To: Jim Coleman, Chair; Michael Campana; Fred Choobineh; Jeff Gray; Malcolm Hughes; Ruby Leung; Young-Doo Wang

From: Gayle Dana, Project Director, Nevada NSF EPSCoR Program
Nick Lancaster, Tom Piechota, Scott Mensing, Nevada NSF EPSCoR Climate Change Project Co-PI's

Re: Responses to Comments from the site visit of the Nevada NSF EPSCoR External Research and Technical Advisory Board (ERTAB), February 5, 2009

Date: March 27, 2009

The External Research and Technical Advisory Board (ERTAB) conducted a site visit and meeting at the Desert Research Institute in Reno, Nevada on February 5, 2009 in order to review the progress to date on Nevada's most recent NSF EPSCoR grant "Nevada Infrastructure for Climate Change Science, Education and Outreach." The ERTAB submitted a report of their visit and recommendations for the project.

The Principal Investigators of the Nevada NSF EPSCoR Climate Change Program very much appreciate the valuable feedback and recommendations of the ERTAB. We have responded to each recommendation with specific strategies on how we plan to incorporate these recommendations. The responses are embedded after each recommendation in the ERTAB's February 5, 2009 Memo. After reviewing our responses, if the ERTAB has any concerns about our approaches, please do not hesitate to contact Gayle Dana.

ERTAB 2-6-09 Report with 3-27-09 responses from PI's embedded

RICE

Office of Research

To: Gayle Dana, Director, Nevada NSF EPSCoR Program

From: Jim Coleman, Chair; Michael Campana; Fred Choobineh; Jeff Gray; Malcolm Hughes; Ruby Leung; Young-Doo Wang

Re: Comments from the site visit of the Nevada NSF EPSCoR External Research and Technical Advisory Board (ERTAB), February 5,2009

Date: February 6, 2009

The External Research and Technical Advisory Board (ERTAB) conducted a site visit and meeting at the Desert Research Institute in Reno, Nevada on February 5, 2009 in order to review the progress to date on Nevada's most recent NSF EPSCoR grant "Nevada Infrastructure for Climate Change Science, Education and Outreach." ERTAB members present at the review meeting included Dr. Michael Campana, Fred Choobineh , Dr. James Coleman (Chair), Dr. Jeff Gray, Dr. Malcolm Hughes, Dr. Ruby Leung, and Dr. Young-Doo Wang. Dr. Eban Goodstein was unable to attend the meeting. The agenda of the meeting consisted of presentations by the Nevada team on their EPSCoR program, including some information about the focus and outcomes of previous EPSCoR programs, in addition to an overview of the newest grant and detailed reports of the progress made to date in implementing this new program. ERTAB members were also given a tour of two impressive facilities at DRI (the EcoCELLs - a unique facility for examining the mass balance of materials in experimental mesocosms, and CAVCaM, which provides computer visualization capabilities such as the 4-sided FLEXICAVE) that were supported by past EPSCoR programs.

Below is a summary of the main points of the ERTAB's discussions: The Advisory Committee was very impressed with both the strategy and vision of the Nevada Infrastructure for Climate Change Science, Education and Outreach program and what has been accomplished over the first five months of the project. The Nevada team had not yet completed its strategic plan for NSF, so ERTAB members were not able to review progress in relation to that plan. However, we were very impressed with the components of the draft plan that we examined, and, based on our discussions with the project team, we were also very impressed with the high degree of planning that has been done to date. Below we list a few observations supporting this overall conclusion:

o The team has produced one-page draft planning diagrams for each component of the project that do an excellent job of depicting the strategic path of each component including the inputs and outputs needed to achieve a desired set of well articulated outcomes.

o The Project Director has produced an excellent planning matrix that makes it very easy to determine what activities need to happen at what point in the project. We observed that members of the project team were using this matrix in their discussions, and we felt that this matrix will help keep the project team focused on the project goals and timelines.

o This is a very complex interdisciplinary project. We were impressed with the organizational structure that has been put in place to manage the program and feel that it is an appropriate structure to manage the complexity.

o The management structures, along with the productive interactions we observed among the team members, gave the ERTAB confidence that the Nevada team will be able to successfully integrate research from a number of disciplines. We generally felt that the Nevada team has therefore created a structure that has a strong potential to maximize the synergies that can arise from interdisciplinary research.

The ERTAB members also made the following recommendations to help improve the project:

1) ERTAB members were concerned that the there is a risk of the Nevada team focusing too strongly on the notion of infrastructure building and diminishing the need for advancing the scientific body of knowledge. We recommend that the senior scientists involved in the grant agree on a scientific path that could influence the infrastructure investments to ensure advancing the body of knowledge, both during the life of this grant and beyond its life.

> **Response #1a:** Infrastructure investments (including provision of funding to faculty and graduate students) in this award are guided by the scientific priorities and research needs for the region (and also the nation) expressed by a number of independent reviews and discussed in the proposal project description. These include, but are not limited to, the following: (1) improved knowledge of past and present climate variability to provide a baseline against which to evaluate future changes; (2) modeling and visualization of the interacting effects of climate change (especially future changes) on landscapes and ecosystem resources; (3) observations of regional climate, ecosystems, and hydrology to provide data to calibrate models, quantify key processes, understand responses, and detect change; and (4) development of management tools to enable land and water managers to incorporate the latest scientific knowledge and information in their decisions.
>
> As part of the strategic planning process, we are developing a science plan for all relevant infrastructure building components that will provide scientific direction by identifying key scientific questions and/or hypotheses to be addressed. This process will also provide direction on prorities for different components and the interactions needed between component activities. For example, development of appropriate statistical downscaling schemes and generation of high-resolution climate model output for the State and region is needed for a variety of hydrologic and ecosystem modeling studies that seek to understand and predict the effects of future climate change. This requires: (1) acquisition and installation of appropriate computer hardware on which to run the models; (2) recruitment of key faculty and postdoctoral researchers to undertake regional climate modeling; (3) acquisition and implementation of statstical downscaling models and code; (4)

provision of model data to researchers via the data portal; and (5) translation of results to decision makers.

Thus, it will be important in the design of the transect to ensure that it is possible to address important scientific questions/hypotheses during the first five years of the project even though it is important to ensure that the transects are designed with enough flexibility to allow for additional questions to be addressed in the future.

Response #1b: The Water and Ecology Components are preparing a Science Plan that will be used to guide the planning of the transect instrumentation and any future add on equipment that may occur as part of additional funding. To augment the science plan and to focus the field efforts, the Water and Ecology components will query their team members for testable hypotheses (plus a short description) that need the presence of an elevational transect in Nevada to address. Requesting the hypotheses will force/encourage the research community to consider how the infrastructure can quickly be used to increase the body of knowledge for how climate change will affect water resources and ecosystem services. These hypotheses will become an important guide for the design and installation of the monitoring stations, including particular instruments that could be purchased early during the project. We intend for these hypotheses to be identified and available prior to the RFP for the Seed Grant funding (approximately $100K per year), which will be made available for the entire project to focus efforts on basic science questions that can be addressed with the new project infrastructure.

2) The climate of Nevada is characterized by very strong variability in time scales from the interannual to multidecadal. Not only does the variance of precipitation totals, for example, tend to be large compared to the mean, but shifts in climate regimes have led to extreme conditions persisting, in some cases for decades. This is bad news and good news for this program. The bad news is that it will present a challenge to determine whether the regional effects of global climate change have emerged from such strong background variations. On the other hand, the good news is that this richly varied climate history provides a wide range of circumstances, even in the last few decades, in which to test models linking climate, ecology, hydrology and society in Nevada. By emphasizing the explanation of what has already happened in Nevada, the project will acquire increased scientific credibility and public interest. ERTAB recommends that the leadership team consider organizing a symposium after a couple of years focusing on the extent to which observed climate variability, and its consequences in Nevada, is well understood.

Response to #2. The nature of climate change in Nevada needs to be carefully evaluated to provide a solid foundation for the project. For instance, in terms of instrumental data, it would be beneficial to update a landmark local publication entitled "Nevada's Weather and Climate", by Houghton et al, published in 1976. Too often the recent history of western climate has been displayed and analyzed using data that are not appropriate for the task, including the PRISM datasets (http://www.prism.oregonstate.edu/), which do not take into consideration the dramatic increase in urban development that has taken place over the past several decades (Chris Daly, personal communication). To provide the best possible information to stakeholders and the public, we will propose to include a session on observed climate variability in the region at our second annual tri-state meeting to guide and inform the modeling activities to be carried out in not

only Nevada but Idaho and New Mexico as well. The second annual tri-state meeting will be held in Nevada in 2010.

3) Developing climate change scenarios for assessing climate change impacts on hydrology and ecosystem is an important goal of this study. Dynamical downscaling is a useful approach to develop high resolution climate change scenarios that are more physically based, and hence provide insights on the interactions between the large scale and regional scale forcings at a wide range of spatial and temporal scales. However, they are computationally intensive (both CPU and data storage), and it is likely that only a few such scenarios can be developed based on a single regional climate model driven by a small number of global climate simulations. Statistical downscaling can complement the dynamical approach to provide a large number of climate change scenarios that enable more robust assessment of climate change effects. ERTAB recommends the team consider an early adoption of a statistical downscaling component, based on an existing, accepted method, will enable climate change impacts to be assessed and provide early insights on climate surprises, interactions between different impacts, areas that require more detailed modeling and analyses, and methods to refine the approach.

Response to #3. The climate modeling component regards development of a statistical downscaling scheme for Nevada and adjacent areas as the first priority for this group. Results from statistical downscaling are needed for development of appropriate hydrologic, land use, and ecological models that assess impacts of climate change at a regional scale. Such models will be developed and used by GRA's working in the climate modeling component under the direction of Dr. Zhongbo Yu (UNLV) and Dr. Scott Bassett (UNR); as well as at least two of the recently awarded graduate Fellows. Statistical downscaling is explicitly included in the statement of work for these GRA's and Fellows.

The climate modeling component is currently recruiting a post doctoral researcher and an assistant research professor in the field of regional climate modeling (to be based at DRI). The first priority of the post doctoral researcher will be to implement a regional statistical downscaling scheme to provide input to hydrological and ecological models. The component lead (Dr. Darko Koracin) is in contact with Dr. Ruby Leung (PNNL) to obtain code for a statistical downscaling scheme developed by her group. Statistical downscaling methods are based on the empirical relationship between the observed climatology at higher resolution than the global climate model results. The empirical relationship is derived using the observations (predictand) and climate model results for the period of available observations and may use many modeled field as predictors. Based on the recommendations, there are two methods that can be tested for our project. For both methods, a high-resolution (e.g., 1/16º) gridded historic observed temperature and precipitation data needs to be developed.

The first method ("delta method") is based on perturbations of the multi-year gridded data by computing monthly mean changes in average temperature and precipitation in the area for the future segments of ten years (e.g., 2020s, 2040s, and 2080s). Then these perturbations (deltas) are applied to the high-resolution historic gridded data to form future climate change scenarios. At each grid point, the regional temperature delta is added to the observed daily maximum and minimum temperatures and the regional precipitation data is multiplied by the daily precipitation. The final result is that 30-year daily temperatures and

precipitation sequences are created that are physically consistent for each future time and each global climate model.

The second and more complex method is described by Wood et al. (2002). The basis of this method is to preserve the observed statistical properties of temperature and precipitation during the 20th century while allowing these to change in the future projections. The monthly–mean global climate model results are bias-corrected and these corrected values are then downscaled to 1/16º grid spacing. A simple spatial disaggregation is applied to temperature and the monthly mean data are disaggregated to daily time steps. Regarding precipitation, the method accounts for the effects of both large-scale processes and changes in atmospheric circulation on the local precipitation.

Wood, A.W., E.P. Maurer, A. Kumar, and D.P. Lettenmaier, 2002, Long range experimental hydrologic forecasting for the eastern U.S., J. Geophys. Res. 107(D20), 4429, doi:10.1029/2001JD000659.

4) The two interdisciplinary science questions (ISQs) to which the potential interdisciplinary science teams are to respond in the seed grant RFP are quite broad, which should ensure that teams will be able to respond with maximum creativity. The specific questions listed below each ISQ are very good examples, but ERTAB recommends that it should be clear that the teams are free to answer whatever question(s) they deem appropriate, as long as the question fits within the general area of the two ISQs.

Response to #4. The RFP for the interdisciplinary science teams refers only to the two major questions, as well as independently identified research needs.

The specific instructions to the proposers state:

"Teams should propose research, education, and/or outreach activities that will: (1) utilize the new infrastructure developed as part of the NSF EPSCoR project; (2) address cross-cutting issues related to the two broad interdisciplinary science questions and research needs above; (3) involve faculty and students from at least two institutions (DRI, UNLV, and UNR), with participation from the Nevada State College and NSHE community colleges as appropriate; and (4) lead to follow-on proposals to NSF or other granting agencies. Teams are encouraged to include graduate and undergraduate students and their faculty mentors who are supported with NSF EPSCoR or other funds".

We believe that this will give maximum flexibility to the groups and the areas which they will pursue. In addition, the PI's emphasized the ERTAB recommendation at the March 11 and 12, 2009 workshops that were held in Reno and Las Vegas to inform faculty and initiate formation of potential teams.

The full RFP can be found at:

http://www.nevada.edu/epscor/nsf/InterdisciplinaryScienceTeamsRFPFinal.pdf

5) Many educators have observed that early intervention programs at the middle school level are necessary to provide the initial spark of interest toward a career in the areas of science, technology, engineering and mathematics (STEM). Waiting until the senior year of high school is often too late, especially for recruiting women into the sciences [reference 1 below]. The ERTAB commends the recognition of this fact within this project by providing very broad and substantive intervention with teachers from middle schools. Although the project

outlines a pipeline of education and outreach from middle school through doctoral research, a missing component is the continued intervention of middle school students in the formative years of high school. A possible scenario is that students become excited about the new material their teachers introduce in the classroom during middle school, but have no outlet to pursue those interests in their high school years such that interest wanes. The ERTAB suggests that the PIs and Component Leaders develop an intervention mechanism that will provide a deep research experience appropriate for a high school student (e.g., close mentoring of students require some shift in funding from other programs, but may also be achieved in some non-funded interactions [reference 2 below]. Such intervention may also need to be more focused on just a few students, rather than the broader intervention of earlier years.

I. Tracking the Reasons Many Girls avoid Science and Math, Science Daily, September 8, 2008, httD://www.sciencedailv.com/releases!2008!09!080905153807.htm
2. Bell, R.L., et al., "Just do it? *Impact o fa science apprenticeship program on high school students' understandings of the nature of science and scientific inquiry," Journal of Research on Science Teaching 2003. 40(5): p. 487-509.*

Response to #5. As the ERTAB has identified, there is a need for intervention at the high school level so that students excited by the program in their middle school classes have a bridge between that experience and what might be available at the college level. Since no funding is currently available for high school intervention, we will follow a course of action primarily based on voluntary work with an effort to reallocate some funds if they become available.

We will seek opportunities to work with existing programs at our universities. For example, we will work with the TRIO program in identifying high school students interested in STEM disciplines and climate change and seek university faculty willing to volunteer time at local schools. We will also work with programs such as exist within the Mathematics and Statistics department at UNR that have faculty working in high schools on tutoring programs. With the INTEL science fair being held in Reno this year, we will also seek faculty volunteers who can mentor high school students. There are a number of faculty being funded through the grant and this will be our starting place for finding those willing to include high school students in their projects. Mentoring and/or internship opportunities may be particularly appealing to students in the Davidson Academy at UNR, but will be made available to students in other high schools in our districts as well. As noted in the ERTAB report, this approach might reach only a few students but may have a deeper impact on those students. We will work with our respective colleges and departments to identify these potential opportunities and faculty volunteers. We will also seek out in-service teachers working on their MA degrees in education and collaborate with College of Education faculty advisors to utilize climate change science education in student's final projects.

We will also seek to redirect some funds if possible to engage high school teachers in our ongoing programs. We will seek out the funds that will allow us to include high school teachers into the 2010 Climate Education Conference. This may simply require paying for substitute teachers as needed. We will work with the school districts to see if we can possibly schedule events on in-service days as part of teacher professional development.

> We will also seek to redirect some funds to attract a few high school teachers (up to three from Las Vegas and three from Reno) to participate in our summer workshop program and thus carry the curriculum on at the high school level. By targeting teachers at high schools that our middle school students will feed into, this may be a way to bridge the middle school and college experiences. While limited in extent, by identifying just one teacher in a relevant discipline at each of three schools each year, this may be sufficient to provide a continuing curriculum experience as well as having a mentor in the high schools who can guide students. We will work with schools and teachers to identify those courses where climate change can be used to augment the existing curriculum (for example the atmospheric chemistry of climate change in a chemistry class).

6) Policy strategies can be broadly characterized by structural and informational dimensions. Structural strategies include tax, incentives, rebate, standards, etc. Recent research shows that the information dimension may be more important than structural one. In this respect, Nevada's policy, decision-making and outreach component is well conceived. It is good that understandable information on water issues can be presented to policymakers, stakeholders and the public. One concern is the information is mainly supply-side oriented (i.e., water recharging). ERTAB recommends that the demand-side such as conservation, water appliance efficiency and water conservation-oriented pricing, etc also be addressed. Also, areas examined should include socio-economic and demographic characteristics, in addition to physical attributes of water availability and demand. The inclusion of some examinations into the demand-side of water availability including socio-economic data should allow the project to be more balanced and integrated.

> **Response to 6:** We appreciate this comment and the Policy and Outreach Component will be looking into ways to include research on demand-side issues while still maintaining a supply-side focus. Demand is intimately linked to demographic profile and one of the targeted hires in the project is someone with a demographic and spatial statistics background in recognition of this need. This new hire will be in Year 3 of the project. Given the current focus on supply-side issues, the Policy and Outreach Component will evaluate ways to include demand-side research, perhaps even trying for greater funding through the interdisciplinary science team funding mechanism that will be available in the coming months. In doing so, the effort of the Policy and Outreach Component will also need to integrate with the study areas of some of the other Components and the stakeholders for these areas.

7) The Nevada Infrastructure for Climate Change Science, Education and Outreach program is on a path to create truly first class infrastructure consistent with the outcomes of several past EPSCoR funded programs in Nevada. It is not clear, though, whether the external community has recognized the fantastic infrastructure that NSF EPSCoR has helped to create in Nevada, and therefore it is not clear whether national and international collaborations have been maximized. The leadership team of this new project should expend some effort to fostering national and international visibility of climate change science infrastructure that is being created. ERTAB agrees that the best way to gain this recognition is to ensure that high quality publications are produced by

scientists and students working on the project. But, ERTAB also recommends that the leadership team explore ways to leverage the existing collaborations and climate change infrastructure developed with the EPSCoR programs in New Mexico and Idaho to bring climate change scientists to this region. Another mechanism recommended by ERTAB is to study the Niwot ridge LTER site in Colorado (http://culter.colorado.eduINWTD - people from around the world go to Niwot Ridge because the infrastructure is there and it is a scientifically fascinating place. Nevada offers similarly exciting ecological, geological and climate characteristics and this Nevada EPSCoR program should be able to create the same sort of magnet. The leadership team might pursue supplemental funds to attract visiting scientists and students (perhaps from non-EPSCoR states) to Nevada to take advantage of the new infrastructure and start creating a national/international hub that will advance the stature of Nevada's scientists and the overall state of climate change science. Additionally, the ERTAB feels that the NSF EPSCoR office in Washington, D.C. needs to be more proactive in ensuring that NSF program officers are aware of the tremendous infrastructure created by NSF EPSCoR programs. Being proactive could facilitate awareness within the research community of the opportunities offered to scientists across the nation by NSF EPSCoR's investments. in Nevada (and elsewhere).

Response to 7. These are great recommendations from ERTAB for ensuring that the infrastructure developed by the project is recognized and utilized by the national and international climate change community. We intend to accomplish this in the following four ways:

1. Educating and informing the external climate change community about our project by:

- Publishing results in high quality journals; this is a targeted metric in our strategic plan.
- Presenting summaries/results of our project at national and international conferences. We presented posters at the 2008 AGU and March 2009 AAG Annual Meetings and will be presenting at the upcoming April 2009 PACLIM Workshop. We also had a booth, with project posters and handouts, at the AAG Annual Meeting that was staffed with faculty and students throughout the meeting. The booth generated a lot of interest from meeting participants.
- Participating in climate change and related national initiatives (e.g., CIRMOUNT [The Consortium for Integrated Climate Research in Western Mountains], NEON, WATERS) and through collaborations with national centers (e.g., NCAR).
- Publishing newsletters and other outreach information that will be sent to the external climate change community. Our Nevada EPSCoR office recently hired a Communications Specialist, Lisa Contreras, who is currently preparing a communications plan for Nevada's EPSCoR programs.

- Implementing our Climate Change Data Portal, which will be the main gateway for climate change information and computing resources for internal and external science and stakeholder communities. The Data Portal is currently in development and a beta version will be running and tested in year 2.

2. Leverage the existing collaborations with New Mexico and Idaho to bring climate change scientists to the region. The primary vehicle for doing this will be the annual meeting of the Tri-State (NV-ID-NM) Western Consortium. The first annual meeting (March 31-April 2009) will be focused on establishing the collaborations among our three states. We envision inviting prominent climate change scientists to subsequent annual meetings to encourage national collaborations. This will culminate in the fifth and last year of the project with a National meeting on Climate Change, co-sponsored by all three states.

3. Study and possibly visit Niwot Ridge LTER (and other LTER sites) as a model for attracting scientists from the U.S. and other parts of the world. The lead PI, Dr. Dana conducted research at the McMurdo Dry Valleys LTER (also an interesting place scientifically) for many years and interacted with many scientists from around the world that visited this remote area to do research. Dr. Dana knows three of the Niwot Ridge PI's (Dr. Diane McKnight – also a PI on the McMurdo Dry Valley's LTER -; Dr. Kathy Tonnessen; and Dr. Mark Williams) and will contact them regarding how they promote Niwot Ridge and the McMurdo sites for use by other scientists.

4. Pursue supplemental funding for attracting visiting scientists. Within the year, the leadership team will target potential funding sources for this purpose.

8) ERTAB members were informed about the possibility of Nevada being eligible for supplemental funding to the original EPSCoR grant. If a supplement is available, we recommend that Nevada consider the following three recommendations in preparing a request for supplemental funding.

o Request funding to support research or seed grants to NSHE faculty to advance the scientific body of knowledge of climate change.

o Request funding to attract visiting scientists and students (perhaps from non-EPSCoR states) to Nevada to take advantage of the new infrastructure and start creating a national/international hub that will advance the stature of Nevada's scientists and the overall state of climate change science.

o Request funding to develop an intervention mechanism that will provide for appropriate engagement of high school students in the project.

Response to 8. If supplemental funding does become available, the leadership will seriously consider targeting funding for the three recommendations above.

Our project is already addressing bullet number one. We are currently offering two funding opportunities for NSHE faculty that are intended to advance the scientific body of knowledge of climate change:

A Seed Grant program. The RFP for this competition can be found at:

http://www.nevada.edu/epscor/nsf/SeedGrantrfp09.pdf

Interdisciplinary Science Team program. The RFP for this competition can be found at:

http://www.nevada.edu/epscor/nsf/InterdisciplinaryScienceTeamsRFPFinal.pdf

Awards will be made in early summer 2009.