation with water providers or known well owners whose water supplies are affected by the release or threatened release of a hazardous substance. In identifying the remedial measures, the needs of the well owners and the water providers and their customers, including the quantity and quality of water, water rights and other legal constraints on water supplies, reliability of water supplies and any operational implications shall be considered. Such remedial measures may include, but are not limited to: well replacement, well modification, water treatment, provision of replacement water supplies, and engineering controls. Where remedial measures are relied upon to achieve ROs, such remedial measures shall remain in effect as long as required to ensure the continued achievement of those objectives.[...]</p>	<p>The FS describes consultation and consideration of RID water supply and use; SRP supply and use; City of Phoenix (COP) supply and use. Consideration of domestic supply wells (if impaired) in the impacted area is not discussed.</p> <p>The FS provides a discussion of options for replacement water supplies noting that the large volume of replacement water that may be required would be challenging to procure. In addition, the FS notes that the existing pumping by RID contains the plume and a replacement supply would therefore allow the plume to migrate. Based on these considerations, the FS rejects replacement supply from further consideration.</p>
R18-16-407(H)(1-3a)	<p>The Department shall conduct a comparative evaluation of the reference remedy and the alternative remedies developed under subsection (E). For each alternative, the evaluation shall be reported in a FS report and shall include:</p> <ol style="list-style-type: none"> 1. A demonstration that the remedial alternative will achieve the ROs. 2. An evaluation of consistency with the water management plans of affected water providers and the general land use plans of local governments with land use jurisdiction. 3. An evaluation of the comparison criteria, including: <ol style="list-style-type: none"> a. An evaluation of the practicability of the alternative, 	<p>Demonstration is presented to meet “<i>protect, restore, replace or otherwise provide a water supply for municipal use by currently and reasonably foreseeable future municipal well owners within the WVB Area</i>”. The remedial actions are planned as well-head treatment to protect the water supply from existing irrigation wells that are planned to serve as municipal supply in the reasonably foreseeable future.</p> <p>The FS presents remedial actions that are consistent with RID’s development plans. Other water providers and local governments have raised issues regarding RID’s plans in their public comments.</p> <p>It is practicable; however current risks are within acceptable thresholds for present use.</p>

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FEASIBILITY STUDY STATUTE & RULE APPLICABILITY		TECHNICAL ANALYSIS (see footnotes regarding administrative status for non technical requirements)
	<p>including its feasibility,</p> <p>short and long-term effectiveness, and reliability,</p> <p>considering site-specific conditions, characteristics of the contamination resulting from the release, performance capabilities of available technologies, and institutional considerations.</p>	<p>Yes, it is feasible.</p> <p>Remedial actions are effective for plume containment and potable supply.</p> <p>Institutional considerations for resolution include water rights and exporting from the current water basin. These are outside of ADEQ’s purview. GAC treatment can meet the ROs and project goals.</p>
<p>R18-16-407(H)(3b-3d)</p>	<p>b. An evaluation of risk, including the overall protectiveness of public health and aquatic and terrestrial biota under reasonably foreseeable use scenarios and end uses of water. This evaluation shall address:</p> <ul style="list-style-type: none"> i. Fate and transport of contaminants and concentrations and toxicity over the life of the remediation; ii. Current and future land and resource use; and iii. Exposure pathways, duration of exposure, and changes in risk over the life of the remediation; iv. Protection of public health and aquatic and terrestrial biota while implementing the remedial action and after the remedial action; and v. Residual risk in the aquifer at the end of remediation <p>c. An evaluation of the cost of the remedial alternative, including the expenses and losses including capital, operating, maintenance, and life cycle costs. Transactional costs necessary to implement the remedial alternative, including the transactional costs of establishing long-term financial mechanisms, such as trust funds, for funding of an alternative remedy, shall be included in the cost estimate.</p>	<p>Remedy is protective for future resource use. Remedy is focused on plume containment and water supply treatment. Source control remedial actions are to be implemented by ADEQ. The evaluation of risk notes that the current concentrations measured (in vapor and in water) do not represent an acute risk (Synergy, 2011). The FS compares concentrations with applicable screening criteria (i.e., specific numerical criteria established for protection of human health) with a prospective comparison of historical conditions (without historical exposure estimates) rather than current resource use and exposure pathways. This presentation of risk evaluation [under R18-16-407(H)(3b)] focuses more on the prospective impacts as opposed to current conditions over the life of the remediation. The consideration of current and future uses may place more emphasis on the timing as to when the proposed remedial actions are necessary. Residual risks will remain in the aquifer.</p> <p>The FS presents costs for the reference remedy and each alternate. The costs for the proposed remedy (less aggressive) are: \$9.5M capital plus \$2.05M operations and maintenance (O&M) for 100 years.</p> <p style="text-align: center;">At 30 years: \$71.M spent.</p> <p>The costs presented above represent the sum of costs and are not converted to a net present value basis.</p>

**Table 2 Technical Evaluation: Roosevelt Irrigation District
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FEASIBILITY STUDY STATUTE & RULE APPLICABILITY		TECHNICAL ANALYSIS (see footnotes regarding administrative status for non technical requirements)
	<p>d. An evaluation of the benefit, or value, of the remediation. This analysis includes factors such as:</p> <ul style="list-style-type: none"> i. Lowered risk to human and aquatic and terrestrial biota; ii. Reduced concentration and reduced volume of contaminated water; iii. Decreased liability; acceptance by the public; iv. Aesthetics; preservation of existing uses; v. Enhancement of future uses; and vi. Improvements to local economies. 	<p>Potable water will be available; the remedial action will slowly reduce plume concentration and volume.</p>
R18-16-407(H)(3e)	<p>e. A discussion of the comparison criteria, as evaluated in relation to each other.</p>	<p>Discussion regarding each remedy in relation to each other is present.</p>
R18-16-407(I)	<p>Based upon the evaluation and comparison of the reference remedy and the other alternative remedies developed under subsection (E), a proposed remedy shall be developed and described in the FS report. The proposed remedy may be the reference remedy, any of the other alternative remedies evaluated in the FS, or a different combination of remedial strategies and remedial measures that were included in the alternative remedies evaluated in the FS. The FS report shall describe the reasons for selection of the proposed remedy, including all of the following:</p> <ol style="list-style-type: none"> 1. How the proposed remedy will achieve the ROs; 2. How the comparison criteria were considered; and 3. How the proposed remedy meets the requirements of A.R.S. § 49-282.06. 	<p>The proposed remedy is the Less Aggressive Alternative Remedy.</p> <p>The FS describes how the ROs are met. The FS describes the consideration of comparison criteria. The FS describes how the recommended remedy meets the A.R.S. requirements.</p>
R18-16-407(J)	<p>Any person, other than a person proposing to perform work under an agreement under A.R.S. § 49-287.03(C), may submit a request in compliance with R18-16-413 for the Department to approve a work plan or a report for all or any portion of a feasibility study. The Department shall approve a feasibility study report if the feasibility study complies with this Section and community involvement activities have been conducted under this Article.</p>	<p>Administratively complete for work plan requirement (3).</p> <p>Technical evaluation/analysis presented in the FS and the community involvement activities that have been completed comply with the referenced section and article.</p>

(1) Administrative requirement; the FS submitted (and this specific remedial alternative) meets this threshold

Table 2 Technical Evaluation: Roosevelt Irrigation District Proposed Remedy – “Less Aggressive”

- (2) Not applicable to site status, WQARF process and ADEQ remedy selection.
- (3) Process step that is applicable under WQARF and it has been completed (or in process of completion)

References:

- ADHS, 2015. Health Consultation: Evaluation of Water Sampling Results in the Roosevelt Irrigation District (RID) Phoenix, Maricopa County, Arizona. Arizona Department of Health Services. January 8, 2015.
- Synergy, 2011. Public Health Exposure Assessment and Mitigation Summary Report. Synergy Environmental, LLC. September 16, 2011.

**Table 3 Technical Evaluation: West Van Buren Working Group (WVBWG)
Proposed Remedy – “Reference Remedy”**

FEASIBILITY STUDY STATUTE & RULE APPLICABILITY		TECHNICAL ANALYSIS (see footnotes regarding administrative status for non technical requirements)
R18-16-407(A)	The feasibility study (FS) is a process to identify a reference remedy and alternative remedies that appear to be capable of achieving remedial objectives (ROs) and to evaluate them based on the comparison criteria to select a remedy that complies with A.R.S. § 49-282.06.	Administratively complete (1).
A.R.S. § 49-282.06(A)(1-3)	<p>Remedial actions shall:</p> <ol style="list-style-type: none"> 1. Assure the protection of public health and welfare and the environment. 2. To the extent practicable, provide for the control, management or cleanup of the hazardous substances to allow the maximum beneficial use of the waters of the state. 3. Be reasonable, necessary, cost-effective, and technically feasible. 	<p>Current risks are within acceptable thresholds for present use, remedial actions taken would not lower current risks by an appreciable amount. Contingency remedial actions are planned that would lower risk if resource is used for potable supply in future.</p> <p>Pump and treat will contain the plume and have mass removal but may not achieve aquifer restoration in a timely manner; plume migration is currently controlled by pumping for irrigation use. Acknowledges that source control by ADEQ is necessary.</p> <p>Most remedial actions are delayed until the resource is used for future potable use; adding one (1) well at 500 gallons per minute (gpm) does not appreciably improve current mass removal – this element is not reasonable.</p> <p>Most remedial actions are postponed until they are necessary such as future use of resource as potable water supply.</p> <p>Cost effective when potable use of water supply is needed, relies heavily on blending to meet potable use criteria.</p> <p>Feasible, although if/when Roosevelt Irrigation District (RID) ceases pumping, the following elements may not be a robust solution: Moving RID-114 to a down-gradient position. Projection of plume conditions in 2026 is optimistic based on the estimated rate of attenuation/concentration reductions. Allowing the plume to migrate to City of Tolleson (COT) and/or Salt River Project (SRP) wells.</p>

**Table 3 Technical Evaluation: West Van Buren Working Group (WVBWG)
Proposed Remedy – “Reference Remedy”**

FEASIBILITY STUDY STATUTE & RULE APPLICABILITY		TECHNICAL ANALYSIS (see footnotes regarding administrative status for non technical requirements)
A.R.S. § 49-282.06(B)(4)(b)	<p>[...]. Rules adopted pursuant to this subsection shall include rules for: [...]</p> <p>4. The selection of remedial actions including the establishment of the level and extent of cleanup at a site or a portion of a site. The rules shall provide for the selection of a remedial action by comparison of alternative remedial actions, which may include: no action, monitoring, source control, controlled migration, physical containment, plume remediation, and the consideration of the criteria in subsection (C) of this section. The rules also shall provide that the selected remedial action meet the requirements of subsection A of this section and the following:</p> <ul style="list-style-type: none"> a. [...soil only...] b. For remediation of waters of the state, the selected remedial action shall address, at a minimum, any well that at the time of selection of the remedial action either supplies water for municipal, domestic, industrial, irrigation or agricultural uses or is part of a public water system if the well would now or in the reasonably foreseeable future produce water that would not be fit for its current or reasonably foreseeable end uses without treatment due to the release of hazardous substances. The specific measures to address any such well shall not reduce the supply of water available to the owner of the well. <p>5. Incentives for initiating early remedial actions and implementing innovative remedial technologies</p>	<p>The basic remedial strategies are discussed in the FS. Acknowledges that source control by ADEQ is necessary. The recommended remedy is protective of public health and the environment; it provides for practicable control, management or cleanup of the hazardous substances to allow the maximum beneficial use of the waters of the state; and is reasonable, necessary, cost-effective, and technically feasible.</p> <p>Not Applicable.</p> <p>Current irrigation use is not impaired; foreseeable future includes potable use. This remedy includes remedial actions to meet the potable criteria on the Salt and RID canals (not on a well-by-well basis) and relies on blending with replacement of one well (RID-114).</p> <p>An administrative action (2).</p>
A.R.S. § 49-282.06(C)(1-3)	<p>In adopting the rules required by this section and in selecting remedial actions, the director shall consider the following factors:</p> <ol style="list-style-type: none"> 1. Population, environmental and welfare concerns at risk. 2. Routes of exposure. 3. Amount, concentration, hazardous properties, environmental fate, such as the ability to bioaccumulate, persistence and probability of reaching the waters of the state, and the form of the substance present. 	<p>Presently, levels are not above risk thresholds (ADHS, 2015); future changes in groundwater use and corresponding risk are addressed.</p> <p>Presently, levels are not above risk thresholds (ADHS, 2015); future changes in groundwater use and corresponding risk are addressed.</p> <p>Most of the plume is at concentrations near the Aquifer Water Quality Standards (AWQSS) for PCE and TCE (range: 5-15 micrograms per liter). Limited areas have higher concentrations (more than 4 times the AWQSS). Plume is already in ‘waters of the state’.</p>

**Table 3 Technical Evaluation: West Van Buren Working Group (WVBWG)
Proposed Remedy – “Reference Remedy”**

FEASIBILITY STUDY STATUTE & RULE APPLICABILITY		TECHNICAL ANALYSIS (see footnotes regarding administrative status for non technical requirements)
A.R.S. § 49-282.06(C)(4-7)	4. Physical factors affecting human and environmental exposure such as hydrogeology, climate and the extent of previous and expected migration.	Presently, levels are not above risk thresholds (ADHS, 2015); future changes in groundwater use and corresponding risk are addressed.
	5. The extent to which the amount of water available for beneficial use will be preserved by a particular type of remedial action.	Future water rights are to be determined (outside of ADEQ). If RID ceases pumping, the groundwater resource could stay within the boundaries of the current water basin.
	6. The technical practicality and cost-effectiveness of alternative remedial actions applicable to a site.	It is feasible/practicable but some elements of the proposed remedial measures may require significant modifications. An overall cost-effective approach is proposed but some elements of the proposed remedial measures are not; 1) adding one 500 gpm extraction well to the existing RID extraction rates; 2) moving RID-114 downgradient (shutting down RID-114 would likely impact RID -113 instead) and a well-head treatment system already exists on RID-114.
	7. The availability of other appropriate federal or state remedial action and enforcement mechanisms, including, to the extent consistent with this article, funding sources established under CERCLA, to respond to the release.	Not directly applicable (2).
A.R.S. § 49-282.06(D)	Notwithstanding this article, the director may approve a remedial action that may result in water quality exceeding water quality standards after the completion of the remedy if the director finds that the remedial action meets the requirements of this section.	An administrative action, to be completed as necessary (3).
R18-16-407(B) & (B)(3)	[...] The FS process shall include community involvement procedures in compliance with R18-16-404. [...] [...]Notification to interested persons of the availability of FS workplan in accordance with R18-16-404[(C)(1)(d)].[...]	Completed in conjunction with ADEQ. Completed in conjunction with ADEQ.

**Table 3 Technical Evaluation: West Van Buren Working Group (WVBWG)
Proposed Remedy – “Reference Remedy”**

FEASIBILITY STUDY STATUTE & RULE APPLICABILITY		TECHNICAL ANALYSIS (see footnotes regarding administrative status for non technical requirements)
R18-16-407(C) & (D)	Not Applicable.	Not Applicable.
R18-16-407(E)(1-2)	[...], the FS shall provide for the development of a reference remedy and at least 2 alternative remedies as follows:	Reference remedy and 2 alternates (less aggressive, more aggressive) are presented in the FS.
	1. The reference remedy and alternative remedies shall be capable of achieving all of the ROs. The reference remedy and each alternative remedy shall consist of a remedial strategy under subsection (F) and all remedial measures to be employed. The combination of the remedial strategy and the remedial measures for each alternative remedy shall achieve the ROs. [...] The reference remedy and other alternative remedies shall be developed and described in the FS report in sufficient detail to allow evaluation using the comparison criteria, [...].	A reference remedy and 2 alternates (less aggressive, more aggressive) are presented in the FS. The FS describes how the ROs are met, the 3 remedies considered are summarized and evaluated in the comparison to the applicable criteria [A.R.S. § 282.06, and A.A.C. R18-16-407(H)].
	2. The reference remedy shall be developed based upon best engineering, geological, or hydrogeological standards of practice, considering the following: <ul style="list-style-type: none"> a. The information in the remedial investigation; b. The best available scientific information concerning available remedial technologies, and c. Preliminary analysis of the comparison criteria and the ability of the reference remedy to comply with A.R.S. § 49-282.06. [...] 	The remedies presented are developed based on the RI data and the best professional judgments of the authors (licensed engineers and/or geologists).

**Table 3 Technical Evaluation: West Van Buren Working Group (WVBWG)
Proposed Remedy – “Reference Remedy”**

FEASIBILITY STUDY STATUTE & RULE APPLICABILITY		TECHNICAL ANALYSIS (see footnotes regarding administrative status for non technical requirements)
R18-16-407(E)(3)	<p>3. At a minimum, at least 2 alternative remedies shall be developed for comparison with the reference remedy. At least one of the alternative remedies must employ a remedial strategy or combination of strategies that is more aggressive than the reference remedy, and at least one of the alternative strategies that is less aggressive than the reference remedy</p>	<p>The remedies presented include a reference remedy and two alternates; one less aggressive, one more aggressive (in comparison to the reference remedy).</p>
R18-16-407(F)(1-6)	<p>The remedial strategies to be developed under subsection (E) are listed below. Source control shall be considered as an element of the reference remedy and all alternative remedies, if applicable, except for the monitoring and no action alternatives. [...] The remedial strategies are:</p> <ol style="list-style-type: none"> 1. Plume remediation [...] achieve water quality standards for COCs in waters of the state throughout the site. 2. Physical containment [...] contain contaminants within definite boundaries. 3. Controlled migration [...] control the direction or rate of migration but not necessarily to contain migration of contaminants. 4. Source control [...] eliminate or mitigate a continuing source of contamination. 5. Monitoring [...] observe and evaluate the contamination at the site through the collection of data. 6. No action [...] consists of no action at a site. 	<p>The basic remedial strategies are discussed in the FS. Acknowledges that source control by ADEQ is necessary. Physical containment through extraction by RID and monitoring is the current condition; small addition of plume remediation via mass removal/treatment is added. Blending to meet beneficial use by RID is proposed with 1 well replacement (as early as 2019). Future remedial actions are focused on MNA with contingencies to replace/move or otherwise address down-gradient water supply wells, if they become impaired in the future.</p>
R18-16-407(G)	<p>Remedial measures necessary for each alternative remedy developed under subsection (E) to achieve ROs or to satisfy the requirements of A.R.S. § 49-282.06(B)(4)(b) shall be identified in consultation with water providers or known well owners whose water supplies are affected by the release or threatened release of a hazardous substance. In identifying the remedial measures, the needs of the well owners and the water providers and their customers, including the quantity and quality of water, water rights and other legal constraints on water supplies, reliability of water supplies and any operational implications shall be considered.</p> <p>Such remedial measures may include, but are not limited to: well replacement, well modification, water treatment, provision of replacement water supplies, and engineering controls.</p> <p>Where remedial measures are relied upon to achieve ROs, such remedial measures shall remain in effect as long as required to ensure the continued achievement of those objectives.[...]</p>	<p>The FS describes consultation and consideration of RID water supply and use, SRP supply and use, and City of Phoenix (COP) supply and use. RID has noted in their response to comments that they differ with the consultation/consideration presented.</p> <p>Consideration of domestic supply wells (if impaired) in the impacted area is discussed and remedial measures are proposed to connect to the COP supply. This remedial action is planned for any domestic wells in the current plume footprint; the same contingent remedial action is included (as a contingency) for future areas if plume migration into down gradient areas impact any additional domestic supply wells.</p>

**Table 3 Technical Evaluation: West Van Buren Working Group (WVBWG)
Proposed Remedy – “Reference Remedy”**

FEASIBILITY STUDY STATUTE & RULE APPLICABILITY		TECHNICAL ANALYSIS (see footnotes regarding administrative status for non technical requirements)
R18-16-407(H)(1-3a)	The Department shall conduct a comparative evaluation of the reference remedy and the alternative remedies developed under subsection (E). For each alternative, the evaluation shall be reported in a FS report and shall include:	
	1. A demonstration that the remedial alternative will achieve the ROs.	Demonstration is presented to meet “ <i>protect, restore, replace or otherwise provide a water supply for municipal use by currently and reasonably foreseeable future municipal well owners within the WVB Area</i> ”. The focus of the remedial actions are on contingent actions to protect or replace the water supply for reasonably foreseeable future municipal wells.
	2. An evaluation of consistency with the water management plans of affected water providers and the general land use plans of local governments with land use jurisdiction.	FS presents contingency remedial actions to meet RID’s future development plans. RID has noted in written comments that they do not support the plan. Plan appears to be supported by other water providers and local governments (COP, SRP).
	3. An evaluation of the comparison criteria, including:	
	a. An evaluation of the practicability of the alternative,	It is practicable however some elements may not be robust: Moving RID-114 to a down gradient position. Projection of plume conditions in 2026 is optimistic based on the estimated rate of attenuation/concentration reductions. Allowing the plume to migrate to COT and/or SRP wells.
	including its feasibility,	Yes, it is feasible.
	short and long-term effectiveness, and reliability,	Contingency remedial actions are implemented when the resource is used for potable water supply and the plume would no longer be contained by irrigation pumping.
	considering site-specific conditions, characteristics of the contamination resulting from the release, performance capabilities of available technologies, and institutional considerations.	Institutional considerations for resolution include water rights, exporting from basin, pumping costs from replacement of wells into the lower aquifer unit, and the water quality and yield of the lower aquifer unit. These are outside of ADEQ’s purview. GAC treatment can meet the ROs and project goals however the projection of the effectiveness of monitored natural attenuation (MNA) is optimistic.

**Table 3 Technical Evaluation: West Van Buren Working Group (WVBWG)
Proposed Remedy – “Reference Remedy”**

FEASIBILITY STUDY STATUTE & RULE APPLICABILITY		TECHNICAL ANALYSIS (see footnotes regarding administrative status for non technical requirements)																
R18-16-407(H)(3b-3d)	<p>b. An evaluation of risk, including the overall protectiveness of public health and aquatic and terrestrial biota under reasonably foreseeable use scenarios and end uses of water. This evaluation shall address:</p> <ul style="list-style-type: none"> i. Fate and transport of contaminants and concentrations and toxicity over the life of the remediation; ii. Current and future land and resource use; and iii. Exposure pathways, duration of exposure, and changes in risk over the life of the remediation; iv. Protection of public health and aquatic and terrestrial biota while implementing the remedial action and after the remedial action; and v. Residual risk in the aquifer at the end of remediation. 	<p>Remedy is protective under current resource use. Remedy is initially focused on containment (until 2026) then moves to managed migration. Source control remedial actions are to be implemented by ADEQ. The FS presents a risk evaluation including fate and transport, current and future resource use, exposure pathways, duration of exposure, and changes in risk over the life of the remediation, and evaluation of protectiveness of public health. Residual risks will remain in the aquifer.</p>																
	<p>c. An evaluation of the cost of the remedial alternative, including the expenses and losses including capital, operating, maintenance, and life cycle costs. Transactional costs necessary to implement the remedial alternative, including the transactional costs of establishing long-term financial mechanisms, such as trust funds, for funding of an alternative remedy, shall be included in the cost estimate.</p>	<p>The FS presents costs for the reference remedy and each alternate. The costs for the proposed remedy (reference remedy) are: \$2.6M capital plus \$17M operations and maintenance (O&M) for 10 years of treatment and 30 years of monitoring (<i>includes all contingency remedial actions</i>).</p> <table border="0" data-bbox="1119 844 1785 1128"> <tr> <td>New MWs & sampling (20 yrs sampling)</td> <td style="text-align: right;">\$2.46M</td> </tr> <tr> <td>Replace 2 SRP wells</td> <td style="text-align: right;">\$5.4M</td> </tr> <tr> <td>Replace down gradient domestic private wells</td> <td style="text-align: right;">\$0.07M</td> </tr> <tr> <td>Replace RID 114 (potable use of Salt Canal)</td> <td style="text-align: right;">\$1.23M</td> </tr> <tr> <td>Continue 18 yrs treatment, 1 well at 500 gpm</td> <td style="text-align: right;">\$18.0M</td> </tr> <tr> <td><i>(Re-inject treated water (18 yrs 500 gpm)</i></td> <td style="text-align: right;"><i>\$5.26M)</i></td> </tr> <tr> <td>1 new core extraction well at 1,000 gpm (operates for 18 years)</td> <td style="text-align: right;">\$28.1M</td> </tr> <tr> <td><i>(Re-inject treated water (18 yrs 1,000 gpm)</i></td> <td style="text-align: right;"><i>\$8.51M)</i></td> </tr> </table> <p style="text-align: right;">30 years Total \$88.6M</p> <p>The costs presented above represent the sum of costs and are not converted to a net present value basis.</p>	New MWs & sampling (20 yrs sampling)	\$2.46M	Replace 2 SRP wells	\$5.4M	Replace down gradient domestic private wells	\$0.07M	Replace RID 114 (potable use of Salt Canal)	\$1.23M	Continue 18 yrs treatment, 1 well at 500 gpm	\$18.0M	<i>(Re-inject treated water (18 yrs 500 gpm)</i>	<i>\$5.26M)</i>	1 new core extraction well at 1,000 gpm (operates for 18 years)	\$28.1M	<i>(Re-inject treated water (18 yrs 1,000 gpm)</i>	<i>\$8.51M)</i>
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<p>d. An evaluation of the benefit, or value, of the remediation. This analysis includes factors such as:</p> <ul style="list-style-type: none"> i. Lowered risk to human and aquatic and terrestrial biota; ii. Reduced concentration and reduced volume of contaminated water; iii. Decreased liability; acceptance by the public; iv. Aesthetics; preservation of existing uses; v. Enhancement of future uses; and vi. Improvements to local economies. 	<p>Potable water will be available when required; the remedial action will slowly reduce plume concentration and volume; groundwater resource within current water basin is preserved for future use.</p>																	

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FEASIBILITY STUDY STATUTE & RULE APPLICABILITY		TECHNICAL ANALYSIS (see footnotes regarding administrative status for non technical requirements)
R18-16-407(H)(3e)	e. A discussion of the comparison criteria, as evaluated in relation to each other.	Discussion regarding each remedy in relation to each other is present.
R18-16-407(I)	Based upon the evaluation and comparison of the reference remedy and the other alternative remedies developed under subsection (E), a proposed remedy shall be developed and described in the FS report. The proposed remedy may be the reference remedy, any of the other alternative remedies evaluated in the FS, or a different combination of remedial strategies and remedial measures that were included in the alternative remedies evaluated in the FS. The FS report shall describe the reasons for selection of the proposed remedy, including all of the following: <ol style="list-style-type: none"> 1. How the proposed remedy will achieve the ROs; 2. How the comparison criteria were considered; and 3. How the proposed remedy meets the requirements of A.R.S. § 49-282.06. 	The proposed remedy is the Reference Remedy. The FS describes how the ROs are met. The FS describes the consideration of comparison criteria. The FS describes how the recommended remedy meets the A.R.S. requirements.
R18-16-407(J)	Any person, other than a person proposing to perform work under an agreement under A.R.S. § 49-287.03(C), may submit a request in compliance with R18-16-413 for the Department to approve a work plan or a report for all or any portion of a feasibility study. The Department shall approve a feasibility study report if the feasibility study complies with this Section and community involvement activities have been conducted under this Article.	Administratively complete for work plan requirement (3). Technical evaluation/analysis presented in the FS and the community involvement activities that have been completed comply with the referenced section and article.

- (1) Administrative requirement; the FS submitted (and this specific remedial alternative) meets this threshold
- (2) Not applicable to site status, WQARF process and ADEQ remedy selection.
- (3) Process step that is applicable under WQARF and it has been completed (or in process of completion)

References:

ADHS, 2015. Health Consultation: Evaluation of Water Sampling Results in the Roosevelt Irrigation District (RID) Phoenix, Maricopa County, Arizona. Arizona Department of Health Services. January 8, 2015.

JULIE CARVER, PE

PROGRAM MANAGER

AREAS OF EXPERTISE

Project and Program Management
Redevelopment of Contaminated Property
Environmental Investigation
Environmental Remediation
Regulatory Agency Negotiations
Stakeholder Consensus Building

EDUCATION

Master of Science in Environmental Science and Engineering, Colorado School of Mines, 1996

Bachelor of Science in Geological Engineering, South Dakota School of Mines & Technology, 1986

PROFESSIONAL REGISTRATIONS

Registered Professional Engineer, Arizona (#58115): 2014 to Present

Registered Professional Engineer, Alabama (# 27191): 2005 to Present

Registered Professional Engineer, Colorado(#33746): 1993 to Present

Registered Professional Engineer, Georgia (#34270): 2009 to Present

Registered Professional Engineer, Kansas (#20804): 2009 to Present

Registered Professional Engineer, New Jersey (#24GE05063100): 2013 to Present

Registered Professional Engineer, Virginia (#042950): 2006 to Present

NCEES Record #27168

CONTINUING EDUCATION/TRAINING

OSHA (29 CFR 1910.120) 40-Hour HAZWOPER and 8-Hour Supervisor

AHERA (40 CFR 763.206) Asbestos Building Inspector & Management Planner

NPDES (40 CFR 122) Stormwater Management & Erosion Control "Qualified Person"

PROFESSIONAL SUMMARY

Ms. Carver is a registered professional engineer with over 27 years of public and private-sector experience in the assessment and remediation of sites burdened with environmental contamination. Julie offers a broad range of experience managing multi-disciplinary, cross-functional teams whose purpose is to solve logistically complex, diverse contaminated property issues on programs and projects for both public and private-sector clients. She provides expertise in the assessment and remediation of hazardous substances and wastes, special wastes, and munitions and explosives of concern (MEC), stakeholder consensus building, and regulatory agency compliance and negotiations. Ms. Carver has worked on sites across the United States and the Asia Pacific, including brownfield, municipal, quasi-governmental and private-sector redevelopment sites, active military installations, Base Realignment and Closure (BRAC) Sites, and Formerly Used Defense Sites (FUDS). She is a nationally-recognized speaker on accelerated environmental closure of contaminated properties in conjunction with redevelopment and beneficial use. As a Vice President with Matrix, she has access to all professional resources within the company and authority to assign work for completion.

RELEVANT EXPERIENCE

McClellan Development Site, Anniston, Alabama - Project Manager to the McClellan Development Authority's Program Management Team responsible for developing remedial designs and providing remediation oversight for the closure and long-term monitoring of seven historical legacy landfills contaminated primarily with CERCLA hazardous substances and limited MEC. Also responsible for developing an active operations plan and updated closure plan for a RCRA -permitted landfill, the remediation of multiple sites with solvent contaminated soil and groundwater and technical peer-review of remedial designs for the cleanup of soil contaminated with metals and munitions constituents at this mixed-use redevelopment/BRAC property.

Fort Monroe Redevelopment, Hampton Roads, Virginia - Program Manager responsible for providing technical oversight services to the quasi-governmental redevelopment authority for the investigation of CERCLA hazardous substances and MEC at this 2005 BRAC site, which is a National Historic Landmark. On behalf of our client and the Commonwealth of Virginia Attorney General's Office, provided technical expertise for the development and implementation of remedial investigations, feasibility studies and records of decision/remedial action plans for firing ranges, groundwater contaminated with solvents in a marina, a historical legacy landfill, underground storage tanks, and contaminated sediment in a moat

Fitzsimons Life Sciences District, Denver, CO - Technical Program Manager to the City of Aurora and Fitzsimons Redevelopment Authority responsible for the \$14.5M investigation and cleanup of 3 historical landfills under a RCRA Consent Agreement integrated with the \$8.5M design and construction of a 2-mile long, 4-lane bypass and a utility upgrade necessary to accommodate significant redevelopment on this 500-acre bioscience and medical facilities redevelopment.

McPherson Redevelopment, Atlanta, GA - Program Manager to the McPherson Implementation Local Redevelopment Agency responsible for the due diligence assessment of environmental contamination at this ~500 acre former military installation. This site is located in the immediate vicinity of downtown Atlanta and the Atlanta International Airport and will be redeveloped as a bioscience park and mixed use transit oriented development.

JULIE CARVER, PE

PROGRAM MANAGER

Hamilton Field, Novato, CA - Deputy Project Manager for the accelerated assessment and cleanup of soil contaminated with metals, fuel and polyaromatic hydrocarbons from former aircraft maintenance facilities and fuel storage at this BRAC property located north of San Francisco. Implemented Early Response Actions using bioremediation and low-temperature thermal desorption so that redevelopment at this former industrial/military property allowing residential redevelopment to proceed.

Liberty Station, San Diego, CA - Project Manager to the San Diego Redevelopment Authority responsible for the development of a detailed human health and ecological risk assessment based on historical investigation work performed by others, and the development of a financial cost model for a potentially-responsible party cost allocation analysis related to the environmental cleanup of contaminated sediments in San Diego Bay.

Uptown Oakland Redevelopment, CA - Environmental Program Manager to Forest City in partnership with the City of Oakland responsible for the initial environmental assessment and characterization of an underutilized, four city-block Brownfield site which was subsequently redeveloped into apartment homes, neighborhood retail and a public park.

Hunter's Point, San Francisco, CA - Program Manager responsible for the implementation of a \$14 M RI/FS for a landfill located on San Francisco Bay, the \$5.0M assessment and cleanup of a tank farm with a network of over 50 USTs and ancillary pipelines, and the completion of three time critical removal actions involving cleanup of soil and groundwater contaminated with heavy metals, solvents, pesticides and/or PCBs.

Underground Storage Tank/Aboveground Storage Tank (UST/AST) Closures, Western United States and the Asia Pacific - Regional Program Manager to the Federal Emergency Management Agency responsible for the investigation/ characterization of fuel releases from storage tanks at Emergency Broadcast Stations, and the subsequent preparation of detailed plans, specifications and cost estimates and construction oversight for the removal and/or closure in place of over 100 USTs and ASTs.

RCRA Subtitle C and D Landfill Closure Systems, United States and Asia Pacific - Project Manager under a contract with the U.S. Air Force responsible for completing landfill characterization work, landfill closure designs and third-party construction management for RCRA Subtitle C and D landfills in Alabama, Arkansas, Colorado, Guam, Louisiana, Maine and Washington.

Aboveground and Underground Mine Closures, CO, NM, AZ, WA - Project Manager for private-sector mining clients responsible for providing regulatory analysis/ compliance services, the implementation of environmental investigations and regulatory agency negotiation assistance related to the development of closure plans.

Aliamanu Remedial Investigation, HI - Project Manager responsible for completion of a multi-million dollar remedial investigation, including a CERCLA human health and ecological risk assessment in a military housing area on property that was formerly used as a pineapple plantation..

Tom McKeon, P.E.
Senior Project Manager (CALIBRE Systems)

EDUCATION

M.S., Civil Engineering, University of Washington
B.S., Environmental Engineering, Humboldt State University

EXPERIENCE

Mr. McKeon is a Principal Environmental Engineer with CALIBRE who has specialized in the investigation/analysis of environmental problems and design of remediation systems. He has over 30 years professional experience with a primary focus on sites with soil and groundwater contamination. He has completed numerous site characterization studies, development of hydrogeologic site models, and designed/installed/optimized soil and groundwater treatment systems. Mr. McKeon is a Professional Engineer (P.E.) with experience addressing environmental and regulatory issues at disposal sites, industrial facilities, and landfills throughout the United States and internationally. He has developed expertise in a wide range of compliance issues including regulations under RCRA, CERCLA and the Clean Water Act. Project experience has included technical and regulatory compliance work for the Nuclear Regulatory Commission, Department of Energy, Department of Defense, Environmental Protection Agency, and private industries.

SOIL AND GROUNDWATER REMEDIATION EXPERIENCE

Remedial Action using Soil Vapor Extraction (SVE), Air Sparging and In-well Stripping. Mr. McKeon has been the lead engineer for dozens of in-situ remediation projects using SVE, air sparging and in-well stripping. Projects have included multiple sites in California, Nevada, Arizona, Washington and international projects in France, Denmark and Taiwan. Responsibilities in these projects have included design, construction oversight, startup, and optimization. He has written remediation design guidance published by the American Society of Civil Engineers (ASCE) and taught courses on remedial systems design/optimization for the National Ground Water Association (NGWA) and US consulting companies.

Remedial Actions using In-situ Groundwater Treatment at Dry Cleaning Sites. Mr. McKeon has been the lead engineer for remedial actions at multiple sites with perchloroethene (PCE) contamination. Project responsibilities have included system design, construction oversight, startup/optimization and operation/maintenance. Projects have included multiple sites in California, Nevada, Washington, and Oregon. Most recent projects (in the last 10 years) have focused on SVE with biological treatment (enhanced reductive dechlorination) for groundwater. The projects have demonstrated excellent performance with PCE concentration reductions of 99.99+% achieved (meeting water quality criteria).

Completing Remedial Investigation/Feasibility Studies (RI/FS) for Protection of City Water Supplies. Mr. McKeon has been the project manager of several RI/FS projects to address solvent impacts to City water supply wells (Santa Barbara and Modesto, California, and Vancouver Washington). Customers have included US EPA and local industries. Remedial actions implemented include well-head treatment (at supply wells) and source-area/plume wide treatment.

Performance-Based Contracting. Mr. McKeon provides consulting support for federal agency procurement of environmental restoration services. Recent projects for the DOD include work for the Army, Air Force, and Navy related to project scoping, planning, and performance-based contracting.

Licensed Civil Engineer, current in Washington and Arizona. Registered with National Council of Examiners for Engineering and Surveying (NCEES, Record # 16876).