Water Resources Center, Desert Research Institute
Annual Technical Report
FY 2002

Introduction

Research Program

Identification of Nutrient Rich Groundwater Inflows to Lake Tahoe

Basic Information

Title:	Identification of Nutrient Rich Groundwater Inflows to Lake Tahoe
Project Number:	2002NV1B
Start Date:	3/1/2002
End Date:	2/28/2004
Funding Source:	104B
Congressional District:	Nevada 02
Research Category:	Ground-water Flow and Transport
Focus Category:	Waste Water, Nitrate Contamination, Non Point Pollution
Descriptors:	surface water quality, turbidity, chlorophyll, nutrient info
Principal Investigators:	Kendrick C. Taylor

Publication

Problem and research objectives:

1) Identify the location of areas in Lake Tahoe that have persistent low water quality.
2) Determine if the clarity loss at Lake Tahoe is caused by organic or inorganic material.
3) Determine the influence that near-shore high-turbidity areas have on the mid-lake clarity of Lake Tahoe.

Methodology:

Spatial and temporal surveys are made of turbidity, temperature, and chlorophyll. Particles in the water are collected and analyzed with a scanning electron microscope. Water movement in the lake is measured with drift buoys.

Principal findings and significance:

Five areas with persistently poor water quality have been identified. Meteorological conditions that lead to degradation of the near-shore water quality have been identified. In summer, most of the clarity loss is due to algae and in many cases is associated with poorly understood nutrient sources. In winter, clarity loss is caused by mineral material in the water and is closely associated with lake level snowmelt. In spring, clarity loss is caused mainly by dissolved organic compounds and is closely associated with stream inflow. We will use 104B funds this summer to determine how much mixing there is between the near-shore and mid-lake waters and how near-shore water quality influences mid-lake water quality.

Assessment of Ground Water Recharge in Mine Altered Regions of Nevada

Basic Information

Title:	Assessment of Ground Water Recharge in Mine Altered Regions of Nevada
Project Number:	2002NV5B
Start Date:	3/1/2001
End Date:	2/28/2004
Funding Source:	104B
Congressional District:	Nevada 02
Research Category:	Ground-water Flow and Transport
Focus Category:	Groundwater, Water Quality, Hydrogeochemistry
Descriptors:	Mining impacts, groundwater recharge, arsenic
Principal Investigators:	Scott Woodman Tyler, David Decker

Publication

1. Turrentine, J. A., T. Halihan and T. Fenstemaker, Vadose Zone Fluid Migration in a Heap-Leach Site using Transient Electrical Resistivity Surveys. Paper No. 7-21. Geological Society of America Annual Meeting, Abstracts with Program. October 26-31, 2002, Denver, CO.
2. Webb, G. and S. Tyler. Leaching and draindown experiments conducted at the Gold Acres Facility. Presented at the 2003 Heap Leach Closure Workshop, Elko, Nevada, March 2003 sponsored by UNR Mining Life Cycle Center and the Nevada Mining Association.

Research Objectives:

This research utilized the unique geometry and construction practices of heap leach gold mining presently used in Nevada to estimate ground water recharge contributions through mining waste material and to quantify the mechanisms of fluid transport through mining waste material. It is well known that it is extremely difficult to accurately measure ground water recharge in arid and semi arid environments. However, heap leach mining structures allow for the collection of all recharge passing through these large (100-500 acre) structures. Following cessation of the mining operation, long term drainage from the heap leach structures can be used to directly estimate the recharge rates (and percentage of recharge to precipitation). Transport through the mining waste material has been investigated in this study through the use of a unique field experiment designed to directly quantify the rates and flow mechanisms (matrix flow, preferential flow, etc.) through actual mining waste material at the Cortez facility in eastern Nevada. Information gathered from a series of leaching and draindown experiments carried out in 2002 and 2003 have shown that fluid flow through the material is highly variable and controlled by heterogeneities in the waste material. These data gathered from this study can be used to assess various waste containment methods for closure of mines as well as rural sanitary landfills.

This project proposes to determine the rate of ground water recharge beneath disturbed mine lands in Nevada, with particular attention to heap leach piles, waste rock dumps and the associated issues of water quality with these areas. In the first year of the project, we have focused on sampling known closed mine sites and designing a field monitoring laboratory to investigate the flow and transport processes in these complex materials. We have and continue to analyze heap leach pile drainage data to determine rates of recharge from these structures. As heap leach piles are lined and drainage can easily be measured, these structures act as very large lysimeters, intercepting ground water recharge before reaching the water table. The integrated fluxes through these structures, long after active leaching and rinsing has stopped represent deep infiltration. Data gathered to date from field investigations shows a complex relationship between surface morphology, precipitation and long-term drainage rate. At several sites, changes in surface cover or management practices have been reflected in declines in drainage rates below that expected for native vegetation at these sites. Water quality from the studies sites shows a wide variation in dissolved constituents, primarily reflecting the mineralogy of the primary ore and waste rock, as well as the rinsing and closure strategies employed. Open pit precious metal mining in Nevada places large volumes of rock, some of which is reactive, at the land surface, both as heap leach piles and waste rock dumps. While the climate of Nevada is generally arid to semi-arid, rainfall and snowmelt can infiltrate following mine closure and become ground water recharge. Given the reactive nature of some of these mining wastes and the almost complete lack of quantitative data on long-term infiltration, it is critical that the rates of water and solute flux through these structures be quantified to determine if a significant potential for ground water degradation may occur and to develop effective management strategies.

As a result of efforts during the first year, we have developed a unique opportunity with Placer Dome Inc., to densely instrument a heap leach pad nearing completion. Currently, there does not exist any detailed, in-place monitoring and sampling facility to study the transport of water and contaminants through gold mining waste at the field scale. The constructed facility represents a partnership between industry and the university of significant benefit to both. At this time, no similar facility exists in the world and will provide tremendous opportunities for future research into contaminant transport from mining waste.

Placer Dome has provided the cost of instrumentation and monitoring as in-kind services, with UNR's activities focused on laboratory analysis, field collection of data, data analysis and experimental design. This site offers a unique opportunity, unavailable to us when the first year proposal was completed, to study in situ, 1) the evolution of wetting and drainage in an active heap leach pile, 2) the geochemical evolution of waters produced during leaching operations, 3) the short term drainage effluent quality following leaching 4) the efficacy of rinsing in reducing toxic species in the effluent waters and 5) to test various cover/closure options to reduce both water flow and toxic element release.

Information on anticipated long-term infiltration through heap leach piles and waste rock dumps at precious metal mines in Nevada is critical for assessing the potential impacts of these structures on ground water quality. Research completed in this project on existing sites (Kampf et al., 2002) and the field investigations in collaboration with Placer Dome Mining have resulted in a much more comprehensive understanding of fluid flow and recharge through mining waste material.

Methodology:

The original proposal had focused on quarterly monitoring of draindown and geochemistry from a bankrupt site in eastern Nevada. With strong industry support, we have revised our original concepts and built a much more detailed instrumentation at Placer Dome's Cortez Gold Acres facility in Crescent Valley, NV. The objectives of this facility are to measure, in space and in time, the fluid flow and contaminant transport processes within a large heap leach structure. The Gold Acres facility was deemed to provide much greater opportunity to study fluid flow in heap facilities, by integrating the sampler design into the construction of the heap leach pile, rather than relying upon a single outflow measurement as we had originally planned in Year 1. In late spring, 2001, UNR was contacted by Placer Dome Mining to develop an in-situ monitoring and research facility at the Cortez Gold Acres heap leach pad in Crescent Valley, Nevada.

This facility, rather than simply monitoring the drainage effluent from the bottom of one heap leach pile, will be constructed such that water quality and flow properties can be monitored at various depths and locations of the heap as well as at the bottom. A large array of samplers were designed and installed in the Cortez Gold Acres heap in January 2002. Figure 1 shows the placement of these lysimeters.

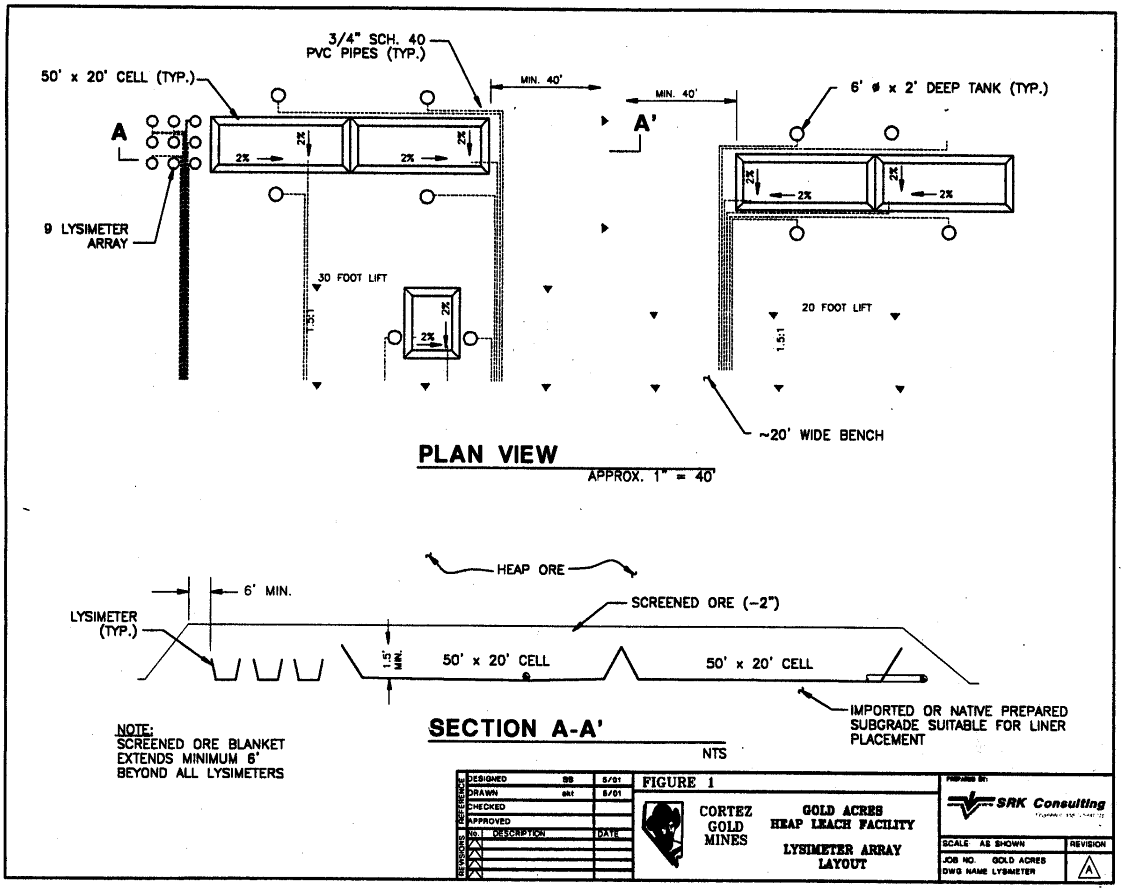

Figure 1. Schematic design of Cortez Gold Acres Facility (CGAF) lysimeter construction and location. Design drawings produced by SRK Consulting Engineers, Inc. for Placer Dome, Inc and the University of Nevada, Reno

Principal Findings and Significance

Due to a series of construction delays and lysimeter failures during construction of the final lift of the Gold Acres facility, the commencement of leaching and rinsing experiments was delayed until Sept-Oct 2002. Lysimeters had to be repaired several times due to accidental bulldozing of the lysimeter drainage lines during construction. As a result, the project has been extended via a no-cost extension through 2004. Several publications and a Master's thesis will be completed by late 2003.

Beginning in September 2002, a 90-day leaching experiment was begun. Field measurement of fluid flow, application rate and geophysical measurements on the top of the heap leach pad were continuously conducted. Lysimeters showed fluid breakthrough in approximately 2 days, close to predicted time based on numerical simulations conducted before the experiments. Fluid flow into the lysimeters was highly variable, showing in the impacts of hydraulic conductivity heterogeneity on the fluid flow field.

Fluxes into the lysimeters were generally between 50 and 60% of the applied flux once steady flow had been achieved. Subsequent numerical simulations, using spatially random generated conductivity field showed that these heterogeneities, combined with reduced permeability of the lysimeter backfill due to compaction are responsible for the reduction in observed flow at the lysimeters.

Draindown was begun in late 2002 and showed predictable results with respect to preferential flow. Those lysimeters that showed evidence of preferential flow during wetting showed rapid draindown (less than 12 hours) and no flows after the initial draindown. However, those lysimeters that showed primarily matrix dominated flow continued to have drainage several weeks after leaching was stopped.

These preliminary results indicate that draindown from closed heap leach mining facilities as well as waste rock materials is dominated by the heterogeneities of the conductivity field. Drainage from large channels will be rapid, however drainage from low conductivity zones will be very slow and may result, if sufficient pyrite is present, in anaerobic conditions dominating in local areas of the material. Such conditions can lead to significant metals transport from the waste material.

A Long-Term Comparative Study of Golf Courses Irrigated with Reuse vs. Municipal Water

Basic Information

Title:	A Long-Term Comparative Study of Golf Courses Irrigated with Reuse vs. Municipal Water
Project Number:	2002NV6B
Start Date:	3/1/2002
End Date:	2/28/2003
Funding Source:	104B
Congressional District:	Nevada 01
Research Category:	Water Quality
Focus Category:	Water Quality, Irrigation, None
Descriptors:	reuse water, irrigation management, golf courses
Principal Investigators:	Dale Devitt

Publication

1. Morris, R.L. and D.A. Devitt. 2002. Taking a Water Sample. Part I. Southwest Trees and Turf. 7(12): 6.
2. Morris, R.L. and D.A. Devitt. 2002. Establishing A Nitrogen Balance Sheet. Southwest Trees and Turf. 7(11): 12.
3. Devitt D.A., R.L. Morris and D.S. Neuman. Impact of Water Treatment On Foliar Damage of Ornamental Trees Sprinkle Irrigated with Reuse Water. J. Environmental Horticulture (In Press, June 2003).

Problem and Research Objectives:

As the population in southern Nevada grows, greater demands will be placed on the available water resources. Addressing this water supply-demand dilemma will require water managers to look at all possible water sources, even waters of lower quality. Utilization of treated sewage effluent (known as reuse water) for landscape irrigation purposes is an environmentally acceptable alternative to discharging to the Las Vegas Wash and reduces the need to expand both the water delivery and sewage discharge systems (viable economic alternative). However, utilizing poorer quality waters for irrigation purposes requires state of the art, science-based management practices. Fortunately for the urban sector, no form of irrigated agriculture consistently meets these requirements better than golf courses.
Specific Objectives:

1. Collection of baseline soil-plant-water data to assess the existing status of golf courses currently being irrigated with reuse water, golf courses transitioning to reuse water in the near future and golf courses that have in the past and will continue in the future to be irrigated only with municipal water.
2. Long-term monitoring (minimum of 3 years) of salt, nitrogen and water in the soil-plant system of golf courses irrigated with reuse water vs. municipal water.
3. Development of response curves to delineate if significant shifts from the baseline occur and project the time in which critical soil and plant threshold values might be reached.
4. Development of management strategies to prevent or minimize any potential negative soil plant response should the threshold values be exceeded.

Methodology:

Nine golf courses in the Las Vegas Valley were selected for a three-year monitoring program. Selection was based on 1) willingness of golf course superintendents to participate in the study, and 2) three courses selected based on long-term (>7 years) irrigation with reuse water, three courses selected based on a projected transition to reuse water within the next two years and three courses selected based on no anticipated switch to reuse water within the foreseeable future. Golf course superintendents were surveyed at the beginning of the monitoring period and annually, over a number of issues regarding the use of reuse water. Superintendents were asked to 1) characterize the golf course in terms of type of course, current management practices and budget allocations, 2) describe any attitude changes in the use or acceptance of reuse water, 3) quantify economic impact that the use of reuse water has on their operations and 4) list changes in management practices that occur as reuse water is utilized.

Fairways, greens and mixed landscape areas are being monitored at each golf course. Soil samples are taken in a 5 x 5 grid within irrigation cells located on the fairway and green of one hole of each of the nine courses. Soil samples are also taken adjacent to trees, shrubs and flowering annuals in the mixed landscape area of the same hole. Soil samples are being taken from the 0-15 cm depths. Soils are being analyzed using the saturation extract procedure outlined by the U.S. Salinity Laboratory (1954). All extracts are being analyzed for salinity, pH and all major cations and anions (including ammonium and nitrate). Grid locations are also analyzed using an EM38 device to measure bulk soil conductance. The bulk soil conductance is being correlated with ECe and soil moisture data to develop empirical models for mapping purposes. Soil sampling will occur at the same locations (slight offset) on a yearly basis and all samples will be analyzed using the same procedures outlined for the initial sampling.

Soil salinity sensors, soil moisture sensors (time domain reflectometry – TDR), solution extraction cups and tensiometers were placed in a nested arrangement at depths of 15, 45, 75 and 105 cm at one location in the fairway, green and mixed landscape area of each golf course and measured or sampled on a bi-monthly or monthly basis.

Turf grass from the fairway and greens and plant material from the mixed landscape area is sampled in the spring of each year and on a per need basis and analyzed for major cations and anions. Leaf temperature, leaf water potential, stomatal conductance and spad-chlorophyll index are taken on a monthly basis at three locations on the fairway and greens and on trees, shrubs and flowering annuals in the mixed landscape area of each golf course. Photographs are taken monthly of the turf grass and mixed landscape areas with a digital camera. A photo library is being established for each golf course to clearly document the visual health of the plants. A visual rating system is also being used to evaluate color, cover and overall health of the turf grass and mixed landscape plant material on a monthly basis. Spectral data is collected using a multi spectral sensor during the summer of each year to develop NDVI response curves (normalized difference vegetation index, vs. nitrogen, salinity, moisture) and to assess the adequacy of the irrigation system. All irrigation cells containing sensors were evaluated for irrigation uniformity distribution. If Hart and Reynolds (1966) adjusted uniformity's were less than 0.80, adjustments in the irrigation systems were made in an effort to improve the spatial distribution.

Water samples are collected monthly from the irrigation pond or irrigation system and from the soil solution cups and analyzed for salinity, pH and major cations and anions. Irrigation ponds are also analyzed for fecal coliform, algal content, dissolved oxygen, temperature and clarity (secchi disk) on a monthly basis.

Weather data (temperature, wind speed, solar radiation, relative humidity) is collected from on-site weather stations or nearby locations for the purpose of monitoring potential evapotranspiration.

Water meters have been placed on all laterals that deliver water to the monitoring locations on all nine golf courses. Meter readings are taken bi-monthly. Precipitation curves (time-pressure-volume) were established using collection cans placed in a grid pattern for all irrigation cells containing sensors. Actual precipitation associated with each irrigation event is predicted using the established curves for each site.
Water balances are maintained by monitoring irrigation input and estimating water loss via evapotranspiration by adjusting potential evapotranspiration estimates with appropriate crop coefficients (Devitt et al. 1992).

All data is being statistically analyzed using analysis of variance and/or multiple regression analysis. Grid data is being kriged and contour maps are being developed for each research plot.

Principal findings and significance: (Primary Project is continuing to 2005).

Water balances closed on the nine courses indicate that many of the courses are being under irrigated, with estimated leaching fractions below 0.15. This is a concern, as five of the golf courses will eventually transition to the lower quality reuse water and all of the courses maintain irrigation uniformity coefficients of approximately 0.85. The combination of low leaching fractions and uniformity coefficients of 0.85 should lead to a non uniform spatial distribution of salts, water and plant response. Sensor monitoring indicates that salt distribution is not only a function of irrigation water quality but also a function of leaching fraction imposed. Although plant response has not indicated any major shift in water status or visual appearance, soil salinity has begun to rise on those courses that have transitioned to reuse water. It will be critical that irrigation management change once threshold soil salinity values have been approached. Continued monitoring will indicate the time required to approach/exceed soil salinity threshold values based on current irrigation management practices.

Information Transfer Activities:

Information gained from the monitoring program is being incorporated into a Cooperative Extension Wastewater Management course, presented at scientific meetings, presented to local golf course superintendents and published in Southwest Trees and Turf. Results will also be published in Cooperative Extension Fact sheets and peer review scientific journal articles once the research has been finalized.

Long-Range Water Supply Forecasting for Nevada and the Colorado River Basin

Basic Information

Title:	Long-Range Water Supply Forecasting for Nevada and the Colorado River Basin
Project Number:	2002NV9B
Start Date:	3/1/2002
End Date:	2/28/2004
Funding Source:	104B
Congressional District:	Nevada 01
Research Category:	Climate and Hydrologic Processes
Focus Category:	Climatological Processes, Water Supply, Surface Water
Descriptors:	hydroclimatology, forecasting, streamflow, water supply, El Nino-Southern oscillation
Principal Investigators:	Thomas C. Piechota

Publication

1. Piechota, T.C., 2002. Climate Variability and Water Supply of the Colorado River Basin. Proceedings of the 2002 Conference on Water Resources Planning and Management, Symposium on Managing Extremes: Floods and Droughts, May 19 - 22, 2002, Roanoke, Virginia, American Society of Civil Engineers, Washington D.C.
2. Piechota, T.C., 2002. Relevance of Climate Variability, Climate Change, and Long-Range Forecasts to Water Agencies in Southern Nevada and the Colorado River Basin. Final Report to the Southern Nevada Water Authority.

Problem and Research Objectives:

A sufficient water supply in the southwest U.S. is a concern for planners and managers of water systems. The southwest has a limited supply of water and in many cases the demand exceeds the supply. In Nevada, 70% of the total water supply comes from surface water. The surface water generally comes from rivers that are snow-melt driven and experience the highest flow values in the spring and summer time. In Southern Nevada, surface water comes from the Colorado River allotment of 300,000 acre-ft per year. It is estimated that the full Colorado River allotment will be used by the year 2007. In Northern Nevada, the Walker, Carson, Truckee, and Humboldt Rivers are the main source of surface water.

The ongoing research seeks to provide information for better management of water resource systems at the beginning of the water year (October, November, December). This will be accomplished by evaluating the influence of large-scale atmospheric and oceanic processes on streamflow variability. An improved long-range water supply forecasts is the major contribution of this work. **Thus, the overall goal of the research is to develop an improved long-range streamflow forecast for major rivers supplying Nevada with surface water.**

The specific objectives of this research are to:

1. Identify the key oceanic and atmospheric phenomena that influence streamflow variability.
2. Develop long-range exceedance probability forecasts for streams in the Colorado River Basin and Nevada.
3. Compare the skill of long-range forecasts to existing NRCS water supply forecasts.
4. Develop procedures for incorporating an uncertain streamflow forecast into a model for a water resource system.

Methodology:

The research is summarized in four main tasks:

The **first task** in this study investigates the relationship between streamflow and various atmospheric and oceanic parameters. These parameters include those that explain the El Niño – Southern Oscillation (ENSO), the Pacific Decadal Oscillation (PDO) and global sea surface temperatures (SSTs). The parameters that have the strongest relationship with streamflow will subsequently be used in the long-range streamflow forecast model in Task 2.

The **second task** is to develop a statistical long range streamflow forecast using the predictor variables from the first task. The forecast that will be developed is an exceedance probability forecast that can be used at a given level of risk that a policy makers and/or water resource managers are willing to accept. The statistical streamflow forecast proposed here uses the SOI, PDO, and equatorial Pacific Ocean SSTs as predictors of future streamflow. Also included as a predictor variable, is the observed streamflow up to the time of the forecast. This may prove useful for one to three month forecasts; however, forecasts with longer lead times (e.g., six months) do not have much persistence and observed streamflow is not a good predictor.

The **third task** is to make a comparison of the streamflow forecasts developed in the second task with existing streamflow forecasts developed in the western United States. In many river basins of the western US, spring-summer streamflow is forecast using snowpack data from the previous winter months. The U.S. National Weather Service, in conjunction with the NRCS, supplies the monthly Water Supply Outlook for the Western United States for five months beginning in January of each year. The NRCS report contains the annual streamflow forecast and the spring-summer streamflow forecast for various stream gauging stations throughout the Western U.S. It is not anticipated that the forecasts developed in second task will replace the NRCS forecasts that start in January. Instead, it will compliment and extend the forecasts to the beginning of the water year.

The **fourth task** is to develop procedures for integration of probabilistic streamflow forecast into water resource system models. The PI will work with water agencies to incorporate streamflow forecasts into existing management models. The goal of this task is to incorporate an uncertain streamflow forecast into the operational model of the system that must meet certain constraints (e.g., water demand, reservoir levels, environmental demands).

Principal findings and Significance:

The main activities in Year 1 of the two-year research project have focused on the first research task of evaluating the influence of various atmospheric and oceanic parameters on streamflow variability in the Great Basin (Task 1) and preliminary development of the long-range water supply forecasts (Task 2).

The first analysis determines the strength of the relationship between the climate indicators and streamflow. In this analysis, the average monthly flowrates (cfs) for each USGS station are averaged for each season (JFM, AMJ, JAS, OND). The average seasonal values are then converted to volume (acre-feet) by multiplying the average seasonal flowrates times the duration (time) of the season. Similarly, the average monthly values for the various climate predictors (MEI, PDO, NP, SST1….12) are developed for each season. The timeframe of the above data ranged from 1950 to 1998. This timeframe represents a common period between the climate indicators and the streamflow.

Linear correlations were performed and appropriate confidence levels (90%, 95% and 99%) were determined to provide a measure of statistical significant the results. Noteworthy observations of the correlations analysis are that the ENSO signal (MEI and SST1) is non-existent in each of the five (5) Great Basin stations selected. The ENSO signal is very strong in the Virgin River (Lower Colorado River Basin) but non-existent to weak in each of the three (3) Upper Colorado River Basin stations. The PDO and NP signals is also non-existent in each of the five (5) Great Basin stations selected and non-existent to weak in the four (4) Colorado River Basin stations selected. SST11, an extra tropical region of the South Pacific Ocean, displayed the strongest and most consistent signal at all stations with the exception of the Virgin River, As previously noted, the Virgin River is the only station displaying a strong ENSO signal. SST5, the Gulf of Alaska region of the Pacific Ocean, was the next strongest and most consistent signal followed by SST3.

A Method to Determine the Effects of Fire, Restoration, and Invasive Species on Local and Regional Hydrology in the Great Basin by the Use of Environmental Tracers

Basic Information

Title:	A Method to Determine the Effects of Fire, Restoration, and Invasive Species on Local and Regional Hydrology in the Great Basin by the Use of Environmental Tracers
Project Number:	2001NV4182B
Start Date:	3/1/2001
End Date:	2/28/2002
Funding Source:	104B
Congressional District:	Nevada 02
Research Category:	Climate and Hydrologic Processes
Focus Category:	Hydrology, Acid Deposition, Methods
Descriptors:	fire, hydrology, geochemistry, isotopes, recharge
Principal Investigators:	James Thomas

Publication

Problem and Research Objectives:

Problem: A combination of periodic fire and the introduction of aggressive, non-native plant species has significantly altered the landscape of the Great Basin and may have affected significant changes in the soil moisture dynamics and hydrology of the region. Shallow-rooted annual grasses (cheatgrass) and deeper-rooted perennial grasses (crested wheatgrass) have replaced native plant communities dominated by deep-rooted perennial shrub and tree species. While the changes in plant community composition have received considerable attention, the accompanying alterations in hydrology in the Great Basin have not been thoroughly investigated. The demands placed on soil moisture and the timing of those demands by the introduced species may change (increase) the quantity of water available for recharge and may create near-surface conditions unfavorable to the continuation of native species.

Research objectives: The proposed study will seek to identify the hydrologic differences between burned and unburned sites in the Great Basin where the introduction of invasive plant species (Cheatgrass) may offer fundamental changes to the hydrologic regime. Two primary results are intended: (i) soil moisture availability and movement throughout the season will be described with relation to the factors that influence the success or failure of different plant communities and, (ii) recharge in adjacent areas characterized by fire-induced differences in plant community will be quantified.

Methodology:

Characterization of historic burns will seek to identify differences in recharge between control sites with native vegetation and burned sites with introduced vegetation using soil moisture measurements and a variety of environmental tracers. Measurements will be made at adjacent locations on either side of fire lines. Soil cores will be taken to depths below the root zone. Soil samples at various depths will be analyzed for chloride, stable isotopes of hydrogen and oxygen of water (deuterium and oxygen-18) tritium, and chlorine-36. These tracers have been used to quantify and determine the rate of recharge in arid regions (Gee and Hillel, 1988; Phillips et al., 1988; Scanlon, 1992;). They will be used to quantify the long-term hydrologic differences between areas with native vegetation and burn areas with introduced vegetation. The primary intent of this field exercise will be to identify differences in recharge rates in control areas with native vegetation and burn areas with introduced vegetation.

Principal findings and significance:

Soil cores have been recovered at two sites in the western Great Basin. Samples were taken to depths in excess of 20 feet. Samples have been analyzed initially for chloride as a basic indicator of site hydrology. Isotope analysis has not yet begun.

Evaluation of Ecosystem Metabolism at Selected Sites in the Lower Truckee River Basin

Basic Information

Title:	Evaluation of Ecosystem Metabolism at Selected Sites in the Lower Truckee River Basin
Project Number:	2001NV4281B
Start Date:	3/1/2001
End Date:	2/28/2002
Funding Source:	104B
Congressional District:	Nevada 02
Research Category:	Biological Sciences
Focus Category:	Ecology, Surface Water, Nutrients
Descriptors:	metabolism, ecosystem, TMDL's,dissolved oxygen
Principal Investigators:	Christian H. Fritsen, Wallace Alan McKay

Publication

1. Green,. M.B. Nutrient balance for periphyton growth along a montane to desert gradient: The Truckee River, Nevada. Masters Thesis, University of Nevada Reno, Hydrologics Sciences Graduate Program.

<u>Problem and Research Objectives</u>:

The lower Truckee River of Nevada is a lotic ecosystem influenced by our societies uses of the Truckee River Watershed's water and land resources. The use of these resources often create point source and non-point source loadings of the lower Truckee River with materials (nutrients, water, pollutants etc.) that influence the biota and water quality (WQ) which are integral components of the lower Truckee river's ecosystem that has a specific targeted set of beneficial uses.

In order to monitor the lower Truckee river's water quality the Truckee Meadows Water Reclamation Facility and the Desert Research Institute has deployed water quality sensors throughout the lower Truckee River (LTR). These monitors are primarily utilized to determine if oxygen levels in the LTR reach threshold levels that may compromise the LTR's beneficial uses. This information also has been used to tune and validate WQ models of the LTR that are being developed and refined as tools for helping guide regulations and operations that will maintain the WQ of the LTR.

As part of the overall efforts to validate WQ models for the LTR, the stocks and dynamics of algae and macrophytes biomass has been assessed in the LTER. The rationale for such monitoring is based on the premise that algae and macrophytes are primary agents of oxygen consumption and production as well as nutrient transformations. The monitoring and assessment of algae and macrophytes biomass in the LTR is an operation that requires hundreds of hours in the field as well as laboratory assessments of biological constituents. In addition, the deployment of personnel into the field presents risks to institutional resources and health. Therefore, we are seeking alternative measures as proxy's for monitoring plant biomass or biomass dynamics in the LTR. Models being constructed for the LTR are indirectly providing means for accomplishing this general objective through mechanistic nutrient accounting and hydrodynamic simulations. Another approach worth exploring is the relationship between oxygen dynamics that are a function of community metabolism and the algal and macrophyte biomass measured in the river during the same time periods. By determining if there are site-specific relationships between algal or macrophytes biomass or biomass dynamics and community metabolism we will be able to evaluate if there is a means to provide a more direct and perhaps more synoptic method for monitoring biomass in the LTR that influences WQ, beneficial uses and ecosystem function during the future.

<u>Methodology</u>:

YSI sondes nominally consisting of probes for the determination of dissolved oxygen, temperature, pH and conductivity were deployed from the bridges located at Mogul, East McCarren, Lockwood, Tracy/Clark, Painted Rock, Wadsworth, Dead Ox and Little Nixon along the LTR. TMWRF personnel maintained these sondes since their deployment starting in 1985. The data collected from these sondes are available on the web at www.tmwrf.com or by contacting TMWRF at 8500 Cleanwater Way, Reno, NV 89503.

DRI personnel also deployed additional sondes at five additional locations during the summer to autumn of 2001. Such deployments were made to make assessments of DO dynamics at sites not traditionally monitored by TMWRF- yet are integral to providing synoptic information for the

LTR. These additional sites also coincided with periphyton biomass monitoring projects for the Lower Truckee River that was accomplished by DRI, TMWRF and Washoe County personnel.

Streamflow data, necessary for community metabolism calculations, were used to determine the discharge, velocity, and depth of the lower Truckee River. The United States Geological Survey (USGS) monitor real-time streamflow with current meters for several sites along the Truckee River including at the North Truckee Drain at Spanish Springs Road near Sparks, Vista, near Tracy/Clark, below Derby Dam, at Wadsworth, and near Nixon. Streamflow data collected by USGS are available on the web at www.usgs.gov. Sites nearest to the areas where DO sensors were deployed are initially being used as proxies for discharge at these sites. Cross sections for discharge at the sites of the DO sensor deployments are being used to evaluate the USGS gauges as measure of discharge at the DO sensor sites.

Principal Findings and Significance:

Results of our activities have been presented to the Truckee River Coordinated Monitoring Committee at Washoe County in the Spring of 2002. Personnel from Washoe County and the cities of Reno and Sparks were present and expressed interest in determining if our findings could provide an better indirect means for monitoring plant material within the Lower Truckee River when coupled with remote sensing. They have water quality sensors deployed on the river that have been augmented to help in determining the community metabolisms of more reaches along the LRT. Furthermore they have expressed interest in utilizing community metabolism as a means to assess the effectiveness of stream restoration efforts.

Information Transfer Program

USGS Summer Intern Program

Student Support

Student Support					
Category	**Section 104 Base Grant**	**Section 104 RCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	6	0	0	0	6
Masters	5	0	0	0	5
Ph.D.	1	0	0	0	1
Post-Doc.	0	0	0	0	0
Total	12	0	0	0	12

Notable Awards and Achievements

Dr. Thomas Piechota has received an NSF CAREER Award on "Improved Hydrologic Drought Forecasting Using Climate Information" as a result of his research funding from the 104B program.

Publications from Prior Projects

None