carbonate such as *Sporobulus airoides*, and tolerance to wind erosion such as *Sarcobatus vermiculatus*. The seedlings of those were planted on artificial dunes, on unaltered lake bed and sands surrounded by tires and drip irrigation with 1 gallon of water per plant per day. Although salinity of the substrate (except unaltered lake bed) and the irrigated water were within the tolerance limit of the plants, most of the plants died, probably due to a poor planting technique - sand blasting. In fact, the plants might have been over irrigated, as indicated by stem rot. Drip irrigation also might not be a good irrigation method for establishing native vegetation, as the root system of those will otherwise develop mainly on the surface but not extending downward to reach more permanent ground water. The problem of sand blasting, together with the water source problem, brings out the question of how the seedlings of those native species establish and develop naturally on such a harsh environment. Desert shrub seedling establishment might, in fact, be a rare event.

The lands surrounding Owens Lake and along the Owens Valley are owned mainly by the Bureau of Land Management (BLM) and the Los Angeles Department of Water and Power (LADWP), who have conducted vegetation surveys on their property. Because of the nature of BLM/s data (grazing management oriented), only findings of LADWP will be discussed and used here.

VEGETATION INVENTORY DONE BY LADWP

Beginning from the mid-80's, LADWP has been performing a vegetation inventory on its property along the Owens Valley including those areas around the Owens Lake playa.

Eightysix vegetation mapping units around the playa and the delta region were selected for the purpose of this study. A total of 43 species were found. Among those, istichilis spicata, *Sarcobatus vermiculatus*, *Atriplex parryi*, and *Suaeda torreyana* were the dominant species in many of the mapping units (Table 2). Except *Suaeda torreyana*, the other three were selected for revegetation studies. All of them occupy wide ranges of habitats with different soil mapping units (Table 2). *D. spicata* and *S. vermiculatus* are well known for their wide range of tolerance to various soil factors (Table 3). *D. spicata*, in particular, is one of the most salt tolerant graminoids in inland dunes and saline wetland. It is always the pioneer plant habituating the most saline area or can be a co-dominant species with other shrubs as well. In general, it is agreed that *D. spicata* has a reduced photosynthetic rate and even showed dwarfism with increased salinity. Its shallow roots indicate the presence of a high water table. However, at Owens Lake playa normal or even taller *D. spicata* (30-50cm) was observed to grow directly on the crusted playa with high salinity and even as pioneer on dunes where the water table is usually very deep. These findings seem contradictory to the previous studies. *S. vermiculatus*, on the other hand, seems to co-dominate with *S. torreyana* on dunes along the NE shore, where *A. parryi* seems able to tolerate harsh physical environments by growing farthest out on the playa surface. As one moves landward where there is an increase in sand accumulation, *A. parryi* drops outland instead *S. vermiculatus* and *S. torreyana* occupy the dunes, which are probably still active and moving. However, there is virtually no literature on the ecology of either *A. parryi* or *S. torreyana*, so their niches are not well known.

OBJECTIVES

In order to have successful bioremediation, at least problems related to inland dune succession mentioned above have to be solved. Owing to the limit of time and resources, the following objectives are set up to investigate spatial succession patterns, which would shed light on understanding of the temporal succession of dunes on and around the playa.

1. To qualitatively and quantitatively descrivbe dune vegetation on and around the playa; and to compare species composition of those and the surrounding non-dune salt bush communities.

2. To desc-be physical and chemical characteristics of sand dunes, and to determine correlation, if any, between species composition and various dune characteristics, including dune size, shape, etc.

3. To investigate seasonal variability of seed bank and seed dispersal of shrub species, if any, on and around the playa.

HYPOTHESES

Based on the above objectives, the null hypothesis corresponding to each objective will be as follows:

1. There is no difference between species composition occupying the dunes and those in surrounding communities.

2. There is no correlation between various dune characteristics and species composition.

3. Seed availability and seedling establishment are not limiting factors for propagation of dune vegetation.

STUDY SITE AND METHODS

Natural dunes along the northeast short of Owens Lake, at the delta region and artificial dunes formed by sand fence construction, and sprinkler plot on the northeast of the playa, are selected as study sites. The natural dunes are formed after the desiccation of the lake (ca. 60 years) and probably are still moving. Artificial dunes are formed within 10 years as mitigation test plots were set up on the playa for sand trapping and sprinkling in various studies.

A species list will be made for each dune or dune system according to the microhabitats: dune top, dune margin and interdune depression. Quantitative data will be obtained by releve on each microhabitat and line-intercept methods across the microhibitats. A cross section profile, percent cover and frequency data, can be generated. Within site and between site comparisons will be made.

Dune height, length, width and shape will be recorded. Dune size and volume of sand can be derived using these data. A layer of pebbles (5cm x 5 cm) will be placed on each side of selected dunes to monitor movement of the dunes. Core samples of selected dunes, representing different size ranges and species composition, will be collected by soil augers. Plant samples on these dunes will be collected and analyzed for various ions including Na, Ca, Mg, CO, Cl, SO and B.

Each soil core will be divided into depth intervals with playa surface as reference level. Particle size, pH, EC, CO, organic matter, NO, Na, moisture content will be determined. Both soil and plant samples will be analyzed in the Soil Laboratory at UC Davis.

Seasonal variability of seeds between the barren playa and dune site and between open areas and beneath canopy on the vegetated sites will be compared. Eight random line transects, each 100m, will be set up approximately perpendicular to the contour line, 4 at the vegetated dune site at NE shore and 4 at the barren playa adjacent to the vegetated site. Ten sample points will be selected randomly along each transect and soil samples of 5cm x 5cm x 2cm deep (80%-90% shrub seeds is at the top 2cm of soil surface) will be collected with a knife at each sample point. The total volume of soil sample will be 400 cm, the soil volume recommended for detection of species in a climax forest based on seed-soil volume curves.

Sample size will therefore be great enough for a desert ecosystem. Soil samples collected at dune sites will be divided into samples beneath canopy and at open areas, so there will be 3 bulk samples, including the one from the playa. The bulk samples will be spread thoroughly to a depth of 2cm in shallow pots, which will be interdispersed at random with pots containing sterile soil for monitoring potential contamination in a greenhouse. The pots will be watered as desired for germination. Each seedling will be pulled out after identification. Emphasis will be put on shrub species for the purpose of this study, so annual and other species will be counted and grouped only according to their life form. Group comparison T-test will be performed for comparing the mean seed number found at various sites. Phenology, volume of canopy and number of seed production of *Atriplex parryi* and *Suaeda torreyana* will be estimated as well.

Appendix

Factor	Control mechanism
1. wind velocity	uncontrollable
2. fetch length	sand fences, water traps, vegetation
3. surface roughness	sand fences, vegetation, dunes, mechanical obstructions
4. coarse saltating particles	dunes, vegetation, flooding
5. efflorescent crust	sprinkling, coating covering, flooding, drying (?)

Table 1. Rrequirements for PM-10 violations from Owens Lake (After Kusko and Cahill, 1984)

species	no. of units dominant (>50% relative cover)	soil units involved
DISPS2	25	419, 423*,602,612, 620, 625,640, 801
ATPA3	12	410,422,423,429,600,601,602, 623,620,623,625,640,801,802
SUTO	10	420,423*,429,601,602,620,525, 626,630
SAVE4	8	419, 422,423,429,601,602,603, 620,627,625,626,630

Table 2. Dominant species on the playa margin. Note their wide range of tolerance showed by the diverse soil units involved.

range of tolerance	Distichilis spicata	Sarcobatus vermiculatus
pH	6.8-9.2	8.0-9.6
conductivity (mmhos/cm)	6-49	37.5-49
% moisture	22-46	20-45
% Na	0.1-0.4	0.091-0.43
% Cl	0-0.2	0.788 (ave)
% SO	0.1-0.7	0.14 (ave)
% total salt	0.03-5.6	0.29(ave)
partricle size	and-clay	sand-clay (prefer medium to heavy texture)
roots	shallow	deep tap root (to >10m)
water table	high	low, ground water
reproduction	vegetative	seedlings
mechanism	excrete salt	accumulate salt under canopy

Table 3. Range of tolerance of D. spicata and S. vermiculatus (Ref: Gates et al. 1956; Flowers and Evans 1966; Ungar 1974; Romo and Eddleman 1985; WESTEC 1984)

EXHIBIT "D"

JOINT POWERS AGREEMENT BETWEEN GREAT BASIN UNIFIED AIR POLLUTION CONTROL DISTRICT AND STATE OF CALIFORNIA, STATE LANDS COMMISSION FOR THE PROVISION OF VEGETATION RESEARCH AND DEVELOPMENT SERVICES

INTRODUCTION

WHEREAS, the Great Basin Unified Air Pollution Control District (hereinafter referred to as "District") has the need for the Research and Development services of the State of California State Lands Commission (hereinafter referred to as "State"), and in consideration of the mutual promises, covenants, terms, and conditions hereinafter contained, the parties hereby agree as follows:

TERMS AND CONDITIONS

1. SCOPE OF WORK:

The State shall furnish to the District, those services and work set forth in Attachment A, attached hereto and by reference incorporated herein.

Services and work provided by the State under this Agreement will be performed in a manner consistent with the requirements and standards established by applicable federal, state, and County laws, ordinances, regulations, and resolutions. Such laws, ordinances, regulations, and resolutions include, but are not limited to, those which are referred to in this Agreement.

2. TERM:

The term of this Agreement shall be from July 1, 1992 to June 30, 1993 unless sooner terminated as provided below.

3. CONSIDERATION:

A. Compensation.

District shall pay State in accordance with the Schedule of Fees (set forth as Attachment B) for the services and work described in Attachment A which are performed by State.

B. Travel and per diem.

Costs of all travel and per diem which State incurs in providing services and work under this agreement are included in the compensation to be paid to State in the Schedule of Fees (Attachment B). State will not be entitled to any additional compensation for travel expenses or per diem incurred by State in performing this Agreement.

C. No additional consideration.

Except as expressly provided in this Agreement, State shall not be entitled to, nor receive, from District, any additional consideration, compensation, salary, wages, or other type of remuneration for services rendered under this Agreement. Specifically, State shall not be entitled, by virtue of this Agreement, to consideration in the form of overtime, health insurance benefits, retirement benefits, disability retirement benefits, sick leave, vacation time, paid holidays, or other paid leaves of absence of any type or kind whatsoever.

D. Limit upon amount payable under Agreement.

The total sum of all payments made by the District to State for services and work performed under this Agreement, shall not exceed **$150,737.00** (hereinafter referred to as "contract limit"). District expressly reserves the right to deny any payment or reimbursement requested by State for services or work performed which is in excess of the contract limit.

E. Billing and payment.

Billing and Payment will be in accordance with the Schedule of Fees (set forth as Attachment B).

F. Federal and State taxes.

(1) District will not withhold any federal or state income taxes or social security from any payments made by District to State under the terms and conditions of this Agreement.

(2) District has no obligation to withhold any taxes or payments from sums paid by District to State under this Agreement. Payment of all taxes and other assessments on such sums is the sole responsibility of State. District has no responsibility or liability for payment of State's taxes or assessments.

4. WORK SCHEDULE:

State's obligation is to perform, in a timely manner, those services and work identified in Attachment A. State will coordinate with District to insure that all services and work will be performed within the time frame set forth by District.

5. REQUIRED LICENSES, CERTIFICATES, AND PERMITS:

State will be responsible for ensuring that any licenses, certificates, or permits required by the federal, state, county, or municipal governments for the services and work described in attachment A, are procured and valid at the time State begins performance of this Agreement. Further, during the term of this Agreement, State must ensure that such licenses, certificates, and permits remain in full force and effect. Licenses, certificates, and permits may include, but are not limited to, driver's licenses, professional licenses or certificates, and business licenses. Such licenses, certificates, and permits will be procured and maintained in force at no expense to the District. State will provide District, upon beginning performance of this Agreement, with evidence of current and valid licenses, certificates and permits which are required to perform the services identified in attachment A. Where there is a dispute between State and District as to what licenses, certificates, and permits are required to perform the services and work identified in attachment A, District reserves the right to make such determinations for purposes of this Agreement.

6. OFFICE SPACE, SUPPLIES, EQUIPMENT, ETC:

State shall provide such office space, supplies, equipment, vehicles, reference materials, and telephone service as is necessary for State to provide the services identified in Attachment A to this Agreement. District is not obligated to reimburse or pay State, for any expense or cost incurred by State in procuring or maintaining such items. Responsibility for the costs and expenses incurred by State in providing and maintaining such items is the sole responsibility and obligation of State.

7. DISTRICT PROPERTY:

A. Personal Property of District.

Any personal property such as, but not limited to, protective or safety devices, badges, identification cards, keys, etc. provided to State by District pursuant to this Agreement are, and at the termination of this Agreement remain, the sole and exclusive property of District. State will use reasonable care to protect, safeguard and maintain such items while they are in State's possession. State will be financially responsible for any loss or damage to such items, partial or total, which is the result of State's negligence.

B. Products of State's Work and Services.

Any and all compositions, publications, plans, designs, specifications, blueprints, maps, formulas, processes, photographs, slides, video tapes, computer programs, computer disks, computer tapes, memory chips, soundtracks, audio recordings, films, audio-visual presentations, exhibits, reports, studies, works of art, inventions, patents, trademarks, copyrights, or intellectual properties of any kind which are created, produced, assembled, compiled by, or are the result, product, or manifestation of, State's services or work under this Agreement are, and at the termination of this Agreement remain, the sole and exclusive property of the State. However, State hereby grants to District an irrevocable non exclusive right to use any such products for any District purpose without payment of any further compensation or requirement of prior State approval.

8. WORKERS' COMPENSATION:

State shall provide worker's compensation coverage, in the legally required amount, for all State's employees utilized in providing work and services pursuant to this Agreement. By executing a copy of this Agreement, State acknowledges its obligations and responsibilities to its employees under the California Labor Code, and warrants that State has complied and will comply during the term of this Agreement with all provisions of the California Labor Code with regard to its employees. Further, State will ensure that any contractor whom it engages to perform work or services under this Agreement will provide workers' compensation coverage for its employees.

9. INSURANCE:

A. General Liability.

State shall procure, and maintain during the entire term of this Agreement, a policy of general liability insurance or a self insurance program which covers all the work and services to be performed by State under this Agreement. Such insurance policy or a self insurance program will have a per occurrence combined single limit coverage of not less than $6,000,000.00. Such policy or a self insurance program will not exclude or except from coverage any of the services and work required to be performed by State under this Agreement. Any policy of insurance will be issued by an insurer authorized to sell such insurance by the State of California, and having at least a "Best's" policyholder's rating of "A" or "A+." District will be named as "an additional named insured" on this policy. State will provide the District with evidence of a self insurance program or a copy of the policy and a certificate of insurance showing the District as "an additional named insured" and indicating that the policy will not be terminated, canceled, or modified without thirty (30) days written notice to the District.

B. Business Auto.

If State utilizes a motor vehicle in performing any of the work or services identified in Attachment A (Scope of Work), State shall cover such vehicle operations by a self insurance program or procure and maintain in force throughout the duration of this Agreement, a business auto liability insurance policy with minimum coverage levels of $300,000.00 per occurrence, combined single limit for bodily injury liability and property damage liability. The coverage shall include all State owned vehicles and all hired and non-owned vehicles used in performing under this Agreement.

Evidence of a self insurance program or a certificate of insurance shall be provided to the District at least ten (10) days prior to the start of work under this Agreement. Any policy shall contain a provision prohibiting the cancellation or modification of said policy except upon thirty (30) days prior written notice to the District.

C. Professional Liability.

If State or any of its employees is required to be professionally licensed or certified by any agency of the State of California in order to perform any of the work or services identified in Attachment A (Scope of Work), State shall cover such professional liability with a self insurance program or shall procure and maintain in force throughout the duration of this Agreement, a professional liability insurance policy with a minimum coverage level of $1,000,000.00. Evidence of the self insurance program or proof of such insurance shall be provided to District at least ten (10) days prior to the start of any work by State.

10. STATUS OF STATE:

All acts of State, its agents, officers, and employees, relating to the performance of this Agreement, shall be performed as independent contractors, and not as agents, officers, or employees of District. State, by virtue of this Agreement, has no authority to bind or incur any obligation on behalf of District. Except as expressly provided in Attachment A, State has no authority or responsibility to exercise any rights or power vested in the District. No agent, officer, or employee of the District is to be considered an employee of State. It is understood by both State and District that this Agreement shall not under any circumstances be construed or considered to create an employer-employee relationship. As an independent contractor:

a. State shall determine the method, details, and means of performing the work and services to be provided by State under this Agreement.

b. State shall be responsible to District only for the requirements and results specified in this Agreement, and except as expressly provided in this Agreement, shall not be subjected to District's control with respect to the physical action or activities of State in fulfillment of this Agreement.

c. State, its agents, officers, and employees are, and at all times during the term of this Agreement shall, represent and conduct themselves as independent contractors, and not as employees of District.

11. **DEFENSE AND INDEMNIFICATION:**

State shall defend, indemnify, and hold harmless District, its agents, officers, and employees from and against all claims, damages, losses, judgments, liabilities, expenses, and other costs, including litigation costs and attorney's fees, arising out of, resulting from, or in connection with, the performance of this Agreement by State, or State's agents, officers, or employees. State's obligation to defend, indemnify, and hold the District, its agents, officers, and employees harmless applies to any actual or alleged personal injury, death, or damage or destruction to tangible or intangible property, including the loss of use. State's obligation under this paragraph extends to any claim, damage, loss, liability, expense, or other costs which is caused in whole or in part by any act or omission of the State, its agents, employees, supplier, or any one directly or indirectly employed by any of them, or anyone for whose acts or omissions any of them may be liable.

State's obligation to defend, indemnify, and hold the District, its agents, officers, and employees harmless under the provisions of this paragraph is not limited to, or restricted by, any requirement in this Agreement for State to procure and maintain a self insurance program or a policy of insurance.

To the extent permitted by law, District shall defend, indemnify, and hold harmless State, its agents, officers, and employees from and against all claims, damages, losses, judgments, liabilities, expenses, and other costs, including litigation costs and attorney's fees, arising out of, or resulting from, the active negligence, or wrongful acts of District, its officers, or employees.

To the extent that State has subcontracted with the University of California, Davis all or part of the work to be performed under this Agreement and by such subcontract the University has expressly assumed the State's obligation to indemnify, defend and hold harmless the District, State shall be relieved of its duty to defend and indemnify District as described in Paragraph 11 of this Agreement.

12. RECORDS AND AUDIT:

A. Records.

State shall prepare and maintain all records required by the various provisions of this Agreement, federal, state, and municipal law, ordinances, regulations, and directions. State shall maintain these records for a minimum of four (4) years from the termination or completion of this Agreement. State may fulfill its obligation to maintain records as required by this paragraph by substitute photographs, microphotographs, or other authentic reproduction of such records.

B. Inspections and Audits.

Any authorized representative of District shall have access to any books, documents, papers, records, including, but not limited to, financial records of State, which District determines to be pertinent to this Agreement, for the purposes of making audit, evaluation, examination, excerpts, and transcripts during the period such records are to be maintained by State. Further, District has the right, at all reasonable times, to audit, inspect, or otherwise evaluate the work performed or being performed under this Agreement.

13. NONDISCRIMINATION:

During the performance of this Agreement, State, its agents, officers, and employees shall not unlawfully discriminate in violation of any federal, state, or local law, against any employee, or applicant for employment, or person receiving services under this Agreement, because of race, religion, color, national origin, ancestry, physical handicap, medication condition, marital status, age, or sex. State and its agents, officers, and employees shall comply with the provisions of the Fair Employment and Housing Act (Government Code section 12900, et seq.), and the applicable regulations promulgated thereunder in the California Code of Regulations. State shall also abide by the Federal Civil Rights Act of 1964 (P.L. 88-352) and all amendments thereto, and all administrative rules and regulations issued pursuant to said act.

14. CANCELLATION:

This Agreement may be canceled by District without cause, and at will, for any reason by giving to State thirty (30) days written notice of such intent to cancel. In the event of such cancellation District shall compensate State for work completed on the date of cancellation. State may cancel this Agreement without cause, and at will, for any reason whatsoever by giving thirty (30) days written notice of such intent to cancel to District.

15. ASSIGNMENT:

A. State may subcontract this Agreement, or any part of it, and assign any monies due or to become due under this Agreement to the University of California, Davis without the express written consent of District. State shall not make other subcontracts or assignments of any monies due or to become due under this Agreement without the prior written consent of District.

B. Without the written consent of State, District shall not assign this Agreement either in whole or in part.

16. DEFAULT:

If the State abandons the work, or fails to proceed with the work and services requested by District in a timely manner, or fails in any way as required to conduct the work and services as required by District, District may declare the State in default and terminate this Agreement upon five (5) days written notice to State. Upon such termination by default, District will pay to State all amounts owing to State for services and work satisfactorily performed to the date of termination.

17. WAIVER OF DEFAULT:

Waiver of any default by either party to this Agreement shall not be deemed to be waiver of any subsequent default. Waiver or breach of any provision of this Agreement shall not be deemed to be a waiver of any other or subsequent breach, and shall not be construed to be a modification of the terms of this Agreement unless this Agreement is modified as provided in paragraph twenty-four (24) below.

18. CONFIDENTIALITY:

State agrees to comply with the various provisions of the federal, state, and county laws, regulations, and ordinances providing that information and records kept, maintained, or accessible by State in the course of providing services and work under this Agreement, shall be privileged, restricted, or confidential. State agrees to keep confidential all such information and records. Disclosure of such confidential, privileged, or protected information shall be made by State only with the express written consent of the District.

19. CONFLICTS:

State agrees that it has no interest, and shall not acquire any interest, direct or indirect, which would conflict in any manner or degree with the performance of the work and services under this Agreement.

20. SEVERABILITY:

If any portion of this Agreement or application thereof to any person or circumstance shall be declared invalid by a court of competent jurisdiction, or if it is found in contravention of any federal, state, or county statute, ordinance, or regulation, the remaining provisions of this Agreement, or the application thereof, shall not be invalidated thereby, and shall remain in full force and effect to the extent that the provisions of this Agreement are severable.

21. FUNDING LIMITATION:

A. The ability of District to enter this Agreement is based upon available funding from various sources. In the event that such funding fails, is reduced, or is modified, from one or more sources, District has the option to cancel, reduce, or modify this Agreement, or any of its terms within ten (10) days of its notifying State of the cancellation, reduction, or modification of available funding. Any reduction or modification of this Agreement made pursuant to this provision must comply with the requirements of paragraph twenty-three (23) (Amendment).

B. This agreement shall not be effective until it has been approved by the Department of General Services.

22. ATTORNEY'S FEES:

If either of the parties hereto brings an action or proceeding against the other, including, but not limited to, an action to enforce or declare the cancellation, termination, or revision of the Agreement, the prevailing party in such action or proceeding shall be entitled to receive from the other party all reasonable attorney's fees and costs incurred in connection therewith.

23. AMENDMENT:

This Agreement may be modified, amended, changed, added to, or subtracted from, by the mutual consent of the parties hereto, if such amendment or change is in written form and executed with the same formalities as this Agreement, and attached to the original Agreement to maintain continuity.

24. NOTICE:

Any notice, communication, amendments, additions, or deletions to this Agreement, including change of address of either party during the terms of this Agreement, which State or District shall be required, or may desire, to make, shall be in writing and may be personally served, or sent by prepaid first class mail to, the respective parties as follows:

Great Basin Unified Air Pollution Control District
157 Short Street
Bishop, California 93514

State Lands Commission
1807 13th Street
Sacramento, California 95814

25. DESIGNATION OF AGREEMENT REPRESENTATIVE:

The Commission and District hereby name a representative who shall represent his or her agency regarding this Agreement. Each agency may change its representative by notifying the other agency as provided for in Paragraph 24.

COMMISSION'S REPRESENTATIVE SHALL BE:

Steve Sekelsky

DISTRICT'S REPRESENTATIVE SHALL BE:

Ted Schade

26. FORM OF STANDARD AGREEMENT:

Paragraphs 1 through 7 on the reverse side of the first page of this Agreement are not intended to be a part of this Agreement and are hereby deleted. These paragraphs have been modified and restated in other paragraphs of this Agreement.

27. ENTIRE AGREEMENT:

This Agreement contains the entire agreement of the parties, and no representations, inducements, promises, or agreements otherwise between the parties not embodied herein or incorporated herein by reference, shall be of any force or effect. Further, no term or provision hereof may be changed, waived, discharged, or terminated, unless the same be in writing executed by the parties hereto.

AGREEMENT BETWEEN
GREAT BASIN UNIFIED AIR POLLUTION CONTROL DISTRICT
AND STATE OF CALIFORNIA, STATE LANDS COMMISSION
FOR THE PROVISION OF
VEGETATION RESEARCH AND DEVELOPMENT SERVICES

IN WITNESS THEREOF, THE PARTIES HERETO HAVE SET THEIR HANDS AND SEALS THIS _____ DAY OF _____, 19__.

DISTRICT

By:_____

Dated:_____

APPROVED AS TO FORM AND LEGALITY:

_____
District Counsel

APPROVED AS TO ACCOUNTING FORM:

_____
County Auditor

STATE

By:_____

Dated:_____

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ATTACHMENT A

JOINT POWERS AGREEMENT BETWEEN
GREAT BASIN UNIFIED AIR POLLUTION CONTROL DISTRICT
AND STATE OF CALIFORNIA, STATE LANDS COMMISSION
FOR THE PROVISION OF
VEGETATION RESEARCH AND DEVELOPMENT SERVICES

TERM: From: July 1, 1992 To: June 30, 1993

SCOPE OF WORK

PROJECT I - SALT AND NUTRIENT DYNAMICS IN VEGETATION, SOIL AND GROUNDWATER OF THE OWENS PLAYA SYSTEM

The state shall perform the following tasks relating to an investigation of the salt and nutrient dynamics of the vegetation, soil and groundwater found on and around the Owens Dry Lake in Inyo County, California.

OBJECTIVES

1. Characterize i) salt composition and distribution and ii) nutrient pools on the bare playa and in natural and man-made dunes with and without vegetation.

2. Relate salt concentrations and composition to root and folia, elemental concentrations. Evaluate potential toxicities and deficiencies in conjunction with Project II.

3. Determine elemental concentrations in shallow groundwater and evaluate this water as a potential source of irrigation water.

TASKS

The following tasks set forth the basic work effort necessary to complete the project. Prior to the actual start of any field or laboratory work, task protocols shall be developed that describe in detail the data collection and data analysis to be performed.

1. Perform a Literature Search

A literature search to collect existing data on soil, vegetation and groundwater chemistry/hydrology of Owens Lake and other similar sites will be conducted prior to the experiments. This effort will take place in conjunction with the literature search performed in Project II.

2. Identify Intensive Study Sites

Working with Great Basin staff and consultants, and with the Project II vegetation investigators, a series of sites will be selected as intensive study locations. These locations will include stable dunes, both man-made and naturally occurring, bare playa, and transitional gradients from vegetated to non-vegetated surfaces. Preliminary selections for the study locations include the Phase II Keeler/Swansea dune, the old pipeline dune, the Dirty Socks dunes, the vegetated dunes north of Keeler and representative bare playa sites in sand, clay and mixed soils.

3. Survey Soil Salt Distribution

An electromagnetic detection device capable of measuring salinity profiles down to 4 to 5 feet deep (EM Model 38 electromagnetic detector) will be used to survey salt distribution in the upper 4 to 5 feet at each location. This preliminary study will be used to develop a salinity map showing spatial variability at each location.

4. Trench Study Sites

Based on the preliminary study of salt spatial variability, representative sites will be trenched and samples collected as a function of depth and horizontal distance along the trench. Where possible, this trenching will be performed to characterize gradients from vegetated to non-vegetated, or from wet to dry sites. Trenching will be performed with a backhoe and will generally be perpendicular to and as deep as the dunes. No backhoe trenching will be performed in areas designated by the project negative declaration as sensitive. All trenches will be backfilled and restored to their original condition.

5. Analyze Water Chemistry

Water extracts will be made for each sample and the following chemical parameters measured: pH, EC (electrical conductivity), Li, Sr, Ca, Mg, Na, K, NH_4, F, Cl, Br, NO_3, PO_4, SO_4, B, Se, As, and Mo. Representative samples will also be screened using an inductively coupled plasma mass spectrometer (ICP-MS) to determine if other elements are present in detectable quantities. Only those elements that exceed detection limits and are important from a plant or toxicological perspective will be analyzed on all the samples. laboratory quality assurance/quality control protocols will follow EPA approved methods including spikes, blind samples, reference materials, setting of control limits, criteria for rejection, and data validation methods.

6. Correlate Soil and Water Chemistry to Plant Uptake

In collaboration with the Project II vegetation subgroup, foliage and roots will be collected along the trench in vegetated dunes to determine chemical concentrations. The vegetation subgroup will map root distribution and the relationship between soil chemistry and plant nutrient/toxic element distribution will be evaluated (see Project II Tasks). Plant samples will be digested using nitric acid. Both nutrient and potentially toxic element concentrations will be measured. The elemental concentrations in the plant materials will be correlated with the nutrient and salt concentrations in the soil solution to determine plant uptake mechanisms and toxicity avoidance mechanisms.

7. Monitor Shallow Groundwater Chemistry

At each study location, shallow groundwater monitoring stations will be installed in conjunction with the network being installed by Great Basin. Shallow groundwater will be collected and chemically analyzed to permit comparison of the chemistry of the plant and soil material to the water that supplies it. This work will be coordinated with hydrologic experts working with the Great Basin APCD in order to derive estimates of groundwater discharge and an estimation of the degree of concentration of salts and toxic ions that occur through evaporation and transpiration. The relationship of shallow groundwater to interstitial pore water in the unsaturated zone will be developed to determine the influence of shallow ground water on dune salt composition. Shallow groundwater samples will be collected throughout the year in order to observe seasonal changes that may occur. Sufficient data will be collected to evaluate the feasibility of a regression model for predicting water chemistry as a function of electrical conductivity values for a given source area. Water chemistry analysis will be performed for those parameters indicated under #5 above (pH, EC, Li, Sr, Ca, Mg, Na, K, NH_4, F, Cl, Br, NO_3, PO_4, SO_4, B, Se, As, and Mo).

8. Evaluation of Results for Study Sites

The state will synthesize and interpret results of vegetation, soil and groundwater analyses in an effort to identify the microsite environmental conditions associated with bare playa and man-made, natural, vegetated and non-vegetated dunes. Results and their interpretation will be given to Great Basin for review and comment. A final project report will be prepared and submitted to Great Basin no later than June 30, 1993.

SCHEDULE	Start	Finish
1. Perform a Literature Search	7/92	9/92
2. Identify Intensive Study Sites	7/92	8/92
3. Survey Soil Salt Distribution	7/92	10/92
4. Trench Study Sites	7/92	10/92
5. Analyze Water Chemistry	10/92	3/93
6. Correlate Chemistry to Plant Uptake	3/93	6/93
7. Monitor Shallow Groundwater Chemistry	7/92	6/93
8. Evaluation of Results For Study Sites	10/92	6/93

PROJECT II - PHYSIOLOGICAL LIMITS OF PLANTS IN DESERT PLAYA ENVIRONMENTS

The state shall perform the following tasks relating to an investigation of the physiological limits of plants found on and around the Owens Dry Lake in Inyo County, California.

OBJECTIVES

1.To determine the tolerance limits to NaCl, $NaSO_4$, and borate individually for a suite of species that occur naturally on dune or playa habitats at Owens Lake.

2.To determine how much the levels of tolerance of the most tolerant Owens Lake species, selected based on the results of objective 1, above, and field observations, are reduced when sodium, chloride, sulfate and borate are provided in combination.

3. To determine the influence of increased Ca/Na activity ratio on the levels of tolerance to sodium, chloride, sulfate, and borate.

4. To relate the results of the greenhouse studies of objectives 1, 2 and 3 to the actual chemical environment of roots of plants growing naturally in playa and dune habitats at Owens Lake.

TASKS

The following tasks set forth the basic work effort necessary to complete the project. Prior to the actual start of any field or laboratory work, task protocols shall be developed that describe in detail the data collection or data analysis to be performed.

1. Perform a Literature Search

A literature search regarding the tolerances of species native to Owens Lake will be conducted prior to the experiments, which may result in modification of the solution concentration ranges selected.

2. Collect Plants

Plant materials to be used will be collected at Owens Lake. When possible, both seedlings and more mature plants derived from transplants, cuttings or rhizome segments, as appropriate, would be utilized and evaluated. Potential species to be evaluated include *Distichlis spicata*, *Sarcobatus vermiculites*, and *Atriplex parryii*. Final decisions on the species to be tested will be based on field observations of species abundance and distribution in the most stressful habitats, literature review, and suitability of species for use in ecosystem development efforts. The number of species that can be evaluated is constrained by the number of test containers in the greenhouse sand-culture system. Five replicates, the minimum number acceptable, of each species in each treatment will limit the list to six species.

3. Collect and Map Soil, Roots and Shoots

Soil samples, root and shoot materials will be collected at Owens Lake and will be coordinated with the work to be performed in Project I. Root profiles will be mapped and correlated with vegetation at the soil/vegetation sampling sites. Roots will be mapped along the trench profile walls excavated for the soil chemistry study. Mapping will include counting fine roots crossing the plane of the profile wall in 5-10 10x10-cm quadrats in each 10-cm soil layer to obtain a semi-quantitative measure of the vertical distribution of fine root density. Root and soil samples will be taken at representative depths through the rooted zone. This work will be coordinated with the work to be performed in Project I.

4. Analyze Soil and Plant Tissue

Chemically analyze field-collected soil and plant tissue samples. Coordinate with work performed in Project I.

5. Compile and Analyze Root Profile Wall Maps

6. Set-up Greenhouse Experiments

The plants for all experiments will be propagated in a greenhouse adjacent to the sand-culture greenhouse. Plants will be adequately supplied with water and nutrients, both during propagation and experimental periods. If possible, seed germination and initial growth (3-4 weeks) will be evaluated simultaneously with longer treatment of more mature plants planted in the same container. The containers' size (30 cm diameter) will be large enough for these evaluations to be done simultaneously without plant-plant interference. The greenhouse experiments will utilize a sand-culture system with programmable control of the root solution composition. This system is currently available in a greenhouse in the Orchard Park facility at the UC Davis campus but will require some refurbishment before it can be used for the Owens Lake experiments. Refurbishment will consist of valve replacements, replumbing and replacing pots. After refurbishment, the system will consist of 180 35-liter pots and a nutrient solution supply system that can be programmed to provide 6 different treatments (nutrient/salt solutions). Environmental conditions and operation of the solution supply system will be monitored with a CR-10 data logger system (Campbell Scientific, Inc. Logan, UT) that is included in the budget.

7. Test Tolerance Limits of Plants

Greenhouse experiments with species and solution concentration as main factors will be conducted to determine the tolerance limits to NaCl, $NaSO_4$, and borate individually for the selected species. Include six NaCl levels ranging from 0.5 mM (milli Moles) to 1000 mM and six boron levels ranging from 0.05 mM to 10 mM. Higher maximum concentrations of both salt and boron may be necessary to define the upper limits of tolerance of the most tolerant species at Owens Lake. Concentrations to be used in these experiments, and for the sulfate experiment, will be adjusted as necessary to span the range of soil solution concentrations found in the substrates adjacent to the roots of plants growing in playa and dune habitats at Owens Lake.

Based on the results of the individual concentration tests, a factorial set of treatments including salt and borate in combination will be conducted to address how much the levels of tolerance of the most tolerant species are reduced. The concentrations to be used will depend on the results of the first two experiments and the soil solution concentrations in Owens Lake habitats. Additional interactions will be studied as time permits.

To determine the influence of increased Ca/Na activity ratio on the levels of tolerance to sodium, chloride, sulfate and borate, interactions of the toxic elements with calcium activity will then be investigated. A factorial set of treatments with stressful levels of salt or borate combined with three Ca/Na activity ratios will be conducted. The Ca/Na activity ratios used will range upward from the very low values in the soil solutions at Owens Lake. An appropriate computer model will be used to develop the specific nutrient/salt solution concentrations for this factorial experiment.

8. Evaluation of Experimental Treatments and Field Data

All experiments will utilize a randomized block design to account for gradients in the environmental conditions in the greenhouse. In all experiments the concentrations of toxic ions will be increased slowly over several weeks to the target levels to prevent osmotic shock and allow time for acclimation to the stress. Plant performance in all experiments will be measured both during the growth period and with a final harvest of the experimental plants. The measurements proposed will be used to make preliminary assessments of some of the key mechanisms of salinity tolerance. Measurements will include: survival; rate of leaf production and growth; biweekly predawn and midday plant water potentials; sodium, chloride and borate content of the xylem sap at biweekly midday and predawn measurements; total shoot and root production; total root length produced; nutrient, salt and boron content of leaves and roots. During the growth period and at the end of the experiments evidence of salt excretion (e.g. by *Distichlis spicata*) or accumulation in epidermal trichomes will also be determined. The nutrient, salt and boron content measurements taken for the greenhouse plants will be compared with the same measurements taken for the field collected plants. The growth period of each experiment will be limited to approximately two months.

An analysis and synthesis of field and lab results will be performed. Analysis of the results of the greenhouse experiments will be conducted using the SAS statistical analysis computer program (Statistical Analysis Systems) and all data will be transformed as necessary to obtain homogeneity of variances and adequate approximation to normality. Field results will be summarized with descriptive statistics for comparison to the treatment solutions used in the greenhouse.

Results and their interpretation will be given to Great Basin for review and comment. A final project report will be prepared and submitted to Great Basin no later than June 30, 1993.

SCHEDULE

		Start	Finish
1.	Perform a Literature Search	7/92	9/92
2.	Collect Plants	7/92	8/92
3.	Collect and Map Soil Roots and Shoots	7/92	10/92
4.	Analyze Soil and Plant Tissue	9/92	1/93
5.	Compile and Analyze Root Profile Wall Maps	9/92	1/93
6.	Set-up Greenhouse Experiments	7/92	4/93
7.	Test Tolerance Limits of Plants	8/92	5/93
8.	Evaluation of Treatments and Field Data	1/93	6/93