



# **TECHNOLOGY AND RESEARCH INITIATIVE FUND (TRIF)**

**Five-Year Project Plan**

**July 1, 2016 through June 30, 2021**


**Submitted by:  
Kimberly Andrews Espy,  
Senior Vice President for Research**

## TECHNOLOGY AND RESEARCH INITIATIVE FUND (TRIF)

### ***1.1 Executive Summary***


At the University of Arizona (UA), our plan for TRIF investments for the last five year period reflects the foundation of why universities do research and development (R&D): to attract outside resources to our state, expand economic opportunities for Arizonans and benefit the well-being of our citizens.

This past year, UA researchers were responsible for more than \$606M in R&D activity – ranking in the top 20 among our public university peers. Particularly deep R&D strengths in the physical sciences are reflected in our # 3 ranking – among the 634 universities surveyed by the National Science Foundation (Id economic opportunities for Arizonans and A)



The University is promoting and accelerating the translation of research results into new products and services that benefit the health, security, and prosperity of Arizona. In the last 5-year TRIF planning period, commercialization of research results was a strong focus – with substantial investments in technology transfer activities through Tech Launch Arizona (TLA). This focus borne substantial fruit – from the beginning of the last five year period through FY15, 314 inventions were disclosed, 61 patents issued, 77 licenses or options executed, and 12 start-up companies were established from UA R&D. The present plan includes a continued focus on commercialization - and with our new participation in National Security Systems TRIF initiative and with the maturity of TLA – even greater results are anticipated.

Finally, R&D activity supports the bottom line




UA's TRIF plan includes activities under four initiatives: **National Security Systems (new), Space Exploration & Optical Sciences, Water/Environment/Energy Solutions, and Improving Health**. Fundamental to our approach to TRIF investments is the University's *Never Settle* strategic plan, which explicates our tactics to achieve our research ambitions: promoting our core strengths to address the grand challenges, boundlessly collaborating with others to increase local-to-global impact and improving our institutional infrastructure to help speed discovery, knowledge and application.

The thrust areas for each TRIF initiative








FY 2014, UA was ranked third in research activity in the physical sciences (\$124 million in expenditures) by the National Science Foundation. UA faculty led ALL institutions in research activity in Astronomy for each and every year in the past decade. UA's planetary science and missions are second to none. The TRIF plan focuses on applying these strengths to new challenges – such as image or sample returns from Mars, instrumentation for a lander on Europa or habitable planet discovery and exploration. TRIF investments in the SEOS initiative have a strong track record of delivering on the identified performance metrics.

SEOS programmatic areas for investment align with UA strengths and areas of Arizona and national need. The SEOS initiative at the UA focuses on four main thrust areas: **Space Exploration, Optics/Photonics; Imaging and Enabling Technologies, Informatics.**

The University expects to realize a substantial return on TRIF investment in SEOS through a combination of increased sponsored R&D awards in FY17 of \$60M annually, commercialization of valuable intellectual property from research activities, and training the next generation of leaders in this area. The planned tactics to realize this return are new strategic faculty hires, investment in catalytic projects that seed large scale collaboration and industry partnering aligned with national need, substantial funding in asset development to speed commercialization to the marketplace, as well as education, outreach and training activities to augment and enhance our high tech workforce.


- x **Water, Environmental and Energy Solutions (WEES)** TRIF initiative seeks to develop novel, economically viable solutions to Arizona's water, environmental, and energy resources challenges with far reaching societal benefits. The UA engages in R&D activities and cross sector partnerships that brings innovative ideas, technologies and resource management practices to address pressing



environmental, energy, and water challenges and to deliver tangible benefits to Arizona, the nation, and world.

The thrust areas identified in the WEES initiative plan are focused directly on areas of current and potential funding, partnerships with business and non-governmental entities, and high-priority workforce needs. The WEES initiative at the UA focuses






supporting R&D activities that improve the lives and health of our citizens, while creating high quality and high paying jobs within the state while engaging students in science to prepare them for high tech careers in the biosciences and beyond. The Arizona Commerce Authority (ACA) identifies biotech as a major target industry for growth.

The UA is the only academic enterprise in the state that links a research university with an affiliated level one trauma/world class teaching hospital, a comprehensive health sciences center, two colleges of Medicine (Tucson and Phoenix), and a collaborative bioresearch institute (BIO5 Institute) that spans R&D areas from agriculture to the Zika virus. With the newly cemented partnership with Banner Health and its commitments to the clinical research enterprise, the planned TRIF IH will accelerate the incorporation of research results into the health marketplace to benefit Arizona and enhance our quality of life.

The UA *Never Settle* plan calls for the following strategies to grow and support our bioscience economy: enhance translational research, grow the entrepreneurial climate, build critical mass of com



IH investments will bring significant public and private external R&D funding to the UA and Arizona by tactics such as recruiting world-class faculty in cutting-edge research areas, and by building interdisciplinary collaboration through funding of catalytic projects among researchers across campus and in partnership with Arizona businesses, and training the next generation of biotech leaders and high tech workers.

The University expects to realize a substa







## **1.6 University Administration of TRIF**

The Office for Research & Discovery, under the leadership of the Senior Vice President for Research, is responsible for the overall strategic planning and execution of this TRIF plan and resource deployment. ORD has identified and selected key leaders to guide the implementation within each initiative, who will work to encourage novel ideas and robust participation that enable the TRIF goals, as well as to intersect with university processes to ensure seamless operations. ORD regularly convenes R&D leadership to maintain focus on goals and provide avenues for problem-solving, and oversees the robust annual reporting process that enables any mid-course adjustments as warranted.


## **INITIATIVES**

### **2. NATIONAL SECURITY SYSTEMS (NSS)**

This 5-year period is the first time that the (UA) has participated in the National Security Systems (NSS) TRIF Initiative. With the new establishment of the Defense & Security Research Institute at the UA, and the recent completion of the strategic hiring of the Director, Austin Yamada from Virginia Tech after a long career at the Pentagon and in large defense contractor industry, UA participation in this initiative is timely. Director Yamada has initiated the staffing of the institute, and has developed the strategic thrust







research. UA is ranked #3 by the NSF in research expenditures in the physical sciences, and have substantial competencies to bring to bear to national defense and security problems. Secondly, by identifying complex challenges in national security and defense that align with UA research strengths, collaborative, inter-disciplinary research teams will provide creative solutions that will positively impact the national security and defense interests of the nation and the State of Arizona. TRIF investment in NSS will pave the way for new, mutually beneficial partnerships between the UA, industry, academia and the federal/state/local/tribal governments by leveraging the University's excellence in the disciplines that play major roles in national security initiatives. Among these strengths are optical sciences, space/astronomy, engineering, materials, computing/informatics energy, medical and biomedical technologies, environmental research, cyber, autonomy, social sciences, and border security/intelligence. These new NSS TRIF investments will promote extensible growth in the Arizona economy in several ways, initially primarily by increasing R&D, which will contribute to the expansion of our existing "Optics Valley" in southern Arizona to address the broader national defense and security needs.

NSS promotes an interdisciplinary approach with newly combined strengths to catalyze compelling initiatives in areas of emerging interest for the Department of Defense (DoD), Department of Homeland Security (DHS), the Intelligence Community (IC), and other relevant federal agencies. In addition, NSS initiative connects with deans, department heads, faculty and administration to identify, develop and implement strategic R&D initiatives and associated infrastructure. In addition, NSS investment will provide opportunities to educate and train the national defense workforce of the future through synergistic partnering with agencies, industry and the university's departments. The overarching NSS goal is to provide national security and defense related expertise to help guide and focus UA strengths to develop/leverage/expand collaborations and partnerships that will help build UA's reputation as a "trusted agent" in the national defense and security community.

### **2.1.2 Discussion of mission, goals, values and vision**

The mission of the new NSS TRIF initiative is to bring new external resources to Arizona, improve the economy of the state of Arizona through an integration of academic and technical leadership, and provide public impact to help solve complex problems in the national defense and security space by:

- x Leveraging TRIF funds to increase external federal and private-sector R&D funding to scale capacity;
- x Identifying and supporting key faculty hires in strategic NSS areas of need and/or opportunity across the UA campus to augment capability
- x Creating new shared infrastructure and facilities that broadly benefit NSS research, the education mission of the University, and enable solutions to industry challenges;
- x Supporting workforce development directly through student research teaming experiences with partnership among defense agencies, the University, and industry; and
- x Setting the stage for innovation and commercialization activities of technology transfer, by spawning new invention disclosures, that will support licensing and the creation of new start-up companies in the future.


NSS values collaboration and innovation, and envisions a prosperous, secure Arizona.

Because UA is participating in the NSS TRIF Initiative for the first time, and thus there is no historical track record for this area. Furthermore, this first 5-year period is focused largely on establishing the personnel and infrastructure to enable success in procuring new R&D awards from DoD and related industry sponsors. However, with the establishment of UA's Defense and Security Research Institute and the supportive defense and security culture in Arizona, we anticipate increasing the total R&D expenditures from DoD by 50% over this initial period.

### **2.1.3 Description of programmatic areas for investment**

The UA's strategic plan, *Never Settle*, has four pillars: engagement, innovation, partnerships and synergy; and TRIF investment programs address each of these pillars. In *Never Settle*, Innovation charges us to advance research to find better answers to the world's grand challenges to deliver public impact and benefit by:

- x Promoting and building upon core strengths to address grand challenges for the state of Arizona and the world;
- x Collaborating boundlessly to increase local-to-global impact;
- x Engaging new strategic partners in the research enterprise to accelerate innovation;
- x Improving institutional infrastructure




large part of the technology base in defense and security, and NSS TRIF investment strategy, the opportunity for substantive return on investment is high. Although this first 5-year period is one off focused “start-up”, the result of NSS investment is expected to increase our base of DoD-related funding by 50% over the period, demonstrated by a direct increase in federal grants, new external funding in collaboration industry partners, participation cooperative agreements, and award of task orders through the federal

This thrust area reflects the intersection of two of UA's extant core strengths called out in the university's strategic plan, *Never Settle*: informatics and space systems. The facilities, technologies, and educational programs related to the understanding of how objects behave in space position UA to provide access to existing capabilities (e.g., telescopes, instruments, and data), develop new data streams (e.g., new instruments or types of observing programs for existing telescopes, perhaps even new telescopes), provide analyzed data products (e.g., develop new techniques for data analysis produced with existing facilities, including targeting the analysis to solve specific problems or answer specific questions), and provide an integrated academic and operational environment in which to train and educate the next generation of talented post-graduate researchers, analysts, and operators who will sustain government and civilian initiatives and interests.

TRIF NSS investment in space dynamics will help integrate multi-disciplinary research to focus on near-Earth space object identification, classification, tracking, and prediction and to identify national security applications, which will enable realizing substantial new R&D funding sources. Finally, with the increasing commercialization of space, new opportunities to partner with large corporations (e.g., Raytheon Missile Systems), as well as smaller local Arizona entities (e.g. Rincon Research Corporation, Paragon Space) will be developed to address this need.


### **2.1.3.2 *Materials Design & Development***

**The Challenge:** The process of designing, manufacturing, and developing materials with desired properties for integration into advanced technologies must keep pace with demand from government and industry. Current practices typically involve a ten year investment from industry to qualify new materials reliably into target platforms due to the required human work force and infrastructure required to process, test, and validate materials properties through computational simulations. Therefore, an approach to designing materials with proven characteristics is needed that combines experimental processing and rapid manufacturing of materials with computational simulations of the processing and observed properties in order to accelerate materials innovation into the marketplace and incorporation into defense assets. Federal agencies and industry



partners are focused on supporting materials research that includes both computational simulation and experimental testing to rapidly design materials with proven characteristics. There is a national interest in meeting this demand with projects that could include sensors and networking, and computational and materials experts that have access to using state-of-the-art facilities and instrumentation required to manufacture






National Security Agency recently said that cyberattacks are causing “the greatest transfer of wealth in history.” McAfee, a security-software company, estimates that the global cost of cybercrime exceeds \$1 trillion.

**UA Advantage:** UA is uniquely poised to provide innovative solutions to NSS challenges







Biosciences is identified as one of the core research strengths in UA's strategic plan, *Never Settle*. In the TRIF NSS initiative, UA will deploy its cyber infrastructure to enable rapid recognition of clinically significant biological events--whether they are due to disease outbreaks, contaminations or poisonings due to either natural causes or terrorism--and that have significance to the health and security of residents, leading to more effective decision making in health and emergency response at the federal, state and local level. UA will leverage big data approaches for a web-based system of near real-time data collection, and automated assessment and analysis to detect relevant disease conditions and symptoms in order to meet the bio-surveillance needs of key local and regional stakeholders, while providing awareness and transparency of events to state and national decision makers to improve clinical outcomes. The longer term goal is to also provide information on critical healthcare infrastructure and relevant interventional needs and care resources. Leveraging the cyberinfrastructure at UA power034eveil.335 09TD-.0006 To


is expected in this initial startup period in the amount of new federal R&D funding for these focus defense and security areas flowing into Arizona. These funds will support not only UA, but also the broader Arizona industry and our partner Arizona universities.

Because the NSS initiative is new for the University, there is no historical data of past success upon which to precisely base expected return. However, the opportunity for reasonable return on investment is high because of the vibrant defense and security community in the state and our reasonable base of expertise in this area. Although this first 5-year period is focused largely on establishing the personnel and infrastructure to enable success in procuring new R&D awards from DoD and related industry sponsors, the establishment of UA's Defense and Security Research Institute and the supportive defense and security culture in Arizona support the anticipation of increasing the total R&D expenditures from DoD by 50% over this initial period.

New faculty hires and expansion in fields that are aligned with national funding will increase prospects for large return via grants, cooperative agreements, competitive procurements, and other transaction authorities. Potential new R&D funding sources that will be pursued as a part of NSS investments examples include:

- x AFRL Center of Excellence for Astrodynamics;
- x Department of the Navy Center of Excellence for High Energy Lasers;
- x Cooperative Agreement with Air Force Research Laboratory;
- x Cooperative Agreement with Army Research Laboratory;
- x Cooperative Agreement with Air Force Office of Scientific Research;
- x DAPRA, IARPA, ONR, and other competitive solicitations;
- x Access to Other Transaction Authorities;
- x Competitive procurements as a prime or sub; including potential classified research

Our equipment investments are also designed to create long-term return on investment through ongoing master research agreements, strategic educational partnership agreements. Targets for such relationships include industry partners with local roots, such as Rincon Research Corporation, Honeywell, and Raytheon Missile Systems, and large national companies like Lockheed Martin Corporation, Ball Aerospace, as well as government organizations like the Navy Res



order to move that technology to the marketplace. Asset Development investments make technologies more attractive to industry partners and further private investment. For select technologies, creating a new venture (startup) is the best commercialization path, resulting in new jobs and economic benefit to the region. For others, it is licensing technology to existing companies. The initial focus of TLA's NSS engagement will be fostering invention disclosures – the fundamental first step in the process. In preliminary work, identification of faculty, capabilities, and resources will enable DSRI to assemble appropriate teams. TLA will make available commercialization assessment and planning in support of key research proposals for this initiative. By the end of this





## ***2.2.2 Annual metrics table of expected outcomes and timeline for achievement***

## **2.3 Initiative Structure**

### ***2.3.1 Organizational structure***

NSS is administered by Austin Yamada, Director, UA Defense & Security Research Institute, coordinated through the Office for Research & Discovery. The director collaborates with deans, department heads and other University leadership to assure maximal impact in implementing NSS programs.

### **2.3.2 Advisory Board**

The DSRI has two advisory boards. An External Advisory Board (EAB) consists of engaged and influential industry and community leaders. The EAB provides high level guidance and advice on strategy and investment, and helps communicate and connect UA national security systems activities to the greater Arizona Aerospace and Defense communities. A Faculty Advisory Board (FAB) consists of UA faculty with interests aligned with the NSS mission and is engaged in shaping and implementing the strategic research areas of investment.

### **2.3.3 Infrastructure**

NSS leverages the infrastructure of the Office for Research & Discovery, the DSRI, and the other relevant supporting organizations on campus. Staff are primarily located in the Marshall Building, adjacent to the support services that deliver research development, strategic business support, communications and marketing, and philanthropic development. Equipment and core facilities supported by NSS funds are located in UA buildings most advantageous for usage.

### **2.3.4 Description of programmatic investments**

At UA, TRIF NSS investment is designed to promote the economic development of the state by catalyzing innovative R&D in target areas of high impact aligned with Arizona businesses; engaging industry in support of R&D to accelerate the commercialization of research results into new products and services that benefit the health, security, and prosperity of Arizona; developing the future high-tech workforce – training students from elementary to graduate school to be science and innovation leaders who will create Arizona's bright future; and providing infrastructure through research services, computing, equipment and facilities that enables innovation and research.

TRIF NSS investments will accelerate capacity through strategic faculty hires in focused areas identified in the University's *Never Settle* strategic plan and further fleshed out in the ORD Strategic Research Roadmapping sessions held in 2015 with hundreds of



researchers across campus. Investments will be made in new transdisciplinary research initiatives to enhance competitive success for securing extramural funding and engage industry in R&D partnerships that accelerate the commercialization of research results and incorporation in defense and security technologies. TRIF will support the training and engagement of students while developing a high-tech workforce and will provide infrastructure that enables innovation and research through facilities and instrumentation.

**2.3.4.1 Catalyzing innovative research**

**2.3.4.1.1 Strategic faculty hiring**

TRIF investment will support high-impact hires in several research areas with national security systems application. Plans are developed with relevant deans and department heads, Provost, and Senior Vice President for Research to identify *catalyzing* faculty, who will supply critically needed vision and have the leadership and experience to lead and grow externally-funded programs in these priority areas. The table below describes targeted hires in each strategic area.

<b>Potential TRIF hires in National Security Systems</b>	
<b>Theme</b>	<b>Expertise</b>
Space Dynamics	Multidimensional data system integration
Materials Design & Development	Material Sciences; Computational dynamics
Cybersecurity	Data mining, machine learning
Imaging & Sensor Technology	Autonomous systems; Sensor development; digital signal processing
Biopreparedness & Disease Surveillance	Algorithm Processing Bioinformatics of disease transmission and prediction/forecasting; Decision support tool development



#### **2.3.4.1 *Developing the High Tech Workforce & Outreach***

TRIF support will ensure cutting edge R&D in NSS and will facilitate UA relationships with local, state and national partners such as the U.S. Government and commercial industry. In addition, the R&D being performed by teams of UA researchers and students at all levels will be directly supported by government and industry customers that to support the need for a stronger, long-term robust workforce. Outreach efforts are aimed at engaging industry and federal defense and security related agencies. Professionals in NSS related research in particular have branded UA as a trusted source for optics, astronomy, deep space mission management, and related research, planning, and engagement.

#### **2.3.4.2 *Infrastructure & Instrumentation***

A significant investment will be made into core facilities and instrumentation that will enable cutting-edge R&D in NSS areas. While user fees can defray a portion of the operating costs, initial equipment investment is supported by the University and the NSS TRIF initiative, generally with significant industry contribution through negotiated discounts. The newly established Strategic Educational Partnership with the Air Force Research Laboratory also facilitates the loan and/or donation of surplus government equipment to the UA. This equipment is available to all investigators at UA, other Arizona universities, and will be aggressively promoted as a resource to industry. Major areas of



by Research Development Services (RDS), as well as two “business development” divisions, Strategic Business Initiatives (SBI) and the upcoming division to be initiated in FY17, Global Research Alliances. RDS provide full-service extramural funding assistance to UA researchers, from opportunity identification, proposal plan development and team building, to proposal management and reviews. SBI connects needs of the business community to the expertise of UA researchers, which results not only in additional industry support for research and development activities occurring at UA, but also more importantly forges partnerships that enable strong UA-industry teams to compete for significant federal contracts. Global Research Alliances performs a similar function, but focuses on developing strong UA, university, industry partnerships internationally.

Finally, a significant effort is being made in philanthropy. The Office for Research and Discovery, in concert with the UA Foundation, has just hired a Senior Director of Development to support transdisciplinary research. Given significant public interest in privacy and security, it is expected that philanthropy will cover a portion of interdisciplinary activities, albeit substantially smaller in magnitude compared to other TRIF initiatives.

### **2.5.2 Timeline for transitioning away from TRIF support**

NSS TRIF investments are used for catalyzing new research and discovery in the national defense and security technology areas. The plan

### 3. SPACE EXPLORATION AND OPTICAL SOLUTIONS

#### 3.1 Investment description/rationale/justification


##### 3.1.1 Brief overview of industry or area being addressed by the initiative to include benefit to Arizona

The Space Exploration and Optical Solutions (SEOS) Initiative program will leverage TRIF funds for continued strong return on investment by attracting external federal and private sector R&D investments, developing intellectual capital, and generating tomorrow's workforce to advance Arizona's high-tech economy. While Optics/Photonics is explicitly captured as a key industry sector by the Arizona Commerce Authority (ACA), UA's strong international reputation, talent base, and linkages in space exploration, advanced optics, photonics, and imaging technologies support growth in literally every industry sector identified by ACA<sup>1</sup> as key to Arizona. There were 191 companies who identify themselves as optics and photonics related industries in Arizona in 2014, an increase of 27% over the past decade, with an average wage of over \$61,000. This sector accounts for more than 25,000 employees, and is responsible for \$2.3B in revenue, over \$45M per firm. The majority (68%) are located in Pima County, and 46% have been in operation for more than 10 years.

In 2013 the National Research Council of the National Academies issued a report entitled, "Optics and Photonics: Essential Technologies for Our Nation," articulating both the enormous impact and future potential of optics and photonics for the US economy, quality of life, and national security<sup>2</sup>. The report specifically calls for stronger coordination and federal investment in areas that are strongly correlated with UA's faculty-driven strategic planning focus topics of Space Systems, Imaging, Defense and Security, Informatics,

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Water/Energy/Arid Environment, and Translational Biosciences. Associated with the needs and opportunities captured in the NRC report, the SEOS team is also witnessing a provocative uptick in the engagement with “non-traditional” technology partners, ranging from corporations such as Uber to the very largest IT companies who are aggressively developing optical solutions in their interfaces between advanced information systems, humans, and the external world. Data in the report explicitly documents how optics and photonics underpin the products and services of a disproportionate share of the most productive companies in the US. Specifically, the NRC report identified 285 publically-traded companies with substantial optics dependencies, and while this amounted to only 1.7% of public US companies, these companies jointly employed 7.4 million individuals and had \$3.1 trillion revenue, which is 6% of the aggregate employment and 10% of the aggregate revenue of all public employer firms in the US.

This highlights a rich landscape and opportunity for SEOS to leverage its strong scientific and technological national and international leadership roles in partnership with private sector partners to transition technology into compelling economic development and commercial impact for Arizona, thereby advancing a significant component of UA’s strategic plan, *Never Settle*, in which “Optics” is identified as a core research strength.

The 2007 AASTA report<sup>3</sup> noted that the total annual economic impact of research in astronomy, planetary sciences and space sciences in Arizona had already reached \$252.8 million, with capital investments exceeding \$1B and a total employment in these research areas in Arizona exceeding 3,300 jobs. SEOS also promises strengthened

Defense & Security Research Institute for collaboration on National Security Systems TRIF initiative to jointly support this sector.

SEOS also affords tremendous opportunities to advance UA's strategic plan, *Never Settle*, through its continued investment in core research strengths in space systems, including scientific mission in astronomy, astrophysics, and space exploration. In FY 2014, UA had more than \$124 million in expenditures in what the National Science Foundation classifies as "Astronomy" (including all of the activities of UA's Lunar and Planetary Laboratory, Department of Planetary Sciences, Steward Observatory, and the Department of Astronomy, as well as related activities in other units) in the NSF Higher Education Research and Development Survey.

The UA's single largest federally-funded project is OSIRIS-REx, a NASA-funded asteroid sample return mission for which \$800M is managed by the UA. This mission is the second NASA interplanetary effort managed by UA, following the Phoenix Mars Lander. In addition, several multi-million dollar instruments on spacecraft have been built at UA, most recently the OSIRIS-REx Camera Suite (OCAMS, a part of OSIRIS-REx), a project involving several UA departments, and tapping into UA's expertise in optics, engineering and planetary science.

UA is also home for the operations centers for the High-Resolution Imaging Science Experiment (HiRISE) at Mars. The UA operates or helps operate more than 20 astronomical telescopes around the world, including observatories in Arizona, Hawaii, Chile, and in space.

Steward Observatory's Richard F. Caris Mirror Lab (RFCML) is a unique national asset, producing the world's largest and most precise mirrors for telescopes, including the current largest facility in the world, the Large Binocular Telescope on Mount Graham, Arizona. Currently the RFCML is fabricating the 8.4m diameter mirrors that will be used in the Giant Magellan Telescope (GMT effective primary mirror aperture of 25m in diameter), under contracts that will total in value over \$150 million. When completed, the GMT will be used by UA researchers to continue our exploration of the Universe, from planets around nearby stars to the most distant galaxies.






*Never Settle*, “Innovation” charges us to advance research to find better answers to the world’s grand challenges that deliver public impact and benefit by:

- x Promoting and building upon core strengths to address grand challenges for the state of Arizona and the world
- x Collaborating boundlessly to increase local-to-global impact
- x Engaging new strategic partners in the research enterprise to accelerate innovation
- x Improving institutional infrastructure to speed new discovery, knowledge, and application
- x Strategically attracting, educating, and engaging first-rate doctoral and other advanced degree seeking students in a variety of disciplines to grow the high tech workforce ;
- x Improving recognition and support for collaborative and interdisciplinary research and scholarship; and
- x Expanding economic development in our region through commercialization of research ideas

These strategies guided the TRIF investments in the SEOS programmatic areas, which were carefully chosen to align with areas of Arizona and national need. The selected thrust areas in the SEOS initiative are focused on generating impact for Arizona, for which UA faculty already have significant expertise, and which have the capacity to grow external federal and industry funding, expand economic opportunity, as a result of the support by this initiative.

### **3.1.3.1 Space Exploration**

**The Challenge:** Leveraging advanced optics as a critical tool to expand our understanding of the universe. Examples range from the obvious impact of powerful advanced telescope technologies to the less obvious ultra-sensitive laser interferometers in LIGO capable of measuring displacements less than one-thousandth the diameter of a proton, which very recently enabled the world’s first detection of gravity waves.



Key opportunities here include exoplanet research and the search for life on other planets within our galaxy, including the theory and modeling of exoplanet formation, geological evolution, and atmospheric science. There are also continuing needs driving aggressive technology for studies of cosmic origins, as well as unmanned mission instrumentation roles to destinations such as Europa and Mars, and sample returns from Near-Earth Asteroids and other Solar System targets. New space related companies in Tucson, such as World View/Paragon Space Ventures, drive home this opportunity ahead. Additionally, funding for observatory operations and instrumentation renewal and innovation is essential to the continued successes of UA faculty using the facilities of Steward Observatory in achieving UA's national leadership in research achievements and associated leading volume in astronomy research expenditures.

**UA Advantage:** UA is uniquely well-positioned in this thrust area, a core research strength area identified in *Never Settle*, UA's strategic plan, stemming both from its unparalleled infrastructure for large optics fabrication and metrology, and its home-grown talent driving world-leading sensor development, adaptive optics, instrumentation packages (imagers, spectrometers, coronagraphs) for the world's most powerful ground and space-based telescopes. Additional strengths include the theory and modeling of exoplanet formation, geological evolution, atmospheric science, stellar interiors and evolution, galaxy formation, cosmology, and opportunities for enhanced and coordinated campus-wide nm-scale materials analytics to support stronger future UA roles in sample-return missions. These capabilities uniquely fun47 missions. TheseOSf1ead.




approaches are required to maximize the efficacy of any imaging system design under a constraint (i.e., size, power, cost, or weight, etc.) for astronomical, biomedical, machine vision, or national security applications. There also are strong opportunities in computation and compressive imaging across a broad spectrum of applications and markets.

**The UA Advantage:** UA's is uniquely positioned to drive a holistic system-engineering approach to imaging system design. In addition to leverage long-standing strength in optical design, hardware, and fabrication, there is an outstanding opportunity to leverage foundational strength in the discipline of image science. Here the ultimate information content and decision process is central to an integrated approach encompassing imaging system acquisition adaptation, hardware design, and software algorithm design, all with a firm mathematical foundation.

Finally, UA's established faculty strength and infrastructure in fabrication technologies for specialized imaging hardware solutions are key to advancing SEOS objectives. In cooperation with corporate partners, these will enable harnessing innovations in imaging design and fabrication based on free-form optics, micro-optics in endoscopy, polarization optics, nonlinear optical microscopy, photonic integrated circuits, and recent exploration of magneto-optics for brain activity imaging. Imaging is a broad strength identified in UA's strategic plan, *Never Settle*.

#### **3.1.3.4 Informatics**

**The Challenge:** SEOS research areas are often critically linked to UA's faculty strength and infrastructure for computation and informatics, i.e., "big data". This facet becomes critically important in the context of the imaging objectives noted above, as managing through "big data" is increasingly an integral part of the imaging system objectives, constraints, and system engineering optimization. Other examples include the Large Synoptic Survey Telescope project, as well as aggressive planetary modeling and cosmic origins studies. In areas linking optics into defense systems, optical observation assets will need to interface into enormous, dynamic space situational awareness databases in a seamless way.



**The UA Advantage:** UA is well positioned to leverage and further expand its faculty strength and experience in big data problems, including the iPlant Collaborative and now CyVerse initiatives to address these challenges in a multidisciplinary environment. UA's deep and broad expertise in Informatics is recognized as a core research strength identified in *Never Settle*, which through SEOS investment can be realized.


## **3.2 Expected Outcomes as a result of TRIF investments**

### ***3.2.1 Specific and realistic outcomes that are clearly measurable***

#### ***3.2.1.1 Return on investment***

SEOS programmatic areas for investment align with UA strengths and areas of Arizona and national need. These areas have the capacity to grow in impact, economic opportunity, and external funding. We expect strong return on investment due to this alignment to result in substantive growth in new federal grant funds into Arizona. These funds will support not only UA, but also Arizona industry and our partner Arizona universities.





path, resulting in new jobs and economic benefit to the region.

### **3.2.1.3 Industry engagement (outreach, partnerships, collaboration)**

UA has demonstrated success in how the many industry partnerships are a key element



### ***3.2.1.6 Government/Agency/Community Engagement (outreach, partnerships, collaboration)***

Partnerships and collaborations in this case represent collaborations in the form of financial or measurable strategic support. Key measures are the number of master agreements, number of industrial affiliate memberships, and government and industry funded research awards.

### ***3.2.2 Annual metrics table of expected outcomes and timeline for achievement***

## **3.3 Initiative Structure**

### ***3.3.1 Organizational structure***

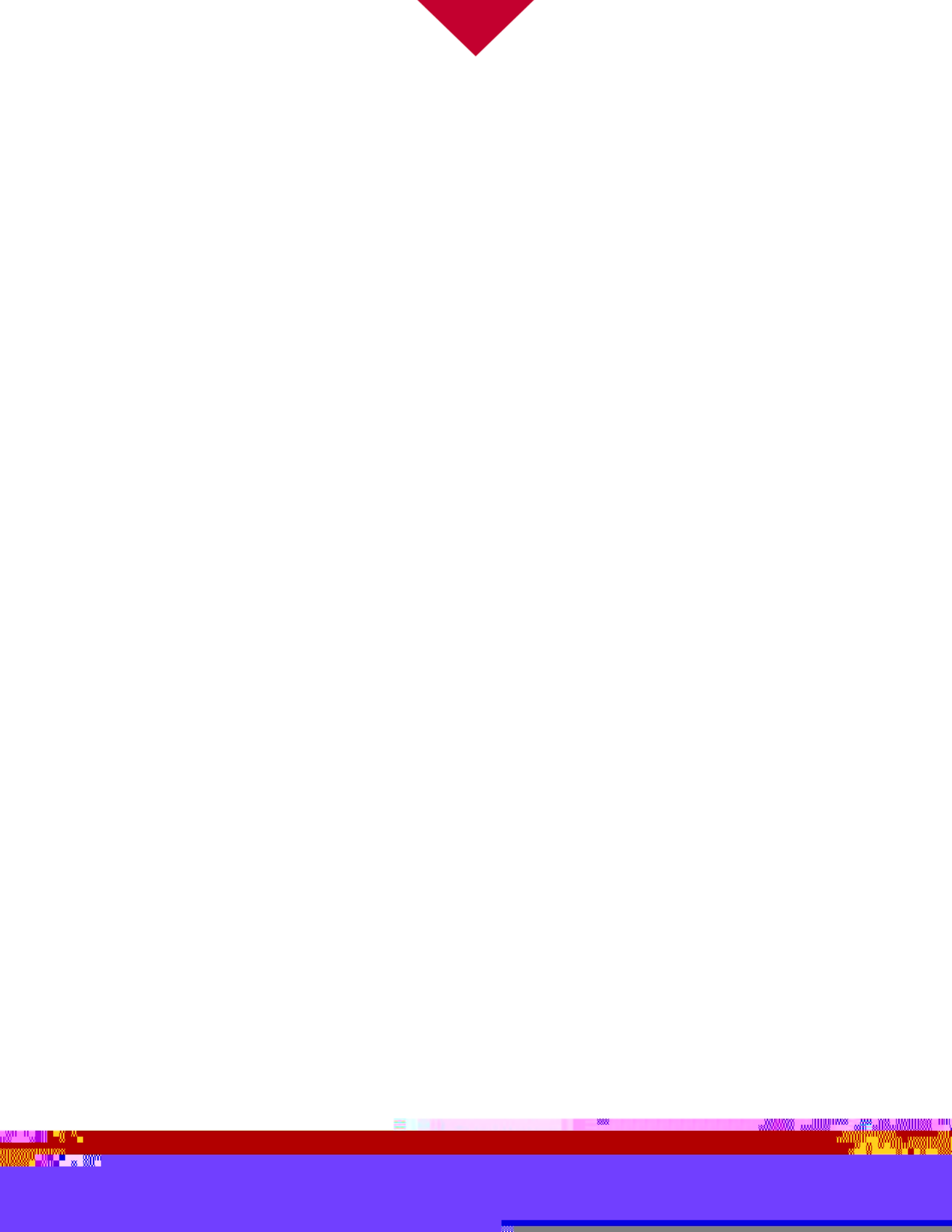
The SEOS TRIF initiative is administered by the relevant deans (co-chairs indicated below), coordinated through the Office for Research & Discovery. SOES organizations

structure is comprised of two committees; the SEOS Administrative Committee and the SEOS Research Sub-Committee. These committees will include balanced representation from participating SEOS units to provide the necessary broad expertise.

### ***3.3.2 Advisory Board***

**TRIF SEOS Administrative Committee:** The SEOS Administrative Committee is responsible for approval and initiation of SEOS faculty searches, establishing the SEOS overall budget structure in conformance with ORD guidelines, and the high-level assurance that the goals of the SEOS initiative are being met.

- **Co-Chairs:** Thomas Koch, Dean, College of Optical Sciences; Professor of Optical Sciences and Electrical and Computer Engineering; Joaquin Ruiz, Vice President, Innovation and Strategy; Executive Dean, Colleges of Letters Arts and Science; Dean, College of Science; Professor of Geosciences; Jeff Goldberg, Dean College of Engineering
- Buell Jannuzi, Director, Steward Obse





Optics/Photonics	Fiber device & subsystem technology; Semiconductor optoelectronics and photonic integrated circuits; Photonic integrated circuit packaging; Infrared technologies
Imaging and Enabling Technologies, Informatics.	Image science; Big data & algorithms; Optical design, fabrication & metrology; Remote sensing; Biomedical optics

### 3.3.4.1.2 Transdisciplinary Research Initiatives

Virtually all of the SEOS investment thrust areas are inherently transdisciplinary in nature by combining engineering, fabrication, and design of complex space or optical systems, or system engineering of image science, with base scientific or technological applications disciplines in Astronomy, Space Sciences, Life Sciences, and areas such as Communications, Information Technology, National Security, and Defense Systems.

Several areas identified are likely to benefit from a broader, coordinated cross-campus infrastructure that would also position UA for future major external funding sources such as NSF Engineering Research Centers (ERCs) or Science and Technology Centers (STCs). Examples might include an Imaging Technology Center, targeting the concept captured earlier for a holistic approach to the system engineering of imaging systems. Another example where a coordinated transdisciplinary center is likely to be productive is the area of augmented reality, where strong private-sector interests seek to blend advances in base technologies with a deeper understanding of human perceptual factors and potential long-term usage impact. Existing transdisciplinary initiatives that link into

3.3.4.2 Engaging Industry & Advancing the Commercialization of Research






NNMI.

Strong industry partnerships are a key aspect of the strategic goals of UA's Never Settle strategic plan. SEOS anticipates generating new pathways to corporate-sponsored efforts, as well as corporate partnerships to secure new federal funding. Technology developed through TRIF will gain more support from our industry and government partners, and new faculty hires supported by TRIF will yield many new grants/contracts, technology, intellectual property, and trained talent to help grow Arizona industry.

Other sources of support include sales and service through core facilities. A “win-win” with industry is achieved when equipment and services, not otherwise accessible for industry, are provided from the UA for an attractive price, which in turn supports the maintenance and growth of these facilities.

The Office for Research & Discovery enables these sustainability efforts through support by Research Development Services (RDS), as well as two “business development” divisions, Strategic Business Initiatives (SBI) and the upcoming Global Research Alliances. RDS provide full-service extramural funding assistance to UA researchers, from opportunity identification, proposal plan development and team building, to proposal management and reviews. SBI connects needs of the business community to the expertise of UA researchers, which results not only in additional manoposal plan






development of strong federal agency and private sector partnerships that leverage TRIF investments into external funding streams for sustainability, as well as commercializing research into the marketplace.

## **4. Water, Environmental, and Energy Solutions**

### **4.1 Investment description/rationale/justification**

#### ***4.1.1 Overview of Industry or Area Addressed by the WEES Initiative***

Human well-being, economic prosperity, and security, all depend on environmental resources of water, energy, food, land, air, and biodiversity. The economic prosperity and health of the state of Arizona are particularly dependent on judicious management of its natural resources, including the efficient use



Integration of water, energy and environmental research is key. For example, energy-efficient water reuse and purification is important for municipal, agricultural, mining and energy production sectors, particularly with the unprecedented drought in the Colorado Basin. The intersection between water and energy is particularly relevant for some Native nations in Arizona that do not have connected water infrastructure on reservation communities and rely on energy to provide desalinated local water sources for residents.

WEES outcomes are consistent with Arizona's goals as articulated by the Arizona Commerce Authority (ACA): to create jobs and increase investment by attracting, growing, and creating businesses. Among target industries for investment identified in ACA's business plan are renewable energy, technology and innovation, and advanced manufacturing sectors. With more than 100 significant solar energy businesses in Arizona and ranked #3 nationwide in solar employment, breakthrough advanced energy solutions will drive substantial economic development to power our future. With significant funding available from the Department of Energy through ARPA-E and other mechanisms, the opportunities to support the Arizona economy are large.

WEES funds also help advance research, tech development, and industry collaboration for improving and testing water treatment technologies critical to advanced manufacturing and for consumptive water uses in innovative technologies. Investments in multidisciplinary transformational research focused on real-world challenges and solutions will help position Arizona as a leader in sustainable growth policies and the incubator of locally oriented and globally relevant water, environmental, and energy solutions. The research proposals seeded by WEES investments will bring millions of dollars of public and private funding to the UA, and deliver innovative ideas, assessments, information, and technologies that benefit Arizona as well as the nation and world. Innovative businesses that are created and grown based on outcomes from UA WEES researchers will be a core contributor to Arizona's technology sector and overall economic future.

#### **4.1.2 Mission, Goals, Values and Vision**


The mission of UA's WEES initiative is to develop the innovative and practical solutions necessary for water, environmental, and energy sustainability in Arizona and other semi-arid regions facing increasing demands on natural resources and the uncertainties of climate variability.

Goals include:

- x Enhance UA's strengths, external funding, and diversity in the areas of water, energy, and environment by promoting interdisciplinary collaboration for science and technology development efforts that lead to innovative, practical solutions;
- x Draw on UA's vast water expertise and community connections to develop new technologies and management approaches to ensure Arizona's water security;
- x Capitalize on Arizona's strong renewable energy industry to develop R&D derived solutions aimed at securing sustainable energy resources for public well-being and a vibrant economy;
- x Leverage the TRIF investment in strategic areas to increase public- and private-sector partnerships and funding;
- x Seed projects that help train the next generation of scientists and engineers, and that have strong potential for technology transfer and commercial development of research ideas into the marketplace.


WEES has a strong track record of delivering on specific TRIF performance metrics towards the vision. Historically, over the last three years of the TRIF WEES initiative, every TRIF dollar invested resulted in nearly a 9x return on investment. In the last four years, 82 invention disclosures were transacted, five new companies started and 9 new patents issued. We expect continued strong return on investment, due to this alignment, to result in substantive growth in new federal grant funds into Arizona. These funds will support not only UA, but also Arizona industry and our partner Arizona universities.





manufacturing sectors. As an arid state and water security is a top concern to citizens, governments, producers and industry. Achieving water security means ensured access






social sciences, engineering, health, and economics/business. Identified as a core research strength in UA's strategic plan, *Never Settle*, the UA is a national leader in basic climate dynamics research, including paleoclimate, Earth-system modeling, and regional-scale climate and hydroclimate modeling, with special expertise regarding the desert southwest. UA researchers are also nationally and internationally recognized for our expertise in interdisciplinary climate science, including the integration of climate with water, carbon cycles, ecosystem, public health, energy, economics and policy, at global and regional scales, in addition for leadership in climate-change adaptation and climate and drought information for management and economic decisions. The University has world-class experimental and data facilities and our faculty have secured millions of dollars in external R&D funding, along with associated jobs and infrastructure for the state. Our focus on Arizona needs for outreach, education, and training assists our local communities, small businesses, and tribes to undertake crucial adaptation planning to secure long-term economic growth and job creation in Arizona through the commercialization of research ideas.

#### ***4.1.3.3 Ecosystems, Conservation, and the Earth's biological systems***

**The Challenge:** Understanding the dynamics of the Earth's biological system is one of the great integrating challenges of the modern era and has direct implications for human habitability on our planet. Our future climate, health, landscapes, and food security are closely connected to the condition and behavior of millions of other species ranging from bacteria, fungi, and algae to plants and animals – small and large. The earth's ecology has changed substantially in the last century, thereby changing distributions and abundance of plants and animals, and impacting how we manage agriculture, wildlife, and environments for production and conservation. Key processes such as the breakdown of wastes, the spread of disease, and the production of food and timber are closely connected to biological communities at the microbial, local, and regional scales. The vast majority of molecular-scale processes are mediated in some way by microbial communities, which collectively can be thought of as “Earth's microbiome” – an area identified as a top federal research priority with the goal of linking molecular-scale





biological, chemical, and physical processes to natural and anthropogenic activities occurring at watershed, ecosystem, and larger scales.

**UA Advantage:** The UA has great strength across the biological sciences, earth sciences, ecology, and natural resources management that already bring millions of






of innovative research in modeling, informatics, and remote sensing supported by high performance computing. For example, new streams of data on land use, genomics, atmospheric conditions, and human resource use need to be integrated so as to understand the connections between environment, health, and food production or the trade-offs between energy production, agriculture, and water supplies. More broadly, we need to understand how to manage the earth system to meet human needs without degrading water, land, or ecosystems beyond safe boundaries. Equally important is the challenge of effectively communicating these integrated challenges and solutions to the public, businesses, and to decision makers who can use the information to develop solutions and make wise choices in management practices.

UA Advantage : The UA has an unparalleled reputation for interdisciplinary research and high end information technology - a core strength, informatics, from UA's Never Settle strategic plan. It is especially well known for its interdisciplinary approaches to water, climate, and environment; for bringing together natural, applied, and social sciences; and for conducting work that is collaborative with stakeholders to develop integrated solutions. In environment and water the UA has developed important datasets and facilities for integrated research, including archives of detailed historical and spatial environmental data for our region and more broadly. The University also have the great advantage of being able to link top researchers in natural and social sciences to professional schools of engineering, business, public health, law, and medicine so as to ensure the delivery of relevant and economically sound solutions and to a land grant tradition of delivering agricultural and other resource knowledge and technologies to the state and society. Our reputation for looking beyond the earth to other planets is matched by our ability to understand and solve the problems of our own. Federal funding agencies as well as philanthropic organizations are keenly aware of the need for integrative research in nexus areas. Likewise, local governments, state agencies, industries, and businesses need user-centered research and data systems that can be utilized within the context of their operational areas. Integrated research and data systems are critical elements in most academic-industrial partnering efforts, helping new businesses establish and contributing





dollar grants for Science and Technology Centers, Long Term Ecological Research sites, National Institutes for Environmental Health Sciences collaborations, earth systems satellite projects and information/data centers, and large international development programs.

- x Federal, state, and local resource management agencies fund and use research on environment, water, and energy and to manage and guide critical forest, mineral, water, and recreational resources on public and private lands. UA can sustain its rich tradition of serving these stakeholders with reliable information on resources and with a well-trained workforce.
  
- x The defense and security agencies and businesses are increasingly concerned

- x Increased demand for high-quality education in science is supported by the knowledge, training, and outreach activities from kindergarten through adult provided by the UA. This benefits the state and can attract funding from government, private philanthropists, and the public to build a more successful workforce.

#### 4.2.1.2 Technology Transfer

Tech Launch Arizona (TLA) continues to actively engage with the WEES initiative and faculty. TLA's cooperation with the WEES initiative will be extended beyond the initiative's funding of asset demonstrations to include broader cooperation from the beginning of the research process and extending through to commercialization. TLA closely coordinates in the identification of faculty whose research and inventions may be the basis for expanded WEES commercialization opportunities.

Arizona is ranked as the No. 1 state for alternative energy and a top ten state for solar energy, with over 8% of the nation's solar industry employment. Additionally, UA is ranked 2<sup>nd</sup> in the world for environmental research and has been building on its strengths through the Water, Environmental and Energy Solutions (WEES) Initiative to translate research far reaching societal benefits in Arizona and the world.

TLA tracks five key metrics for outcomes: invention disclosures; provisional patents filed and awarded; total licenses; startups; and asset development. Growth of invention disclosures illustrate the success of TLA's outreach efforts to faculty and staff. Approximately 60% of such invention disclosures result in a provisional patent application being filed. A license is the transfer of the University's rights in a particular invention to a third party in order to move that technology to the marketplace. Asset Development investments make technologies more attractive to industry partners and further private investment. For select technologies, creating a new venture (startup) is the best commercialization path, resulting in new jobs and economic benefit to the region.





#### **4.2.1.6 Government/Agency/Community Engagement**

WEES programs actively engage governments, agencies, and communities throughout Arizona and beyond. A strength of many WEES programs is their ability to simultaneously engage broadly and educate. Engagement requires faculty and staff involvement in maintaining contact lists, keeping interactions current, regular communications, and development of effective engagement mechanisms. WEES programs are trusted sources for information, analysis, and data, particularly regarding water, climate, energy, and environmental information. Expected outcomes include responding to data requests by local and regional governments and utilities in addition to outcomes listed under educational outreach.

#### **4.2.2 Annual Metrics Table (See attached metrics table)**

### **4.3 WEES Initiative Structure**

### ***4.3.1 WEES Organizational Structure***

WEES is administered by co-directors Dr. Sharon Megdal, director of the Water



<b>Potential TRIF hires in Water, Environmental, and Energy Solutions</b>	
<b>Theme</b>	<b>Expertise</b>
Water Security in Arid Environments	Water security/groundwater/surface water; water quality/reuse - desalination
Climate & the Earth System	Regional climate modeling; carbon cycle analysis
Ecosystems	Biodiversity links to health or food; Earth microbiome
Environmental Health/contaminants	Environmental health risks or policy
Advanced Energy Solutions	Energy forecasting

**4.3.4.1.2 Transdisciplinary Research Initiatives**

WEES will provide support to new initiatives in WEES thrust areas through internal competitive grants focused on growing new interdisciplinary collaborations at large scale to realize strong continued growth in R&D, as well as to existing initiatives within the programmatic investment areas that have demonstrated early success and show strong promise for large future return on investment in order to fu81.mo/e& 3& 3& 3& 3& 3& 3&

air and water quality. Eleven industry members are collaborating with water treatment investigators to advance high-tech water treatment and reuse research. WEES investments are designed to augment and expand industry funded R&D to advance partnerships and return on investment.

#### 4.3.4.1.4 Developing High-tech Workforce and Outreach

WEES support of student training provides experience in fields such as water-quality technology, water science writing, informatics/imaging program implementation, and climate modeling. Using the exciting new TRIF supported mechanism to further link industry (non-profits included), researchers and students, WEES supports bringing together a team of undergraduate researchers, a graduate student team leader, and interdisciplinary university-industry R&D mentorship to conduct jointly funded R&D. These innovative teaming models help prepare our students for collaborative work environment in industry, satisfy increasing workforce needs and make Arizona a more attractive location for founding and growing companies in the SEOS area.

WEES also supports the award-winning Arizona Project WET which promotes water stewardship and K-12 STEM literacy through teacher professional development, student outreach, and community engagement. Outreach efforts are aimed at engaging industry, governments, and professionals in WEES research, and in particular have branded UA as a trusted source for water, drought, and climate information, research, planning, and engagement. Newsletters, web communications, seminars, conferences, and publications help showcase UA WEES TRIF investments to the broad stakeholder base throughout the state.

#### 4.3.4.1.5 Infrastructure and Instrumentation

WEES funds instrumentation and infrastructure to enable innovative research and technology development at UA. This has been a very successful part of the WEES program to date and we propose to commit significant resources to shared and core equipment, high capacity comput

## 4.4 WEES Budget

## 4.5 Plan for Sustainability

### *4.5.1 Anticipated funding sources for ongoing support*

WEES activities will continue to be operationalized by the ORD, topical interdisciplinary centers and institutes such as the Institute of Environment, the Water Resources Research Center, and Arizona Institute for Advanced Energy4 ta[ETcifrdis6h Center1Taz



## 5 IMPROVING HEALTH


### 5.1 Investment description/rationale/justification

#### 5.1.1 *Brief overview of industry or area being addressed by the initiative to include benefit to Arizona*

Arizona's TRIF investment in the UA Improving Health (IH) initiative is funding research to improve the lives and health of our citizens, while creating high quality jobs within the state, and engaging students in science to prepare them for the high tech jobs of tomorrow.

The Arizona Commerce Authority identifies biotech as a major target industry. Arizona clinical services provide care to over 6.5M persons, with Banner Health the largest private employer with 19 hospitals across the state. In 2015, the bioscience sector increased by 320,000 jobs, with an average annual





sciences center, two colleges of Medicine (Tucson and Phoenix), and a collaborative  
bioresearch institute











The promise of these technologies is to advance population health on a grand scale – one of the key areas identified in UA’s strategic plan, *Never Settle*. With partners in Medicine, Eller College of Management, Tech Launch Arizona and Public Health, UA will turn and connect sensor responses into recommended actions to optimize health and performance, and will deploy new sensor systems

discoveries of the role of microbes in human health and disease. Finally, cross disciplinary scholars are collaborating to understand transmission of Zika, how variation in the mosquitos in Arizona may inform strategies to stop transmission, and keep Arizona free of this disease. Together, this effort fits right in with the translational bioscience priority area identified in UA's strategic plan, *Never Settle*.

#### **5.1.3.5 Bio-informatics and Data Driven Discovery**

**The Challenge:** Big data is everywhere – and the biosciences are no exception. Bioinformatics combines computer science, statistics, mathematics, and engineering to analyze and interpret biological data, and integration across levels of analysis (genome to phenome). Bioinformatics is an especially integral part of understanding omics, and the need for strong bioinformatics undergirds the other IH research emphasis areas such as imaging, wearable technology, and ecosystem genomics. Big data approaches reveal patterns in data, including human clinical health information, that are not evident through experimental analysis alone, and enable the connection across levels of analysis not possible at experimental scale.

**UA Advantage:** Several recent investments by UA leave this field poised for explosive growth – why this area was identified as a core research strength in UA's strategic plan, *Never Settle*. The new NSF-sponsored CyVerse consortium (an outgrowth of iPlant) and our new university-wide translational bioinformatics institute brings strengths in extracting actionable knowledge from large data sets that span multiple levels of analysis. The partnership with Banner Health means that enormous amounts of de-identified health records data are available for researchers to seek novel associations that drive subsequent experimental and drug discovery work. New cross disciplinary teams are exploring using these approaches in predicting asthma events in advance to enable health care services to rapidly adjust to environmentally induced outbreaks. Bioinformatics is synergistic with growth in omics, as clearly the former enables the practical application of the latter. IH will further build the bioinformatics infrastructure to enable the highest quality and most rigorous collaborative bioresearch.

### 5.1.3.6 *Bio-imaging & Enabling Technologies*

**The Challenge:** Imaging has revolutionized our understanding of biology from the molecular to the human scale, elucidating both structure and function. The limits of our understanding of the basis of disease are largely a function of the limits of our observational imaging tools. Through application of rigorous theory, ever-advancing source and detector technology, and improved methods of sample preparation or accommodation of *in vivo* subjects, bio-imaging is enabling fundamental new discoveries in areas such as brain connectivity and function, as well as empowering patient-specific clinical treatment strategies.

**UA Advantage:** UA has tremendous strengths in image and optical science, imaging technology development, imaging methods, and clinical translation, seated in our world-class College of Optical Sciences, Biomedical Engineering, and Medical Imaging, as well as in our active applications community in Science and Health Sciences. IH seeks to leverage UA recognized research strengths in optical sciences/imaging described in its strategic plan, *Never Settle*, to further enhance bioimaging's reach through technology development, enabling new scientific discoveries, and improving clinical outcomes. The faculty that support biomedical imaging have established strong extramurally funded pre-clinical and clinical research programs that have fostered multi-disciplinary collaborations within the University (e.g., the College of Optical Sciences, Biomedical Engineering, Electrical and Computer Engineering, Psychology, Physiological Sciences, Speech and Hearing Sciences, Applied Mathematics, Cancer Biology, Chemistry) as well as with other universities, industry and the military. It serves as the hub and intellectual center for expanding collaborations and cultivating tremendous opportunities for growth and expansion in the increasingly important areas of molecular imaging, multi-modality imaging, and clinical translation. The research also plays a critical role in advancing the fields of cancer, cardiovascular, neurological, musculoskeletal, cross-sectional and non-invasive biomarker imaging technology, with the ultimate goal of translating basic science innovations and developments into clinical applications that impact patient care. This research is guided by the vision of integrating physical science and technology

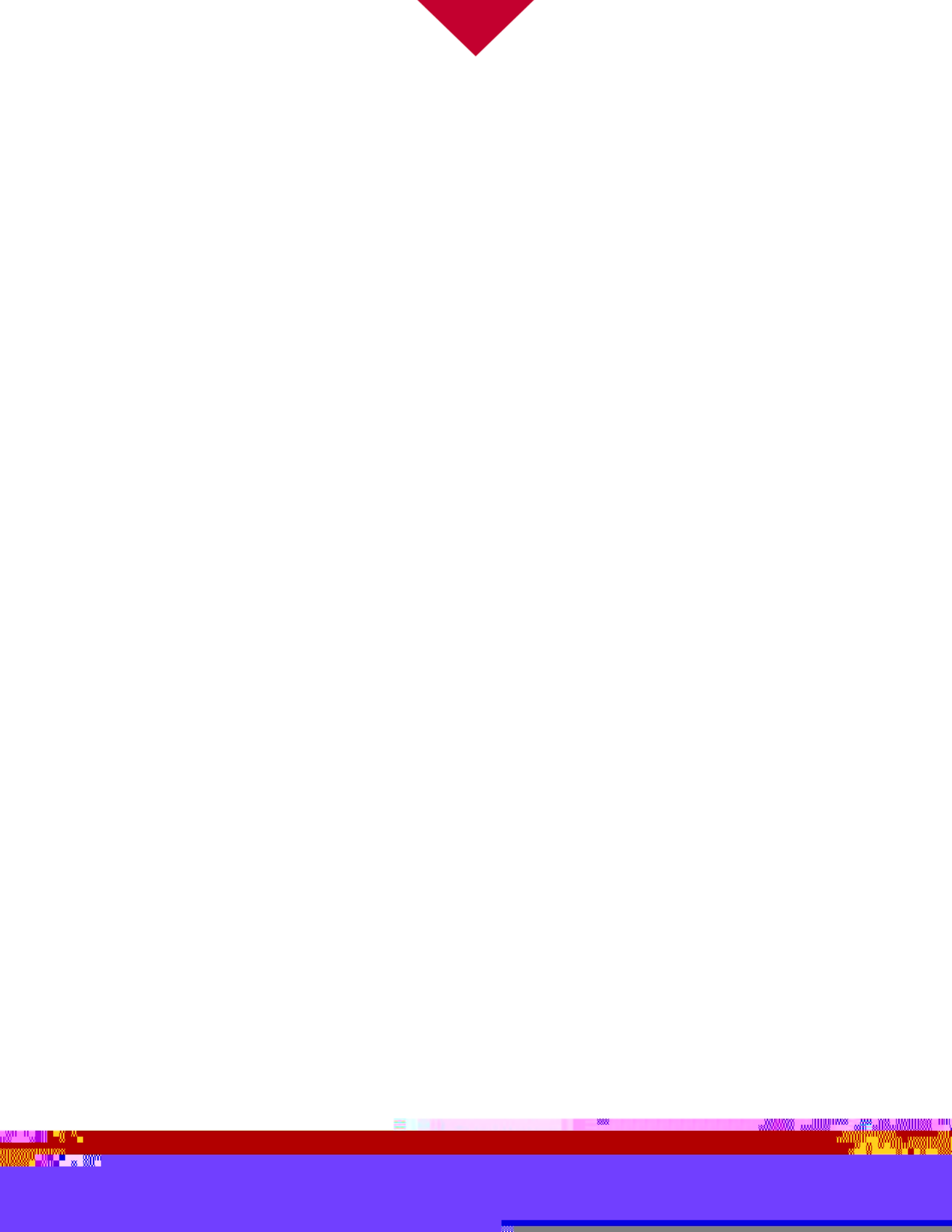




### **5.2.1.2 Technology transfer**

The faculty members associated with IH are highly innovative, and together with Tech Launch Arizona (TLA), IH will assure that their inventions are disclosed and translated into medicines, methods, devices, and diagnostics that better the lives of Arizonans. While TLA prioritizes licensing technologies to companies within Arizona, the breadth and research UA technology extends beyond Arizona. Technologies related to IH make up more than 50 percent of all inventions disclosed at the UA. IH identifies promising faculty and new discoveries for attention by TLA, e.g. recipients of seed funds and attendees at workshops. Asset development funding for Proof-of-concept and to enhance market readiness are made into promising disclosed technology to create additional value, and researchers who desire to start new businesses are supported in development activities.

TLA tracks five key metrics for outcomes: invention disclosures; provisional patents filed and awarded; total licenses; startups; and asset development. Growth of invention disclosures illustrate the success of TLA's outreach efforts to faculty and staff. Approximately 60% of such invention disclosures result in a provisional patent application being filed. A license is the transfer of the University's rights in a particular invention to a third party in order to move that technology to the marketplace. Asset Development investments make technologies more attractive to industr





## **5.2.2 Annual metrics table of expected outcomes and timeline for achievement**

### **5.3 Initiative Structure**

#### **5.3.1 Organizational structure**

The BIO5 Institute will administer the IH TRIF initiative for the UA, with coordination under the Office for Research & Discovery. BIO5 is led by a director who reports to the Senior Vice President for Research at the UA, and the director collaborates closely with Deans and the Senior Vice President for Health Sciences, as well as department heads, to assure maximal impact in implementing IH programs.

#### **5.3.2 Advisory Board**

IH has three advisory boards. An external business advisory board (BAB) is populated with engaged and influential industry leaders. The BAB meets regularly to review progress, advise on strategy, and help communicate and connect what happens at UA to

the greater Arizona bioscience and biotech communities. A Deans' Board includes the deans of the colleges of Agriculture and Life Sciences, Engineering, Medicine, Pharmacy, and Science to assure that the programs of Improving Health are maximizing impact and synergizing with college-level activities, particularly with respect to strategic hiring, a major emphasis of this TRIF funding period. Finally, a Faculty Advisory Board is engaged in shaping and implementing the strategic research areas of investment and connections to faculty on the ground.

### **5.3.3 Infrastructure**

IH leverages the infrastructure of the Office for Research & Discovery, the BIO5 Institute, and the UA Health Sciences to effectively deliver IH TRIF impact. Staff are primarily located in the T.W. Keating Biosciences Building. Equipment and core facilities supported by IH funds are located in the building most advantageous for usage; currently the majority are housed within the Keating building. The under-construction Biosciences Research Laboratory (BSRL) building will accommodate the increasing growth in IH investigators and activities. This building will house a state-of-the-art imaging resource in the basement with equipment, staffing, and support structures for *in vivo* imaging from small and large animals to clinical research.

### **5.3.4 Description of investment mechanisms**

At the UA, TRIF promotes the economic development of the state by: catalyzing innovative research in target areas of high impact aligned with Arizona businesses; engaging industry and accelerating the commercialization of research results into new products and services that benefit the health, security, and prosperity of Arizona; developing the future high-tech workforce – training students from elementary to graduate school to be science and innovation leaders who will create Arizona's bright future; and providing infrastructure through research services, computing, equipment and facilities that enables innovation and research.

TRIF investments will accelerate capacity through strategic faculty hires in focused areas identified in the University's *Never Settle* strategic plan, and further fleshed out in the



ORD Strategic Research Roadmapping sessions held in 2015 with hundreds of researchers across campus. Investments will be made in new transdisciplinary research initiatives to enhance competitive success for securing extramural funding and engage industry and accelerate the commercialization of research results. TRIF will support the training and engagement of students while developing a high-tech workforce and will provide infrastructure that enables innovation and research through facilities and instrumentation.

### ***5.3.4.1 Catalyzing innovative research***

#### ***5.3.4.1.1 Strategic faculty hiring***


IH will support high-impact hires in the programmatic areas for investment, with the goal to attract new external funding from the federal agencies, industry and foundations to Arizona. Specific hiring plans are developed





enhance application opportuniti





faculty hires supported by TRIF will yield many new grants/contracts, technology, intellectual property, and trained talent to help grow Arizona industry.

A significant effort is being made in philanthropy. The Office for Research & Discovery, in concert with the UA Foundation, has recently hired a Senior Director of Development, and is actively seeking a Director of Development for Interdisciplinary Bioscience Programs. Given significant public interest in bioscience and health areas, it is expected that philanthropy will cover an increasing proportion of interdisciplinary activities. An endowment for the KEYS program has been established, and a major push will be made for that flagship program to be

