

**ARIZONA UNIVERSITY SYSTEM
NORTHERN ARIZONA UNIVERSITY
TECHNOLOGY AND RESEARCH INITIATIVE FUND
(TRIF)**

ERDENE:

**Environmental Research, Development and
Education for the New Economy**

BUSINESS PLAN

**Approved by Arizona Board of Regents
March 2007**

Executive Summary

Northern Arizona University (NAU) has been recognized for research, training and collaboration focused on ecological understanding, landscape management, forest restoration, environmental engineering and applications of these areas for the benefits of communities and their economies. The University houses numerous federal and tribal programs which enable it to extend on-campus research and programs to national parks, national forests, farm and ranch lands, the Colorado River watershed and vast tribal lands in northern Arizona.

“Environmental Research, Development and Education for the New Economy (ERDENE)” builds on Northern Arizona University’s leadership in Environmental Sciences and Engineering and its longstanding federal, state and tribal collaborations. The program emphasizes research to achieve better ecological understanding and the application of that understanding to reduce human impact on the natural world and to mitigate previous actions detrimental to our natural heritage and ultimately to ourselves.

Within the ERDENE program, application of ecological research to real world problems occurs through applied research, education, workforce training, community outreach and business relations and developments. ERDENE is designed to better understand and manage our natural resources, to accelerate Arizona’s environmental business climate and to prepare Arizona’s workforce for the many new opportunities becoming available in environmental research, design, mitigation and management.

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1. Core Vision/Project Description

Viable long-term environmental and human health rests simultaneously on ecological understanding, economic vitality and social values. No one of these three elements can be sustained successfully without the other two. Projects supported by ERDENE seek better ways to advance ecological understanding and technological ingenuity while incorporating the power of our economy to sustain the health of our environment and the vitality of our communities. To do this, scientific research and education must learn to imbed ecological principles into public services and marketable technologies that grow the economy while benefiting the life of citizens and the health of the planet. ERDENE cultivates opportunities for environmental research, education, outreach and business that address the pressing economic and social needs of the 21st century.

1.1 Industry Overview

Northern Arizona University (NAU) has developed the Environmental Research, Development and Education for the New Economy (ERDENE) program around five major initiatives: ecological restoration, comprehensive monitoring and management of complex systems, water resources and management, renewable energy technologies, and applied research for sustaining rural communities. Ecological restoration is an expanding field of scientific study that is rapidly becoming integrated into natural resource use and management. Comprehensive monitoring of complex systems applies both to ecosystems where change is measured longitudinally and used for holistic management of ecosystems and also to build systems for acquiring comprehensive real-time data on resource use to make environmentally beneficial and economically sound decisions. Issues related to water availability and use are at the forefront of Arizona's concerns as the population of the state is expected to double in the next 25 years. Renewable energy technologies are among the fastest growth sectors in the technology industry. Arizona has one of the highest potentials in the U.S. solar industry with Class 5 solar in most of the state. Applied research for sustainable development focuses on enhancing Arizona's ability to preserve our rich environment and culture while simultaneously building our economy. Integrating environmental health, economic vitality and social values benefit all aspects of rural and urban life.

1.2 Mission and Goals

The ERDENE program creates new opportunities to deepen and extend our understanding of the natural world and the relation of human beings to it. In particular, it emphasizes new ways to apply ecological knowledge to lessen human impact on the natural world and to mitigate previous actions detrimental to our natural heritage. The program seeks to sustain these environmental benefits by stimulating economic and community structures to support and maintain them. Application of ecological research to real world problems in economically viable and community supportive ways will continue to characterize ERDENE as the program moves forward.

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The mission of ERDENE is captured in four program goals.

- Promote environmental and ecological health
- Address real world problems
- Support environmental initiatives having economic and social benefits for Arizona citizens
- Leverage additional funds to advance these goals

Pursuit of these goals will lead to new ways of doing research, teaching and learning at NAU, as exemplified by a broad and diverse group of activities. These efforts have resulted and will continue to result in important outcomes in curriculum, teaching methods, research projects, community programs, collaborations, business developments and financial leverage.

As a result of the successes shown in the first three-year report and evaluation, we will continue the core research and outreach of the ERDENE program as reflected in the focus areas described in section 1.5 below. While maintaining continuing funding for several of the projects that have demonstrated success, we will also broaden the opportunities for new start-up projects through a campus-wide RFP process described below. Our goal is to balance longer-term support for programs that annually demonstrate successful outcomes with seed funding for new projects showing high promise of success.

1.3 Products or Services Provided

The ERDENE program will yield diverse products that simultaneously address environmental, economic and social dimensions, including:

- A. New curriculum and teaching methodologies
- B. A prepared and experienced workforce
- C. Publications, presentations and conferences focusing on research and outreach
- D. Creative community programs
- E. Patentable technologies and spin-off companies
- F. Lasting partnerships with institutions, organizations and businesses building synergies
- G. Investment dollar leveraging to accelerate all of the above

1.4 Positioning

Through ERDENE, NAU will build on its leadership in ecological restoration, monitoring of complex systems, water resources and management, renewable energy technology, and applied research for sustaining rural communities. These Arizona-based activities are and will continue to be recognized nationally and internationally for their contributions to professional knowledge and to the achievement of more sustainable environments and communities.

1.5 How Initiative Goals will be Met

The ERDENE project is organized around focal areas that represent the University's major environmental research strengths. It consists of five cluster areas of activity, each with its own manager, coordinated through a central project director. The area managers are experts in their designated fields and have extensive experience leading projects of this type. The central project director has broad administrative and technical experience. Working with the area managers, he insures that project activities and outcomes are directed toward Proposition 301 goals approved by the Arizona Board of Regents. Each of these areas promises benefits that will advance knowledge, improve the quality of life in Arizona's rural and urban communities, and strengthen the State's economy. These areas together comprise a significant part of the *Sustainable Systems* platform identified by the Battelle Memorial Institute as one of four leading platforms for technology development in Arizona (Battelle, "Core Competencies Assessment," April 2003, p. vii-ix).

1.5.1 Ecological Restoration and Mitigation

1.5.1. a. Forest Restoration.

Research in the structure and dynamics of forests and application of results to improve forest management, restore degraded forests to better health, promote sustainably harvested wood products, and benefit the economies of tribes and communities in or near forested areas of the State.

1.5.1.b. Grasslands Restoration.

Research in the structure and dynamics of grasslands and application of results to improve grasslands management, restore degraded grasslands to better health, and increase opportunities for ecologically-sound, economically viable and sustainable uses of grasslands.

1.5.1.c Riparian and Wetland Restoration

Research on the structure and dynamics of wetland and riparian areas and application of the results to improve their management, restore degraded areas to better health, and increase opportunities for ecologically-sound, economically-viable and lasting sustainable uses of these areas.

1.5.1.d. Environmental Mitigation

Research and application of new methods and techniques to reduce or reverse significant environmental damage or degradation that also promise benefit for environments, communities and local economies.

1.5.2 Renewable Energy

Research, development, testing, and market applications of solar, wind, biomass, geothermal and other renewable energy sources.

1.5.3 Sustaining Rural and Tribal Communities

Research and development of environmentally, economically and socially viable businesses, products and services that will help to continue, directly or indirectly, rural and tribal community life and cultural traditions including such areas as farming, ranching, distributive energy, wood and fiber products, and eco-tourism.

1.5.4 Water Resources and Management

Research into diverse factors affecting water availability, improving management of water resources, reducing demand for water, and application of the results to improve the availability, access and equitable distribution of water for essential human and non-human needs.

1.5.5 Environmental Monitoring and Management of Complex Systems

1.5.5.a Ecosystems

Research in the structure and function of ecosystems, applications of new techniques and technologies for monitoring ecosystem change, development of new information systems for managing environmental data, and incorporation of the results into improved ecosystem management.

1.5.5.b Built systems

Research and development of new technologies, information systems and management systems designed to conserve natural resources, reduce environmental impact, and improve the cost-effectiveness of operations of large, diverse institutions.

1.5.6 Research and Development Cycle

By supporting a wide range of projects within these focal areas, ERDENE will produce tangible and intangible products through a research and development cycle that involves education, creative thinking, research, testing, evaluation and application. Projects will be prioritized that promise significant environmental, economic and social benefits to Arizona.



Figure 1

2. The Market

ERDENE competes in several markets, among them:

- A. The \$21 billion market for grant support for research and development (R&D) in the environmental sciences and technology
- B. The national market of 261 doctoral/research universities that prospective students can choose to further their education in environmental science and environmental studies.
- C. The markets for partnerships with government and private entities who need help with conceptualizing, planning and executing projects which enhance the sustainability of natural resources (such as water, air, and land) and "green products" that have been created, processed and delivered with minimal waste and net energy use.
- D. The national and international markets for environmentally preferable products and conservation technologies.

2.1 Choices Available to Potential Customers

With regard to the markets specified above:

- A. All manner of institutions, public and private, universities and businesses, compete for R&D support. Universities have traditionally emphasized competing for grants from governmental (federal, state and local) entities and non-profit foundations. As with business organizations, these grantors want to invest in people and institutions that have a track record of success in the area of interest. NAU is a significant player in this marketplace. In the first three years of the ERDENE program, from 2002 to 2004, core programs leveraged over \$23,000,000 in federal funds alone.
- B. Any entities wanting to invest public or private dollars in entrepreneurial or public service ventures want knowledgeable, affordable and experienced partners in order to maximize their investment. ERDENE project members live and do their research in Arizona -- in the same kind of habitats and economic situations that face those of their partners. We compete effectively because we understand the issues facing our customers, and have examined those issues thoroughly through years of research.
- C. Students, particularly graduate students, select the institutions they will attend based on the prominence of the faculty and their opportunities to become involved in leading-edge research. NAU's location in the Southwest, on the Colorado Plateau, its environmentally-oriented programs in sciences, engineering, public policy and the humanities and its nationally-prominent institutes such as the Ecological Research Institute (ERI), Center for Sustainable Environments (CSE) and Merriam-Powell Center for Environmental Research (MPCER) allow NAU to compete successfully for the best and brightest students interested in environmental research that makes a difference in the health and viability of ecosystems and human communities that support them.

2.2 Market Size and Trends

Historically, the Federal government has been the largest source of research and development expenditures, with industry lagging well behind. Since 1980, however, when expenditures in both sectors were approximately even, this trend has begun reversing itself. In 2000, industry was funding about 68% of all R&D efforts with the federal government funding only 32% (Source: Science and Engineering Indicators – 2002.) ERDENE has demonstrated outstanding success acquiring funding from federal sources and, more recently, is building its track record of success with industry partnerships (see section 2.4 below).

2.3 Rivals and Competition

ERDENE competes in a regional but largely national and occasionally international marketplace. While more than 800 academic institutions compete for federal R&D funds, NAU's competition stems primarily from the 261 doctoral/research universities. NAU, however, is highly competitive for federal R&D funds as evidenced by a funding rate in recent years of 50% compared to a national average of 17% for proposals submitted to the National Science Foundation's Division of Environmental Biology. Additionally, NAU and the Environmental Protection Agency have entered into a cooperative agreement to facilitate directed research projects. The doctoral/research universities also are primary competitors for students, particularly doctoral graduate students, who can choose from more than 130 programs in the ecological and environmental sciences. Examples of institutional competitors for environmental research and doctoral education include Stanford, Duke, University of Michigan, University of Nevada at Las Vegas, Utah State University, and the University of California, Davis.

2.4 Suppliers

ERDENE members have been successful in obtaining support from such diverse entities as the Ford Foundation, United States Forest Service, Aeromag Corporation, Arizona Public Service Company, National Park Service, and the Kaplan Foundation. We have established collaborations with, among others, the Navajo and Hopi Nations, Arizona Public Service, the Grand Canyon Wildlife Council, Grand Canyon Trust, the Salt River Project, the National Renewable Energy Laboratory, U.S. Geological Survey, National Park Service, Sandia National Laboratory, Arizona Department of Commerce, Museum of Northern Arizona, and the Coconino National Forest. We expect the breadth and diversity of these suppliers to continue and expand as the program moves forward.

2.5 Alternatives to Traditional Approaches

While ERDENE members contribute to NAU's traditional degree programs, we also focus on professional development, public outreach workshops and innovative curriculum development. For example, Sustainable Energy Solutions (SES) includes instruction for rural community members on business planning and development. NAU engineering departments are developing a curriculum that

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will educate bachelor- and master's-level engineers on innovative, sustainable energy and environmentally preferable construction systems. This education will help Arizona companies do more with less energy and fewer materials, thus making them more profitable. Moreover, SES and CSE are teaming together to work with the local wind power industry to advance small wind turbine systems for use on farms, ranches and tribal lands.

Innovative advances by the Merriam-Powell Center for Environmental Research linking gene sequences in key species such as cottonwoods to the structure and function of ecosystems promise enormous benefits for more comprehensive ecological understanding and for specific applications to landscape-level management and restoration that help to minimize human impact and revitalize environmental health.

With ERDENE funding, the Ecological Restoration Institute (ERI) has applied the principles of forest ecology to develop a better basis for forest fire management in the arid Southwest and, in turn, has leveraged significant federal funding, diverse community participation in forest survey efforts, and supported new community-based businesses using small diameter wood from forest thinning projects.

These examples illustrate only a few of the ways in which ERDENE has stimulated new ways of doing business at NAU that integrate teaching, curriculum and research with environmental health, community benefits and economic growth. It is ERDENE's goal to fill in the gaps in standard educational programs to build more sustainable environments with innovative workforce training, product development and community services that the market requires.

2.6 Estimated Sales

ERDENE programs will enhance the economies of Arizona communities by providing new environmental services and business opportunities in the five cluster areas identified above. The Ecological Restoration Institute (ERI) will continue to contribute to significant job development and cost-avoidance in rural areas by advancing applied research and changing policy regarding forest thinning, wildfire protection and community buffer zones. Preliminary tests employing designer microbes with sophisticated tracers have helped to clean-up toxic wastes at significantly lower costs and promise to contribute to new business and product development in this important market. The Center for Sustainable Environments (CSE) will continue to develop geographical labeling and direct market systems to enhance sales and provide higher returns for rural farmers and ranchers. Collaboration among engineers, computer scientists, and ecologists promises to develop new technologies and new computer systems for acquiring and managing data for complex ecosystems and complex built systems. Sustainable Energy Solutions (SES) has already marketed new wind energy technologies and begun a spin-off business. It will continue to research wind and solar systems, including uses of renewable energy sources for water desalination, and enhance development of new products in this industry.

3. Operational Strategies

3.1 Development and Production

3.1.1 Development Status

TRIF funding through ERDENE has been allocated to initiatives that have a strong track record to accelerate efforts already underway. This has allowed the projects to produce results during the time that TRIF funds have been available. These results include, among other things, acquisition of approximately \$23.5 million in external funding leveraged by ERDENE dollars, one patent application in renewable energy, two spin-off companies and six business expansions principally in the renewable energy field.

3.1.2 Production Process

Research is conducted in NAU's campus facilities, at private and public partner facilities, and also in the field. Production is carried out at facilities external to campus.

3.1.3 Cost of Development

Development of products and high-end services is supported by grants, contracts and TRIF resources. Although ERDENE is very successful in attracting external resources, the costs of infrastructure to facilitate technology transfer remain a significant impediment.

3.1.4 Labor Requirements

The ERDENE project requires the services of a variety of trained professionals -- research faculty, engineers, administrators, writers, technical staff and clerical staff. Approximately 50 full-time-equivalent (FTE) positions are currently supported by TRIF. This number is expected to grow to approximately 72 by the tenth year. Over 75% of each year's proposed allocation is committed to Ph.D. faculty and professional staff with Master's degrees or higher. We recognize that it is imperative to attract and retain leading talent. A number of jobs have been created in other organizations through our many partnerships

3.1.5 Expenses and Capital Requirements

Operations and capital expenses for ERDENE projects are moderate. Approximately 20% of each year's funds have been committed to operations and computer or equipment acquisitions.

3.2 Marketing and Promotion

3.2.1 Strategy

ERDENE's marketing and promotion strategy is to build a visible presence on the NAU campus through open competition for available funds to support projects and programs in each of the five cluster areas. Access to support will be fair and

equitable among all researchers working or proposing to work in any of the cluster areas. The program will expand its visibility beyond campus by traditional research approaches including public and professional presentations at conferences and also by building broad and diverse partnerships that help to leverage additional funding, advance business start-ups and technology transfer and educate the public through outreach events.

3.2.2 Method of Promotion

- A. Traditional research approaches
 - 1. Publishing articles in professional journals
 - 2. Presenting at professional conferences
 - 3. Sponsoring professional conferences at NAU
 - 4. Serving on professional and governmental advisory boards
- B. Build partnerships
 - 1. Building relationships with national, state and local governmental entities and Native American tribes.
 - 2. Creating new relationships with strategic community groups.
 - 3. Establishing working relations and development agreements with private sector partners.

3.2.3 Advertising and Promotion Plans

Publications in professional journals, presentations at professional conferences and especially sponsoring conferences in Flagstaff and in Arizona brings visibility and credibility to ERDENE programs and projects, as well as to NAU and Arizona. Exposure and credibility are invaluable when competing for grant awards, as well as for the best and brightest graduate students. During its first three years, ERDENE sponsored programs and projects have contributed to more than 600 professional presentations and publications, 74 sponsored conferences, and 450 graduate and undergraduate students involved in research.

Community and governmental relationships have provided mechanisms for visibility, recognition and synergy. So far, over 175 collaborations have developed between ERDENE participants and other universities, community colleges, government agencies, corporations, non-profit organizations and tribes. As the program continues to grow, this level of outreach and recognition will continue to expand.

Among the many collaborations that have developed, highlights include: The Nature Conservancy, Southwest WindPower, Aeromag Corp., APS, Arizona State University, University of Arizona, Coconino Community College, Flagstaff Renewable Fuels, the Four Corners Institute, Pinchot Institute, SRP, Sustainable Northwest, Babbitt Ranches, Sunshine Wind Energy, La Posada Hotel, Hubbell Trading Post, Lon's at the Hermosa, Savannah Pacific, Young's Farm, Applegate Partnership, Common Ground, The Escalante Center, Los Alamos Volunteer Task Force, Navajo Nation, White Mountain Apache, Kaibab-Paiute, Mescalero

Apache, Greater Flagstaff Forest Partnership, Willowbend Education Center, Hualapai, Hopi, Paiute, Havasupai, Diablo Trust, Grand Canyon Trust, Wildlands Council, Dine College, Tohono O'odham Community Action, Nature Foods, Jemez Pueblo Natural Resources, Zuni Cultural Preservation, the Museum of Northern Arizona, Hopi Tribal Natural Resources. Sandia National Lab, National Renewable Energy Lab, the Western Governor's Association, the Trust for Public Lands, the Wilderness Society, Arizona Game and Fish Dept, National Ecological Observatory, Governor's Forest Health Council, Governor's Solar Energy Council, U.S. Geological Survey, U.S. Forest Service, National Park Service, Food Security Coalition, Southwest Direct Marketing Association, and the Bureau of Land Management.

3.3 Project Management

3.3.1 Organizational Structure

The ERDENE program has a program director that oversees the goals and operations of the program and insures that it accomplishes TRIF outcomes. The central project director has broad experience in administration, teaching, research, programming and community outreach. Each of the five focus areas described above has its own manager who works with the program director. The area managers are experts in their designated fields and have extensive experience leading projects in their area. Working with the project managers, the program director will insure that project activities and outcomes are directed toward the overall ERDENE program goals identified above.

Projects in the five focus areas will be funded through an annual open campus-wide competition. The Vice-Provost for Research in consultation with the R&D Advisory Board will release a Request for Proposals (RFP) each year that clearly describes the goals of the program and the criteria of selection. At least six weeks will be allowed for proposals to be developed and submitted. Proposals will be evaluated by the R&D Advisory Board with the assistance of additional experts as deemed necessary by the Board. Projects will be funded for a maximum of two years with the expectation that they will obtain alternative support to continue thereafter.

3.3.2 Advisory Board or Other Oversight

A new Research & Development Advisory Board has been formed to oversee the next 5 years' TRIF initiatives in biotechnology and ERDENE. This board consists of two deans, two faculty, and five people from off campus with expertise in environmental biotechnology areas.

Advisory Board members are as follows:

Laura Huenneke, Dean of the College of Engineering and Natural Sciences, David Patton, Dean of the Consortium of Professional Schools, Thomas Whitham, Regent's Professor, Biology, Barry Gold, Packard Foundation, David LaRoche, Environmental Protection Agency, Edwin Lewis, Professor of Chemistry and

Biochemistry, Michael Bittner, Translational Genomics and Research Institution, Mary O Connell, Professor of Agronomy and Horticulture, New Mexico State University, Will Ott, Northern Arizona Technology and Business Incubator, Stephanie McKinney, Greater Flagstaff Economic Council

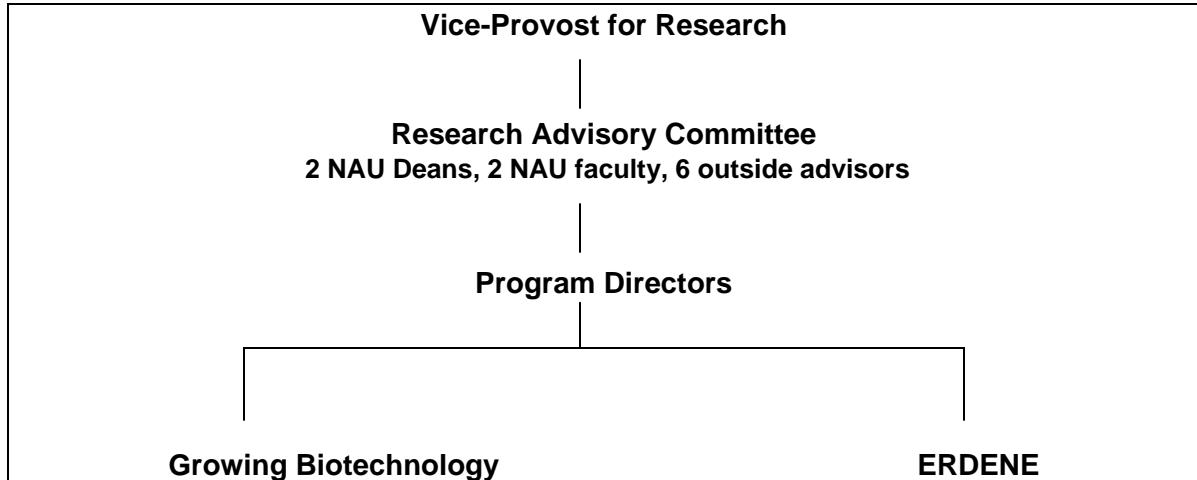


Figure 2

3.3.3 Support Services Required

Administration and support services for the program will be maintained as cost-effectively as possible. Adequate funds will be set aside for administration and support sufficient to meet program expectations, evaluation, financial management and reporting requirements. At a minimum, this includes support for the ERDENE program director, financial manager and clerical assistance. Managers of focus areas may also receive modest support to help meet evaluation and reporting requirements in their areas.

3.4 Risks and Plans to Overcome Them

3.4.1 Legal Risks

Environmental science and technology innovation operate in an inherently legal and regulatory system. ERDENE leadership not only recognizes this fact, but also necessarily participates in the political (and, as necessary, legal) processes that influence opportunities for creative design and development. Through active leadership in local, state, regional, national and international advisory bodies, we maintain contemporary perspectives on current and future legal influences on our research and development initiatives.

3.4.2 Regulatory Problems

The many disciplines within environmental science and technology operate in a highly regulated structure. This structure presents barriers, but also provides opportunities. ERDENE and its many partners are quite knowledgeable about this regulatory environment, and constantly seek to utilize it rather than to view it

as a problem. A very recent example is the important role of the Ecological Restoration Institute in identifying and stimulating business opportunities created by the high-profile need for new forest management and wildfire prevention practices.

3.4.3 Political Risks

Minimal, yet we are very mindful of the often-erroneous perception that environmental sustainability, wise resource management and economic growth are competing rather than complementary goals. The aim of the ERDENE program is to identify key areas in which environment, economy and social values can be integrated to benefit long-term sustainability.

3.4.4 Business Risks (supply and demand)

Areas of focus in the ERDENE business plan represent targeted areas in which NAU has a strong track record and, simultaneously, sectors in which Arizona business and industry are expected to grow in the near future. The Battelle Memorial Institute has emphasized the advantage for Arizona of developing research and technical expertise in arid ecosystems, water resources and management, renewable technologies, forestry and related industries. By combining strength of research areas with Arizona's needs for the future, the ERDENE program is reducing business risks.

3.4.5 Competitive Risks

The major competitive risks for ERDENE come from other Universities engaged in similar research and seeking similar funding opportunities. These risks can be reduced by the three Arizona universities carefully targeting areas of research and development that do not duplicate among them. ERDENE has sought to do this by focusing on NAU's distinctive strengths in the focal areas of the program. Competitive risks can be further reduced by teaming with federal agencies that seek many of the same goals (environment, economy, community) as ERDENE and have access to their own funding sources.

3.5 Sustainability

While we expect the general focus areas listed above to remain consistent over the five years, since they reflect NAU strengths and Arizona needs, we anticipate rather turnover of individual projects every two years. We will select projects that need dollars for start-up, but we expect them to either become self-sustaining or to cease operation within two years of their initial TRIF funding.

4. Deliverables

4.1 Types of Deliverables

4.1.1 Return on Investment

This category covers public and private dollars leveraged by invested funds. That is, total funding received to support ERDENE projects and programs compared to total dollars received from TRIF.

4.1.2 Technology Transfer

This category covers new products or processes developed with ERDENE support that lead to new patents, new products or processes in the marketplace, new businesses or new business expansions.

4.1.3 Companies Identifying the University as a Reason for Relocating

This includes new companies or branches of companies that identify NAU as a reason for starting up or moving to the greater Flagstaff area.

4.1.4 Workforce Contributions

This category includes undergraduates, graduates, and post-doctoral students who participate in ERDENE supported projects and programs as a significant part of their education and field experience prior to graduation, so that the particular environmental, social and economic dimensions of the program can be said to have played an important role in preparing them as citizens and professionals.

4.1.5 Specific Curriculum Innovations for Access and Workforce

This category includes new degrees, certificates, curricular programs, courses, workshops, trainings, and continuing education that advance the goals of ERDENE to integrate environmental, economic and social considerations into teaching and learning.

4.1.6 Specific Collaborations

Collaborations include formal or informal partnerships that are significant in terms of the time, effort, expertise and financial contributions from the parties involved. Partners may be federal, state, municipal, corporate, business, tribal, non-profit, community college, university or other.

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ERDENE Deliverables Projected 2007-2011	FY 2007	FY 2008	FY 2009	FY 2010	FY2011
	Projections	Projections	Projections	Projections	Projections
1. Return on Investment					
Leveraged Federal and State Funds	\$3,600,000	\$3,900,000	\$4,200,000	\$4,500,000	\$4,800,000
Leveraged Industrial Dollars	\$300,000	\$300,000	\$400,000	\$400,000	\$500,000
Leveraged Other Dollars	\$500,000	\$600,000	\$700,000	\$800,000	\$900,000
Qualitative returns including presentations & publications	140	150	160	170	180
2. Technology Transfer					
Patent applications generated/and or patents received	0	1	2	3	4
Spin-off Companies generated	0	0	1	2	3
Products generated that are in market-place	1	3	6	8	10
Sponsored conferences and workshops	3	5	10	15	20
Business expansions	0	1	2	3	4
3. Companies identifying the university as a reason for relocating		0	1	2	3
4. Work Force Contributions					
Graduate Students in pipeline or graduated	60	62	65	68	70
Post-doctoral Students in pipeline or graduated	6	6	6	6	6
Baccalaureates produced in related disciplines	40	42	45	48	50
Certificates granted	5	5	5	5	5
New k-12 teachers in science and mathematics	0	0	0	0	0
Undergraduate students in pipeline	50	55	60	65	70
Continuing Education Professionals	120	130	140	150	160
5. Specific Curriculum innovations for access and workforce					
New programs - Full time students	0	1	1	1	1
New courses - Full time students	0	2	3	3	3
Revised programs and courses	1	3	4	4	4
New programs - Practicing professionals	1	2	2	2	2
6. Specific Collaborations					
Community college	2	4	6	8	10
Tri-University	5	8	12	15	18
Industry/private sector - university	35	38	40	42	45
Community-based (including Tribal)	35	38	40	42	45
Regional, national, international	35	38	40	42	45

4.2 Timeline for Achievement of Goals

The quantified goals listed in the chart above are estimated numbers of deliverables of each type over the five-year period covered by this plan FY2007-2011. Generally the numbers of deliverables increases with time as each year builds on the work of previous years in a cumulative fashion.

4.3 Early Proof of Performance

4.3.1 Implementation Goals for First Three Years

The quantitative goals for deliverables for the first three years are reflected in the chart above. With four years of history, ERDENE is already well established on the NAU campus. The concept and strategy for the program are in place. Existing programs have a distinguished record of success in achieving outcomes. Mechanisms for campuswide RFP's, proposal review, awards, reporting and financial management have been implemented and refined. Virtually no start-up time will be required to begin implementing this plan for FY2007-2011.

4.3.2 Special Efforts to Produce Rapid Results

While we will not overlook longer term projects and programs that tend to be characteristic of educational institutions, we will give special consideration in the review process of those proposals that fit ERDENE goals and realistically promise results within one or two years. Awards will be for project start-up for one year with the possibility of a second year only with documented evidence of tangible results. Projects funded in open competition will be required to show sufficient results to leverage outside support in the first year and additional outside support in the second year to continue in thereafter without ERDENE support.

5. Pro Forma Financials

5.1 Cash Flow Statement

n/a

5.2 Income Statement

n/a

5.3 Funding Request

	FY 2002 Actual	FY 2003 Actual	FY 2004 Actual	FY 2005 Actual	FY 2006 Actual	FY 2007 Budget	FY 2008 Budget	FY 2009 Budget	FY 2010 Budget	FY 2011 Budget	TOTAL
Carry Forward	\$ 0	\$ 175,540	\$ 224,067	\$ 254,812	\$ 476,956	\$ 667,386	\$ -	\$ -	\$ -	\$ -	
New TRIF Revenue	1,450,500	1,551,412	1,681,405	1,977,600	2,080,472	1,872,092	1,872,092	1,872,092	1,872,092	1,872,092	\$18,097,857
TOTAL REVENUE	<u>1,450,500</u>	<u>1,726,952</u>	<u>1,905,472</u>	<u>2,234,412</u>	<u>2,557,428</u>	<u>2,539,478</u>	<u>1,872,092</u>	<u>1,872,092</u>	<u>1,872,092</u>	<u>1,872,092</u>	
Personal Services	\$ 1,062,225	\$ 1,260,419	\$ 1,426,244	\$ 1,639,348	\$ 1,425,695	\$ 2,387,108	\$ 1,759,766	\$ 1,759,766	\$ 1,759,766	\$ 1,759,766	\$16,259,811
Operating	212,735	242,466	224,416	259,376	464,347	152,370	112,326	112,326	112,326	112,326	\$1,880,046
TOTAL EXPENDITURES	\$1,274,960	\$1,502,885	\$1,650,660	\$1,898,724	\$1,890,042	\$2,539,478	\$1,872,092	\$1,872,092	\$1,872,092	\$1,872,092	\$18,431,555
ROI	5.1:1	3.4:1	3.0:1	7.2:1	2.8:1	1.7:1	2.6:1	2.8:1	3.0:1	3.3:1	

* Note: ERE includes tuition remission for graduate assistants working on ERDENE projects

6. Benefits for Arizona

6.1 Environmental

The ERDENE initiative at NAU will stimulate new forms of education with a hands-on environmental focus that integrates economic and social factors into environmental education. Students will participate in innovative research and field experiences. There will be an emphasis on immediate environmental problems and their economic and social consequences, including such timely issues as drought, bark beetle infestation or forest fire management. ERDENE-supported research will produce new knowledge and insights about ecosystems, landscapes, and water resources on the Colorado Plateau that will assist land managers, water managers, farmers and ranchers in their efforts to sustain healthy vegetation, wildlife and water supplies while enhancing tourism and food and livestock production in the region. New methods of monitoring environmental impacts and sophisticated information systems for accessing data will have the combined goals of improving environmental and institutional management while reducing financial costs for managing ecosystems and built systems. Creative new techniques of using microorganisms to mitigate environmental damage promise to improve environmental health and contribute significantly to economic viability. Arizona can be at the cutting edge of reducing fossil fuel dependency by developing renewable energy resources including solar, wind, geothermal and biomass. ERDENE promises to capitalize on this opportunity through new research, technology and business opportunities that will benefit the environment while growing renewable energy businesses and industry.

6.2 Economic

A workforce better trained to integrate environmental, economic and community needs and to respond with innovative, comprehensive and realistic solutions represents a vital step-forward for Arizona higher education and workforce development. New products in the marketplace with environmental significance and economic potential will hold promise for future benefits, as will growth in collaborations between university faculty and businesses. Leveraging millions of dollars of outside funding beyond that contributed by TRIF will contribute to the economy of Northern Arizona with important increases in jobs, salaries and secondary local spending. Perhaps most importantly, the ERDENE program will spearhead thinking about the interrelations of environment, economy and the community. While much ground remains to be covered in recognizing economic services provided by a healthy environment and incorporating environmental considerations as an integral part of growing the economy, ERDENE has made significant steps in the right direction and will continue to do so.

ERDENE Business Plan

By prioritizing focus areas that fall within the Sustainable Systems platform of the Battelle Report, ERDENE seeks to extend core scientific and engineering competencies at NAU--especially environmental science, agro-ecology, environmental engineering and research informatics-- into applied technologies that will enhance the State's economy and quality of life. The Sustainable Systems platform includes commercial sectors in which, according to the Battelle Institute, Arizona could take the lead. These include focus areas identified in the ERDENE program: water resources, sustainable systems, sustainable forestry, renewable energy, environmental monitoring and management, and bio-products (including microbes designed for environmental mitigation). By advancing applied research and technology transfer in these focal areas, ERDENE is pursuing one of the central recommendations for Arizona, namely to harness the core competencies of the State's universities and apply them to benefit both the environment and the economy.

6.3 Social

In the next five years, ERDENE will continue to address needs facing rural communities in northern Arizona and, indirectly, in other parts of the state. In particular, ERDENE-supported programs in solar and wind energy, water resources, forest ecology and management, environmental mitigation, and systems management, and local food production and distribution will have valuable benefits for rural Arizona communities. Advancing community solar and wind energy production on reservations has enormous potential for tribal communities for distributed energy with economic benefits and without the negative environmental impacts of coal-fired energy plants currently dominating tribal energy enterprises. The participation of a wide-cross section of community members in activities such as forest surveys will build social capital for launching community businesses focused on forest products such as small diameter logs for construction, bio-power or value-added wood products. Finally, the development of environmentally sound and cost-effective methods of food production among rural farmers and ranchers and the formation of direct markets in rural communities for local food and fiber products represents a spectrum of benefits for the land, economy and communities that epitomizes the integrative character of the ERDENE program and the broad applicability of its results to Arizona's land and people.