Attachment 1, Part I – Application Cover Sheet

Application for a grant under § 78645 of the Safe, Clean, Reliable Water Supply Act of 1996

Dennis Falaschi – General Manager
Panoche Drainage District
52027 W. Althea Avenue
Firebaugh, California 93622

Of the County of Fresno, State of California, does hereby apply to the California Department of Water Resources for a grant in the amount of $184,960.

For the following project under the Drainage Reuse Grant Program of the Safe, Clean, Reliable Water Supply Act of 1996:

Development of a Tailored System for Treating Concentrated Brines from Desalination Processes (especially Reticle ESD)

By ____ Date: January 6, 2015

Dennis Falaschi, Panoche Drainage District General Manager

Telephone: (209)364-6136 Email: dfalaschi@aol.com

Brief Proposal Description

Deionization technologies remove ions from water and concentrate them in brines. Such processes shift the problem from a large volume of water to a smaller volume of water. Reverse osmosis (RO), electodialysis (ED), and ion exchange (IX) all create a concentrated brine from initially salty feedwater. Reticle Inc. (a California-based small business) has developed an electrostatic deionization (ESD) cell to economically clean the water in the Panoche Drainage District (PDD). Like the other processes, it will concentrate ions into a brine, using a low voltage attraction to initially arrest ions. The brine contains all of the ions removed from the water, including hazardous or deleterious elements such as selenium, boron, arsenic, lead, etc. It is important to understand that while we are primarily discussing brines, some drainage waters and even wellwaters can have similarly high salinity levels and need to be mitigated before they can be used or disposed. All high salinity brine waters are candidates for the proposed process to recover any value and remediate the brines of toxic or hazardous materials. Brines created by methods such as solar thermal are also amenable to treatment and remediation under this proposal.

The concentrated brine contains salts that have economic value if the various elements can be selectively removed. If processed correctly, the cleaned salt will be more amenable to disposal, resale, or recycle as an additive to agricultural water. Such is the challenge with brine—to remove and monetize valuable constituents, to remove and isolate pernicious constituents, and to create a benign (or no) disposal problem.

Reticle has developed several process strategies that can be used to treat brines. However, knowing which processes to use, and which will be unnecessary or futile, is determined by the constituents of each brine. For this reason, Reticle proposes to construct a portable pilot-scale test laboratory (mounted on a trailer bed) that can be transported to any site that has concentrated brine and the brine processed on site. While we recommend using Reticle ESD sites specifically because the concentration of the brine can be more easily controlled, the test laboratory will be able to use any saline solution from any source.

The Reticle facility is comprised of a series of small tanks plumbed together in series. The tanks will sequentially precipitate specific constituents from the brine, mindful that some of the precipitates may have value, such as gypsum, potash, metals, etc. Brine from the site will be pumped into a head tank which will feed the process. If the brine tested is void of a certain constituent, the stage designed to remove that constituent will become just a pass-through process with no addition of reagents at that stage. In the stage by stage Reticle process, metals will be removed first as a sulfide precipitate using a proprietary Reticle reagent (Reagent T[1]), followed by metalloids (such as selenium and arsenic) which will use either iron salts (Reagent F) or Reagent T to remove and recover the value. Both Reagent T and F have been proven to be non-toxic and add fertilizer value to the water enhancing their reuse. After the first two removal processes, alkalines (calcium and magnesium) will be removed in a process that will directly produce gypsum or dolomite which may have resale value to farmers in the area. Finally, the anions, such as sulfate, and chlorides can be removed in a polishing stage using precipitates such as lime, barite or other natural precipitants. Solids will be filtered out of the slurries and tested for composition (and economic value) at each stage. The primary constituents of the remaining water will be nitrates, some chlorides and the alkali metals (sodium, potassium, etc.) The process to recover potash (potassium oxide, K_2O) from the final solution is known, but in some instances may be too expensive to use. The final brine will be evaluated for whether a final separation is necessary or not. Ultimately, the results of the individual testing on-site will be used to determine the effectiveness of several treatment processes, and will lead to a plant design that can be constructed for the full-scale desalination operation or drainage flow treatment. When you think about what we are proposing, it is a four stage process that can remove metals, metalloids, alkalines, and finally (if required) alkali metals. The final brine will not contain pernicious components and will be disposable.

This proposal is coordinated with our Reticle ESD proposal, but it is technically and chemically decoupled. One can clean up brines generated from virtually any source. It would seem most valuable, however, to clean up brines from desalination processes because of the pressing need for desalination in the State of California.

[1] The specific identity of the reagent is proprietary. This proposal articulates what the reagent will do. Third parties may become familiar with the reagents during the project. The agents will be licensed under confidentiality.

Attachment 1, Part II – Applicant's Representatives

Project Name: ***Development of a Tailored System for Treating Concentrated Brines from Desalination Processes (especially Reticle ESD)***

Primary Project Contact

Name __Mr. Dennis Falaschi__ Title: _General Manager__

Address: Panoche Drainage District_______
52027 W. Althea Avenue________
Firebaugh, California 93622_____

Telephone: ____(209) 364-6136_____ FAX: __(209) 364-6122
Email: __dfalaschi@aol.com__ ________________

Alternate Project Contact

Name __Dr. Carl C. Nesbitt__ Title: _Chief Technical Officer/Vice President__

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27121 Adonna Court
Los Altos Hills, California 94022

Telephone: ____(906) 231-7203_____ FAX: __(775) 784-1833____
Email: ____Carl.Nesbitt@ReticleCarbon.com___

Alternate Project Contact

Name __Mr. Jack Mastbrook__ Title: _Chief Operating Officer

Address: Reticle Inc
27121 Adonna Court
Los Altos Hills, California 94022

Telephone: ____(310) 347-6888_____ FAX: __(650) 948-8830____
Email: ____Jack.Mastbrook@ReticleCarbon.com___

Type of Organization: Panoche Drainage District; Firebaugh, California
Reticle Inc. California-Based Small Business

Attachment I, Part III – Summary of Project Costs

		% of Total Cost
Total Cost of Project:	$ 204,960	
Amount Requested:	$ 204,960	100%
Amount of Cost Share:	$ -	0%
Amount of Federal Contribution	$ -	0%
In-Kind Contributions:	$ -	0%
Amount to Funded by Other Sources	$ -	0%

Additional explanation:
No in-kind, federal or private cost share will be used to complete the project.

Attachment I, Part IV – Authorizing Resolution

(Panoche Drainage District will adopt the authorizing resolution at the January Board Meeting. A copy will be transmitted to DWR shortly thereafter.)

Attachment 2 – Project Proposal and Task Breakdown

Development of a Tailored System for Treating Concentrated Brines from Desalination Processes (especially Reticle ESD)

Outline

1 TITLE OF THE PROJECT

Development of a Tailored System for Treating Concentrated Brines from Desalination Processes (Especially Reticle ESD)

Presented By: Reticle Inc
27121 Adonna Ct
Los Altos Hills, CA 94022

2 PROJECT PERSONNEL

Project Director: Mr. Dennis Falaschi, General Manager Panoche Drainage District
dfalaschi@aol.com

Administrative Point of Contact: **Dr. Dale M. Nesbitt**
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Los Altos Hills, California 94022
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Principal Investigator and Technical Point of Contact: **Dr. Carl C. Nesbitt**
Dept of Mining and Metallurgical Engineering
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Field Assistant: **Mr. Jack Mastbrook, COO**
Jack.Mastbrook@ReticleCarbon.com

Reticle Inc. is a California-based company owned and operated by Drs. Carl Nesbitt and Dale Nesbitt. Dr. Carl. Nesbitt, CTO, and cofounder, is the inventor of Reticle Carbon and the processes to manufacture it. He is the Goldcorp Chair of Mineral Engineering in the Mining and Metallurgical Engineering Department at the University of Nevada, Reno since 2008. From 1990-2008, he was a tenured professor of metallurgical and chemical engineering at Michigan Technological University. He has over 25 years of combined expertise in materials processing, hydrometallurgy and hydrochemistry with mineral processing industry experience. Dr. Nesbitt was educated at the University of Nevada, Reno (UNR) and the University of Michigan (U of M). He has two advanced degrees in metallurgical engineering (an M.S. in 1985 and a Ph.D. in 1990) and two degrees in chemical engineering (a B.S. from UNR in 1980 and an M.S.E. from U of M in 1989.) He began his academic career in 1990 at Michigan Technological University and has generated numerous publications and a number of patents worldwide, including the Reticle patents. His combination of industrial and academic experience gives Dr. Nesbitt a unique expertise to manage all Reticle technology, especially the brine treatment process.

Dr. Dale Nesbitt, CEO, and co-founder, is a well-known consultant in the oil and gas, electricity, high technology, infrastructure, resource, and transportation fields. Dr. Nesbitt has co-founded and built two successful companies (consulting and software development). He cofounded Decision Focus Incorporated (DFI), where he remained as a principal until 1995, and Altos Management Partners whose products, branded MarketPoint™, are world class forward market and decision support models used by major companies worldwide. He sold those companies to Deloitte and founded ArrowHead Economics LLC to continue advisory and market work in the energy, mining, and commodity industries. Dr. Nesbitt was educated at Stanford University, earning a Ph. D. degree in 1975, in Engineering-Economic Systems (Ph.D. thesis defense with honors), an M.S. degree in 1972, in Engineering-Economic Systems, an M.S. degree in 1970, in Mechanical Engineering with an emphasis in Nuclear Engineering, and, before Stanford, at the University of Nevada, with a B.S. in 1969, in Engineering Science with high honors.

Mr. Jack Mastbrook, who directs Reticle Carbon production, assembly and field testing, completed his studies at Vanderbilt Electrical Engineering School and moved to the West Coast to work in the aerospace industry for Consolidated Systems Corporation of Monrovia, CA. At CSC, he was a field engineer responsible for system support and redesign at numerous missile sites including Atlas ICBM, Minute Man Test and at NASA's Huntsville facility. When CSC was acquired by Scientific Data Systems, Jack was promoted to National Tech Support Manager for the SDS 940, the first Internet server, and conceived a method for remotely diagnosing system failures. When Xerox acquired SDS, he was promoted as the Midwest Regional Tech Support Manager. Later, he was transferred to the El Segundo, CA facility as a Senior Member of the Technical Staff to design and implement Xerox's Long Range Field Support Strategy and was ultimately promoted to Research & Development Manager. After Xerox, Jack started a computer support company (which he sold to GE) and started an environmental remediation and safety company. Since 2008, he has been with Reticle Inc., where he has the responsibility for marketing and development of the manufacturing and logistics plan for the company.

Project Plan

Reticle has implemented many research and development projects over the past decades. By virtue of such experience, we have developed a thorough plan for completing the project in a timely fashion within the budget. Dr. Carl Nesbitt brings expertise in the precipitation of metals, anionic species and metalloids (selenium, aluminum, etc.), and he will be directly involved in the design and construction of the laboratory testing facility to take to any applicable site in the Panoche Drainage District (PDD) for testing. He has completed a preliminary design of a portable "plant" that can sequentially remove or remediate all of the constituents in the brine, leaving only alkali and chlorides to dispose—even these may have recoverable value, such as potash (K_2O). The Reno-based engineering firm Kappes Cassiday Associates (KCA) will be hired to finalize engineering, order and assemble the plant to our specifications. Dr. Nesbitt, with the aid of Mr. Jack Mastbrook, will operate the plant at every site that is producing concentrated brines—whether natural or from a deionization process such as Reticle ESD. This project and the Reticle ESD project would optimally be part of a cooperative study testing the use of Reticle electrostatic deionization (ESD) on brackish water and would be available to help in the operation of the small process. Carl and Jack will work in consort with PDD to ensure the deliverables and tasks are completed on-schedule and on-budget. Email memorandums will serve as the primary form of communication; however, frequent conference calls will be scheduled to inform PDD management of progress on the project throughout the duration of the project.

3 SCOPE OF WORK

3.1 Technology Description

All desalination processes produce clean water from brackish water by transferring the ions from a bulk, dilute solution of ions into a small, concentrated solution of the same ions (brine). A logical way to think about it is that in all desalination processes, the ions from the brackish water are transferred into a smaller volume of water. The net result is that the concentrations (mg/L) in the brine are substantially higher because we have the same number of ions but a smaller volume of water. Reverse osmosis (RO) uses membranes that allow water to pass through, thereby concentrating the ions on the high pressure side. Electric dialysis (ED) uses applied potential to draw ions through membranes into concentrated brines; capacitive deionization (CDI) uses applied potential to arrest ions from the water before being released into concentrate brine. With the possible exception of borates (which RO does not effectively remove), all of these processes can remove any of the ions equally well. In Reticle ESD, ion-bearing water is passed between two oppositely charged electrodes, the negatively charged ions are arrested or "adsorbed" on the anode and the positively charged ions are arrested on the cathode by simple electrostatic attraction. This is one of the only deionization technologies that will remove all cations and anions, no matter how complex the molecule, from the water and place them in a concentrated brine—if it is ionized, it is removed by Reticle ESD.

Without exception, these techniques create brine that is four (4) to six (6) times more concentrated than the original water treated. That is to say, if an RO unit is processing a 2000 ppm TDS stream, the concentrated brine produced by "pushing water molecules" into the "clean" side of the membrane will likely be 8-9000 ppm TDS. ED has similar "concentrating" proportions. Reticle ESD, however, has been shown to produce brine 4 to 10 times higher in concentration than the original water. That is to say, Reticle ESD can be operated to recover over 90 percent of the original water, passing the ions into the remaining 10 percent of the influent flow.

All of the ionic components in any brackish water or brine are either cations (positively charged ions) or anions (negatively charged ions). The net cumulative charge of cations and anions in the water must be equal (that is, there will always be a net zero charge) at all times. (To illustrate with an acid solution, a 0.1M HCl solution will have 0.1M of H^+ and 0.1M of Cl^- dissolved in solution—there is an exact equal amount of positive and negative charge in the water.) The anions potentially present in the brine solution are typically chemical compounds comprised of non-metals, halides, oxides, etc. For example, a typical water in the Panoche Drainage District will have different combinations of chlorides (Cl^-), sulfates ($SO_4^=$), carbonates ($CO_3^=$), phosphates (PO_4^{-3}), nitrates (NO_3^-), etc. These compounds are chemically stable, and they do not change states easily. However, some of the anionic compounds can oxidize or reduce to different valence states, creating different chemical species in water, complicating removal. Included in this category of anions are complex chemicals of different elements, such as boron, [which can form orthoborate $(BO_3)^{-3}$ or tetraborate $(B_4O_7^{=)}$], selenium [which can form selenates $(SeO_4^{=)}$ and selenites $(SeO_3^{=})$], arsenic [which can form arsenates (AsO_4^{-3}) and arsenites (AsO_3^{-3})], etc. Typically, the base elements of these species are known as metalloids in the periodic table.

The cations are ionized metals that can be further characterized by their associated group in the periodic table of elements. For instance, the Group I elements, such as sodium (Na^+), and potassium (K^+) are typically the most prevalent cationic species in brackish water. They can be characterized as the most soluble ions present, as well. The Group II elements (which include calcium (Ca^{+2}), and magnesium (Mg^{+2})) are also common, but these can form insoluble compounds with change in pH (as metal hydroxides) or with addition of carbonate and sulfate anions. The transition metals (also called base metals) are in Groups IIIB-IIB on the periodic table, and are less common, but can be easily identified in water. These cations include species such as dissolved copper (Cu^{+2}, Cu^+), iron (Fe^{+2}, Fe^{+3}), manganese (Mn^{+2}), zinc (Zn^{+2}), cadmium (Cd^{+2}), etc. Notice that these (like some of the anionic species) can be present in multiple ionic states, which can complicate treatment. The “heavy metals” are typically the more toxic cationic species, such as lead (Pb^{+2}), and mercury (Hg^{+2}), and the radioactive elements, such as thallium (Tl^{+3}), uranium (U^{+3}) and thorium (Th^{+4}). These are extremely rare in ground water, but care must be taken to ensure they are not present, because even minute doses can be very toxic. It must be understood that “toxicity” is applicable more than just danger to humans. Slightly elevated concentrates of selenium, boron, and nitrates can be toxic to plants or animals. Care must be given to remove all of these elements from the “water cycle” in the valley. Precipitation processes are the most economical means of ensuring that soluble elements are removed from water in solid form and thereby isolated.

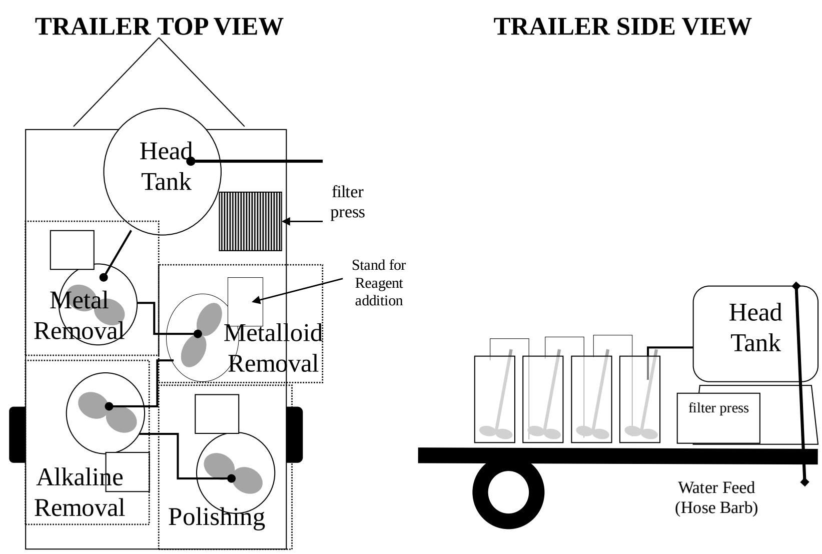
It is important to understand that the ESD technology is at the core of the Reticle business service. However, Dr. Carl Nesbitt (CTO and inventor of Reticle Carbon used in ESD) has over 35 years of experience with the largest soluble metal industry in the world—the mining industry. Over the years, Dr. Nesbitt has developed processes to selectively remove copper, cadmium, and zinc from acid rock drainage solution. He has developed techniques to remove lead and mercury from natural water (even in small concentrations) and has developed processes to remove selenium from water into salable forms. This proposal is presented to offer his expertise in a full range of “after process” engineering to treat the brines generated by ESD or any other desalination technique. As far as we know, this may be the first time that a mining-metallurgical solution chemist will apply known but proprietary skills to the problem of precipitation of pernicious or bothersome ions from brine.

The Reticle process (while seemingly complicated at first blush) is quite simple. Once a concentrated brine is identified, a series of chemical analyses (assays) will tell us how many elements, and how much of each are present. From this initial information, Dr. Nesbitt can immediately create a process path to eliminate the hazardous materials, the toxic materials, and even some of the unwanted brine components. The process can be as simple, or as complicated, as the amount of each element in the analysis warrants. The resulting solution from the process will likely contain mostly K^+ and Na^+. If the concentrations are high enough, these could be fed to a potash producing plant to recover the K_2O value. An assessment of whether this additional step is economical will be conducted on each "product water" as testing progresses.

As an example, Dr. Nesbitt has developed and tested a technique that not only removes the metals (and some metalloids) as solids, but also places simple fertilizers into the water, enhancing their value in agricultural applications. The specific reagent to do so (which we term Reagent T), is proprietary to Dr. Nesbitt and Reticle. However, with non-disclosure and non-circumvent agreements in place, the simplicity and safety of these reagents will be understood.

For this project, Dr. Nesbitt has preliminarily designed a series of processes that will sequentially remove (in order) transition metals, metalloids, alkaline elements and many anions from solution. The portable plant (as illustrated in Figure 1) can be constructed and transported anywhere in the PDD (or other areas) where a problematic brine or brackish water exists. To amplify what we summarized earlier, water is fed into a process head tank at the front of the trailer. Flow from the head tank will be metered through valves to (in order) the "Metal Removal" step, "Metalloid Removal" step, "Alkaline Removal" step and a "Polishing" step. Each "step" is simply a mixing tank with a reagent pump to deliver the precipitants to the mixing chamber. A small filter press will be used to remove solids created at each juncture, and the solutions will be fed to the next step in progression. The individual steps in the plant can be "turned on" or "turned off" as dictated by the composition of the brine at each interim phase. For example, if there are no transition metals in the brine, that particular step in the process will become a "pass-through" step (no reagents added).

Figure 1: Schematic of the Mobile Plant Facility With Tanks for Each Stage of Processing, and a Filter Press to Remove All Precipitates



After all the individual processes are shown to work, information gathered by the operation of the plant will be used to design full-scale salt treatment facilities. Of vital importance in this project will be the ability to identify and separate constituents that are valuable and could return some revenue from constituents that we simply want to isolate and remove from solution.

Materials such as gypsum, potash, iron are already commodities farmers purchase to improve farming lands. These will likely be products from the process that will be produced, and either reused by the water district or other farmers in the San Joaquin Valley.

4 PROJECT OBJECTIVES AND PROGRAM PRIORITIES

As stated previously, Dr. Carl Nesbitt is a specialist in precipitation chemistry, especially of metals in water. His expertise has been used to develop processes for selective recovery of valuable products from water and has also been used to remediate toxins from water into a form that can be easily disposed in landfills or sold to companies that can use the products in their processes.

It is interesting, and quite enlightening, that mining and metal recovery engineers have not been particularly involved in brine treatment in the agricultural industry. They have had their hands full in the mining industry, and the value of the solution streams has been much higher. However, with the escalating importance and value of desalination for agriculture, human, and industrial consumption, the balance is shifting. People with the advanced metal recovery skillset and history of Dr. Nesbitt are just now beginning to enter the desalination industry. This will be one of the first deployments of that skillset to your industry as far as we know.

We emphasize that Reticle brine treatment (especially in consort with Reticle ESD) provides a viable solution to all of the issues specified in the solicitation from California DWR pertaining to the treatment of Irrigation Drain Water under Prop. 204, released on Oct. 30, 2014:

1. **Source control of salinity and toxins**[2]
2. **Desalination of agricultural drainage water**[2]
3. **Detoxification of the brine produced to protect wildlife and the environment.**
4. **Treatment of the brine constituents to produce marketable products such as potash.**
5. **Acceptable capital and operating costs**
6. **Environmentally responsible**

This section addresses the applicability of the demonstration project in each of these six required areas.

4.1 Source Control of Salinity and Toxins

Panoche is unique in California. Privately owned well-water in the District has relatively moderate salinity (2000-3000 ppm TDS), but the water is still too saline for prolonged application to the crops in the area. Agricultural drainage from fields picks up salinity from the

[2] Reticle is providing a separate proposal to specifically handle these areas using Reticle ESD to produce clean water and brine from waters with a variety of salinity. The detoxification and economic recovery of salts from these brines would provide an excellent opportunity to prove the treatment strategy. However, it is important to understand that the objective of this project is to test the processing strategy for treating any brine, economically and efficiently.

fields, with end salinities in excess of 5000 ppm TDS common. Effectively, 2000-3000 ppm TDS wells are "dry holes," just not quite capable of and therefore economic for agricultural or human use. Especially hazardous in these source waters is the presence of borates and selenium. Borates, left unchecked, can irreparably damage crops, nut trees, and other agricultural products grown in this area. They represent a serious impediment to using such waters for agriculture.

Boron, which is not easily eliminated by standard reverse osmosis (RO), is eliminated by Reticle's technology, thereby adding measurably to the benefit of the Reticle process. All of the salt ions will be sequestered in the regeneration brine. This proposal provides a palpable method for sequentially treating the final brine and especially eliminating borates and other salt ions from the wellwater after deionization. In fact, this proposal is one of the only means of eliminating many of the constituents from the agricultural water cycle. The net result of this proposal should be a viable, economical process for eliminating valuable and pernicious ions from brines and rendering them either easily disposable or further processable.

4.2 Desalination of Agricultural Drainage, as well as source water

Agricultural drainage water has a rather high ion concentration, in the range of 2000-8000 ppm TDS. There are too many ions in it to be useful in irrigation or to release it to the environment, especially when many of the ions are pernicious to agriculture, human, or wetlands. Whether accurate or not, such waters are "suspected" of being pollutive downstream. Reticle plans to review the analyses of the drainwater from several of the PDD tile systems to determine likely candidates to demonstrate our mobile unit. The information we will gather from the tests will be important for us to design a full-scale plant capable of effectively eliminating all of the salinity from the drainage. Whether Reticle ESD or another desalination technique is applied, we will demonstrate that we can precipitate or otherwise sequester all the ions from the concentrated brine and render it entirely suitable for reuse. This is an immense act of water conservation. All cleaned drainage water can be recycled and put back into commercial use, or discharged to the wetlands safely. The impact of that on California could scarcely be understated.

Reticle ESD is the only "sure-fire" way to safely, inexpensively, and reliably remove such elements as boron and selenium without additives, antiscalants, or any other chemicals. Our portable brine treatment plant will demonstrate how effectively the brine can be treated to recover valuable salts, and will ultimately result in a larger plant that could be constructed on site (or at a regional site) to clean the desalination brines.

4.3 Detoxification of the Brine Produced to Protect Wildlife and the Environment

Dr. Carl Nesbitt is an internationally renowned inorganic chemist and CTO of Reticle Inc. (a California-based company). He knows the chemistry of wildlife-threatening toxins, such as selenium, arsenic, and others. He knows Reticle ESD and its ability to maximally concentrate the pernicious toxic ions into brines. He knows all the other desalination technologies and what sorts of brines they would produce. He knows how to isolate, precipitate, and render dissolved ions inert, keeping them out of the water life cycle. Protection of wildlife is a wonderful byproduct of the proposed Reticle ESD demonstration and the brine treatment plant. By assay, this project will demonstrate that in fact Reticle brine treatment will fully remove all the wildlife-threatening ions, especially selenium, arsenic, metals (such as mercury and cadmium), etc. We know how important this has become in California, politically as well as palpably.

4.4 Treatment of the Brine Constituents to Produce Marketable Products Such as Potash

The number of salts that are present in each feedwater can very easily be assessed for economic value. Such constituents as copper, potassium, calcium, magnesium, etc. all have economic value, either as the metals or as salts of the metals. For instance, any significant amount of copper in the solution could recoup up to $3 per pound when and if the copper is collected properly. Calcium and magnesium are important elements in lime and dolomite which are natural pH amendments added to farmland. All of the potassium ions (K^+) in solution could be collected and sold as potash (K_2O) (a fertilizer or soil amendment), as well.

The key to this proposal is to recover the valuable ions or salts selectively and successively. Dr. Nesbitt knows from his mining and chemistry experience that this can and is done more efficiently based on the more highly concentrated brines, such as the Reticle ESD discharge brines. Using the more concentrated brines is exactly the scope of this proposal. Base metals (such as copper and zinc) are easily removed selectively from concentrated brines using sulfide precipitation (we use Reagent T for that). Metalloids (such as selenium, arsenic, alumina, silica) are more easily removed after the metals have been extracted (we can use Reagent T or ferric salts to remove these). The alkaline metals (Ca^{+2}, Mg^{+2}) can be selectively removed as gypsum, lime or dolomite solids, or the water could be recycled to mix with fresh water to add some of the “good salt” value of the water. The remaining alkali (Na^+ and K^+) and can be separated using high temperature “salt legs,” but the value of potash recovered needs to be assessed against the expense to separate them. This assessment will have to be evaluated on a brine-by-brine basis. These are precisely the expertise and experience areas that the Reticle engineers bring to the table, and the backbone of this proposal.

4.5 Acceptable Capital and Operating Costs

The cost of producing the portable plant is extremely reasonable. The idea of creating a portable “laboratory” with every processing step sequentially available is an excellent means of testing all of the possible process efficiencies on the actual brines being produced. Each process that is tested will be investigated for efficiency of removal, cost of removal of the species, and will ultimately be used to model a tailored treatment plant for the operation. Chemical analyses of the feed and products will be used as the metric of success of the processes. An independent economic evaluation of the process will be conducted at each location as a second metric of success.

It should be noted that the Reticle plant that is the subject of this proposal is not intended to be the “full-scale” treatment plant. Rather, it will help us to better know what needs to be included in the overall treatment process across a range of brines and salinities. With the results from this pilot-scale plant, we will have the flowsheet and kinetic data required to fully engineer a large plant inexpensively and efficiently.

4.6 Environmentally Responsible

The intent of this project is to test and determine the optimal treatment processes to eliminate toxic and hazardous substances from being discharged to the environment. What could be more environmentally responsible than that? Almost nothing. The agricultural waters in the PDD need to be treated. Continued use of such water results in crop damage and farmland damage as the salts build, not to mention wetlands and wildlife risks. It is imperative that desalination processes be used to improve the water quality into the future and remove and isolate the pernicious constituents from the agricultural cycle. However, the disadvantage of all desalination processes is that all of the salts in the water need to be concentrated in a waste stream. This becomes the new hazard, albeit in a substantially reduced volume (which is a major plus). Our brine treatment project will lead to processes that produce solid wastes from toxic substances, like borates and arsenates. These solids can be containerized and placed safely in specialty landfills, and thus be eliminated from the agricultural water cycle. The volumes of the solids will be considerably smaller and more controllable than concentrated brines that contain the hazards.

But more importantly, this processing strategy may open pathways to developing salable or at least reusable products from the salts that have to be removed from the agricultural water cycle. Recycling potash or gypsum is “low hanging fruit” as far as the ease of recovery, and marketability of products go. However, other products may be missed that can “pay the bills” of treating brine.

5 WORK PLAN AND TASKS

5.1 Statement of Work by Deliverables

The project described could be applied to any concentrate brine from any desalination process or drainage water. The timetable and deliverables have been made assuming it is a stand-alone project. However, there are distinct benefits if it operates in conjunction with the Reticle ESD project (if funded). One of the obvious advantages is that Dr. Nesbitt’s time can be divided equally between the operation of the ESD cells and the cleaning of the brine. Another advantage is that the Reticle ESD can be operated to produce an even higher concentration brine (nearly 10 to 1) compared to the initial water concentrations, making the treatment processes even more economical to operate in the field.

Most of the specific deliverables and tasks outlined in the present proposal can be accomplished concurrently, ain conjunction with the operation of the brine treatment process at a variety of locations, with (presumably) a variety of constituents. All of the processes can be accomplished using small tanks, mixers and plumbing that can be unitized to fit on a small trailer or truck bed. A Reno-based firm (Kappes Cassiday Associates) has over 40 years of experience in producing plants that are shipped in containers around the world. They will be subcontracted to design, construct and deliver the plant to PDD for testing. After completion of the experiments, the data will be analyzed to determine the effectiveness of the process flow chart, kinetic removal factors and estimated value of all precipitate products. The information will be used to design a full-scale plant for the site that will handle the maximum output of the source of the water.

The Project will consist of four general areas of deliverables:

Deliverable I: The mobile brine treatment process to test on various waters (either from desalination processes or from drainage waters in PDD)

a. Kappes Cassiday Associates of Reno, Nevada will be consulted and will help to design the actual footprint of the trailer, to include tanks, locations, electrical, plumbing, etc.

b. The trailer, tanks, and pumps will be ordered

c. KCA will oversee the assembly of the trailer in their Reno operations.

Deliverable II: Identify and schedule at least four up to eight test locations for the plant with the help of PDD officials

Deliverable III: Use the mobile plant at the locations to test various unit processes to remove various components

a. Candidate brines will be assayed to determine the content of all of the following salt constituents:

   i. Heavy metals, such as lead, mercury, cadmium, etc.
   ii. Toxic metals, such as cadmium, selenium, arsenic
   iii. Base metals, such as iron, copper, zinc, etc.
   iv. Anions, such as sulfates, chlorides, nitrates

b. Each test on-location will be conducted as follows:

   i. Fill the head tank on the trailer
   ii. Open the valve to allow water to flow to the first of four separation processes
   iii. Operate the specific processes on the trailer that are required (as dictated by the analysis).
   iv. Remove and collect solids from all of the stages that produce a solid precipitate

c. Solution analyses and solid assays will be conducted at various points of the process to determine the specific cost of reagents, reaction rates, removal and recovery of various material, and determine the economic value of each constituent recovered from the mobile plant.

Deliverable IV: Complete the final design (±30 percent) of a full-scale plant capable of handling the total brine output of the site

Deliverables III and IV are in the form of final reports that will be repeated for each location. (That is, there will be at least eight different reports generated at the end of the project).

5.2 Statement of Work by Task

We have, thus far, identified the specific tasks to complete the deliverables project. They are now summarized in a bit more detail with an estimated duration for each task:

Deliverable I: The mobile brine treatment process to test on various waters (either from desalination processes or from drainage waters in PDD)

Step I.1 Engineer a small, 1-10 gallon per minute, series of tanks that can be used for testing various processes for complete removal of all elements encountered in brines (1-week). With KCA, we will determine tank/mixer sizes and a generic flowsheet that can treat all of the possible elements encountered in concentrated brines. The operating strategy (that is, which unit processes are used) will be determined by the analyses of the brines being fed to the plant. The tanks will be arranged with the following removals (in order):

a. Metals and heavy metals (such as copper, lead, iron, etc.)
b. Metalloids (such as selenium, arsenic, etc.)
c. Alkaline Earth Metals (such as calcium and magnesium)
d. Anions (such as sulfates, chlorides, etc.)

Step I.2: Assemble the mobile plant on a trailer to test at various locations throughout the PDD (6-weeks). There are three tasks that will be accomplished during this step.

Task 2-1. The trailer will be delivered to KCA for construction of the plant.

Task 2-2 Delivered equipment is will be assembled and plumbed on the trailer, as per the engineering sketches from Step 1.

Task 2-3 Once the unit has been tested for leaks and proper operation, arrangements for transporting the unit to the first PDD location will be made. This could be any site where high salinity water or deionization brines are produced

Deliverable II: Identify and schedule up to eight test locations for the plant with the help of PDD officials (1-week) Reticle and PDD officials will meet to determine a "Plan of Attack" for the trailer to be used most efficiently. Together we will determine the best schedule to most efficiently use the trailer at up to eight different sites. Analysis of the waters will be used to determine if there is enough difference in compositions to warrant an independent test. Geography will also be used to make a better progression from site to site.

Deliverable III: Use the mobile plant at the locations to test various unit processes to remove various components

Transport the mobile plant to the sites to begin the testing regimen (3-days at each location). There are four tasks required to complete this step:

Task 4-1. Move the trailer to the site

Task 4-2. Fill the trailer head tank with high salinity brine

Task 4-3. While metering the inlet flow rate, the brines will be subjected to the processes that are pertinent to the brines being treated.

Task 4-4. Report on the kinetics, efficiency (i.e., removal and recovery rate), and final brine quality (i.e., assay of final brine to determine whether further processing is required.)

Deliverable IV. Complete final plant design and submit final report to PDD, CWR and the party whose site was used for the testing (3 days). We will write a report with preliminary design calculations for a full-scale plant with the flow and process steps as determined by the testing.

Notice that Deliverables III and IV are repeated for every location. At a location, the tests will take approximately three days to complete--filling the tank, operating the processes and collecting the data from each run. Shutdown will include draining all tanks, and securing the equipment for transportation to the next site.

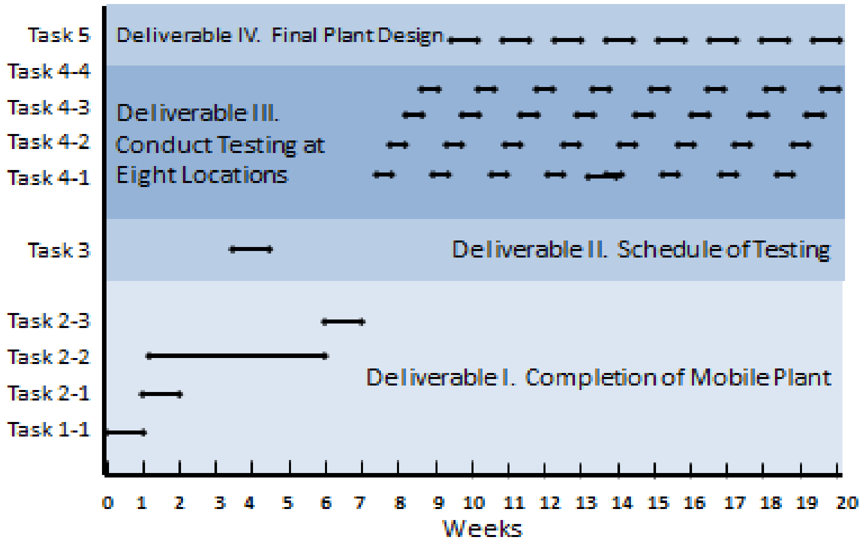
6 METHODS, MATERIALS AND SCIENTIFIC MERIT

Some of the methods that will be used by Dr. Nesbitt and the Reticle team are proprietary (particularly the reagent schemes used to remove certain elements.) However, with proper non-disclosure agreements between PDD and the potential water test sites, the full-disclosure of the reagent schemes can be made. All of the processes that will be used have been published in scientific journals or are currently used in water treatment or mining/metallurgical facilities across the country to remove certain elements. They are "trade secrets" of Reticle. These (along with a few proprietary processes) will be used in this study. All materials of construction of the plant will be consistent with the compatibility in saline water. Corrosion, scaling, etc. will be monitored after each location. The processes for removing ions are proven and scientifically valid. Solid/liquid separation processes (filtering) can be difficult with some of the precipitates formed, but a recycle of slurries can be used at each station to improve precipitation yield and filterability.

7 SCHEDULE

The completion of the project will take approximately 20 weeks (5 months) to complete. This includes engineering, purchasing the equipment, assembling and transporting the mobile plant to 8 different brine sources throughout the district. A timeline is provided in Figure 2 that shows the estimated schedule for the project.

Figure 2: Timeline to Complete the Brine Treatment Project



8 BUDGET

The following table summarizes our estimate for the cost to complete the project presented in this proposal:

	Reticle Cost Chart		
	ITEM	DESCRIPTION/RATE	TOTALS
	Administration Expenses	Panoche Drainage District	$ 20,000
Deliverable I	Tanks (6 process, 3 reagents)	Mixing tanks and process	$ 23,360
	Stirrers/mixers (4 total)		$ 6,700
	Pumps (6 mag drive pumps)	Sethco Mag Drive Pumps	$ 15,000
	Plumbing	1.5"OD CPVC, ~ 800')	$ 5,000
	Valves, fittings, couplings		$ 3,000
	Flow meters, controllers		$ 2,000
	Metal frames/supports		$ 5,000
	Flat-bed "Stake" Trailer		$ 4,500
	Pre-engineering of Trailer	Kappes Cassiday Associates	$ 20,000
	Assembling plumbing/electrical	Kappes Cassiday Associates	$ 15,000
	Analytical Laboratory Costs		$ 10,000
	Small Filter Press and pump	For removal of solids	$ 12,000
	Reagents (precipitants, etc.)		$ 20,000
Del 2-	Travel and Per Diem		$ 5,000
	Staff Compensation	320 hours @ $75/Hr.	$ 24,000
	Technician Staff Compensation	320 hours @ $45/hr.	$ 14,400
	Costs for Brine Treatment Project		***$204,960***

The four tanks are associated with the four individual steps (i.e., metal removal, alkaline recovery, etc.), and the mixers are required to ensure complete reaction of the reagents needed to react with the constituents. A larger tank will be used as a head tank, and will likely be elevated above the rest, so as to use a constant head pressure to feed the process to better control the feed rate to the plant. The reagent tanks will likely be small off-the-shelf carboys from Cole-Parmer or another supplier that have bottom valves to open/close flow of reagent to the system. Small piston reagent pumps will be purchased to ensure exact metering of reagents so as to better control reagent addition and help in determining a max/min flow rate to optimize the individual processes. Larger tanks will be larger drums (likely 60-gallon plastic tanks) with holes strategically located for discharge or overflow of solution. The plumbing will likely be 1-½" CPVC that has been cut to fit and cemented together to fit within the framework of the trailer (a flat-bed trailer with staked sides would work nicely.) Valves and fillings will allow us to isolate all of the reagents, tanks, etc. to ensure the smooth operation of the process.

Once the trailer is delivered to a site, the personnel need to move with it and will accrue about 3-4 days of per diem at each site. A total of 8 sites (3-days each) can be completed in approximately four weeks of testing. Personnel food, lodging and transportation are included in the budget, along with compensation for time spent on-site.

9 SUMMARY OF DELIVERABLES

The project will have the following deliverables at the end:

- A fully contained facility to treat any brine, drainage water, or highly saline well-water that can be tailored to remove any or all constituents. The unit will be capable of cleaning 1-10 gallons of brine per minute or about 700 gallons of concentrated brine daily.

- A schedule for delivering and testing brines at eight locations throughout the Panoche Drainage District

- Analysis of feedwater and final water from the eight locations in PDD

- The final reports of the results of testing the removal of constituents from the brine, including the following information:

    - Effectiveness of removing any or all of the following:
        - Metals (such as copper, iron, mercury, etc.)
        - Metalloids (such as selenium, boron, arsenic, etc.)
        - Alkaline Metals (such as calcium and magnesium)
        - Anions (such as chlorides and sulfates)

    - The kinetics of precipitation at all steps. How fast the removal happens.

- The best effort process engineering design of a full-scale plant for each location.

- A final report of the results of the testing of the unit on several wellwaters and drainage water in the Panoche Drainage District and California Water Resource Division (funding source)

10 CONCLUSIONS

Saline and brackish waters are becoming more than just a nuisance to farmers in the California Central Valley. They are beginning to threaten short and long run viability of the industry. Salt buildup in fields is reducing crop yields and product yields for an increasing number of farmers in the Valley. The constant recycle of salty water is increasing salinity in fields at plant roots, killing plants and hurting the livelihood of the area. The need for desalination is inarguable. However, without methods for extracting deleterious elements from both the originally salinated water as well as the final concentrated brine (e.g., boron or selenium), agricultural water reuse and zero discharge is doomed to fail as these salts (as well as all others) will continue to cycle from crop to crop and ultimately to wetlands where environmental damage will continue to be exacerbated. There are no techniques that have been incorporated into the process that can treat, remediate, or recycle the salts that have to be collected. This proposal should ameliorate that.

Reticle engineers are familiar with a host of techniques that can be used to precipitate the salt components as solids from concentrated brines (quite like the ones that would be accumulated in deionization and desalination processes). The process described in this proposal would accomplish that. They will necessarily be tailored to the specific components found specific wastewater brines. After just a few days of testing the mobile plant on a site, we will know the optimum process flow diagram, the process tank volumes and the processing efficiency of a full-scale plant that can handle all of the brine, brackish water, drainage water, etc. of the Panoche Drainage District. That should allow rather quick design and deployment of commercial size facilities to begin to recover and isolate pernicious or inconvenient dissolved salts in wastewater brines.

Attachment 3 – Eligibility Requirements

Eligibility Checklist		
Applicable?		
Yes	No	Eligibility Criteria
		Local Agency Certification
X		1) Local Agency: The applicant must provide a written statement (and additional information if noted) containing the appropriate information outlined below: ↳ Is the applicant a local agency as defined in CA Water Code §78640(b)? ↳ What is the statutory or other legal authority under which the applicant was formed and is authorized to operate? ↳ Does the applicant have legal authority to enter into a grant agreement with the State of California? ↳ Describe any legal agreements among partner agencies and/or organizations that ensure performance of the proposal and tracking of funds.
	X	2) Basin Plan: Is each project consistent with a Regional Water Quality Control Plan (Basin Plan)?
		Urban Water Suppliers
	X	3) Urban Water Suppliers: List the urban water suppliers that will receive funding from the proposed grant. Please provide the agency name, a contact phone number and an e-mail address. Those listed must submit self-certification of compliance with CWC §525 *et seq*. and AB 1420 (links to appropriate forms in Appendix A).
	X	4) Urban Water Suppliers: Have all of the urban water suppliers listed in #3 above submitted complete Urban Water Management Plans (UWMPs) to DWR? Have those plans been verified as complete by DWR? If not, explain and provide the anticipated date for having a complete UWMP.
		Groundwater Projects/Users
	X	5) Groundwater Projects: Does the proposal include any groundwater projects or other projects that directly affect groundwater levels or quality? If so, provide the name(s) of the project(s) and list the agency(ies) that will implement the project(s).
	X	6) Groundwater Projects: For the agency(ies) listed in #5 above, how has the agency complied with CWC §10753 regarding Groundwater Management Plans (GWMPs)?
	X	7) Groundwater Users: List the groundwater users that will receive funding from the proposed grant. Please provide the agency/organization name, a contact phone number, and an e-mail address. If there are none, please indicate so and skip to #9.
	X	8) Groundwater Users: Have all of the groundwater users, listed in #7 above met the requirements of DWR's CASGEM Program? http://www.water.ca.gov/groundwater/casgem/ If not, explain and provide the anticipated date for meeting the requirements.
		Agricultural Water Suppliers
X		9) Agricultural Water Suppliers: List the agricultural water suppliers that will receive funding from the proposed grant. Please provide the agency/organization name, a contact phone number and e-mail address. If there are none, please indicate so and go to #11.
X		10) Agricultural Water Suppliers: Have all of the agricultural water suppliers, listed in #9 abov, submitted complete Agricultural Water Management Plans (AWMPs) to DWR? Have those plans been verified as complete by DWR? If the plans have not been submitted, please indicate the anticipated submittal date.
		Surface Water Diverters
	X	11) Surface Water Diverters: List the surface water diverters that will receive funding from the proposed grant. Please provide the agency/organization name, a contact phone number, and an e-mail address. If there are none, please indicate so.
	X	12) Surface Water Diverters: Have all of the surface water diverters, listed in #11 above, submitted surface water diversion reports to the State Water Resources Control Board in compliance with requirements outlined in Part 5.1 (commencing with §5100) of Division 2 of the CWC? If not, explain and provide the anticipated date for meeting the requirements.

Attachment 3 – Eligibility Requirements

Local Agency Certification: Panoche Drainage District.

Panoche Drainage District (PDD) is a California local agency formed under the Drainage District Act of 1903, set out in Appendix 8 of the California Water Code. PDD has legal authority and authorization from its Board of Directors to enter into funding assistance agreements with Federal and State agencies as well as with private parties.

Grant fund performance and reporting requirements will be included in the agreement(s) between PDD and the private party(ies) carrying out the specified work. These agreements will spell out the all relevant requirements of the State grant agreement, including invoicing procedure, project performance measures, schedule, and reporting requirements.