

AGRARIAN'S CONTROL MEASURE DEVELOPMENT STRATEGY ON OWENS LAKE

INTRODUCTION:

Agrarian Research and Management Company has been involved in projects relating to the development of land and water resources for over 25 years. In that time, Agrarian has formulated unique and highly effective methods of project development that focus on conceiving and implementing a project that enjoys the simultaneous benefits of **low life cycle cost and high levels of simplicity and reliability**. When natural resources are precious, human resources costly, and the consequences of failure unacceptable, Agrarian's approach merits a closer look.

On the Owens Lake, Agrarian has been working to develop dust control measures using water and vegetation that will meet the dual requirements of control effectiveness and low initial and long-term costs. There are two entities that must initially support the dust control program: Great Basin Unified Air Pollution Control District ("District") and Los Angeles Department of Water and Power (LADWP). The District, in its role as regulator, specifies which of various control measure options are acceptable and the air quality performance criteria for those measures; LADWP as the implementer chooses among the acceptable measures based on other criteria involving resource use. The challenge in this project is to deliver a control measure that simultaneously meets the following performance criteria:

- High demonstrated effectiveness for dust control
- Simplicity of operation so as to minimize risk of failure
- Reliability of materials and use of appropriate technology to minimize on-going inputs for repair, maintenance, and operation
- Low on-going resource use, especially of water
- An efficient balance between initial costs and operation, maintenance, and management costs that results in low life cycle costs
- A ecological and administrative endpoint, which means that the natural and organizational processes that contribute to the measure's effective operation and function are sustainable and can be accurately predicted

What these performance criteria require is the development of an ***integrated strategy that allows for phased implementation that could include achieving rapid effectiveness by utilizing high initial inputs, followed by a successive development towards a lower input state.***

Agrarian's approach for meeting these objectives has been to:

- 1) evaluate the control measures that are approved for implementation
- 2) conduct a spatial analysis of the playa conditions to which the measures would be applied
- 3) engage in a thorough investigation of the methods that could be brought to bear on efficient resource use for each measure at the appropriate locations

***TWO SOILS x TWO MEASURES x TWO TECHNOLOGIES =
OPTIMAL SOLUTION***

Agrarian has taken the three steps outlined above in its role as consultant and contractor to the District for the dust control measure development process on the Owens Lake. The ***control measure analysis*** has resulted in two measures that are supported jointly by the District and by LADWP. The measures are ***SHALLOW FLOODING and MANAGED VEGETATION***.



The first measure relies on delivering water to the playa in quantities sufficient to either saturate or to develop a shallow layer of water on the surface, thus preventing dust emissions during wind events. The second measure requires that the saline/sodic playa soils be reclaimed to a state adequate for the growth of vegetation which will act to prevent wind erosion, thus stabilizing the surface and preventing dust emission.

The ***spatial analysis*** resulted in the conclusion that there are two basic soil types on the Owens playa. They are ***COARSE SANDS*** and ***FRACTURED CLAYS***.



In the District's initial recommendations to the LADWP, they specified that shallow flooding was more appropriate to the coarse sands, and managed vegetation more suitable to the fractured clays. Further analysis of these soil types has revealed that these recommendations do not in all cases utilize the optimal locations for these measures.

Therefore, Agrarian is pursuing a strategy of investigating the application of each measure to each soil.

The *methods analysis* has led to the investigation of alternative strategies of delivering water to the control measures. The initial recommendations of the District operated under the assumption that both shallow flooding and managed vegetation would be implemented using **FLOOD IRRIGATION**. This method utilizes high flow velocities to distribute water over the sites by rapid surface flow. Agrarian, in reviewing available technologies for water distribution, has determined that there is great promise of significantly reducing water use on both measures by delivering water by **DRIP IRRIGATION**.



The results of the three analyses suggest projects that have been implemented to test the technical feasibility of broader application of the measures to the soils using alternative water delivery methods. Agrarian has studied and/or implemented all of the eight potential measure configurations suggested by the analysis. A more complete description of the projects follows.

Shallow flooding on sand soils using flood irrigation was a project developed by the District. This method is being improved by Agrarian in a 320-acre project that implements shorter run distances for water spreading and utilizes recapture and recycling of applied water from drains installed at the downslope and lateral edges of the project. Water use efficiencies are being maximized for this alternative.

Shallow flooding on sand soils using drip irrigation has been investigated by Agrarian on a 60-acre model. A 60-acre prototype is in preliminary design that will incorporate the information gained from the model regarding optimal line spacing, emitter spacing, and emitter capacity. The two dark rectangles shown below are from drip lines at 7 foot spacings.



Managed vegetation on sand soils using flood irrigation has applicability only as a replacement measure for shallow flood on sand. If drains capture the applied water held above the natural saline water table and discharge this water to another location, the soil above the shallow water table will leach and eventually be suitable for plant growth. Continual operation of these drains could make it feasible to grow plants on the former shallow flood site. Such a progression could potentially result in high savings in water duty, as the plants do not require water to control dust during the winter months. Agrarian has not been empowered at this time to pursue this alternative.

Managed vegetation on sand soils using drip irrigation has been developed on a 20-acre site using saltgrass, shrubs, and trees. This project utilizes a successional strategy in which saltgrass is planted on densely placed drip lines, and will rapidly colonize the site resulting in quickly achievable dust control. The shrubs are planted in more widely spaced arrays intended to function as windbreaks. As they achieve full size, the saltgrass between them can be abandoned, thus providing a substantial saving in water duty. Finally, there are tall trees planted in yet more widely spaced arrays designed as windbreaks. When the trees have attained full growth, the shrubs can be abandoned as well, bringing the water duty for the site down to a fraction of the original requirement.



Shallow flooding of clay soils using flood irrigation has is being tested on a site characterized by fractured clay soils. We have constructed 8 ponds on a 10-acre site, where the floors of the ponds have been treated to defeat the soil cracking. This project is exploring the efficiencies of water use that can be accomplished with high salinity water that can eventually produce a non-erosive surface of solid salt. Shallow flooding thus can convert to a non-water-use alternative.



Shallow flooding on clay soils using drip irrigation is being tested by Agrarian on a 10-acre plot. The surface preparation is similar to that used for shallow flooding on clay using flood irrigation, but the water is distributed from closely spaced drip lines. Total ground coverage and surface saturation are being carefully monitored, as is water use.



Managed vegetation on clay soils using flood irrigation has been thoroughly investigated by Agrarian on a 50 acre site. Complete studies involving leaching, drainage, irrigation efficiency, and plant colonization and husbandry have been carried out on this site. The data are readily applicable to all vegetation projects undertaken on the fractured clay soils of the Owens Lake playa.



Managed vegetation on clay soils using drip irrigation has been implemented by Agrarian on two 10-acre plots. The leaching and drainage information acquired on the flood irrigated site have been applied to the design at this location, and plants are responding with good growth. Soil leaching under this irrigation system, plant cover, and water use are being thoroughly monitored at this site.



The table shown below provides a summary of the benefit/risk analysis for the eight alternatives described above.

Benefits and risks associated with the control measures on different surfaces and using different water delivery methods.

TYPE	BENEFIT/ADVANTAGE	RISK/DISADVANTAGE
SHALLOW FLOOD		
Flooding on sand	Low infrastructure cost Simplicity of operation Can use low quality water Proven effectiveness	Sensitive to topography High water use Inefficient water distribution Requires high water table
Flooding on clay	Low infrastructure cost Simplicity of operation Can use low quality water Control water flow with berms Appropriate for poorly drained sites	High water use Fractured clays impede efficient flow High surface preparation cost
Drip on sand	Low water use High water distribution efficiency Simplicity of operation Low infrastructure cost Insensitive to topography	Higher maintenance cost Requires high water table Poor quality water may plug emitters
Drip on clay	Low water use Simplicity of operation Low infrastructure cost Insensitive to topography Appropriate for poorly drained sites	Higher maintenance cost Fractured clays can impede water spreading Poor quality water may plug emitters
MANAGED VEGETATION		
Flooding on sand	Could use less water than SF Leaching is rapid Excess water can be recycled	Water distribution inefficient High water use Installation of drains costly Operation complex and costly Sensitive to topography
Flooding on clay	Low infrastructure cost Proven effectiveness	High water use Leaching is slow Operation complex and costly Drainage problems in some clay sites
Drip on sand	Low water use Leaching is rapid Good growth environment for plants Simplicity of operation Highly reliable Insensitive to topography	Higher maintenance costs Installation of drains costly
Drip on clay	Low water use Simplicity of operation Highly reliable Insensitive to topography	Leaching is slow Higher maintenance costs Drainage problems in some clay sites

METHOD OF PROJECT DEVELOPMENT IN THE FIELD

The purpose of the demonstration projects implemented by Agrarian is to provide data and experience for complete analysis of the measure alternatives for all of the performance criteria listed above. In addition to the acquisition of conventional data on water use, plant growth, and material performance, there are six critical elements associated with the development of any new methods or technology. These elements are:

- 1) Skills.** The Owens Lake playa is a highly unique location. Climatic conditions are severe, and involve temperature extremes, high winds, excessively salty crusts and soils, and groundwater that is shallow, highly saline, and largely anoxic. Any control measure that will be implemented on the playa will require very specific skills associated with it, and these skills can only be acquired in a field setting. Examples of skills are selection of irrigation materials that can withstand the environmental extremes and remain functional; methods of plant introduction to the small nodes or patches created by drip lines; short-term protection of newly introduced plants from harsh environmental conditions; and the development of irrigation regimes using drip lines instead of basin flooding that are applicable to the highly atypical soil textures and conditions found on the fractured clay soils. These are skills that need to be developed through this research and development program.
- 2) Experience.** Although distributing water for irrigation and cultivating plants are scarcely novel enterprises, constructing infrastructures and conducting these activities on the Owens Lake present particular challenges that a development program must address directly. Examples of experience concerns that a program must identify, document, and resolve include construction activities including buried drain installation and surface soil preparation in heavy clays and in near-saturated soil conditions; and customizing sampling protocols to a non-continuous vegetated environment.
- 3) Demonstration.** The technological feasibility of a control measure cannot solely be inferred or modeled, but rather must be demonstrated at some reasonable scale empirically. Each measure, for example, if it is sufficiently different in configuration from the control measures analyzed in the District's current implementation plan, must be subjected to dust control effectiveness monitoring. Additional examples of demonstration include data sets that detail soil leaching rates and plant growth data under conditions of water delivery via drip lines to demonstrate that favorable conditions for plant growth can indeed be produced by this method; shallow groundwater data that indicate effectiveness of sub-surface water management infrastructures; and operational data that demonstrate the technological feasibility of actually operating and maintaining a project and its infrastructure in this environment . Agrarian's projects are primarily ***demonstration projects*** that will work towards developing and demonstrating measure refinements.

- 4) **Proof of Concept.** The concept that is being advanced with each development program is that the control measures can be implemented both more broadly and less expensively than had initially been proposed. Data to support that concept must be developed as part of any research program. Information that lead to proof of concept demonstration include costs associated with construction; analysis of all inputs to the project's on-going operation, including labor, materials, and water; maintenance requirements for the project for its entire projected life; and the development of life cycle costs for the measure as developed in the research program. Only with these data can a convincing case be made that the measures as developed during this process should be implemented.
- 5) **Verification, calibration, and substantiation.** There is a large body of theory regarding the behavior of water, soil, plants, construction materials, and surfaces that has led to the development of specifications for everything from irrigation design to road construction to agricultural manuals. In some cases, these specifications are applicable to the Owens Lake playa, and in others they are not. It is task of each development program to explicitly call out where predictions are being made and where these predictions must be verified, substantiated and/or calibrated based on field data. Examples of such verifications and calibrations include performance of heavy equipment in playa conditions; water spreading from drip lines on clay or sand soils; leaching behavior of clay and sand soils in the presence of cracks and drains; and survivorship and growth rates of plants in high salt, boron, and pH environments.
- 6) **Design criteria and specifications.** The data collection efforts associated with each of the points of investigation described above will lead to the development of design criteria. The collected skills, experience, demonstration of technical feasibility, the proof of concept, and the verification of theoretical predictions will allow for the development of specific criteria that a designer must adhere to in order to achieve success in the actual implementation of a control measure of a particular type at a particular location on the Owens Lake playa. Design criteria and specifications state how and with what some infrastructure is to be constructed; how much water over how much time will be required to operate it at what different stages; how it is to be operated and maintained; and what provisions must be made to cover the lifecycle costs associated with the measure. The ability to develop design criteria and specifications for each control measure is of primary importance in each development program.

Agrarian can assist the project implementers in gaining the necessary skills and experience associated with the preliminary design and operation of a demonstration project. Subsequently, we generate information regarding proof of concept and verification that can be applied to design criteria and specifications. This approach to control measure development responsibly addresses all aspects of control measure

research, and will allow for confident and reliable implementation of the measure on the playa.

AGRARIAN'S APPROACH TO PROJECT DEVELOPMENT

There are always multiple criteria on which the success of any given project will be evaluated. In resource management projects, critical criteria are certain to include overall cost, reliability, and simplicity of management. Many implementers, in their focus on initial costs and project effectiveness, lose sight of the longer range goals of life cycle costs and operational issues that stretch far into the future. As experienced managers of land and water resources, Agrarian recognizes that meeting the short-term goals of constructing a project on budget and meeting the client's requirements for an immediately effective project only go part way towards the development of a resource management solution that promises sustainability.

The development of the dust mitigation measures at the Owens Lake is an example of a "cradle to grave" approach to project development that requires the interdisciplinary approach that can only be achieved by professionals who specialize in long-range thinking. ***Life cycle cost*** analysis is second nature to Agrarian, and we provide responsible analyses that allow for selection of optimal strategies in context of both long range and short range goals. Furthermore, experience has taught us that a ***sustainable*** project must not only provide short term benefits, but must optimize for technological and operational strategies that emphasize ***simplicity of operation and reliability of materials and methods.***

Agrarian has the ability to conceptualize projects based on the orderly and intelligent acquisition of skills and experience. We also have developed the foresight and on-the-ground skills to implement demonstration projects that lead to proof of concept and verification of anticipated results. Together, these capabilities allow Agrarian to offer design services and construction and operation expertise that virtually guarantee the realization of the long term viability of a resource management project.