DISCLAIMER

Electronic versions of the exhibits in these minutes may not be complete.

This information is supplied as an informational service only and should not be relied upon as an official record.

Original exhibits are on file at the Legislative Counsel Bureau Research Library in Carson City.

Contact the Library at (775) 684-6827 or library@lcb.state.nv.us.

7

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/If not in response to a program announcement/solicitation enter NSF 03-2

NSF 03-515 03/17/03

FOR NSF USE ONLY

NSF PROPOSAL NUMBER

0331249

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)

GEO - GEOSCIENCE EDUCATION

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
				134599174	

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)

886000024

SHOW PREVIOUS AWARD NO. IF THIS IS
☐ A RENEWAL
☐ AN ACCOMPLISHMENT-BASED RENEWAL

IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE

University of Nevada Desert Research Institute

AWARDEE ORGANIZATION CODE (IF KNOWN)

0089078000

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE

University of Nevada Desert Research Institute
2215 Raggio Parkway
Reno, NV. 895121095

NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE

PERFORMING ORGANIZATION CODE (IF KNOWN)

ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS
☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS

☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Late Pleistocene Extinction and Paleoenvironments in Southern Nevada: Combining Effective Geoscience Curricula with Authentic Research for High School Students and Teachers**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 341,066	24 months	07/01/03	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☐ BEGINNING INVESTIGATOR (GPG I.A)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.B, II.C.6)
☒ HISTORIC PLACES (GPG II.C.9)
☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.C.11)
☐ VERTEBRATE ANIMALS (GPG II.C.11) IACUC App. Date _____
☐ HUMAN SUBJECTS (GPG II.C.11)
Exemption Subsection _____ or IRB App. Date _____
☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.9)
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.E.1)

PI/PD DEPARTMENT
Division of Earth & Ecosystem Sciences

PI/PD FAX NUMBER
702-895-0514

PI/PD POSTAL ADDRESS
2215 Raggio Parkway
Reno, NV 89512
United States

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME Paul Buck	PhD	1990	702-895-0424	paul@dri.edu
CO-PI/PD Cathy Andrews	EdD	2000	702-799-5438	candrews@interact.ccsd.net
CO-PI/PD Stephen M Rowland	PH.D.	1978	702-895-3625	srowland@nevada.edu
CO-PI/PD				
CO-PI/PD				

Electronic Signature

P

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the individual applicant or the authorized official of the applicant institution is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), as set forth in Grant Proposal Guide (GPG), NSF 03-2. Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

In addition, if the applicant institution employs more than fifty persons, the authorized official of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of Grant Policy Manual Section 510; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Appendix A of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Appendix B of the Grant Proposal Guide.

Certification Regarding Lobbying

This certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure of Lobbying Activities," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME Linda Piehl	Electronic Signature	Mar 17 2003 6:12PM

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
775-673-7481	lindap@dri.edu	775-673-7485

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

PROJECT SUMMARY

This innovative geoscience education partnership links the administration and faculty of the new Shadow Ridge High School (to open Aug. 2003), the Clark County School District K-12 Mathematics, Science, and Instructional Technology Services (MSITS) Department, geoscientists from the University and Community College System of Nevada (UCCSN), and a number of influential community partners for the development and implementation of an innovative, more effective inquiry-based model of earth system science teaching and learning. We will open Shadow Ridge HS with **the District's first earth science honors class.** The class integrates three powerful learning components to improve student achievement in earth science and increases the numbers of students completing a rigorous earth system science class: 1) the **EarthComm™** modules and laboratory activities, co-developed by the American Geological Institute and NSF, published by It's About Time, Inc; 2) establishment of the **Bill and Ted Gilcrease Earth Science Laboratory** in the new high school, based on a large collection of extinct fauna fossils collected from Pleistocene deposits near the high school, and 3) **authentic research at the Tule Springs site** by students and their teachers, placed on the National Register of Historic Places for its paleontological, geological and archaeological importance. These activities will be linked through an engaging theme still vigorously debated in the professional paleontological and archaeological literature: the cause (or causes) of extinction in North America of almost three dozen genera of mostly mammals at the end of the Pleistocene. Through specially developed Inquiry Modules, students and teachers will explore such topics as the purported association of human artifacts with extinct fauna in the Tule Springs deposits, evidence for climate change during the late Pleistocene, biology and ecology of the extinct Colombian mammoth, and others. UCCSN geoscience and archaeology faculty will work with Shadow Ridge HS earth science teachers and CCSD curriculum specialists to develop and implement these Inquiry Modules in the classroom. Block scheduling will be used to facilitate extended periods of field research for all students in the class; math, English, and social studies teachers will integrate earth science literature, data, and examples into their own classes. New teachers are currently being hired (as of March 17, 2003) with this project in mind.

Intellectual merit: This project implements a new earth science honors course based on national science standards and use of effective instructional tools and teaching methodologies (EarthComm) to improve student achievement and increase the numbers of students taking challenging earth science coursework. We will provide authentic research opportunities in field and laboratory settings for students to link their course work with a nationally important geological and paleontological site next door to the new high school. Visualization technologies will be used to enhance learning, and we will link many activities across disciplinary boundaries in the high school curriculum. Evaluation will be conducted by the Shadow Ridge HS and MSITS to determine the projects effectiveness.

Broader impacts: If the project described is effective at Shadow Ridge HS, wider implementation of this type of program with its curricular and research elements could significantly improve high school students chances of passing the new state mandated science proficiency exam, required for graduation for the class of 2006. The project may be used as a model for earth science honors classes in high growth school districts such as CCSD (population in Clark County increased 68% between 1990 and 2000) where the establishment of new schools provides frequent opportunities for significant change in approach and curriculum. If successful, the program may be adopted in some of the 30 new secondary schools planned for the CCSD, potentially reaching thousands of secondary students. A strong community partnership coupled with commitment from the high school to divert discretionary revenue to the program and the adoption of a high school proficiency exam in science will help sustain the program.

TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.C.

Section		Total No. of Pages In Section	Page No.* (Optional)*
Cover Sheet for Proposal to the National Science Foundation			
A	Project Summary (not to exceed 1 page)	1	
B	Table of Contents	1	
C	Project Description (Including Results from Prior NSF Support) (not to exceed 15 pages) **(Exceed only if allowed by a specific program announcement/solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)**	14	
D	References Cited	2	
E	Biographical Sketches (Not to exceed 2 pages each)	5	
F	Budget (Plus up to 3 pages of budget justification)	16	
G	Current and Pending Support	3	
H	Facilities, Equipment and Other Resources	2	
I	Special Information/Supplementary Documentation	7	
J	Appendix (List below.) **(Include only if allowed by a specific program announcement/ solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)**		
	Appendix Items:		

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

DESCRIPTION OF PREVIOUS EDUCATIONAL EFFORTS OF THE INVESTIGATORS

Cathy Andrews, co-PI (Principal, Shadow Ridge HS). As a school principal, Dr. Andrews has written and received several grants from the Clark County School District's Public Education Foundation, Summerlin Children's Forum, and Becker Community School. These grants provided funds for extensive teacher training across the curriculum. One provided funds to purchase a weather station for the science department at Becker Middle School which enabled students to track weather locally, nationally, and internationally, and to conduct weather-related research and projects within the school population and/or as a collaborative effort with students in locations outside their city, state, and country. Dr. Andrews is a founding member and member of the executive board of the Summerlin Children's Forum, a non-profit organization that provides community recognition and grant funds to 18 public and private schools in the community of Summerlin in Las Vegas, Nevada.

Paul Buck, PI (Assistant Research Professor, Desert Research Institute [a branch of the University and Community College System of Nevada, UCCSN]). Buck directed the Nevada Science Teacher Enhancement Project (N-STEP), a 3-year Teacher Enhancement project (NSF award #9731285). Fifty high school teachers worked closely with research scientists, education faculty, and high school students on authentic field-based research projects in geoscience, biological sciences or social sciences (Buck, 2003; http://www.dri.edu/Education/NSTEP/). Major program goals were to increase teachers understanding of authentic scientific research, improve teachers content knowledge, foster closer professional collaboration between high school teachers and research scientists, and help teachers better incorporate research into classroom teaching. Buck is also the lead education consultant for DRI's IRCEB project (NSF award # 0078325), a $3M award for a 5-year project designed to explicitly test a number of hypotheses about the relationship between climate, atmospheric CO_2, and net ecosystem productivity. Middle school teachers will develop lesson plans and other activities to supplement classroom teaching. Buck is currently Director of the Increasing Diversity in Science in Nevada program, a component of the UCCSN's recent EPSCoR award to improve science infrastructure in Nevada (NSF award #0132556, J. Coleman PI, see http://www.nevada.edu/epscor/proposal.html). This component targets middle school through undergraduate students in a continuous series of incentive-based activities designed to lead minority students to graduation from a UCCSN campus with a degree in a science field.

Steve Rowland, Co-PI (Professor of Geoscience, UNLV). Dr. Rowland is a paleontologist and geologist who spent 4 years teaching high school biology and earth science before returning to complete his Ph.D. He has twenty-five years of university teaching, with abundant experience teaching introductory courses for non-majors and non-credit courses for the general public. Rowland is co-creator of an outdoor public geologic interpretive display and interpretive geologic trail on public land adjacent to Las Vegas (see website, below, for a detailed description of this geologic interpretive site). He has created a teaching website concerning the geology of Southern Nevada (http://www.unlv.edu/Colleges/Sciences/Geoscience/pub/rowland/Virtual/virtualfm.html) used by local university, community college, and high school teachers and students, as well as those from other areas, to learn about the geological evolution of Southern Nevada. He is on the advisory board of the Las Vegas Natural History Museum, recently published a book with the Clark County Museum, and routinely confers with exhibit and curatorial staff at the Nevada State Museum in Las Vegas. Through museum exhibits, outreach, and publications, Dr. Rowland helps to disseminate high-quality science to the 1.6 million people of the Las Vegas region. He has published four articles about teaching and one geology textbook. He is a recipient of the UNLV Foundation Distinguished Teaching Award for 2003.

PROJECT DESCRIPTION

The project proposed here will develop, implement, and evaluate an innovative earth system science classroom curriculum combined with authentic laboratory and field based research components using a National Register-listed paleontological and archaeological site (the Tule Springs site). The main stimulus for this proposal is the August, 2003 opening of a new high school (Shadow Ridge HS, Cathy Andrews, Principal and Co-PI) to serve 2,600 students located only 100 meters from the **Tule Springs**

site, a stratified sequence of late Pleistocene alluvial and spring deposits containing a remarkable record of extinct large mammals and birds, perhaps associated with traces of the earliest human occupants of the Las Vegas Valley. This site will be used as an educational and research laboratory by students and teachers, working in concert with higher education, school district, and community partners.

This project is an entirely innovative approach to earth science education in the Clark County School District (CCSD), the nations 6th largest school district serving 256,000 students (the District currently operates 33 comprehensive high schools). It is designed as problem or project based learning based on **discovering the cause(s) of the Pleistocene extinction** of a number of genera and species of animals formerly found in Las Vegas Valley. The project will: 1) develop and evaluate a new model for earth science preparation of students to pass the Nevada science high school proficiency exam administered for the first time in April 2003; the class of 2006 must pass the exam to graduate from high school. Exam content is about 1/3 earth and space science; 2) promote higher math and science achievement of students who typically do not take advanced math and science courses and increase their enrollments in advanced math and science classes; 3) create new data on Pleistocene fauna and flora of Las Vegas Valley, and address a long-standing question about the connection between prehistoric human hunting and extinct mammoth raised by previous excavations; 4) develop in students a deeper understanding of earth system science to promote stewardship and long-term preservation of the Tule Springs site, threatened by continued growth and urban development in one of the fastest growing cities in the US.

This proposal is an expansion of some ideas contained in a proposal to the NSF MSP program recently submitted by the CCSD (proposal # 0315086, J. Ebert PI); although the two proposals are complementary in some respects, they do not duplicate programs (connections between the two proposals are described below and in the budget justification section). We propose a redesigned earth system science class at Shadow Ridge high school with integrated field research components in paleontology, geomorphology, paleoecology, and archaeology. This work will be conducted through a collaborative partnership between Shadow Ridge HS, the Curriculum and Professional Development Division of CCSD, UCCSN institutions, nonprofit preservation educational groups, and private industry. We are requesting funding from NSF for two years to start the program; if effective in raising student achievement, funding for program continuity will be sought from the school district, State of Nevada, and our community partners.

- ***Earth Science Honors course.*** We will design a new, more rigorous but engaging inquiry-based earth system science course grounded in national earth science teaching standards (NRC 1996, NRC 2000) guided by *The Blueprint for Change: Report from the National Conference on the Revolution in Earth and Space Science Education* (Barstow 2002) and "Geoscience Education: A Recommended Strategy," produced by the NSF Geoscience Education Working Group. Currently approved earth science textbooks will be replaced by EarthComm texts and laboratory activities if EarthComm is shown to be more effective. The Nevada science teaching framework and the CCSD earth science curricula have recently been realigned with these national standards.
- ***Authentic research in laboratory and field.*** The new course will incorporate new, authentic research guided by academic faculty from the University of Nevada Las Vegas and the Desert Research Institute in paleontology, geomorphology, soils, geophysics, and archaeology. These research activities will have a central theme of Pleistocene extinction and paleoenvironments, and will use newly created "Inquiry Modules" aligned with EarthComm activities and topics. Some of the activities will use existing fossil and archaeological collections to be housed at Shadow Ridge HS in the ***Bill and Ted Gilcrease Earth Science Laboratory.*** Other activities will be designed around new field investigations of stratigraphy, paleontology, and archaeology of the nearby ***Tule Springs site*** (more below).

Rationale for approach. The partners consider earth system science to be as important in the curriculum as biology, chemistry, and physics for a number of reasons: (1) the National Science Standards recognize Earth Science as a core educational requirement from K-12, in parity with chemistry and physics; (2) the Nevada economy is critically dependent on the activities of earth scientists, since

mining is the 2nd largest industry in the state; (3) understanding many societal and environmental issues requires earth science input, (4) earth science provides an improved understanding of other allied sciences in an applied context, and (5) millions of dollars in Nevada's general fund were generated by the discovery and production of natural resources on state lands by practicing earth scientists.

The CCSD and Shadow Ridge HS have additional pragmatic reasons for making earth system science a requirement for all students. All Nevada high school students in the graduating class of 2006 must pass the science proficiency exam to receive a high school diploma. This exam contains many questions about earth science content and science process standards, reflecting the importance of earth science in the Nevada science teaching framework (see http://www.nde.state.nv.us/sca/standards/standardsfiles/science/scicont.pdf for science proficiency standards). In the framework, approximately 1/3 of the content standards are related to earth and space science. However, currently less than 9% of high school students statewide take any earth science class, meaning that most of what students know about earth science they learned (perhaps) in the 7th grade, at least 4 years prior to the proficiency exam.

This project will also strengthen the underdeveloped linkage between academic research faculty in science programs of the UCCSN and high school programs in the CCSD to provide more qualified students to science, technology, engineering, and mathematics programs (including geoscience) in the UCCSN. It will promote stewardship of public lands and help students develop a "sense of place" through active research by students and teachers in a nationally and locally important paleontological and archaeological site at their doorstep.

Painting showing reconstruction of hunters attacking American camel at Tule Springs site (artist Jay Matternes)

Why at Shadow Ridge High School?

Simply put, the geographic proximity of a new high school to a major geological, paleontological, and archaeological resource is too good to pass up. *The project builds on what students (think they already) know, and then leads them to a deeper, more accurate understanding.* It was only about 140 years ago that it became widely accepted that people at one time in the past co-existed with now-extinct species of animals (Grayson, 1983, Grayson and Meltzer, in press). Even at that early date some argued that many Pleistocene mammals were driven to extinction through human overkill--they were hunted to extinction. Students and teachers have seen that popular media often portrays prehistoric people hunting now-extinct animals. There is still considerable debate in the professional and popular literature about the importance of human predation in Pleistocene extinctions (more on this below). Regardless of the extinction issue, additional research examining human hunting of Pleistocene mammals and late Pleistocene climatic change in the Las Vegas area is needed.

Project goals

- Prepare students to do well on the earth and space science portions of the high school science proficiency exam;
- Develop a challenging inquiry based earth system science course emphasizing current understanding of earth system science;
- Integrate relevant earth science Inquiry Modules into other science courses (e.g., paleontology of Columbian mammoths, radiocarbon dating in chemistry, seismology in physics);

- Spark increased student interest in earth system science in 9th grade to promote increased interest in taking more advanced chemistry, physics, and biology courses later in high school;
- Make earth system science more accessible to underrepresented students, who typically do not take the more advanced courses;
- Provide an enhanced earth system science foundation for prospective elementary education majors in college who typically take few college science courses before becoming teachers;
- Develop a visible, effective education and research program widely supported by the community to help in the preservation and use of an archaeological and paleontological site of national, state, and local importance;
- Improve student understanding of earth system science to better manage the adverse effects of unprecedented population growth in Las Vegas Valley.

PROJECT PLAN

The establishment of a brand new school, with new teachers and a new administration enthusiastic about earth system science, coupled with an incredible outdoor geoscience laboratory next door, provides a unique opportunity for innovation. It is sometimes difficult for an existing school with established teachers to change directions—either in scheduling, programming, or curricula. Discretionary funds that might be available (for example Green Valley HS in the CCSD generates ~$250,000/yr in discretionary funds through student activities and PTA) are often already devoted to athletics or music programs and unavailable for new innovative programs like the one proposed here. All partners in the project agree that a new high school with broad support from the principal, Department Chairs, and incoming teachers can successfully implement the program described here.

The proposed project has three key components, to be supported by an integrated, team-teaching pedagogy and extended class periods: more effective instructional materials from EarthComm, inquiry laboratory activities using an extensive collection of Pleistocene fossils from the immediate school area, and authentic field research at the Tule Springs site.

A. New earth science honors class

Background. High quality earth system science instruction is seemingly of greatest value in southern Nevada, an arid region with readily visible geology, heavy reliance on earth system science for maintenance of adequate freshwater stocks, impending geological disposal of the nation's high-level nuclear waste, and an important industry dependent on accurate and detailed knowledge of the earth system (mining). In the CCSD, there are only two generally available earth science classes in high schools: Earth Science, course 669; and geology/environmental science honors, course 673H (this is available only at 2 schools). Both are taught as year-long lab courses. Field trips are rare, and activities are designed for students with the lowest stanines. Few CCSD students take either of these courses. In Nevada less than 9% of students statewide take earth science in high school (Barstow 2002:16). Students avoid earth science because it is not required for high school graduation and most universities favor biology, chemistry, and physics for admission. Earth science courses in CCSD have a reputation of being "dummy" courses. Foothill HS, for example, recommends that students with the lowest stanines (1-4) take earth science, which has the same stanine rating as their "Principles of Science" course which has no lab and does not meet lab science requirements for college entrance.

Shadow Ridge HS and its partners are committed to increasing the quality of earth science instruction and increasing the number of students who take challenging earth science curricula. We will do this by developing an Honors earth science class on par with Honors biology and transforming earth science class from a "dumping ground" for students with lowest stanines to a class for high achievers on par with other honors classes. Recently a group of CCSD earth science teachers and curriculum specialists met to design the course goals and objectives for this class to be implemented in August 2003 at Shadow Ridge (see Supplementary Materials). Entering freshman students (we expect the first year class of 9th graders will number about 600, and half of these will take earth science honors) will have the choice of earth

science honors or biology honors if they have stanine scores in the upper range, and students with lower stanines will be required to take Biology I.

Textbooks currently on the approved list for use in earth science high school courses in the CCSD are: Glencoe "Earth Science" 1999 or 2002; Prentice-Hall "Exploring Earth Science" 1999; and Holt "Modern Earth Science" 1998. Although we are not aware of any in-depth independent reviews of these texts, these publishers' middle school earth science texts have uniformly poor ratings. The AAAS Project 2061 has reviewed middle school science texts from Glencoe, Prentice-hall, and Holt (among others). In each case at least 12 of the 19 earth science criteria rated as "poor," and for Glencoe 18 of 19 were rated as poor. Approximately 91% of the students currently graduating from CCSD high schools will have taken only middle school earth science, and most CCSD middle school students had one of the texts receiving poor ratings by the AAAS project 2061. If this trend is not reversed, there is a very high probability that most students will do poorly on the high school science proficiency exam.

EarthComm: Reforming earth science instruction and materials. We will supplement current texts with *EarthComm* text and companion classroom kits for use in all earth science honors classrooms (Earth Science Honors, 669H) at Shadow Ridge HS. Because of the lengthy formal textbook adoption cycle of the CCSD, we plan on using the EarthComm materials formally as "supplementary" materials during the life of this grant, retaining the approved texts until the CCSD textbook committee next meets October 2003. We expect EarthComm to be added to the list of approved texts shortly thereafter. The CCSD textbook buying cycle will likely allow formal adoption and purchase of EarthComm in 2005. On-site training by AGI/Its-About-Time will be provided for all earth science honors teachers to effectively implement EarthComm in Shadow Ridge classrooms before Aug. 2003.

The American Geological Institute and the National Science Foundation developed the EarthComm instructional materials and methods collaboratively
(see http://www.its-about-time.com/htmls/ec/ecframe.html for details). EarthComm is the first high school earth science program developed by content specialists through the collaboration of the American Geological Institute, the largest professional geological society that addresses the national science education standards. It works well with block schedules, and is designed to be used in heterogeneous classes, making it accessible to all students. EarthComm emphasizes important concepts, understandings, and abilities that Shadow Ridge HS students can use to make wise decisions about southern Nevada's land, air, and water resources. It will help them think critically, and understand and appreciate the linked earth systems: atmosphere, biosphere, and hydrosphere. The texts are in the form of 5 books (modules), each with 3 units. The five modules are: earth's dynamic geosphere, earth's fluid spheres, understanding your environment, earth system evolution, and earth's natural resources. They will be used at Shadow Ridge with their complementary activity kits and laboratory protocols that extend and elaborate on topics covered in the texts. The high school will purchase the texts (no funds from NSF are requested for this); we are requesting funds to purchase the durable supplies and two years of consumables for 9 earth science sections.

Inquiry Modules. Shadow Ridge earth science teachers will work with CCSD K-12 science curriculum specialists and project scientists to develop and implement inquiry-based investigations in laboratory and field settings to extend EarthComm lessons and activities to locally important authentic research projects. We call these "Inquiry Modules." Some of these inquiry modules will be built around faunal, geological, and archaeological collections to be used in class. Other inquiry modules will be developed around authentic field research in paleontology, stratigraphy geomorphology, archaeology and others to be conducted by students and teachers in the field at the Tule Springs site. Specific examples of possible inquiry models are described below; we have not yet determined how many or exactly which of these modules will be developed (we will decide that through consultation with Shadow Ridge teachers during the summer).

These inquiry models and the overarching theme of Pleistocene extinction and climate change will be linked and integrated with other freshman courses. Students taking World Literature for example may read selected writings of Mark Twain (1835-1910), who lived through the scientific revolutions of the 19th century, and his writings contain numerous references to geology, paleontology, archaeology, and

astronomy. Just a few of many possible examples are (1) an essay titled "Paleontology" in which Twain discusses the interpretation by archaeologists of stone tools, (2) a passage from "Life on the Mississippi" in which Twain describes and discusses meanders of the Mississippi River in the context of the then-new concept of uniformitarianism in geology, (3) a Twain essay about fossil footprints found near Carson City, Nevada, and (4) a private letter to his fiancée, written in 1870, in which Sam Clemens philosophically discusses new scientific views about deep geologic time and deep cosmic space. All of this material is extremely fertile territory for teachers and students to examine the evolving relationship between science and American culture in the nineteenth and early twentieth centuries. One of the P.I.s of this proposal (SMR) is currently writing a book about science in the writings of Mark Twain; one component of the proposed project will involve compiling a collection of appropriate Twain readings and working with the English teachers of Shadow Ridge H.S. to help them integrate science and literature.

Other readings with engaging earth science themes may also be used, such as recent popular novels by Bjorn Kurten (*"Dance of the Tiger: A Novel of the Ice Age"*), Jean Auel (*"Clan of the Cave Bear"*), or even science fiction with significant geoscience content such as the Mars series by Kim Stanley Robinson (*"Red Mars," "Green Mars," "Blue Mars"*). Algebra I classes will be encouraged to use geoscience data when developing activities and problems. Data collected by the students themselves can be used for discussions of statistics, measurement error, and other important concepts. This approach is made possible because all the teachers will be new to the school, and because during the hiring process now on-going (mid-March 2003) the high school administration is selecting staff in part based on their willingness and ability to align their teaching with our project goals. The freshman class will be team taught, with earth science, English, and math instructors in regular communication and each having the same students. This orchestration of content, pedagogy, and scheduling will extend to the field, where three times a year all earth science students will be in the field for an entire day with their earth science teacher and the other three class teachers they would normally have that day (see discussion below of block scheduling to be implement at Shadow Ridge, in part to enhance earth science instruction).

We intend the inquiry modules to "spark" student interest in the 9th grade, motivating students to take more advanced math and science in grades 10-12. One inquiry module will examine the evolution of prehistoric weaponry in North America, focusing on engineering design of thrusting spear, throwing spears, spearthrowers, and bow (e.g., S. Hughes 1998). The motions of these projectiles are explained through Newtonian physics, and require understanding of mathematical equations for kinetic energy, drag and penetration. Although students may not have the background to fully understand the physics, they will appreciate how an atlatl or thrusting spear was used to kill a 3-ton mammoth. These concepts will be illustrated concretely by having students use replica atlatl and darts and modern bows and arrow. Another inquiry module on the morphology and measurement of mammoth teeth can be extended in 10th grade biology to a broader investigation of morphometrics and biology, and adaptation of desert-adapted animals. An inquiry module on the identification of artifacts and meaning of artifact variation will provide a basis for an Anthropology class proposed for junior and senior year.

B. Bill and Ted Gilcrease Earth Science Laboratory

We will establish an earth systems science laboratory in the high school for the study of existing paleontological/archaeological collections and use computer-based visualization technologies and software to enhance learning and research. This laboratory is proposed to be named the ***"Bill and Ted Gilcrease Earth Science Laboratory"*** (needed approval from the CCSD Board or Trustees School Name Committee will be sought). The lab will be located in one of the earth science classrooms in the high school, and will contain an extensive Pleistocene faunal collection loaned by Bill Gilcrease, a resident of Las Vegas since 1916 (see attached letter of support). Active use of previous collections is part of the inquiry-based approach to be implemented in the classroom. Other collections are also available at the Nevada State Museum (NSM) in Las Vegas. One inquiry module in the lab will be based on the measurement of mammoth teeth in the collection. Using the collection of perhaps 40 teeth loaned from Gilcrease, students will examine variation in tooth dimension, learn how to identify different molars and mandibular and maxillary teeth, understand mammoth growth and development, and determine whether

the collection represents a natural death assemblage or is likely to be the result of other factors (such as human predation). This inquiry model may also include a trip to the NSM to examine a complete mammoth skeleton there.

Extensive archaeological collections are housed at the DRI, an official artifact repository in southern Nevada. These include primarily lithic collections of hunter-gatherers from southern Nevada and adjacent regions, but also include ceramic collections from Utah and Arizona. These materials will be used to introduce students to prehistoric tool technologies, focusing on the mechanical and physical attributes of toolstone for prehistoric tool production, provenance analyses of (especially obsidian) tool stones (e.g., R. Hughes 1986, Jones et al. 1997), and discrimination of natural versus human caused modification of stone. An integral part of this module will be measurement of projectile point morphology, especially important for chronological control (e.g., Thomas 1981). These modules will be the foundation for recognition of stone artifacts during field work in the Tule Springs site.

Other inquiry-based modules may be developed in the future as external support builds. These may include modules based on particle size analyses of soils and sediments collected from the Tule Springs site (sieve analyses of the sand size fraction and hydrometer for the finer fraction). A palynology module may also be developed, focusing the identification of pollen present in the sediments of the later Pleistocene units. It may be possible to have students collect soils samples containing pollen, have the more dangerous digestion and extraction work done by an outside lab, and then have students learn to identify pollen types and make the pollen counts. These can then be compared to modern pollen rain and pollen production and distribution models.

Visualization and modeling technology. Student use of computers for visualization, modeling, and simulation is a key element of the proposed earth science honors class. Students will construct topographic maps of the site using a theodolite and the SURFER topographic mapping program from Golden Software. We will use SimEarth, produced by Electronic Arts, Inc. SimEarth is a planet simulator that treats the planet as a whole—life, climate, the atmosphere and the planet itself. Loosely based on Gaia theory of James Lovelock, it presents a useful model simulating the complex interactions between atmosphere, geosphere, and biosphere and allows students to modify various elements and begin to learn interaction mechanisms in a fun, engaging way.

The Shadow Ridge HS will have a fully internet-equipped computer lab for student use. Priority will be given to students enrolled in earth science honors, and it is intended that at least once every two weeks students will spend a class period on the computer lab. The Digital Library for Earth Science Education (DLESE) web site will be used to complement EarthComm activities and collect data on southern Nevada, looking especially for collections of fossil faunas from the Pleistocene. Because of the alternative scheduling and team-based approach to 9th grade education at Shadow Ridge, computer technology is to be broadly integrated into all classes, including earth science honors. In fact, during the quarterly all-day trips planned for earth science honors students, the computer specialists will accompany the students.

C. Authentic field research at Tule Springs

To enhance learning and teaching, earth science curricula should provide opportunities for field research by students (Barstow 2002:34, NRC 1996). Tule Springs is a 980 acre parcel listed on the National Register of Historic Places for its paleontological, archaeological, and geological importance to the nation. It contains a 50,000-year record of climate change, extinct fauna, and possible human activity. It was the source of many charcoal and wood samples for Dr. Willard Libby, and allowed him to perfect radiocarbon dating and develop one of the best chronologies of late Pleistocene alluvial deposition in the western US. Its a perfect outdoor laboratory for many geoscience projects—and it is literally steps away from the new Shadow Ridge High School. There are several reasons for new field investigations at the site: 1) authentic research is a key ingredient of effective earth science education, 2) many scientific questions remain unresolved, such as the nature of the small mammal assemblage, taphonomy of the faunal collection, and related paleoclimatic studies, 3) the sample sizes of faunal remains and artifacts are too small for statistical analyses, 4) testing of hypotheses of association between human artifacts and extinct fauna, and 5) to refine chronological control through ^{14}C dating

Description of the Tule Springs site and the new high school. The new Shadow Ridge HS occupies about 40 acres in the NW ¼ NW ¼ of section 12, T. 19S, R. 60 E (Figure 1). The SW corner of the 980 acre Tule Springs site is about 300 feet (100 m) due east of the southeastern corner of the high school grounds. About 317 acres of land is deeded to the State of Nevada Parks Department; the balance of the site is owned by the Bureau of Land Management. The proximity of the site to Shadow Ridge HS has several implications: 1) students will see the site every day, 2) important paleontological and archaeological localities known since the 1930s are within an easy walk of the school, allowing frequent visits, 3) presence of the school and a visible active education/research program will promote preservation and stewardship.

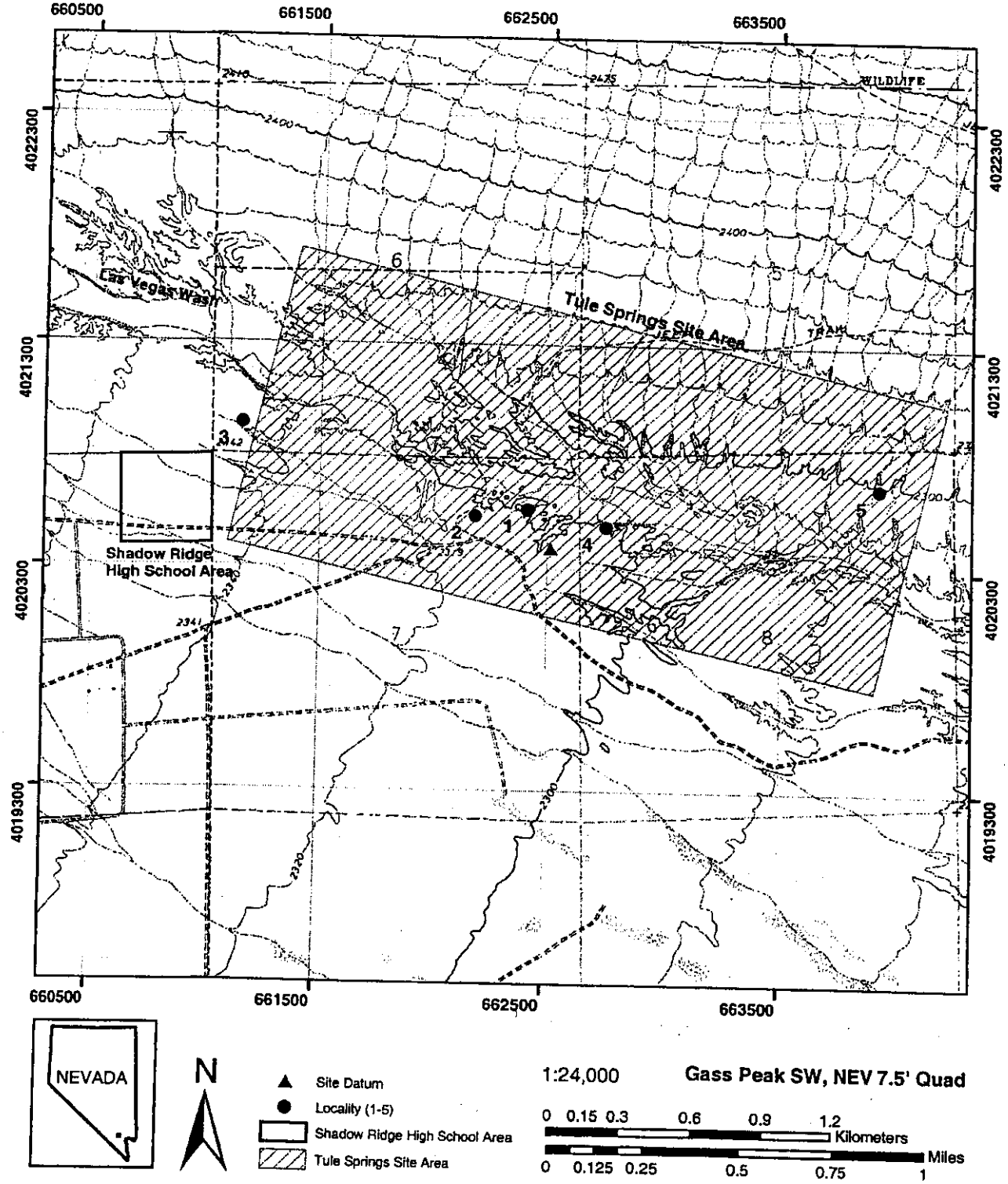
History of research at Tule Springs. In 1933, in a side gully of Tule Springs wash, Fenley Hunter of the American Museum of Natural History found a concentration of charcoal associated with bones of extinct camel, horse, and bison (Simpson 1933). Lying within the matrix was found an obsidian flake, an undoubted human artifact. Later that year, M.R. Harrington of the Southwest Museum in Los Angeles visited the locality and excavated two more bone deposits associated with "charcoal," finding two bone objects he considered to be artifacts. Almost 20 years later, a mixed sample from the Hunter locality and the bed excavated by Harrington was sent to Dr. Willard Libby for radiocarbon dating (Libby received the Nobel Prize for Chemistry in 1960 for his radiocarbon dating technique). It provided a date of more than 23,800 years BP (Libby 1955). In 1955 the Southwest Museum began survey and mapping work, and tested 18 localities. The following year 13 more localities were tested. In one of these, Ruth D. Simpson found a scraper; a carbon sample from this location provided a date of 28,000 years BP.

In February 1962, Libby, as Director of the Institute of Geophysics at UCLA, called a meeting to discuss radiocarbon dating and archaeology. Attending that meeting were Wallace Broecker, J. Desmond Clark, Carl Hubbs, and a number of others familiar with the archaeology of the western US. Libby offered the services of his radiocarbon lab for dating if a suitable site could be found. The group proposed a number of sites but it was ultimately decided that an interdisciplinary project at Tule Springs be started. Attending the meeting was Mr. Herschel C. Smith a wealthy building contractor from Los Angeles with a passion for early man studies. Smith wound up financing much of the later excavations at Tule Springs.

The project workers at Tule Springs camped about 500 feet away from the site of the future high school from September 1962 through January 1963. About 7,000 feet of bulldozer trenches were excavated, averaging 15 feet deep and 30 feet wide. Over 38 different, specific localities were investigated, and 80 carbon samples were radiocarbon dated. More details are provided below regarding the paleontological, geomorphologic and archaeological results from the 1962-63 project.

Recently, Nevada Power's Centennial powerline project crossed the Tule Springs site in a 200-foot-wide corridor. Significant new paleontological and archaeological investigations were undertaken in this corridor, and a large number of paleontological specimens are undergoing analyses at the San Bernardino County Museum (Stan Rolf, personal communication 2003). No artifacts were found in stratified context with Pleistocene fauna.

Summary of geological units and paleontology findings. The Tule Springs site contains young sedimentary rocks that were deposited over the past few tens of thousands of years. Depositional environments in which these sediments were deposited include springs, perennial streams, ephemeral streams, marshes, and the toe of an alluvial fan. In response to oscillating Pleistocene and Holocene climate change, these environments expanded and contracted, appeared and vanished, producing a kaleidoscope of overlapping sedimentary deposits, each carrying its own distinct paleoclimatic signature. In any given exposure, one typically sees the sedimentary products of two or more environments, often with channelized gravelly deposits lying within finer-grained material. The individual cobbles within the coarser-grained stream deposits, which were transported in from some distant mountain range, represent a wide range of additional sedimentary rock types, each with its own story of deposition, uplift, erosion, and transport. The general stratigraphy of this complex was characterized as part of the 1962-63 excavation. But virtually no work has been done in the area since that time and much more could be


660500
661500
662500
663500
4022300
4021300
4020300
4019300
WILDLIFE
Las Vegas Wash
Tule Springs Site Area
Shadow Ridge
High School Area
1
2
3
4
5
6
7
8
NEVADA
N
Site Datum
Locality (1-5)
Shadow Ridge High School Area
Tule Springs Site Area
1:24,000
Gass Peak SW, NEV 7.5' Quad
0 0.15 0.3 0.6 0.9 1.2
Kilometers
0 0.125 0.25 0.5 0.75 1
Miles

P

done. This wide range of sedimentary rock types, exposed in a small area, is a perfect place for students to learn to observe, sample, analyze, and interpret the geological record.

The vertebrate fossils discovered at the Tule Springs site during the 1962-63 excavation are representatives of the so-called Rancholabrean fauna, which is the late Pleistocene fauna that is best known from the La Brea tar pits of Southern California. Rancholabrean species that have been documented at Tule Springs include Columbian mammoth, two species of giant ground sloth, American lion, two species of horse, Pleistocene camel, and bison. This fauna was briefly described in a chapter (Mawby, 1967) of the monograph on the 1962-63 Tule Springs project (Wormington and Ellis, 1967), and has remained completely unstudied since that time. There has been no detailed paleoecological analysis of this fauna.

Summary of archaeology. Six individual locations were examined during the 1962-63 season for human artifacts: Locality 1-3 are on State of Nevada State Park land; 4, 4A and 5 are on federal land (BLM). (No artifacts were found in the single test pit excavated for the Nevada Power powerline project and this project will not be discussed further).

At least 4 flakes (debris resulting from manufacture of stone tools) were found at Locality 1 geological unit E2. This unit was ^{14}C dated at 10,000 +/- 200 yrs. BP. Found in this same geological unit were camel, *Tetrameryx* sp., deer, mammoth, and two species of *Equus*. The investigators noted however that this fauna may not be associated with the flakes, since they appeared to be weathered and rolled. They may be derived from an older unit (Stein 1967:318).

At locality 3, a putative bone awl was found in either unit E1 or E2, which at other localities date from 7,000-11,200 years in age. It was not found with any other artifacts, forcing Fitzwater (1967:356) to place this object in the "possible" artifact category. Fauna identified include Pleistocene puma (*Felis* sp.), the smaller species of horse, camel, and meadow mouse. All were found in unit E1.

The original Fenley Hunter flake was recovered with camel remains and was either from unit E1 or the base of E2 at locality 4—but the flake and bones may possibly have been mixed, and do not belong together at all (Haynes 1967:34). Additional work in the 1962-63 season was conducted at locality 4 where a large area about 13 feet by 12 feet was exposed, followed by deeper excavations covering a few square feet. Fauna excavated from unit E1 included mammoth, camel, and horse. No artifacts were found.

At locality 4A, in Haynes unit E1 and E2, a quartzite scraper was found in situ, likely in the lower part of E2 which dates to around 11,000-10,000 BP (Fitzwater 1967:357). Fauna found in the underlying unit E1 are somewhat older – up to 17,000 years BP, and included camel, a large species of horse, and pronghorn. No fauna were recovered from E2. At locality 5, a great variety of mammal bones were recovered largely from unit E1, including mammoth, horse, camel, pronghorn, coyote, and giant condor. These deposits ranged in age from about 11,000 to 9,700 yr. BP (Tuohy 1967:374). A putative "bone tool" was found in the lower channel fill, described as a bipointed tool probably made on camel bone. It was found in stratum A of lower channel deposit, equivalent to unit E1. This bone is not clearly a human artifact, although to Tuohy it was likely so. This unit at locality 5 is dated 13,100 +/- 200 to 12,920 +/- 220. Found in unit E1 at this locality were remains of mammoth, small horse, camel, Tetrameryx, and giant condor.

Pleistocene Overkill? Even after 40 years, our understanding of human occupation and use of the Tule Springs site is poor. The slight evidence of association between human artifacts and extinct fauna has largely been discredited, although tantalizing contexts and possible artifacts invite additional research. Chronological control is generally poor. Only a handful of acceptable artifacts have been found that most agree are indeed artifacts; none were found associated directly with extinct fauna. There is abundant evidence of Pleistocene fauna slightly earlier (that is, in unit E1), but no solid evidence of artifacts associated with this time or these fauna. Recent amateur excavations at the fossil spring on the Gilcrease Nature Sanctuary, just two miles from the Tule Springs site, found a Clovis point resting on top of a mammoth molar in situ in the fossil spring (Rowland, personal communication).

Some knowledgeable archaeologists do not believe that humans caused Pleistocene extinctions anywhere in North America (Grayson and Meltzer, in press). However, for some paleontologists the

overkill hypothesis is quite compelling (Ward 1997). There is good evidence that two species now extinct (mammoth and mastodon) were indeed hunted, and that many other species still extant (bison for example) were also hunted and killed. There is good evidence in 14 locations of human occupation (Clovis, ~11,000 yrs. BP) associated with mammoth and mastodon, although there is no solid evidence of artifacts associated with any other extinct fauna anywhere in North America (Grayson and Meltzer in press).

The question of the cause of Pleistocene extinction is important enough, and engaging enough, for high school students and teachers to use as a heuristic device for linking people and large fauna. It provides a high interest level and a rationale for continued student research. Leaving the association of extinct fauna and human hunters aside, there is little information available about subsistence of humans during the Clovis time period. Additional search for and excavations of artifact bearing deposits could provide such evidence, even if no association between extinct fauna and people can ultimately be demonstrated.

OPERATIONAL PLAN

All freshmen (9th graders) will have three options for science: if they have low stanines and/or test scores from 8th grade, they will take Biology I. If they have higher test scores/stanines they may choose either Earth Science Honors or Biology Honors. All earth science honors students will use EarthComm and the laboratory activities and participate in the authentic research through inquiry modules described above. We expect about 300 of the 600 entering freshman to choose earth science honors.

Most high schools in Las Vegas have a 6 or 7 period day, consisting of ~51 minute class periods five days per week. Although there are few data showing that block schedules alone result in increased scores on standardized tests (e.g., Bateson 1990), in one study of biology classes in North Carolina schools (http://www.ncpublicschools.org/accountability/evaluation/evaluation/evalbriefs/vol1n1block-.htm) those biology classes with a longer blocked schedule had significantly higher test scores than comparable non-blocked biology classes). Another study (Smith and Camara 1998) found that biology students in AP classes earn higher grades in year long courses that met for extended or longer periods each day.

Shadow Ridge HS will implement a 4 by 4 A/B block schedule, with students taking four 90 minute classes on the A days and four different classes on the B days. The cycle repeats every two weeks. Students in 9th grade will be assigned to four teachers on an interdisciplinary team; this means that they are not split between electives and academic classes at the same time and this enables teachers to control a block of time each day in which they can adjust the length of individual classes or combine classes to form one class that meets for a 270-minute block of time.

Whether or not block scheduling by itself will result in higher scores in earth science honors classes, a longer period is necessary to allow students to conduct authentic research at Tule Springs site. We plan approximately 30 hours of field time for each student over the year-long course. Different activities are planned for the 90 minute sessions and the all-day sessions. These are described below.

A typical earth science honors class will be 90 minutes long, enough time to walk to and from a nearby field site and conduct a short field session. We will have about eight 90-minute field sessions in the academic year for each class, focused on specific individual or small group projects. These activities will more narrowly focus on the research themes selected by each class early in the school year, and may build on one or more of the inquiry modules. Each theme will be part of the larger Pleistocene extinction and paleoenvironment problem, and will allow each class to concentrate on a single project or problem for the entire year. Suitable projects may be things like Quaternary stratigraphy and dating; collection of camel bones from a specific locality; excavation of likely place for human artifacts, collection of sediments for pollen analysis etc.

Three times per year all the students of any given earth science teacher will spend the full school day together at Tule Springs. The 4 by 4 A/B schedule at the high school will allow three classes of students, 96-105, in Earth Science Honors classes and their four teachers to spend a total of 270 minutes on site. The student's other teachers will be replaced in their classes by substitute teachers for the day. To

make the group manageable and allow productive investigations, the group of 100 will be split up into smaller work groups. These will be directed by the disciplinary teachers, assisted by undergraduate and graduate students, UNLV and DRI faculty, and docents from the Tule Springs Preservation Committee. Activities will be carefully designed. Groups may rotate through a number of stations/activities in the field that illustrate key concepts previously discussed in classroom, through the EarthComm activity kits, or on computer lab.

EVALUATION PLAN

We believe the pilot project proposed here will be success if: 1) Shadow Ridge students who have taken the earth science honors course do significantly better on the science proficiency exam than students who have taken earth science at other high schools in CCSD; 2) a substantially higher proportion of students in 9th grade take earth science honors compared to the proportion taking earth science in other CCSD high schools; 3) EarthComm and it's companion laboratory activities are implemented in all the earth science honors classes at Shadow Ridge HS; 4) earth science honors teachers at Shadow Ridge are satisfied that the new class is more effective and enhances student learning; 5) by the end of the grant period CCSD approves EarthComm as a textbook for high school earth science; 6) sufficient community resources are available to sustain the program after the grant expires. Long-term success will be realized if this or similar programs are adopted at many high schools in CCSD, and ultimately if students do well on the science proficiency exam.

We plan internal formative and summative evaluations, with assistance from the MSIT Department of the CCSD (see letter of support). The Project PI and Co-PI's will conduct an implementation evaluation several times during the year to evaluate whether project activities have occurred as designed. Development of formative evaluation plan will be coincident with design of the Inquiry Modules we propose. We will use feedback from the earth science teachers and other disciplinary teachers to help us perfect the Inquiry Modules. We will measure a number of outputs expected for the grant duration. For example, each of the Shadow Ridge teachers will be trained in use of EarthComm, will help develop Inquiry Modules, will be expected to use the EarthComm laboratory activities in class, and become knowledgeable about the DLESE.

A key indicator of the long-term success of the program will be an improved pass rate on the high school science proficiency exam. The class of 2006 must pass this exam to graduate; the exam is being administered for the first time in April 2003 and annually thereafter. With help from the CCSD, we will compare scores of the Shadow Ridge earth science honors students with scores from other students around the district for years 2004 and 2005. Another indicator of success is the number of students who enroll in earth science and eventually the percentage of high school graduates who take earth science. Again, this cannot be readily determined in a short 2-year project, since entering 9th graders in Aug, 2003 will not graduate until May 2007. We will compare the proportion of students who take earth science honors at Shadow Ridge with the proportion at other high schools, but the comparison is difficult because no other high school will have an earth science honors course.

Long-term outcomes are not expected until the pilot project described here is institutionalized and widely adopted. One major purpose of seeking NSF support is to provide start-up funding as a stimulus for the CCSD to explore the potential beneficial impact of this innovative program on earth science education in the District, and longer term on the ability of its students to pass the science proficiency exam.

DISSEMINATION PLAN

We plan to disseminate the results of this program a number of ways. Buck and Rowland will prepare an article describing the methods and results of the program after 2 years for publication in the *Journal of Geoscience Education*. We also plan to present results of the project at annual meetings of the Nevada State Science Teachers, and make presentations to the CCSD Board of Trustees about the project. We will also produce (using a student in the UNLV Film Studies program) several short videos (10-15 minutes each) showing some of the Inquiry Modules and incorporating fieldwork and laboratory

activities. These will be used to train teachers, and will also be used at other high schools to enhance the spread of these kinds of programs in the CCSD. We also plan an annual Shadow Ridge HS Geoscience Summit, to be hosted by Shadow Ridge. Students (either individually or in small groups) will develop and present a research poster and give a brief oral presentation during the end of year "Geoscience Summit Conference" at the high school.

We propose to use the Digital Library for Earth System Education (DLESE) in two ways: as a classroom and laboratory resource and as a distribution node for some of the Inquiry Modules we plan to develop. The DLESE website will be an important asset for the earth science honors students, primarily used during their biweekly computer lab session in support of the class. Classes will use satellite images and digital aerial photography of southern Nevada, learn about the Pleistocene Epoch, and find data on Pleistocene fauna.

We also plan to contribute resources to the DLESE. For example, a recent search of DLESE showed no "hits" for "Pleistocene extinction," "mammoth" (as fossils at least), and only a single item for "Superposition." These are all concepts and activities to be explored through our Inquiry Modules, and making them widely available through DLESE could assist others in understanding these concepts. For example because we propose to have students construct stratigraphic drawings of late Quaternary deposits with suitable chronological control at the Tule Springs site, we should be able to develop meta datasets useful for discussion of superposition and absolute dating in an authentic context. Similarly, we can provide access to a database of mammoth tooth measurements based on the Gilcrease collection potentially useful to others interested in mammoth anatomy.

We feel this kind of project is especially suitable for establishment at other new schools planned in the CCSD. Since 1988, four separate bond issues have resulted in the construction of 79 new elementary schools (there are currently 172), 24 new middle schools (currently 43), and 23 new high schools (there are currently 33). Because of continual growth in the student enrollment in the CCSD, Shadow Ridge HS was planned as one of 16 to be built by a voter-approved bond issue in 1998. By 2008, an additional 50 Elementary, 22 Middle, and 16 High schools are planned.

EVIDENCE OF INSTITUTIONAL COMMITMENT

The creation of a strong long-lasting partnership is the key to long-term sustainability and hence long-term positive impact on earth science education at the high school level, and also at the undergraduate institutions in southern Nevada in earth science. This commitment is perhaps best exemplified by the formation of the southern Nevada Math and Science Partnership, described in a pending proposal to the NSF's MSP program (proposal #0315086). Four key groups, many also in the Partnership described above, have converged to support the ideas proposed here: Shadow Ridge HS itself, the K-12 Mathematics, Science, and Instructional Technology Services Department of CCSD, higher education partners of the UCCSN; and local preservation groups and non-profits. Others are also interested in helping, such as the Bureau of Land Management and Nevada Power Company. We will form an advisory board comprised of individuals supporting the education and research project outlined here. This board will include the PI and Co-PIs, two teachers from Shadow Ridge High, a representation of the Gilcrease family, a representative from the CCSD K-12 math and science department, the Executive Director of the OLVF, and a representative from the Tule Springs Preservation Committee. It will also include two high school students. .

UNLV and the Desert Research Institute will provide content expertise on paleontology, geomorphology, archaeology and related topics. Dr. Rowland teaches a paleontology course available to earth science teachers and has several undergraduate and graduate students interested in conducting research on the Pleistocene fauna. Buck will continue to seek external funding for projects in archaeological research and education and provide guidance on program direction. DRI is an entirely soft-money organization whose faculty are funded entirely by grants and contracts (letter of commitment is attached)

Shadow Ridge HS (Cathy Andrews, Co-PI on this proposal, is the Principal of Shadow Ridge HS) has committed $10,000 a year beginning with the 2005-06 school year towards sustaining the program

from discretionary funds derived from vending machine sales, sporting events, etc. This is in addition to (after 2005) providing the EarthComm texts as the standard text for the class, and of course providing most of the instructional resources and material and teachers for the project. This funding will also supply substitute teachers to allow non-earth science teachers to participate in the large group field trips three times per year. Part of this funding will be devoted to laboratory consumables required by EarthComm, future radiocarbon dates and other specialized analyses.

Math, Science, and Instructional Technology (MSIT) Department of the Curriculum and Professional development Division, CCSD is a key supporter of the project, primarily because of the potential to help students pass the science proficiency exam (see attached support letter). The CCSD is the sixth largest school district in the country, enrolling over 256,000 students. Clark County also has one of the lowest ratios of high school diplomas per capita of any equivalent county and one of the highest dropout rates nationally, especially among Hispanics. Moreover, Clark County ranks 196th out of 216 metropolitan areas nationwide in the percentage of residents holding at least a BA degree. The MSSI will make available some of the earth science curriculum development staff, teachers on special assignment, and arrange for other knowledge earth science teachers to help in the development of Inquiry modules and activities.

The Nevada State Parks Department has also agreed to help. They will expedite permits to allow new research on the Tule Springs site, and help coordinate with the State Lands Divisions and the State Historic Preservation Office. We will work together to develop an interlocal agreement with State Parks to allow our students and teachers to conduct new investigations on Tule Springs site (on the portion of the site owned by State of Nevada). Contacts here are Wayne Perock, Administrator of State Parks, and in Las Vegas, Gary Rimby.

A number of ***key foundations and non-profit organizations*** also support this project. The ***Gilcrease Nature Sanctuary*** will loan their fossil collection to the high school for study. Ted Gilcrease was 4 years old in 1920, when he and his family moved to Las Vegas. He and his brother Bill have lived on their ranch ever since, which is located a mile or so from the Tule Springs site just a short distance from Floyd Lamb State Park (formerly named Tule Springs Park). The Gilcrease brothers have been active philanthropists in the community, donating land for shelters, opening a bird sanctuary, and opening their orchards for local families to pick fruit seasonally. Mr. Gilcrease actively sponsored excavation of a fossil spring on his property, recovering dozens of mammoth, camel, and horse specimens which will form the basis of the teaching collection of the new earth science lab. We are working with the Gilcrease brothers to establish an endowment for the earth science Lab at Shadow Ridge HS. ***The Tule Springs Preservation Committee*** has been active for a number of years in efforts to preserve and use for educational purposes the Tule Springs site. They sponsored the 40th reunion of "Big Dig" scientists in November 2002, bringing together again after 40 years many of the principal investigators of the Tule Springs site (http://www.reviewjournal.com/lvrj_home/2002/Nov-08-Fri-2002/weekly/19920704.html). The Tule Springs Preservation Committee is an advisory group to the Floyd R. Lamb State Park (State Parks has administrative jurisdiction over that portion of the Tule Springs site on state lands---about 317 acres of the 981 acre site). The purpose of the committee is to provide volunteer services, facilitate fund raising efforts and carry out historical research for the park. Committee goals include the restoration of the historical buildings of the National Register of Historic Places-listed Tule Springs Ranch, a visitor's center, grants for archaeological and paleontological studies, historical research on the families that have lived at and owned the park property, bird studies and compiling research for education materials for distribution to the public. The Society will help in a number of ways, including fundraising, docents, and management plans (see attached letter). The ***Outside Las Vegas Foundation,*** a newly formed non-profit organization in southern Nevada composed of the four federal agencies having jurisdiction over 7 million acres of federal land in southern Nevada, will also help in several ways (see letter of support). The OLVF will help develop funding to support the project through the Southern Nevada Public Lands Management Act, where up to 10% of the funds acquired through the sale of federal land can be used to support conservation and environmental education projects.